Localizing a Global Network: Urban Internet Infrastructure

Christopher Sarli

A thesis presented for the degree of
Bachelor of Arts with Honors

BROWN

Urban Studies Program
Brown University
Providence, Rhode Island
April 22, 2022

Localizing a Global Network: Urban Internet Infrastructure

Christopher Sarli

This thesis by **Christopher Sarli** is accepted in its present form by the faculty of the Urban Studies Program of Brown University as satisfying the thesis requirement for the degree of Bachelor of Arts with Honors.

Date 4/23/2022 John Logan
Advisor Name (printed)

DocuSigned by: John Logan
7FCA84FBF212496...
Advisor Signature

Date 4/27/2022 Marion Orr
2nd Reader Name (printed)

DocuSigned by: Marion Orr
E3FED9AD035144B...
2nd Reader Signature

Date 4/22/2022

DocuSigned by: Kenneth Wong
6CF600216A3E48B...
Kenneth Wong, Interim Director
Urban Studies Program

Abstract

The Internet is increasingly important to urban life, but Internet service in American cities is overpriced and slower than it should be. Even though it is technically possible to allocate high quality connections to all those who want one, significant populations are stuck with very poor connections or lack a connection altogether, an inequity that reinforces gaps in access to healthcare, education, and employment. This thesis examines the extent of this urban digital divide and explores the policies and (lack of) regulation that have allowed it to worsen. It also covers efforts to overcome these issues and the challenges opponents of the status quo face. In that vein, this thesis stresses not just the importance of providing connections, but also considers the implications of *how* those connections are provided, with an eye towards the role of local political power in infrastructure and grassroots participation.

Acknowledgements

A tremendous number of people provided me help, both big and small, in writing this thesis. At Brown, Professors John Logan and Kurt Teichert each served as primary advisors for this project and were extraordinarily good sounding boards throughout the research and writing processes. Professor Marion Orr served as a secondary reader and advisor for this work, for which I am immensely appreciative. Professor Sandy Zipp was very helpful in the very early stages of ideation and topic selection. Professor Deborah Hurley, over the course of several conversations, was able to give me much helpful context surrounding broadband infrastructure policy. Most of all, Professor Lauren Yapp and my thesis cohort peers—Elana Hausknecht, Zoe Pottinger, Thomas Wilson, and Hanna Wells—provided both sincere moral support and actionable feedback on drafts I produced. My parents, Michael and Teresa Sarli, served as proofreaders and sounding boards throughout the thesis process.

This document was typeset using LaTeX. The serif body font used throughout is Matthew Carter's Charter. The sans serif font used for headings is Fira Sans, designed for Mozilla by Erik Spiekermann and Ralph Carrois. Zotero was used to store and manage research sources, and to generate bibliographic information.

Contents

Chapter 1

Introduction

"Annihilating time and space," it has been said, "is what most new technologies aspire to do: technology regards the very terms of our bodily existence as burdensome."[1] Technological change in cities, viewed through this lens, can be seen both in positive and negative lights. Cities themselves, by concentrating and organizing large populations, annihilate the time and space between social and economic interactions that drive human society. Simultaneously, such density creates new burdens: pollution, disease, and the crushing nature of visible inequality. The focus of this thesis is one specific technology, the Internet, in the context of American cities.

The Internet is perhaps the most complete realization of the annihilation of time and space. At a global scale, the Internet can transmit vastly more information from one side of the globe to the other at a vastly lower cost than any other technology, and it can do it in periods of time measured not in months, weeks, or hours, but in factions of seconds. On a micro-scale, the Internet's ability to annihilate the time and space of daily activities dwarfs the densest cities or fastest cars. The role of the Internet in American culture and business has so expanded that many refer to a *cyberspace* to emphasize that the widespread use of the Internet has created an extension of life with a geography not constrained by physical distance. But, while cyberspace may represent a near total annihilation of time and space, *exclusion* from this virtual space is its own burden.

In the United States, exclusion is not absolute or even particularly intentional—it is a matter of haves and have-nots. *Having* a strong, reliable, and ubiquitous connection to the Internet allows one to exist in cyberspace, and by extension participate fully in modern life by seeking education, employment, community, and entertainment. *Not having* such a connection means not only sacrificing conveniences, it means accepting relative burdens as the world moves on. Such a phenomenon is not unique to the Internet: humans lived for millions of years without mastery of electricity, but once electrical technology became available, those who failed to adopt it found themselves quickly at a severe disadvantage. Disparity between the haves and have nots has been building for decades but was sharply highlighted in 2020 as the COVID-19 Pandemic forced more of the activities of society into cyberspace. Such exclusion is also not entirely unique to American cities, but the density and diversity of American cities prompt several unique considerations. While these dynamics include many challenges to decreasing inequities in Internet connectivity, they also provide avenues for solution that are uniquely urban.

This thesis begins in Chapter 2 with a discussion of the architecture and current nature of the Internet itself. The Internet has no formal charter and intentionally lacks formal governance. It has been declared a fundamental human right[2] and feared as the implement of beyond-Orwellian surveillance.[3] The network is held in place by a tapestry of technical decisions, historical precedent, and a mutual (dis)trust that lacks peers in human history. These abstract mechanics of the network must be understood on a basic level to fully appreciate the technical challenges of universal connectivity and the potential solutions I cover later in the thesis. In contrast to this abstract discussion of the possible, I then turn to a brief description of *de facto* Internet infrastructure—how a severe lack of competition in an oligopolistic telecommunications industry is largely responsible for urban inequities, and why past efforts to diagnose and alleviate this digital divide has failed. Given that these topics are by their nature somewhat dry and technical, I further try to highlight the human impact of the status quo by illustrating the weight of disconnection during the pandemic with relevant anecdotes.

Chapter 3 examines the possibility of a Federal intervention to alleviate the digital divide of urban internet connectivity. Given that many of the inequities that will be identified in Chapter 2 are perpetuated by massive interstate (or multinational) corporations that are too large for any individual City to effectively control or regulate, it can be easily argued that a suite of top-down Federal regulations to limit the harms of near-monopoly power is warranted, if not necessary. While such an approach may be worth pursuing, prevailing political and regulatory winds make such an exercise of power unlikely; current Federal efforts to close the digital divide exclude cities and further entrench the status quo.

Building on this, Chapter 4 argues that in the absence of strong centralized leadership on this issue, cities (both municipal/regional governments and community groups) can and should attempt to break the status quo by themselves. While they may lack the authority to effectively regulate the telecommunications industry, the decentralized nature of the Internet discussed early in Chapter 2 creates openings for these smaller entities to compete directly with the incumbent providers by building out their own networks. While there is no silver bullet, the technical flexibility of the Internet allows for these *smaller players* to offer comparable service. Beholden to communities and not shareholders, these urban networks can prioritize universality of connectivity over profitability, both benefitting the currently disenfranchised and better reflecting the fact that modern society views Internet as a public good and not a commodity, and that cyberspace (at a broad level) is an extension of the public realm, not a gated community.

Finally, in Chapter 5, I theorize that cities, by sheer population density, tendency to attract a diversity of skills and talents, and with their historical role as hotbeds of progressivism and reform movements are uniquely positioned to challenge the status quo of Internet service provision not just within their borders, but in the world more broadly. While this thesis highlights the ills the status quo of Internet service provision in American cities, similar ills exist elsewhere. It is my belief, though, that only in cities will real solutions to these ills be born, and it is only in cities that sufficient public support for true reform can be raised. As national government has an established record of inaction and corruption in this matter, change seems more likely to come from the bottom than the top. While these changes will be urban and local in focus, because the Internet is (to some degree) singular and universal, these changes need not be necessarily confined to city limits and have the potential to benefit the network that connects half the world's population, regardless of physical geography.

Citations for Chapter 1

1. Solnit, "The Annihilation of Time and Space."
2. Human Rights Council, *Resolution adopted by the Human Rights Council on 5 July 2018*.
3. Lessig, *Code*, 208.

Chapter 2

Decentralization and The Digital Divide

A good analogy for the development of the Internet is that of constantly renewing the individual streets and buildings of a city, rather than razing the city and rebuilding it. The architectural principles therefore aim to provide a framework for creating cooperation and standards, as a small "spanning set" of rules that generates a large, varied and evolving space of technology.

RFC 1958[4]

This chapter first establishes a common understanding of how (on a very broad level) the Internet works, and how it has changed over the course of its existence. The first section includes content covering both the technical standards that Internet-connected devices rely on, the history and evolution of those standards, and the vaguely libertarian themes that are embedded within. This chapter also includes an overview of a different set of rules and traditions, those born not in academia, but in the telecommunications and regulatory worlds. As will become apparent throughout the thesis, these technical factors play a significant role in how the network is grown, deployed, and regulated, so it is vital establish a few key facts before delving into those discussions.

This chapter also examines the state of American Internet infrastructure and the impact of its deficiencies. Specifically, §2.3 interrogates the true nature of American Internet connectivity by critiquing the commonly-held narratives about access and use and the statistics that prop up such arguments, and §2.4 summarizes the ways the digital divide has grown both slowly and steadily over the past decades and more sharply in response to the COVID-19 Pandemic. Ultimately, this chapter finds that the consolidation of Internet service provision in a few, large telecommunications companies has led to a lack of competition which has produced Internet connectivity options which are wholly unsuited to the needs of Urban America, and which magnify existing inequities.

§ 2.1 The Network, In Abstract (And In RFCs)

"The internet," in general, is hard to define. On the technical level, it isn't hard—it's just *very* complicated. As noted by this chapter's epigraph, the architecture of the Internet is constantly being reengineered, and the work to design and build future additions to the network *are* very challenging indeed. But the technologies that deliver what the general public might think of as "the Internet" are known quantities. The technology *works,* and it was built by humans. The Internet's *protocols,* predefined sets of rules that computers can use to exchange information, have been in the public domain from their earliest forms. For example, Simple Mail Transfer Protocol (SMTP), the protocol that defines basic email, was introduced in 1981. If I were to send you an email, it wouldn't arrive by magic. It would be transmitted according to a well-defined set of protocols (SMTP, amongst others). Neither I, the sender, nor you, the recipient needs to be familiar with the SMTP standard (or even know that it exists) to use email, so for us "the Internet" may be thought of as "that app I use to do my email." But, with the proper knowledge, it would be entirely possible to dissect that email, breaking it into packets of information, breaking those packets into the binary signals that pulse through circuit boards and fiber optic cables, and even analyzing those signals with the fundamental laws of math and physics, if we were so inclined. With the email dissected, we can prove, definitively, how the email gets from me to you. It's not magic, it's just so incredibly complicated that we could be excused for thinking it is.

In this way, the Internet isn't dissimilar from other utilities. When most people turn on a light switch or open a water tap, they don't need to understand the complexities of the power grid that provides electricity or the nature of wastewater management. For most, the utility is defined by the interface it is accessed through—the tip of the iceberg.

However, if we extend this metaphor, I'd argue that the Internet would be represented by a very unusual iceberg. With other utilities (electric, water, sewer, landline phone, etc.) there tends to be one distinct tip. Electricity, for example, flows through cables, either connected to a grid by transmission line or to an on-site generator or renewable source. Most use electricity by plugging or unplugging a cable from a socket—it's easy to understand that you're physically bringing pieces of metal into contact. If the power goes out, it's not hard to conceptualize that somewhere in the larger grid a wire has been cut, a transmission line has gone down. On the metaphorical iceberg, this issue would be "below the surface," but the water is clear enough that the issue isn't a *complete* mystery.

In the "early days" of the Internet ("early" as in when the general public began to use the network in the 1990s, not when it was confined to research laboratories), there were equivalents to the tangible experiences of plugging in a socket or opening a tap. Given that many connected to the network through dial-up on a landline phone service, itself a physical network with tangible interfaces, a unique set of chirps and buzzes used in establishing the connection became engrained public consciousness. Once connected, users found that the network was small, at least by today's standards. AOL Instant Messenger and Yahoo! were distinctly "Internet" things, with their own culture and identity. But now, there are an estimated 4.5 billion people using the network, more than half the world's population, and in many countries (and especially in many cities), the vast majority of people use the

Internet. The Internet is massive, so massive that it is not merely a subculture that some participate in, but a venue in which much of human culture lives.

As has been highlighted during the pandemic, much of human activity now involves the Internet, in many cases to a greater degree than the classical utility of the telephone. Education, healthcare, employment, dining, shopping, communication, and dating, all happen, to some degree, in cyberspace. As Internet access and usage becomes more ubiquitous and reliable, it becomes more invisible. Invisible in the sense that "it works better," so that it is easy to take the network for granted, and in the sense that the devices that most of the world use as their primary portals to the network, smartphones, have become seemingly magically small and complicated in their own accord, and almost exclusively connect to the Internet through electromagnetic waves (be it a Wi-Fi or cellular connection), which cannot be perceived by humans. The point of the metaphorical iceberg, then, is not sharp and jagged, but is instead shrouded in a mist or fog—to most, it is not entirely clear where the internet begins. . . or ends.

So, while the extremely complex entity that is "the Internet" *can* be described in excruciating detail, most users of the internet do not possess the vocabulary and context to do so. "The Internet," for most, is a vague permeating tech thing, identifiable only by user-friendly interfaces. Technically, the Internet is immensely intricate, so even an intermediate knowledge of the protocols that underly it would be a barrier of entry too high for most of the world's population. The unavoidable side-effect of this, then, is that there are a great many assumptions about what the Internet is, how it works, and what it can or can't do that are not rooted in reality.

This breakdown in understanding of the network occurs not just for the general public, but also for the government officials and regulators who represent, in theory, the public interest. Lawrence Lessig, a law professor and activist who has contributed significant scholarship in the area of cyberlaw, summarized the situation as such in 2001:

> It might be a bit hard to see how a principle of network design could matter much to issues of public policy. Lawyers and policy types don't spend much time understanding such principles; network architects don't waste their time thinking about the confusions of public policy.
>
> But architecture matters. . . How a system is designed will affect the freedoms and control the system enables. And how the Internet was designed intimately affects the freedoms and controls that it has enabled. The *code* of cyberspace—its architecture and the software and hardware that implement that architecture—regulates life in cyberspace generally. Its code is its law. Or in the words of Electronic Frontier Foundation (EFF) cofounder Mitch Kapor, "Architecture is politics."[5]

For all the strict technical protocols that define how the Internet functions, how those protocols are planned, developed, and implemented is remarkably fluid, given the number of people that rely on the Internet and the huge sums of money that are transacted over, generated by, and invested in the network. The Internet is decentralized, both technically and organizationally. There is no “Internet, Inc.”—the organizations that act as stewards for the Internet, such as the Internet Engineering Task Force (IETF) and the Internet Corporation for Assigned Names and Numbers (ICANN) are self-appointed and derive their authorities from the trust of individuals and companies and from a belief in mutual benefit through administrative cooperation.

Compare this arrangement to that of a historical communications monopoly, the Bell System. The American Telephone and Telegraph Company (AT&T) and its subsidiary local operating companies were near-total monopolies (with the goal of universal service), and in many cases seemed synonymous with the medium of telephony itself. Really though, AT&T was a corporation with shareholders, a board of directors, and a CEO. This corporate hierarchy (plus the regulatory oversight of the FCC) were relatively straightforward and easy to understand. A single entity that could be blamed by politicians for ridiculous service prices or served a wiretap order by law enforcement. When something wasn’t working or needed to change, the chain of accountability and blame was clear. Such clarity can be comfortable.

When one connected a phone to the Bell System, it was connected through physical wires to a central office, which coordinated the phone network. But the Internet doesn’t have any “central” offices—the Internet is decentralized and, by design, does not give preference to one connected device over another. Whereas an individual’s phone was always one of millions of appendages to the centralized Bell System, a cheap Internet-connected smartphone today is, from a network topology perspective, just as much a “part” of or participant in the Internet as an expensive server sitting in a datacenter and running a major business operation.

Perhaps complicating matters, the history of the network (and much of the base-level infrastructure which *cannot* be easily changed) is tangled up in academia, libertarianism, the Cold War, and the spirit of the American freedom of speech. The decentralization that is characteristic of the Internet can be traced to American fears that a single, well-aimed Soviet nuclear strike (at a major city or long-distance equipment office) could cripple the entire nation’s communications.

> [Precursors to] The Internet was conceived and developed as a network of communication for the day after a nuclear strike. Even if the Soviets could carry out a surprise nuclear attack, the US would deprive them of victory—a doomsday communication network would partially survive, preserving some command and control capabilities and allowing a nuclear response...[6]

So, therefore, before the Internet itself was created, the notion of a network lacking singular points of failure. In the research networks that followed these experimental defense networks, other influences were clear:

> The Internet was born at universities in the United States. Its first subscribers were researchers. But as a form of life, its birth was tied to university life.[7]

Not only was the network decentralized in design, but the collegial nature of the researchers who developed the early Internet ensured that the *design process* was decentralized as well, with no single entity *declaring* the nature or future of the Internet (as Bell had for decades with the telephone network).

The architecture of the Internet is developed over time through Requests for Comment (RFCs). Each RFC is a peer-reviewed memo that proposes the technical specification for a protocol or offers commentary on the state and future of the network. Given that many of the early memos were written by graduate students in University working groups,[8] it is unsurprising that RFCs read more as articles in an academic journal than they do as edicts or laws.

RFC 1958, titled "Architectural Principles of the Internet," has been cited[9] as one of, if not the best attempt at stating not the technical underpinnings of the Internet, but the principles that justify those underpinnings. "Attempt" is necessary in describing the RFC, because the Internet has no formal charter or constitution. As Lessig remarked:

> The "nature" of the Internet is not God's will. Its nature is simply the product of its design. That design could be different. The Net could be designed to reveal who someone is, where they are, and what they're doing.[10]

RFC 1958 is couched in intentionally vague language. In attempting to directly answer the question "Is there an Internet Architecture?" For example, it replies:

> Many members of the Internet community would argue that there is no architecture, but only a tradition, which was not written down the first 25 years... However, in very general terms, the community believes that the goal is connectivity, the tool is the Internet Protocol, and the intelligence is end to end rather than hidden in the network.[11]

In a sense, this means that the network should be "dumb." The Internet developed around the primary goal of communication, the ability to send arbitrary information reasonably efficiently between any two connected devices, not with the goals of profitability or control. The physical infrastructure, the fiber optic cables and network switches, that support the modern Internet surely are expensive and specialized, but they aren't totally proprietary. The core infrastructure, the protocols, that such equipment must work with is held in the public domain, thus demanding a degree of interoperability and cooperation. The RFC's point about the "end-to-end" nature of the intelligence reinforces this general theme.

But since the first RFC was published in 1969, and especially since RFC 1958 was compiled in 1996, the Internet has grown exponentially from its humble beginnings in a few university labs. The companies that run the physical infrastructure operate with goals that are much closer to those of the original AT&T than to those codified in RFC 1958. With so many users (and so much money) dependent upon the Internet, there is significant profit and power to be gained through increased control of the Internet that simply didn't exist in the first decades of the network's existence. Mentioned earlier, the push by the telecommunications industry to repeal the legal codifications of net neutrality is a direct rebuke of the principle of end-to-end intelligence.

§ 2.2 The Commercialized Network

While at its core, the Internet isn't a business in the same way AT&T's telephone monopoly was, Internet connectivity is still big business. In the United States, the predominant model for Internet connectivity involves individuals and organizations subscribing to a "last mile connection" from a commercial Internet Service Provider (ISP). Because there is no inherent fee to Internet usage itself, this subscription pays for the ISP to run its own regional Internet infrastructure, and then connect the subscriber's building to that network. Rather than calling this leg of the connection the "last mile," some suggest calling it the "first hundred feet" to reflect that the overall quality of Internet connectivity is reliant on hyperlocal infrastructure.[12] Because a deep understanding of what the Internet is and how it works is not common, most think of their Internet connection only as this last-mile leg which they do have some knowledge of (after all, subscribers receive "Internet" bills from commercial ISPs).

The actual type of infrastructure used for data transfer is not fixed... the Internet has, mostly in the past, been delivered to homes through dial-up connection bootstrapped upon the existing (and centrally planned and controlled) telephone network. It is also accessed over the cellular networks of the word. In theory, you could deliver an internet connection by carrier pigeon if you wanted (it would be painfully slow and ridiculously expensive).

The open architecture (or tradition, as RFC 1958 suggests as possibly a more apt description) of the Internet has allowed small community groups, without significant financial or political resources to provide these last-mile links. These groups, which are a subject of discussion in Chapter 4, can use something of a hodgepodge of different fiber optic cables and wireless transmitters to relay their signals, enabling them to choose from a lively and competitive market the equipment that best suits the needs of their members and the prices they are willing to pay. But, recalling that many of these projects have been formed out of a frustration with the status quo, it is perhaps not surprising most people do not connect through such seemingly virtuous connections. Commercial ISPs have become the dominant purveyors of Internet service in American cities largely because they *did* build out much of the early infrastructure in the form of the telephone network. To a large extent, modern ISPs grew from existing phone companies, which incrementally upgraded much of their infrastructure to provide dedicated Internet service as usage stretched dial-up to its breaking point. To sell the last-mile connection as just another service was natural for such companies, and to buy such a service was natural for consumers.

Even though "the cloud" is a now-common stand-in for services and computing accessed over the Internet, most of the connections that form the Internet are in reality cables, suspended a few meters from the ground by the utility poles, routed through conduits just under the ground, or insulated in several inches of protective coatings and sitting on the ocean floor. For the recent past and immediate future, physical cables are generally the "best" way to connect most people to the Internet.[13]

As alluded to, these cables vary. The cables suspended from utility poles that serve a small suburban subdivision in New Mexico need to be able to physically withstand different conditions than a cable routed through subterranean conduit in Boston. The infrastructure built in New Mexico might be good for a hot, arid climate and for serving at most a few dozen households, but it would utterly fail in Boston, where it would likely need better waterproofing and would be woefully insufficient for carrying the Internet traffic of potentially thousands of households rather than tens. The requirements for an undersea cable, say between London and New York, are even more extreme, as such a cable would need to carry huge amounts of data while withstanding the corrosion of ocean water, the pressure of an ocean, and the occasional shark bite.

The deployment of infrastructure is driven by market forces, often aligned with the efficient use of resources. It simply wouldn't make sense to use undersea cabling to wire a New Mexico suburb. . . that would be obscenely expensive overkill. Almost no single entity (exceptions being huge industry leaders like Google and Amazon) needs the bandwidth of their own undersea cable. The reason it's worth the expense of developing and deploying these undersea cables is because they are public and because they are big, because everything on the Internet can use them without paying a toll.

Because there is no connection without the last mile of infrastructure, commercial ISP control over this infrastructure translates into significant profits for the telecommunications industry. As a chokepoint, increased control over this infrastructure means that profits can be maximized when competition is minimized. Because the Internet, unlike a premium cable package, is more necessity than luxury, people will tend to pay for even a lackluster service if they can afford it. Owing to the fact that commercial ISPs tend to be highly territorial and are difficult to displace once established in an area, much of the United States is served by few ISPs, meaning that low levels of competition have led to poor service and high prices. The next section will show that this is an issue both in urban and rural areas, and Chapter 3 will show that while the telecommunications industry operates commercial ISPs under near-monopoly conditions, they are subject to effectively none of the public controls that a government-sanctioned monopoly would.

§ 2.3 Lies, Damned Lies, and Statistics

RFC 1958 claims that a goal of the Internet is connectivity, meaning that at the most basic level the network can be assessed purely on how well it provides communication services. While "the Internet" may be seen as an extension of the public realm, that extension relies on connectivity.

While, in the history of the Internet, connectivity originally referred to the communication lines between research university, government laboratories, and military institutions, it now, of course, has a much more general and diverse meaning. This paper takes a somewhat narrower approach by dispensing with concerns of transoceanic cables and datacenters and adopting individual-centric conception of connectivity, which can be largely explored with a simple set of questions: *Who* has an Internet connection, and *where?* How *good* is it, and how much does it *cost?*

There is a prevailing narrative, or at least a prevailing assumption, that American cities are well connected to the Internet. For example, American politicians have traditionally cited the digital divide as a primarily urban-rural schism. Though many rural areas do have readily available Internet connections, not all do, and it intuitively makes sense that while an apartment building in the middle of a city is likely to be well connected, a small farm "in the middle of nowhere" might not be.

This narrative *seems* sensical. Given that most Internet service is delivered via physical wires (whether they be metallic or fiber-optic), initial capital costs of installation scale linearly as distances increase. In cities, many (potentially hundreds or thousands of people) can use (and pay monthly fees for) a single installation. In rural areas there are both fewer individuals to serve and the low density means that each new connection requires a greater per-person capital investment. In short, such reasoning holds that "distance has a chilling effect on potential service providers and exacerbates a large disparity in broadband performance."[14] Writ large, this reasoning holds—even if per-mile construction costs in an urban area are significantly higher than in a rural area, the potential profit from the typical multi-tenant apartment building is likely to more than make up for the relatively high level of investment.

While that reasoning is most sound, however, the oversimplified narrative that this ensure cities are well-connected warrants deeper investigation. Really, fewer urban Americans have the plentiful and affordable Internet connections that such a statement suggests. A combination of deceptive marketing and questionable measurement approaches have obscured the fact that while *more* urbanites are near to a connection, the connection may be too slow to use, too expensive to afford, or both. Whereas large geographic areas of rural America may have limited connectivity options, in America's cities disconnection is generally weaved throughout the entire region. "What's unique about metropolitan broadband gaps is the variation within the same community. Even though urban cores and mature suburbs in the nation's largest 100 metro areas have the highest median broadband adoption rates, they also experience the widest variation among their residents."[15] As this section will show, these disparities follow well-established patterns of inequity. Lack of a competition and quality Internet service is an urban issue in general, but it is an acutely problematic issue for the urban poor.

§ 2.3.1 Flawed Broadband Access Analysis

There is a well-documented "revolving door," where Federal Communications Commission (FCC) employees come to the agency after working for the telecommunications industry (telecom), or are offered positions in the industry after leaving the Commission.[16] Significant issues arise from the sometimes-cozy relationship between telecom and the FCC, given that the FCC is intended to be one of the primary regulators of the industry.

Whether it be due to this conflict of interest or any number of other political reasons, the FCC has for years promoted figures and released maps that paint an overly optimistic picture of the state of American Internet infrastructure and has generally failed to push the industry towards increased competition, lower prices, and better services. For example, in 2020, the FCC issued a report suggesting that fewer than 14.5 million American lived in areas lacking broadband access[i] and that this was more than a 20% year-over-year decrease.[17] However, an independent study sampled broadband availability options at 11,000 addresses to determine that number of Americans without broadband access was closer to 42 million.[18]

One specific source of this undercounting is the reliance on FCC Form 477 and the limitations of Census block-level reporting:

> For purposes of the analysis of access to advanced telecommunications capability in this Report, a census block is classified as served if the FCC Form 477 data indicate that service is available in the census block, even if not to every location. Therefore, it is not necessarily the case that every household, housing

i. "Broadband" is a somewhat nebulous term, but the FCC defines it as Internet service the delivers a consistent connection at 25 Mbps download and 3 Mbps upload. "Access" means that a service is purchasable by the general public, not that it is used ("usage" is discussed later).

> unit, or person will have coverage from a given service provider in a census block that this analysis indicates is served. Thus, as the Commission has previously explained, this analysis could overstate the coverage experienced by some consumers, especially in large or irregularly shaped census blocks.[19]

Essentially, the FCC will count a census block as having broadband access if an ISP advertises service at a *single* address within that block, even if no service is available at every other address within that block.

Relying on ISPs to faithfully self-report their coverage is likely inadvisable.[20] Verizon, in a contract with the City of New York to install fiber optic service to every residence in the municipality, reported that it had met the terms of the contract requiring it to "pass" every building. Typically, this term is interpreted to mean that occupants of a building can purchase that service if they so wish, but many residents and landlords reported that this was not the case, prompting an audit of Verizon's buildout by the City's Department of Information Technology and Telecommunications (DoITT). Verizon, it turns out, was claiming that it was "passing" buildings by installing its infrastructure "near" buildings, even though it would refuse to install last-mile connections that would make such infrastructure useful to nearby residents.[21]

Given these concerns, the current methodology has been criticized in studies,[22] by journalists,[23] by technology companies,[24] and in Congressional hearings.[25] During her confirmation hearing, current FCC Chairwoman Jessica Rosenworcel said that the maps produced from this data "stink" and has committed to taking a new approach.[26]

While a methodology so reliant on census blocks impacts data for geographies across the country and may have more extreme influences on data reported for rural areas,[27] that fact does not preclude that methodology from also misrepresenting urban areas. Unlike larger census tracts, which the United States Census Bureau tries to define such that each tract has a roughly equal population,[28] blocks are purposefully delineated without regard to population.[29] On one extreme, in rural areas the large but sparse block size may mean the FCC's incumbent methodology may overestimate access for a small handful of individuals per block. In cities, blocks are most often defined coincidentally with city blocks (the colloquial definition of "block," meaning as bordered by city streets). Thus, for a typical block of row houses in Baltimore, the FCC's overestimates may have impacted dozens of individuals per block. In denser and large city blocks, such as those found in the Jackson Heights section of Queens, New York, a worst-case scenario may be in the hundreds of people per block.

§ 2.3.2 Weak Density/Access Correlations

While the previous section explains that the methodology generally used in determining levels of "access" is severely flawed, this approach remains common practice. This section indulges that Form 477 block-based methodology, but finds that applying it on a national level reveals a relatively weak relationship between population density (which stands in here as a rough quantitative measure of urbanity) and levels of access. Both the overall advertised connection speeds and the deployment of forward-looking infrastructure is evaluated in this manner.

Measuring Access with Connection Speeds

The FCC releases block-level data it collects from Form 477 submissions to the public.[30] Each entry in this dataset corresponds to a single fixed Internet service offering in a single census block (so blocks with multiple competing providers have one entry for each provider). In addition to several provider identifiers, each entry includes an indicator whether the service is consumer-facing (as opposed to business- or government-oriented) an indicator of the technology in use (satellite, cable modem, last-mile fiber optics), and the advertised download and upload speeds for that service.

While Census Bureau-defined urban areas are often used to analyze this data, in order to more directly examine the claim that increased density of cities has led to naturally higher rates of access, the advertised upload and download speeds for services can be averaged first by block, and then averaged again across blocks in a tract. Using 2019 tract-level population estimates,[31] a population density can be calculated for each of these tracts, and correlations between density and various measures of access can be calculated. While such a methodology is hardly more statistically rigorous than the FCC's incumbent methodology, it does provide rough insights into the extent of the urban-rural divide.

Table 2.1 displays correlation values calculated for tract density and the number of providers offering various levels of services in each tract. The approach of counting the number of providers of a given service in each area is adapted from the FCC's presentation of its current national broadband map.[32] While it is a rather blunt measurement, counting the number of providers in a given area is suggestive of relative competition, which is what many see as key to improving the quality of Internet connectivity.[33][34] The table shows that while generally higher densities tend to be correlated with greater numbers of providers at all levels of service, at no level is the correlation particularly strong. The FCC's official definition of broadband (25 Mbps download and 3 Mbps upload, commonly written "25/3") *does* correlate more strongly with density than the presence of *any* fixed-broadband service, as do all other services that approach advertised Gigabit[ii] download speeds. However, Gigabit download and symmetric Gigabit services[iii] tend to be correlated less strongly with

ii. "Gigabit" refers to 1 Gbps in this context. 1 Gbps is equivalent to 1,000 Mbps.

iii. "Symmetric" service means that advertised upload and download speeds are the same, so symmetric Gigabit service advertises Gigabit upload and Gigabit download speeds.

$s_\downarrow$	$s_\uparrow$	$\rho_{D,\|P_s\|}$	$\tau_{D,\|P_s\|}$	$r_{D,\|P_s\|}$
0	**0**	0.203	0.281	0.412
25	**3**	0.290	0.342	0.490
25	**25**	0.425	0.333	0.472
100	**10**	0.452	0.386	0.544
100	**100**	0.403	0.114	0.149
250	**25**	0.334	0.340	0.474
250	**250**	0.298	0.181	0.233
500	**500**	0.304	0.204	0.262
1000	**100**	0.111	0.050	0.064
1000	**1000**	0.122	0.069	0.088

Table 2.1: Correlations between tract density and number of providers at several minimum advertised speed cutoffs. $s_\downarrow$ and $s_\uparrow$ represent minimum cutoffs for advertised download speed in Mbps and advertised upload speed in Mbps, respectively. D represents the set of census tract population densities, and P is the set of Fixed broadband service providers in each census tract. P_s is a subset of P for a given census tract such that $p \in P_s$ for provider $p \in P$ if p advertises download and upload speeds greater than or equal to those indicated by $s_\downarrow$ and $s_\uparrow$. ρ indicates the Pearson (standard) correlation, τ represents the Kendall rank correlation, and r represents the Spearman rank correlation.

density than Internet service overall.

Of course, it is vital to note that these are average trends across a large and varied nation. Studies of Internet service subscription rates, find that density is an inverse predictor of technology in some cases:

> In a number of states in the Northeast, rural broadband subscription rates were higher than urban subscription rates. Urban households trailed rural households by 8 percentage points in Rhode Island, 3 percentage points in Connecticut and New Jersey, and 2 percentage points in Massachusetts. Rural populations in these states had higher levels of median income than their urban counterparts.[35]

Measuring Access with Fiber Optic Infrastructure

While the availability of broadband has just been analyzed at multiple speed thresholds, analysis of access is frequently only evaluated with the FCC's official 25/3 definition. However, that definition has, since its adoption in 2015, been criticized as "both useless and harmful."[36] The Electronic Frontier Foundation (EFF), a US-based digital rights group, further describes the standard with accusatory language:

> It [the FCC definition] masks the rapid monopolization of high-speed access occurring in the United States and obscures the extent to which low-income neighborhoods and rural communities are being left behind. And, it attempts to mask the failures of our telecom policy to promote universal broadband. But this failure can't be masked during this pandemic, when millions of Americans are experiencing it as they try to work, learn, and entertain from home.[37]

The EFF further claims that 25/3 should have been considered an absolute minimum for use in 2015's digital landscape, but is "downright slow by today's standards and needs, and is practically near obsolescence."[38] And, as affirmed by a 2021 report by the United States Government Accountability Office focusing on broadband access by small businesses, 25/3 is *not* nearly as universally accessible as previously accepted.[39]

The telecommunications industry seems to acknowledge this to some degree but has adopted a rather hesitant stance in attempting to address the issue. In a March 2021 statement in response to calls from legislators to increase the speed requirements of the FCC's broadband definition, Joan Marsh, Executive Vice President of Federal Regulatory Relations for AT&T, makes two claims which are contradictory. First, she asserts that the current 25/3 service is "sufficient to support zoom working and remote learning," addressing the pandemic-related use-case that thrust the issue into national prominence. The EFF, amongst others, would obviously beg to differ whether this should be considered acceptable for any given individual, but Marsh herself clarifies that even if 25/3 is sufficient per-person, a pandemic-era household would likely need more: "When zooming [*sic*], streaming and tweeting is combined in an average household of four, it's easy to conclude that download speeds must increase."[40] So, even if Marsh's first statement, that 25/3 service is sufficient for modern life, is accepted, to it must be attached a caveat that this statement does not hold for family sizes greater than one, a rather glaring hole in Marsh's overall argument.

The fact that the connectivity speed needs of Americans increase over time has led many to advocate for mass installation of fiber optic cables as the ultimate "future-proof" investment in Internet infrastructure. Fiber optic cables (which carry data signals as pulses of light through glass rather than pulses of electricity through the metal of traditional communication wires) have long been seen as the technology that will enable the wide-scale adoption of symmetric Gigabit service. Symmetric Gigabit speeds are well in excess of the FCCs definitions of broadband (40 times the minimum broadband download speed of 25 Mbps and more than 300 times the minimum broadband upload speed of 3 Mbps). Since the 1980s, fiber optics have been used for undersea and other long-distance cable transmissions[41] but was traditionally viewed as "too expensive" to install on the "last mile" of a connection terminating at a residential or commercial building (a model frequently referred to as "fiber-to-the-home").[42] But, because fiber optic cables themselves are just strands of glass and the speed of light is limited not by the state of human technology but by the laws of physics, fiber optics are generally seen as "future-proof," and worth the high-cost investment because they will continue to be usable for decades to come. Fiber optic cable capacity can also be increased by simply and cheaply replacing the transmitters on each end of the cable, meaning that future upgrades are unlikely to be nearly as expensive.[43]

While symmetric Gigabit services delivered via fiber-to-the-home is likely excessive for the needs of most individual households and small businesses in 2022, it is likely that multi-Gigabit connections will eventually become the norm.[44] As such, the resistance on the part of the telecommunication industry to invest in such infrastructure may be a bellwether of continued issues with the industry. Marsh makes several arguments in her statement that signal AT&T's opposition to a redefinition of the FCC's broadband definition and a general unwillingness to build additional fiber infrastructure in rural areas. While there may be a kernel of truth in this claim (that rural fiber *is* expensive), there are several examples of rural installations proving this is not insurmountable.[45]

And, if fiber is so much more profitable to build in cities, one would expect America's urban centers to be fully saturated with the technology. Here too the imprecision of this urban versus rural generalization easily obscures a lack of urban infrastructure both overall and in otherwise underserved areas. Table 2.2 uses a similar (admittedly limited) methodology to the one used to generate Table 2.1, instead reporting the correlations between service technologies and census tract densities they are deployed in. While the flaws inherent to the methodology should preclude these figures from being used to directly inform public policy, they do demonstrate that fiber optics are clearly not an exclusively urban phenomenon.

§ 2.3.3 Access Case Study: Baltimore City and Baltimore County

To further examine how these national trends (or lack of trends) between density and access manifest in individual cases, this subsection uses Form 477 data for a case study of Baltimore City and Baltimore County, Maryland. Baltimore is perhaps an extreme example, but illustrates nicely how subpar measurement and methodology can obscure the extent of the digital divide, and especially how this divide follows the region's other lines of disparity. Baltimore City and Baltimore County are politically separate entities (though the City is surrounded by the County, it is independent of the County's Government). The City is significantly denser, while the County is more suburban, wealthier, and Whiter. While this subsection is mostly based on Form 477 and demographic data, the next subsection, §2.4, adds human narrative to the finings reported here.

This case study is inspired by a study[47] of broadband access in Los Angeles which measured the distributions of census block group median household income for block groups that include at least one block that has advertised fiber service and broadband competition. The authors noted distinct rightward skews, indicating that even using the FCC's

Technology t	$\rho_{D,\|P_t\|}$	$\tau_{D,\|P_t\|}$	$r_{D,\|P_t\|}$
Asymetrical xDSL	0.051	-0.074	-0.094
ADSL2	-0.299	-0.252	-0.314
VDSL	-0.213	-0.156	-0.193
Symetrical xDSL	-0.035	-0.049	-0.060
Other Copper Wireline	0.214	0.066	0.081
Cable Modem	-0.040	-0.037	-0.045
Cable Modem-DOCSIS1,1.1, and 2.0	0.116	0.021	0.026
Cable Modem-DOCSIS 3.0	0.038	-0.058	-0.072
Cable Modem-DOCSIS 3.1	0.168	0.175	0.222
Optical Carrier/Fiber to the End User	0.114	0.094	0.125
Satellite	0.162	0.362	0.504
Terrestrial Fixed Wireless	-0.061	-0.213	-0.291
All Other	-0.012	-0.022	-0.027

Table 2.2: Correlations between tract density and number of providers of service using different technologies. Technologies t are listed according to specification of the FCC's original dataset.[46] D represents the set of census tract population densities, and P is the set of Fixed broadband service providers in each census tract. P_t is a subset of P for a given census tract such that $p \in P_t$ for provider $p \in P$ if p is provided via technology t. ρ indicates the Pearson (standard) correlation, τ represents the Kendall rank correlation, and r represents the Spearman rank correlation.

limited Form 477 data, a disparity is clear. Such an approach has been replicated to produce Figures 2.1 and 2.2, which examines the block groups of a combined Baltimore City and Baltimore County, Maryland.

In these figures, the same pattern is shown, where fiber deployment appears to be clustered areas that are, on average, wealthier. Given that block groups are each composed of several census blocks, the earlier limitations of this mode of analysis are magnified: one address that *does* have fiber service can potentially misrepresent the access at the addresses across *several* adjacent blocks, not just one, so the "Fiber" partition over-represents the number of people who have fiber access. On the other hand, because block groups are included in the "No fiber" partition only if *all* contained blocks have *no* fiber access at *any* contained address. So despite the limitations of the dataset, it is clear that in the Baltimore area there are large areas with no fiber access, and these tend to be concentrated in poorer areas.

Of the 571 block groups within Baltimore City limits, 85 have some fiber access, leaving

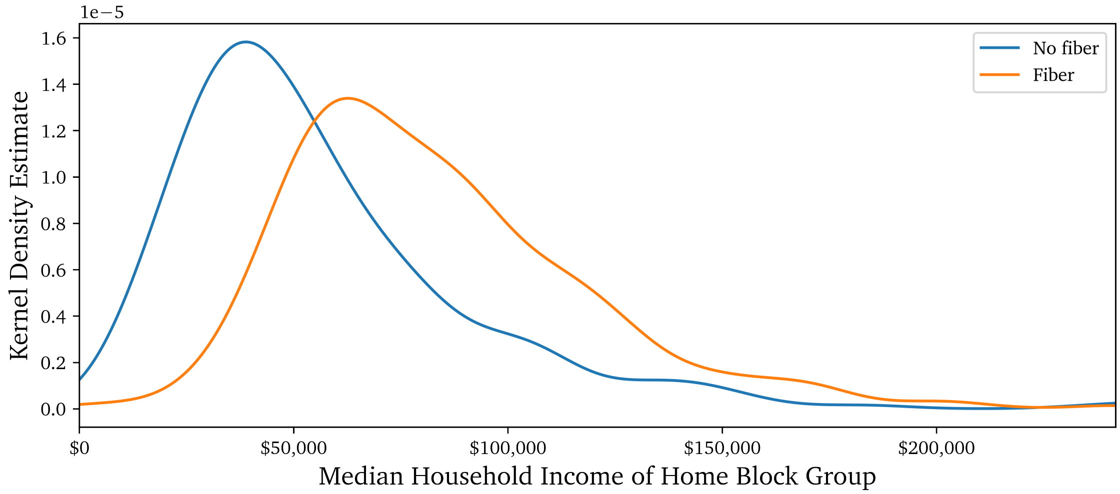


Figure 2.1: A Kernel Density Estimation plot drawn from two sets of ACS 5-Year median annual household income (in 2019 inflation-adjusted dollars) estimates (ACS detail variable `B19013_001E`[48]) for block groups in either Baltimore City or Baltimore County, Maryland. The estimates are partitioned into two sets depending on whether FCC Form 477 data indicates that for a given block group, fiber optic service is available in any of the blocks that are contained within that block group.

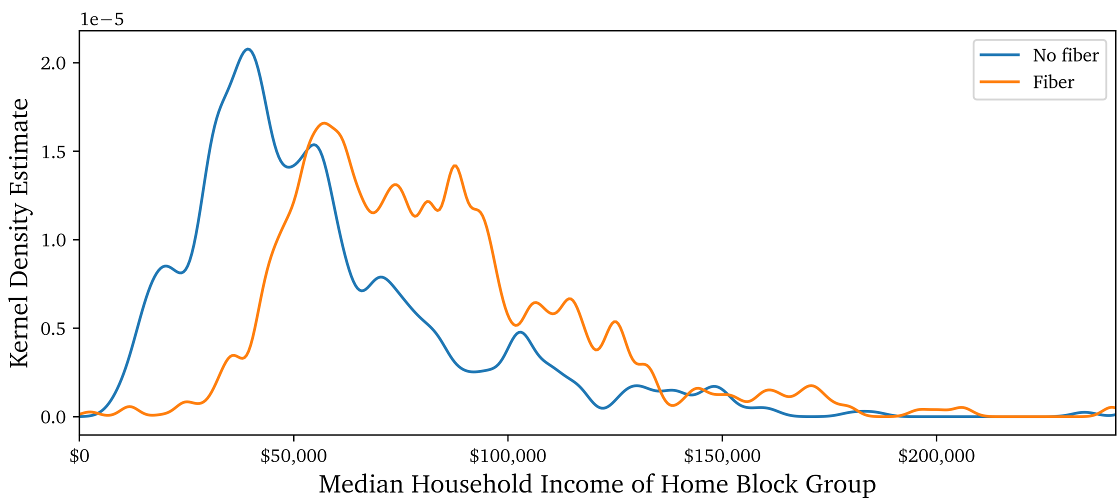


Figure 2.2: A Kernel Density Estimation plot drawn from the same data used in Figure 2.1, but the household income of each block group is represented with a multiplicity equal to the population estimate (ACS detail variable `B01001_001E`[49]) for that block group. In effect, this plot is a version of Figure 2.1 that accounts for variations in block group populations.

486 without. In Baltimore County's 516 block groups, 507 have fiber, while only 9 do not. Given less than 2% of the County's block group is not served at all with fiber access, it is

not appropriate to disaggregate this data. However, Figures 2.3 and 2.4 are adaptations of Figures 2.1 and 2.2, respectively, which demonstrate the significance of the political boundary as well.

And, to reiterate the flaws of the assumption that density and access are strongly correlated that were introduced in §2.3.2, this methodology can again be adapted. Figure 2.5 shows the distribution of census tracts in Baltimore City that contain at least one block served by fiber according to the densities of those tracts. As earlier, Baltimore County is included but not disaggregated, as few block groups in the County have no fiber access whatsoever. Of the 200 tracts in the City, 60 have some fiber access and 140 have no fiber access. Figure 2.6 is a version of Figure 2.5 which accounts for tract populations. While much of the County is relatively low-density, it tends to have relatively high levels of fiber access. In the City itself, it is clear that tract density does not appear to act as strong predictor of current fiber deployment, and current deployment skews slightly toward lower-density areas of the City.

These trends become even more striking when the underlying data is represented geographically. Figure 2.7 shows the maximum download speeds advertised in each census block within Baltimore City or Baltimore County, by any technologies. The case of Baltimore City and Baltimore County is particularly illustrative because of the clear divide in infrastructure investment that follows the border between City and County. While mapping maximum advertised download speeds does produce some insights that the City specifically lacks investment, Figure 2.8, which maps maximum advertised upload speeds, shows this even more starkly. While the more rural northern parts of the County are served with relatively slow maximum upload speeds (typically not more than 35 Mbps), the suburban ring that borders the City in the southern part of the County is served with upload speeds that can be in excess of 100 Mbps. It would be sensible that the City, of higher density than the suburbs that surround it on all sides, would have similar or better service. But, the City's maximum upload speeds are much more similar to the rural areas to the north of the County than to those immediately adjacent to it. The same clear divide is seen in Figures 2.9 and 2.10, which show fiber-to-the-home deployment and broadband subscription rates, respectively.

§ 2.3.4 Access Is Not Usage; Cost Is Key

As a side effect of Marsh's statement being published as a blog post on AT&T's public policy website, members of the general public were able to post feedback alongside Marsh's comments. Many take a tone of frustration, and many rural Americans air somewhat anti-urban sentiments, based largely on the familiar narrative that all city-dwellers have good connectivity. Conversely, a poster under the screen name "Graham" claims to be a programmer who lives within 20 miles of Atlanta, close to a major State highway, and unable

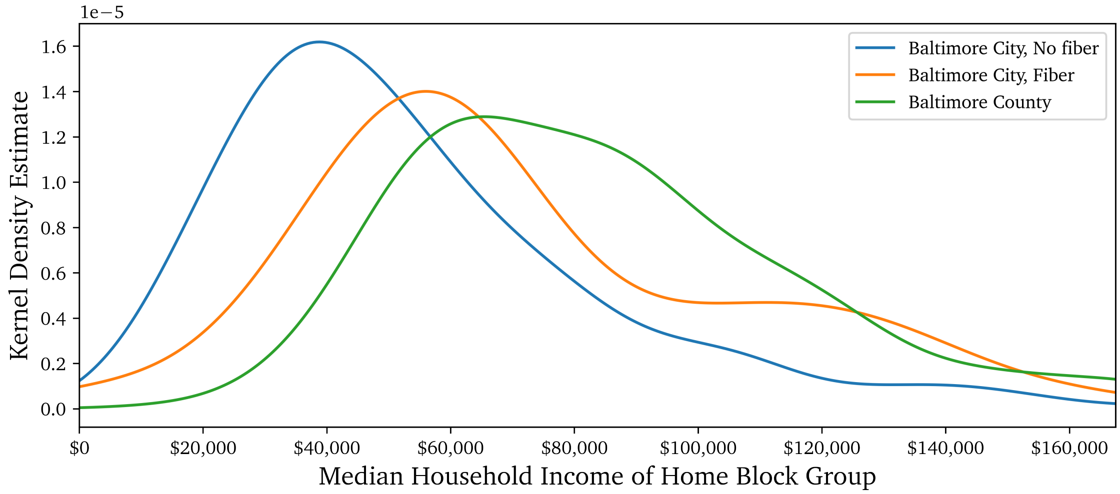


Figure 2.3: A Kernel Density Estimation plot drawn from two sets of ACS 5-Year median annual household income (in 2019 inflation-adjusted dollars) estimates (ACS detail variable `B19013_001E`[50]) for block groups in either Baltimore City or Baltimore County, Maryland. The estimates are partitioned into three sets depending on whether the block group is located within the County, or if it is located within the City, if FCC Form 477 data indicates that for a given block group, fiber optic service is available in any of the blocks that are contained within that block group.

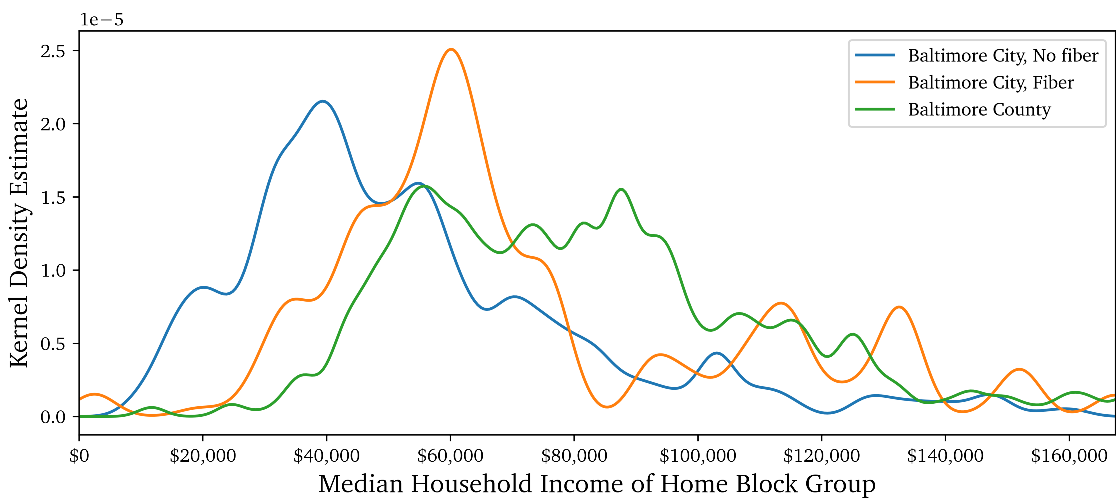


Figure 2.4: A Kernel Density Estimation plot drawn from the same data used in Figure 2.3, but the household income of each block group is represented with a multiplicity equal to the population estimate (ACS detail variable `B01001_001E`[51]) for that block group. In effect, this plot is a version of Figure 2.3 that accounts for variations in block group populations.

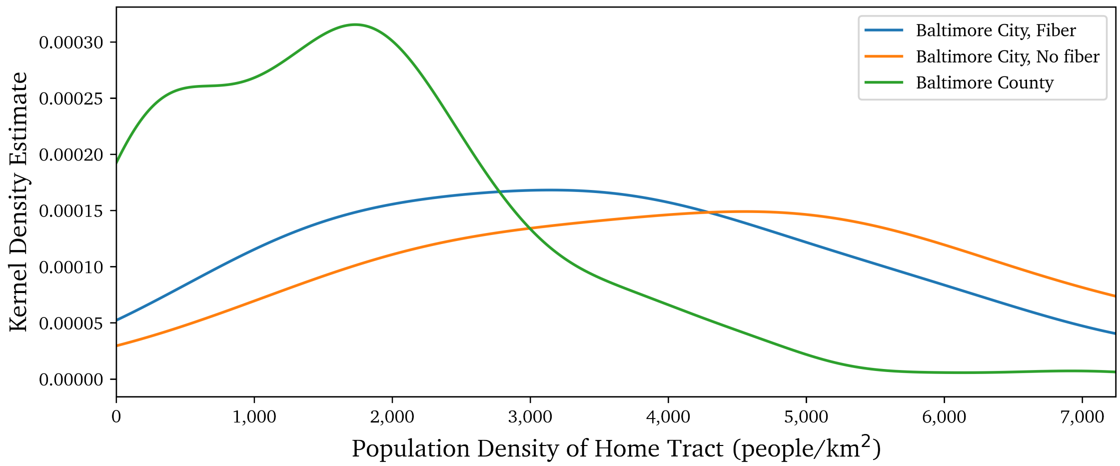


Figure 2.5: A Kernel Density Estimation plot drawn from tract-level population density estimates for Baltimore City and Baltimore County, Maryland. The estimates are partitioned into three sets depending on whether the tract is located within the County, or if it is located within the City, if FCC Form 477 data indicates that for a given tract, fiber optic service is available in any of the blocks that are contained within that tract.

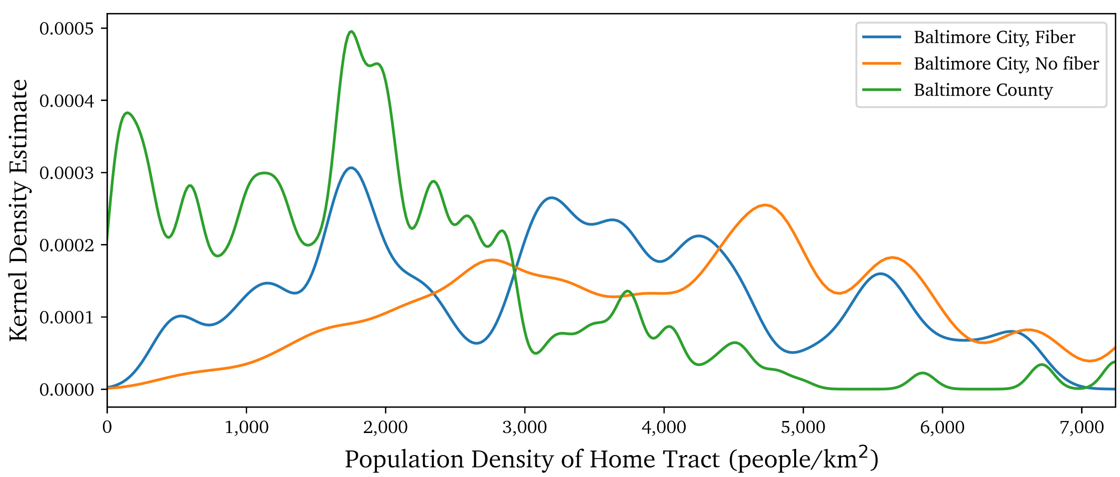
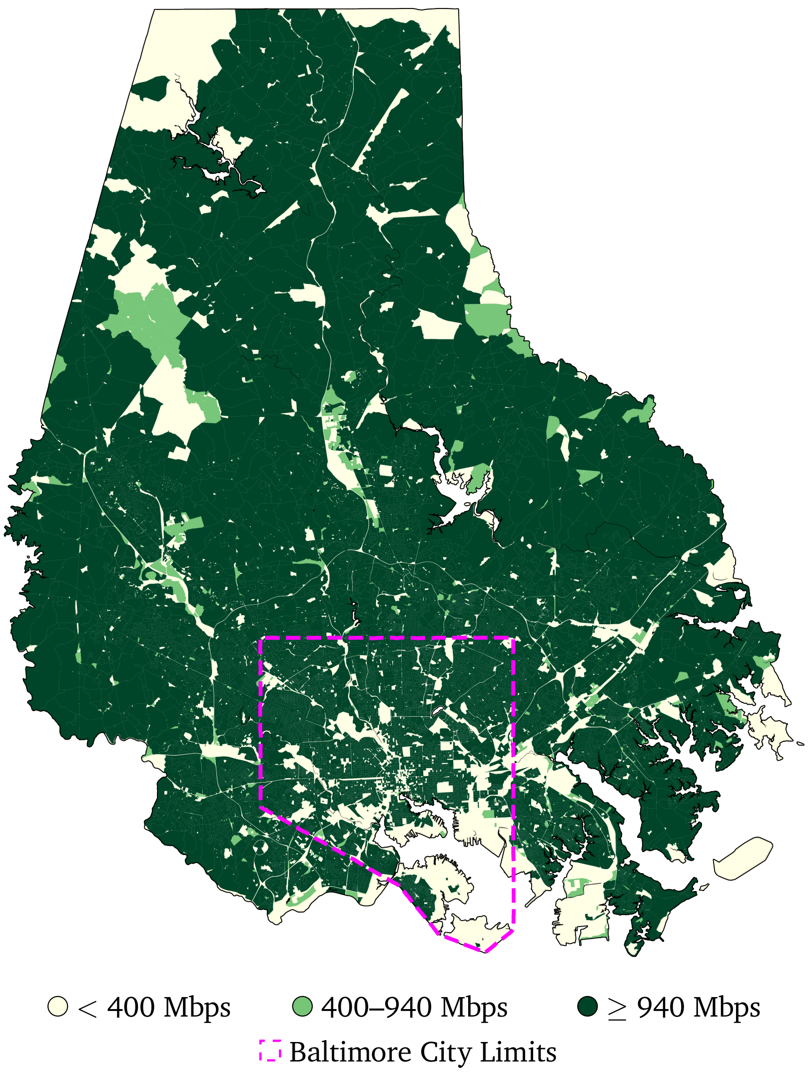


Figure 2.6: A Kernel Density Estimation plot drawn from the same data used in Figure 2.5, but the household income of each tract is represented with a multiplicity equal to the population estimate for that tract. In effect, this plot is a version of Figure 2.5 that accounts for variations in tract populations.

to purchase speeds greater than 6 Mbps download and 0.6 Mbps upload because AT&T "refuse[s]" to update its utility lines in the area. Another individual, using the screen name "Matt Pritchard," voiced similar sentiments, citing specific perceived socioeconomic stratification:

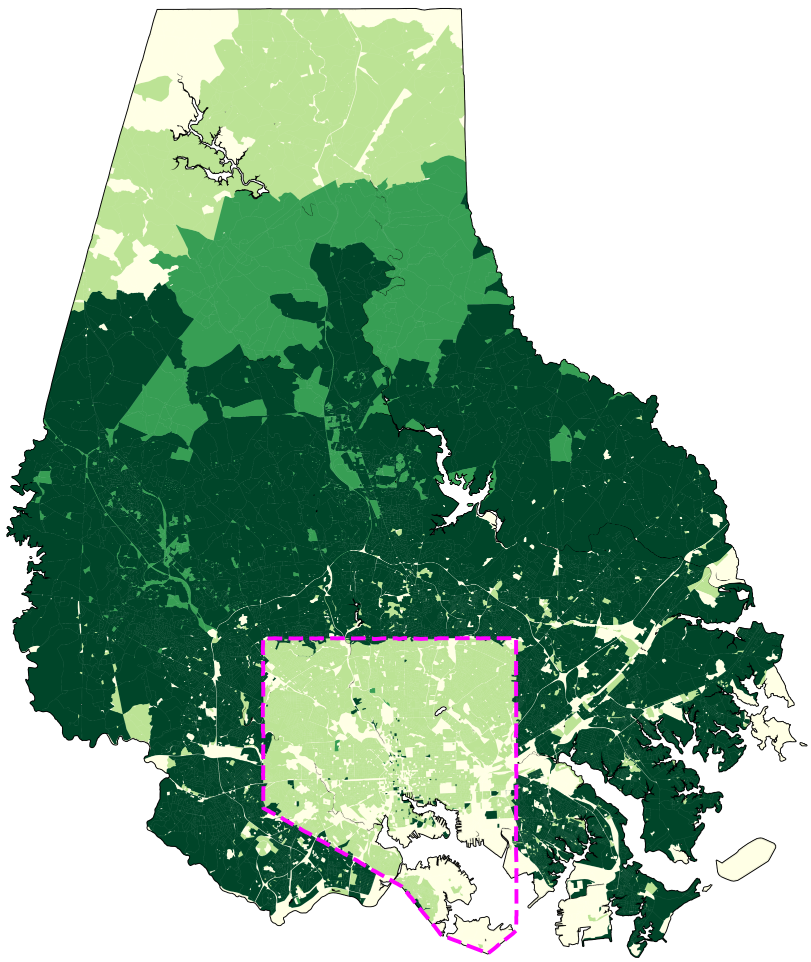
Figure 2.7: Maximum advertised download speeds for Baltimore City and Baltimore County, derived from the FCC's fixed wireline deployment data.[52]



> The area of Atlanta I live in is majority black and there's no fiber here unlike other areas. I grew up in rural Appalachia where there's no fiber there either. However when I lived in Pittsburgh and other parts of Atlanta, I could get fiber and it was cheap. Marginalized people deserve the same affordable, symmetrical, highspeed Internet you'll gladly build and market as superior in wealthier/whiter areas.

Pritchard's sentiments have been supported by several recent studies. A study of competition amongst broadband providers and the deployment of fiber in Los Angeles County drawn from the FCC's Form 477 data finds indications "that broadband competition is more likely in the more affluent communities:"[56]

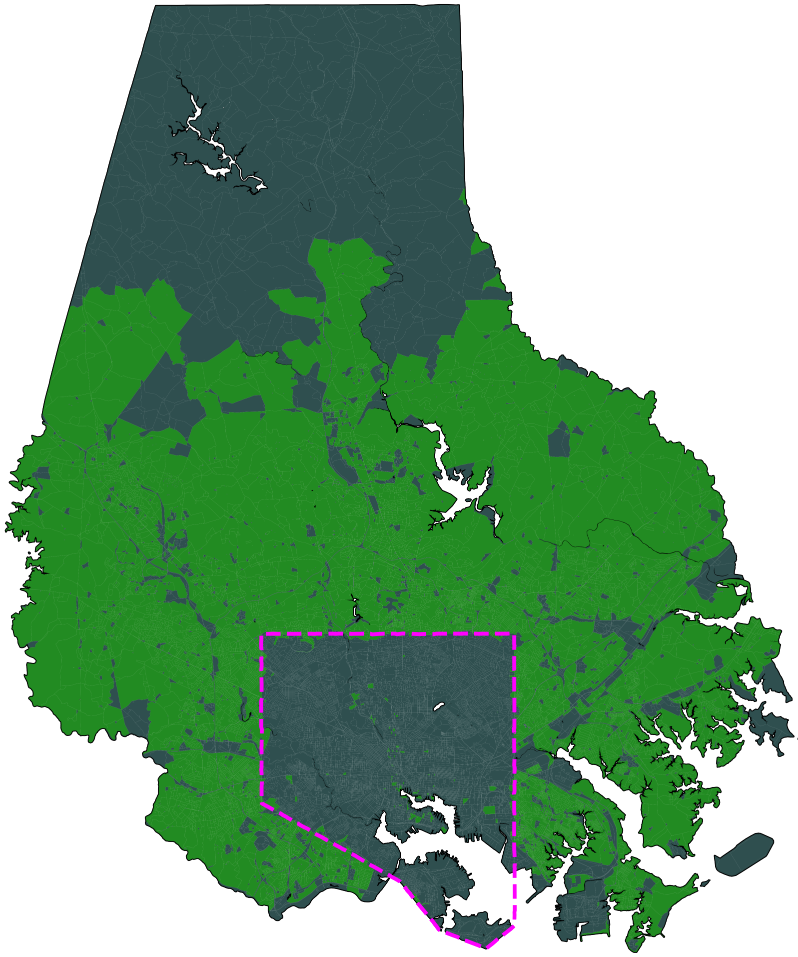
Figure 2.8: Maximum advertised upload speeds for Baltimore City and Baltimore County, derived from the FCC's fixed wireline deployment data.[53]



> ...while the odds of broadband competition are higher and relatively similar in affluent areas regardless of the share of Black residents, the odds fall rapidly in poor communities as the share of Black residents increases. Notably, the odds fall below 50% in majority-Black low-income communities.[57]

While it is clear that the American digital divide is not simply urban versus rural, the question as to why is perhaps less straightforward. While much of the aforementioned data has suggested that the density is no guarantee of robust Internet service, the basic logic that dense areas *should* have high-quality access is sound. The City of Chattanooga, Tennessee has developed municipal broadband (discussed later), and has economically developed fiber-to-the-home infrastructure capable of ten-Gigabit speeds in an area with a population

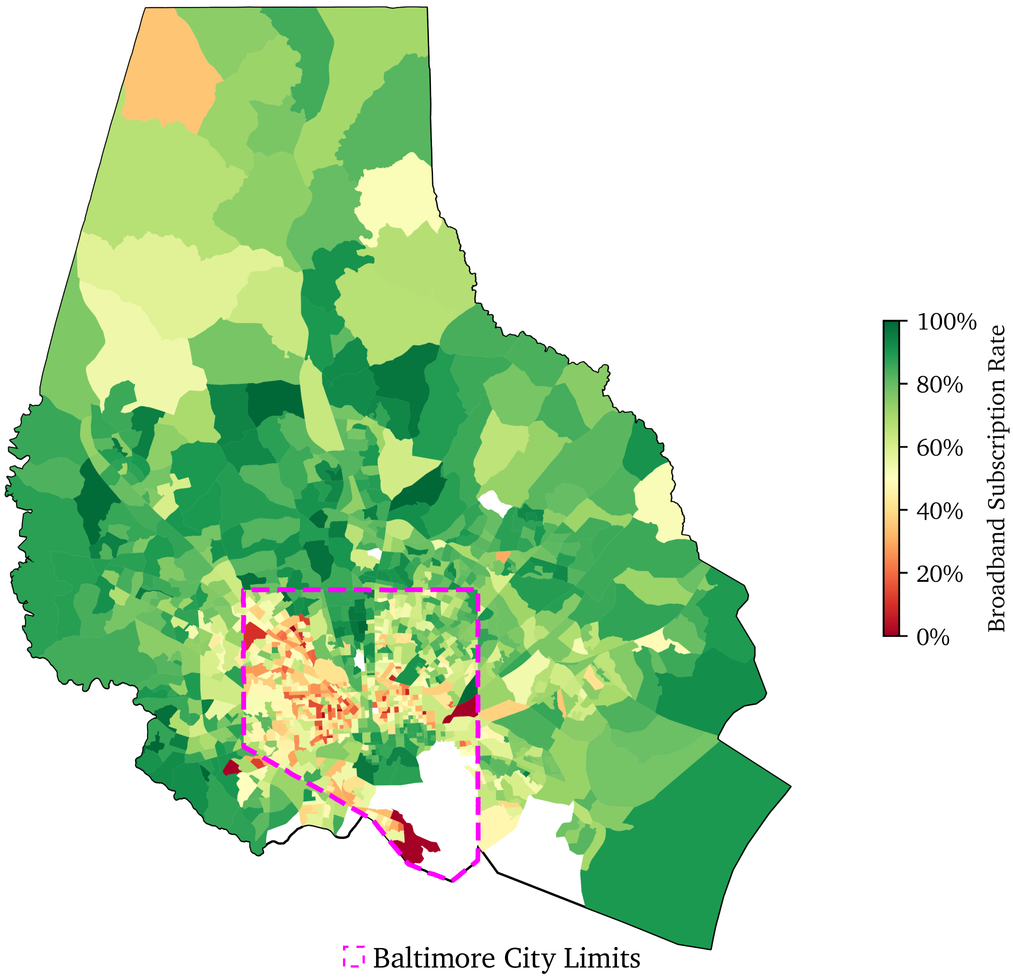
Figure 2.9: Fiber-to-the-home deployment in Baltimore City and Baltimore County. Derived from the FCC's fixed wireline deployment data.[54]



of roughly 1,222 people per square mile.[58] And, while the success of one project should not be taken on its own to make more universal claims, it is worth noting that a co-op in rural Missouri has been able to deploy Gigabit speeds via fiber technology in an area that average 2.4 people per square mile.[59] In a city like New York (which has a population density of more than 27,000 people per square mile, more than 25 times that of Chattanooga), where Verizon has already "passed" all buildings with fiber optics, surely it would be profitable to connect those buildings and collect monthly fees. As one commentator notes, while economic and technical challenges may pose issues in rural America, "there is no good excuse for discriminatory deployment decisions in densely populated urban markets" which are "fully profitable to serve."[60]

The private companies that make up the telecommunications industry are under no

Figure 2.10: Rates of broadband subscription in Baltimore City and Baltimore County. Derived from ACS 2015-2019 5-Year Estimates, Group B28011.[55]



obligation to report in any depth the factors that lead to their decisions of where to deploy their services, but from what can be gleamed from publicly available information, it appears these actions are motivated not by a desire for profitability, but for *maximizing* profit. In areas of higher (or even moderate) rates of poverty, telecommunications companies will often decline to upgrade local infrastructure (or in the case of Verizon in New York, connect their new infrastructure to adjacent buildings) under the belief that while such investments *would* turn a profit, the rates of financial hardship mean that such an effort would be reward with less overall profit than more affluent areas of similar or even lower density. And, due to the lack of competition in many of these same areas, there is little-to-no market pressure for such companies to improve their service, meaning that they can still make a tidy profit off of existing, outdated service because residents have few alternative options, if any. If a population is already paying as much as it can for relatively bad service, a commercial ISP sees little to gain out of making improvements, even if the amortized monthly subscription fees will ultimately pay for the investments in newer infrastructure. Because there is such limited competition, and poor populations cannot afford to be upsold, it is more profitable for the ISP to just pocket the money, or reinvest it elsewhere, where wealthier residents can pay more.

A study, which arrived at many of these conclusions, interviewed several individuals involved in the process. One of the interviewees, themselves an installer working in the telecommunications industry, summarized the situation:

> I myself as an AT&T technician cannot get fiber mainly because the company doesn't want to take on the cost of providing connectivity to areas where it isn't extremely easy or profitable.[61]

The operative word in this quotation is *"extremely."* While many urban communities may be profitable to serve, they are not profitable *enough* for major providers to even offer.

Up to this point, this section has considered connectivity in terms of access—more or less the same basic type of metric that has been used, with poor results, for decades. Access, the measure of whether an individual *can* get an internet connection at a given address as service, is certainly vital to connectivity, but once access is available, it must actually be used for connectivity to occur.

Through 2021, the number of Americans not using the Internet has continued to decline,[62] a trend which was further accelerated by the COVID-19 Pandemic.[63] While there may be some who choose to not use the Internet (ever, or in the context of their residence or workplace), this is already a rare occurrence amongst all groups,[64] largely mirroring the near-universal adoption of other utilities, such as electricity, which are now considered "essential" services. For better or worse, the Internet now pervades communities both urban and rural, and it is difficult to participate fully in American society without use of the Internet.[65]

Assuming that Internet connectivity is therefore nearly universally desirable, the question shifts to why people who *have* access do not *use* it. The single biggest factor is affordability. Figures 2.1–2.4 have already been used to demonstrate that there are significant differences in *access* according to area median income, but how about actual use of that infrastructure?

Whereas the FCC only collects provider-side information about which services are offered at the block level from Form 477, the Census Bureau has collected information about Internet usage and subscription (as well as computer/device ownership) since 2013 as part of the American Community Survey.[66] The information collected, reported under ACS group `B28011`,[67] only pertains to whether a household connects to the Internet or not, and if it does, whether that connectivity is enabled through a subscription. If the household is connected through some type of subscription service, the type of that service is collected as one of the following: dial-up, Broadband (such as cable, fiber optic, or DSL), Satellite, or another type of subscription service.[68] This data is, unfortunately, somewhat limited. While information about "broadband" subscription rates is collected, no information about monthly rates and observed speeds is recorded (likely because this would be impractical information for the ACS to collect), and the phrasing of the questionnaire does not refer to formal FCC definitions or speed requirements.[69] Additionally, another study notes that "the sample size is not sufficient to provide estimates for small intra city analysis because the Census Bureau is geared toward providing aggregated data from multiple years large metropolitan areas."[70]

Area	C	C_d	C_b	C_s	C_o	C_n	$\neg C$
Baltimore City	-0.455	-0.001	-0.591	-0.054	-0.023	0.109	0.462
Baltimore County	-0.459	-0.035	-0.497	0.162	0.036	0.205	0.438
Baltimore (Combined)	-0.565	0.004	-0.678	0.021	0.005	0.199	0.558
New York City	-0.523	-0.016	-0.520	-0.020	0.059	0.172	0.502
San Francisco	-0.569	0.015	-0.585	0.023	-0.018	0.255	0.543
Chicago	-0.539	-0.078	-0.606	-0.035	0.006	0.222	0.512
Los Angeles	-0.545	-0.036	-0.578	-0.150	0.002	0.207	0.528
Philadelphia	-0.455	-0.021	-0.538	0.202	0.052	0.161	0.428
Boston	-0.389	-0.073	-0.382	-0.024	0.155	0.127	0.365
Detroit	-0.625	-0.039	-0.710	0.128	0.007	0.258	0.577
Twin Cities	-0.528	-0.007	-0.582	-0.038	0.138	0.389	0.423
Chattanooga	-0.460	-0.075	-0.569	0.003	-0.079	0.147	0.442

Table 2.3: Pearson (Standard) Correlation coefficients for the relationship between poverty rates within tracts and Internet connectivity within block groups within those tracts for several metropolitan areas. Areas refer to encompassing counties, so Baltimore City and County refer to different Census County definitions, New York City refers to the counties coincident with the five boroughs, Chicago refers to Cook County, Boston refers to Suffolk County, Detroit refers to Wayne County, Twin Cities refers to the union of Hennepin and Ramsey Counties, Chattanooga refers to the union of Hamilton and Marion Counties, and San Francisco, Los Angeles, and Philadelphia refer to the counties of the same names, respectively. Poverty rates are calculated at the tract level from data in ACS group `B17001`[71] and usage rates are calculated at the block group level from data in ACS group `B28011`.[72] C refers to the correlation between poverty rate and the home Internet access rate, and subscripted versions of C similarly refer to correlations for specific types of connection. C_d indicates dial-up subscription service, C_b indicates FCC-defined subscription "broadband" (through fiber, modem, etc.), C_s indicates subscription satellite service, C_o indicates some other subscription service, and C_n indicates a non-subscription form of service. $\neg C$ indicates the correlation between poverty rates and lack of *any* home Internet service.

Nonetheless, the ACS can still provide useful insights. Table 2.3, for example, summarizes correlation values for poverty rates and Internet connectivity in several relatively urban American counties. Observe that in each area, C, the correlation between tract-level poverty rates and *any* form of home Internet connectivity is roughly -0.5. While not a terribly strong correlation, the statistic is found in a variety of cities across the country, and is significantly stronger than the density/access correlations summarized in Tables 2.1 and 2.2. While correlations C_d, C_s, C_o, and C_n (pertaining to connections using dial-up subscriptions, satellite subscriptions, another subscription type, or a non-subscription service, respectively) are relatively weak, correlations C_b (representing broadband connectivity) tend to be more strongly negative than C for each area summarized in the table (New York City and Boston being slight outliers to this rule). Similarly, $\neg C$, the correlation between poverty rates and total *lack* of Internet connectivity, is stronger and positive.

A similar study, conducted in San Antonio, Texas, came to a complementary conclusion after reviewing access and usage data for that city and conducting interviews and outreach in relevant areas:

> Income is a major factor that is likely to influence broadband adoption especially where technology is available. Higher household incomes and higher educational levels are strongly associated with broadband access while very low-income households do not have broadband connections in their homes. Despite the availability of broadband, lacking in higher education and income creates systematic disadvantage and socially excludes low income San Antonians from accessing job opportunities online, completing school work for children, and limiting them from accessing important health and other information keeping them at a disadvantage.[73]

Because it is senseless to focus on building out Internet infrastructure, which is too expensive to be used, efforts to control monthly subscription rates are as if not even more important than the buildout of improved infrastructure. Recall from §2.2 that because the Internet itself requires no toll, this is mostly a matter of the last mile (or first hundred feet) of the connection.

§ 2.4 Pandemic—When "Everything" is Online

The digital divide is nothing new—in the United States, it has existed in some form since the Internet first escaped from the developmental labs of academia. Though for the first few decades of its existence the Internet was far from popular, by the 1990s it had become clear that the network had the potential to be revolutionary for communications and enable a new era of education. It is fitting then that the first time "digital divide" appears in the United States Congressional Record is in reference to schools, in 1996:

> I believe it is imperative that we link all the classrooms in the country because it is the only way that we can mitigate against a growing digital divide where some schools get access and others do not. We must bring all our kids along to the future. No nation can hope to prosper in a fiercely competitive global economy where information is the coin of the realm if it does not give the bottom 10, 15, or 20 percent of its society the Information Age tools necessary to compete for jobs in such an economy.[74]

This prediction has largely, and obviously, been proven accurate. Besides the relative luxuries Internet connectivity makes possible and accessible to a mass-audience, numerous studies have found that widespread connectivity is linked with increases in productivity, job creation, and overall economic development.[75] While the Internet itself is agnostic towards use case, and much Internet traffic is related to entertainment, shopping, or any number of other purposes, the conceptual link between the network and education has remained strong. The north star of universal service, the notion that everyone everywhere should be able to access the world's information instantaneously, shines especially brightly when framed in the context of public education. The purity of wanting to use technology to transcend decades of inequity in public education to truly secure a better future for every child and young adult is nearly absolute, and perennially effective in mobilizing at least some support for change.

The failed realization of those aspirations, however, has been painfully obvious for the unconnected.[76] Perhaps unsurprisingly, once large swaths of relatively privileged populations were connected with *decent* (even if poor by international standards[77]) service, universal service became a less valuable and less immediately redeemable political token, and became perpetually "right around the corner." Nobody would argue *against* a push for universal service, but the seeming lack of urgency meant it was easy to defer, and defer, and defer. With the COVID-19 Pandemic, however, those disparities sharply resurfaced in the larger public consciousness, as most aspects of life "went remote," demand for broadband surged, and Americans became momentarily more aware of their Internet use.[78]

Jessica Rosenworcel, the current[iv] Chairwoman of the FCC, is credited with coining the term "homework gap"[79] to refer to the impact of unequal Internet access on students several years before the pandemic. When asked to describe the term in a 2015 nomination hearing, Rosenworcel replied:

> So when I was growing up, when I wanted to do my homework, it required

iv. Rosenworcel served a term on the FCC from 2012-2015 and was renominated to serve an additional term in 2015, but was not confirmed due to politicking unrelated to her performance. She was nominated and confirmed again in 2017, and was named acting Chairwoman in early 2021, when the former Chairman Ajit Pai resigned coincidentally with the beginning of the Biden Administration. She was later nominated for a full term as Chairwoman and confirmed in December 2021.

> paper, a pencil, and my brother leaving me alone. Today, more often than not, it requires the Internet. There are studies that suggest that 7 in 10 teachers assign homework that now requires Internet access.
>
> But data from the FCC suggests that one in three households do not have that access. And the Pew Internet in American Life Survey has found that there are 5 million households with school-age children in this country that do not have Internet access. So just imagine what it is like to be a kid in one of those households. Getting your basic schoolwork done is hard; applying for a scholarship or job is challenging.[80]

Rosenworcel has made this gap a central focus of her tenure, highlighting it both in official statements[81] and in numerous editorials she's penned.[82] The term has been used increasingly in legislative and policy discourse and in the media[83] since the beginning of the pandemic, as the libraries, community centers, and coffee shops that filled in for home connections were shuttered, and it wasn't just homework that was taking place online, but classroom instruction and socialization as well.

The homework gap, exacerbated into a wider education gap by the pandemic-induced remote learning, began to spark greater frustration and protest. Kimberly Vasquez, then a high school student in Baltimore and member of Students Organizing a Multicultural and Open Society (SOMOS),[84] a student activism group, described her situation in a mid-2020 interview:

> "Every morning my family had to decide who had priority to use the internet," Vasquez said. "My parents needed to work and provide for our family, for me and my sisters who needed to pass our classes. We even had scheduled times, I would do my work more towards the afternoon while my sisters did their work more in the morning."[85]

SOMOS, in alliance with Baltimore Councilman Zeke Cohen, sought to immediately petition Comcast,[v] the major service provider in the city, to increase speeds on its "Internet Essentials" program, which was the $10 per month plan that Vasquez's and other families relied on.[86] The plan was originally advertised with 15 Mbps download and 2 Mbps upload speeds, notably below the FCC's already-criticized definition of high-speed broadband. With the onset of the pandemic, Comcast increased the speeds to meet the FCC's 25/3 definition, claiming this was sufficient for "up to three high-quality Zoom calls at the same time, four simultaneous high-quality video calls on Skype and as many as three simultaneous group video calls on Microsoft Teams, as well as educational sources like Khan

v. Appeals were also made to the Baltimore City Council and Legislature of the State of Maryland, both for direct financial assistance and for similar demands to be made of Comcast.

Academy and Blackboard."[87] This assurance was widely ridiculed by users of the Internet Essential Plan (echoing the Electronic Frontier Foundation's criticisms, amongst others'). Chase Roper, an employee of Comcast who quit in frustration over this very issue, posted a message on Twitter to similar effect:

> I just quit working for Xfinity/Comcast. I want families to know that the special Essentials program they offer to low income households for [$]9.95/mo is only 25mbps and in almost every case, not an adequate speed for children to do their live "zoom" online class work.[88]

In an interview, Roper later expressed frustrations identical to those embedded in Rosenworcel's "homework gap:"

> Roper said that talking with Comcast customers every day showed him how wide the gulf is between families who can afford top-tier internet connections and those who can't and opened his eyes to the way in which inequality infringes on some students' right to a public education.
>
> "I had a parent call in who has four kids — two were in college, two in high school and middle school," he said. "They were paying for a second internet connection at their house, both for 1-gigabit-per-second download speed, to make sure all the kids had no problems. I was just like, Wow [*sic*], the privilege to be able to do that when there are for sure kids in the same district who can't even get a connection, and they'll be graded the same."[89]

Foremost amongst the changes the advocates sought were increases to the speeds offered in the Internet Essentials program to 100 Mbps.[90] Comcast initially rejected this demand, but later agreed to at least a temporary compromise of 50/5 Mbps speeds at no additional charge.[91]

Cohen, who proctored meetings between a Comcast representative and SOMOS, reported that the representative was generally dismissive of the original claims that its 25/3 service was insufficient, insisting that it was. Cohen and Vasquez recognize Roper's tweet (which had gone "viral"[vi] and attracted media attention) as having played a role in the compromise.[92] While clearly a problem that manifests at the local-level, Cohen is realistic in discussing approaches to the root problem:

> This is not just a Baltimore problem, this is an American problem, and until Congress and the FCC decide to address it directly, we're going to continue to suffer.[93]

vi. More than 40,000 Retweets and more than 175,000 Likes.

The next chapter examines such Federal approaches to relieve local hardship. Unfortunately, while Cohen is likely right that centralized action to tackle the root causes would likely be helpful, my findings suggest that this progress in this arena is nominal at best. Chapter 4 will further argue that in the absence of strong centralized action, local efforts not dissimilar in spirit from the one undertaken by SOMOS are necessary.

Citations for Chapter 2

4. Carpenter, *Architectural Principles of the Internet*, 2.
5. Lessig, *The future of ideas*, 35.
6. Hart, *The American Internet advantage*, 48.
7. Lessig, *Code*, 33.
8. Lessig, *The future of ideas*, 36.
9. Ibid.
10. Lessig, *Code*, 38.
11. Carpenter, *Architectural Principles of the Internet*, 2.
12. Hurley and Keller, *The First 100 Feet*.
13. Cyphers, "The Case for Fiber to the Home, Today: Why Fiber is a Superior Medium for 21st Century Broadband."
14. Reddick et al., "Determinants of broadband access and affordability," 3.
15. Tomer and Fishbane, *Neighborhood broadband data makes it clear*.
16. Dunbar, *The FCC's rapidly revolving door*.
17. *Fourteenth Broadband Deployment Report*, 2.
18. Busby, Tanberk, and Cooper, *BroadbandNow Estimates Availability for all 50 States; Confirms that More than 42 Million Americans Do Not Have Access to Broadband*.
19. *Fourteenth Broadband Deployment Report*, 13.
20. Zakrzewski and Alcantara, "Biden's ambitious broadband funding has a key impediment."
21. Reece, *New York's History with Telecommunications Lobby's Efforts to Replace Historic Municipal Franchising Regimes for Telecommunications with Centralized State Franchising, and Corresponding Influence of Regulatory Regime Upon Fios Buildout Outcomes*, 21.
22. Busby, Tanberk, and Cooper, *BroadbandNow Estimates Availability for all 50 States; Confirms that More than 42 Million Americans Do Not Have Access to Broadband*; Grubesic, "The U.S. National Broadband Map"; Ford, "Challenges In Using The National Broadband Map's Data"; Tomer, Kneebone, and Shivaram, *Signs of Digital Distress*.
23. Levin and Downes, "Cities, not rural areas, are the real Internet deserts"; Zakrzewski and Alcantara, "Biden's ambitious broadband funding has a key impediment"; Brandom and Joel, *This is a map of America's broadband problem*.
24. Kahan, *It's time for a new approach for mapping broadband data to better serve Americans*.
25. Doyle et al., *Legislating To Connect America: Improving The Nation's Broadband Maps*; Rosenworcel, *Executive Session and Nominations Hearing*.
26. Rosenworcel, *Executive Session and Nominations Hearing*, 3:14:15.
27. Busby, Tanberk, and Cooper, *BroadbandNow Estimates Availability for all 50 States; Confirms that More than 42 Million Americans Do Not Have Access to Broadband*.
28. *Census Tracts*.
29. Rossiter, *What are census blocks?*
30. *Fixed Broadband Deployment Data: June 2020 V1*.
31. *Index of /geo/tiger/TIGER2019/TRACT*.
32. *FCC Fixed Broadband Deployment*.
33. Reece, *New York's History with Telecommunications Lobby's Efforts to Replace Historic Municipal Franchising Regimes for Telecommunications with Centralized State Franchising, and Corresponding Influence of Regulatory Regime Upon Fios Buildout Outcomes*, 21.
34. Rosenworcel, *Executive Session and Nominations Hearing*, 00:54:07.
35. Martin, *Computer and Internet Use in the United States: 2018*, 8.
36. Falcon, *The American Federal Definition of Broadband Is Both Useless and Harmful*.

37. Falcon, *The American Federal Definition of Broadband Is Both Useless and Harmful*.
38. Ibid.
39. *Broadband: FCC Should Analyze Small Business Speed Needs*.
40. Marsh, *Defining Broadband For the 21st Century*.
41. Abbott, “Review of 20 years of undersea optical fiber transmission system development and deployment since TAT-8,” 1.
42. Hurley and Keller, *The First 100 Feet*, 187.
43. Cyphers, “The Case for Fiber to the Home, Today: Why Fiber is a Superior Medium for 21st Century Broadband,” 22-23.
44. Falcon, *The American Federal Definition of Broadband Is Both Useless and Harmful*.
45. Mitchell, *United Fiber Tackles Missouri’s Most Rural*.
46. *Fixed Broadband Deployment Data: June 2020 Status V2 | Data | Federal Communications Commission*.
47. Galperin, Le, and Wyatt, “Who gets access to fast broadband?”
48. Your friendly API robotic overlord, *Census Data API: B19013*.
49. Your friendly API robotic overlord, *Census Data API: B01001*.
50. Your friendly API robotic overlord, *Census Data API: B19013*.
51. Your friendly API robotic overlord, *Census Data API: B01001*.
52. *Fixed Broadband Deployment Data: June 2020 V1*.
53. Ibid.
54. Ibid.
55. Your friendly API robotic overlord, *Census Data API: B28011*.
56. Galperin, Le, and Wyatt, “Who gets access to fast broadband?,” 2.
57. Ibid., 4.
58. Falcon, *The FCC and States Must Ban Digital Redlining*.
59. Mitchell, *United Fiber Tackles Missouri’s Most Rural*.
60. Falcon, *Every State Has a Chance to Deliver a “Fiber for All” Broadband Future*.
61. *AT&T’s Digital Redlining: Leaving Communities Behind for Profit*.
62. Perrin and Atske, *7% of Americans don’t use the internet. Who are they?*
63. Mitchell, *United Fiber Tackles Missouri’s Most Rural*.
64. Perrin and Atske, *7% of Americans don’t use the internet. Who are they?*
65. Whitacre, Strover, and Gallardo, “How much does broadband infrastructure matter?,” 261.
66. Martin, *Deconstructing the Digital Divide: Identifying the Supply and Demand Factors That Drive Internet Subscription Rates*, 1.
67. Your friendly API robotic overlord, *Census Data API: B28011*.
68. Ibid.
69. *Sample ACS 2019 Questionnaire*, 5.
70. Reddick et al., “Determinants of broadband access and affordability,” 2.
71. Your friendly API robotic overlord, *Census Data API: B17001*.
72. Your friendly API robotic overlord, *Census Data API: B28011*.
73. Reddick et al., “Determinants of broadband access and affordability,” 10.
74. *Conference Report On S. 652, Telecommunications Act Of 1996*.
75. Katz, *The Impact of Broadband on the Economy: Research to Date and Policy Issues*.
76. Hurley and Keller, *The First 100 Feet*.
77. Falcon, *The U.S. Internet Is Being Starved of Its Potential*.
78. Branscombe, *The Network Impact of the Global COVID-19 Pandemic*.
79. Basu, *Why the “homework gap” is key to America’s digital divide*.
80. Rosenworcel, *S.Hrg. 114-228 — NOMINATION OF HON. JESSICA ROSENWORCEL TO BE COMMISSIONER OF THE FEDERAL COMMUNICATIONS COMMISSION*.
81. *Rosenworcel Hails American Rescue Plan Funds to Close Homework Gap*.
82. Rosenworcel, *Bridging the Homework Gap*; Rosenworcel, *Falling through homework gap*; Rosenworcel, *Filling in the homework gap*; Rosenworcel, *Limited Internet access a challenge for Detroit kids*.
83. Johnson, *FCC approves $7 billion to get better equipment to remote learners*; Dvorak, “When ‘back to school’ means a parking lot and the hunt for a WiFi signal.”
84. Kang, “That Spotty Wi-Fi?”
85. *Call to expand free wifi in Baltimore City*.
86. McLeod, *Philly, Baltimore and Detroit lawmakers calling on Comcast to expand free Wi-Fi, hotspot access*.
87. O’Donovan, *A Former Comcast Employee Explains Why Low-Income WiFi Packages Aren’t Helping Students*.
88. Roper,
89. O’Donovan, *A Former Comcast Employee Explains Why Low-Income WiFi Packages Aren’t Helping Students*.
90. Ibid.
91. O’Donovan, *After Defending Its Low-Cost Internet Offering, Comcast Agrees To Increase Speeds*.
92. O’Donovan, *A Former Comcast Employee Explains Why Low-Income WiFi Packages Aren’t Helping Students*.
93. Cohen, *Baltimore’s ’digital divide’ exacerbated by pandemic*.

Chapter 3

Reforming From the Top?

> *If the position is "you don't have authority," you don't have the right to then tell the States they too don't have authority. Because by virtue of you [the FCC] choosing to exit this area of the law, you don't get the right to preempt others. . . We're now living in a universe where these interstate networks are so important to what we do, and the question is how do we have a mix of Federal Authority and State consumer protection that manages these kinds of service. And I don't think we have the digital age jurisprudence to fully manage that right now.*
>
> FCC Commissioner Jessica Rosenworcel[94]

Having reviewed the technical and regulatory backgrounds of the Internet and the seriousness of deficiencies in access in Chapter 2, the next two chapters will discuss approaches to resolving those deficiencies.

This chapter will focus primarily on the role regulation *can* but *doesn't* play in resolving the issues that past regulation (or lack thereof) has created. In contrast, Chapter 4 will focus on efforts that leverage the unique qualities of the technical underpinnings of the Internet architecture allowed *within* current regulation to address the deficiencies that regulation itself is failing to address. Put simply, this chapter highlights how the Federal Government is failing to act, and the next chapter suggests how cities should take matters more into their own hands, and why they should. In both cases, the efforts to bridge the digital divide that are discussed can be seen as antagonistic to the telecom industry, which has produced the results described in the previous chapter. While Chapter 4 examines grassroots (arguably "guerilla") efforts taken to claw control and autonomy of Internet connectivity from incumbent providers, it is first important to understand the potentials and limitations of top-down actions taken to remedy these issues.

§ 3.1 Telecom's Tendency Towards Monopolization

Left to their own devices, most telecom companies would likely prefer to grow towards monopolies, becoming modern-day reincarnations of the Bell System. While the United States prevented such extreme national consolidation from reemerging since the Bell System agreed to fragment itself as a result of antitrust litigation, it is vital to keep in mind that telecommunications companies, as entities first and foremost concerned with the production of profit, have these tendencies. And, while ISPs run by the modern telecommunications industry share much in monopoly mindset with Bell, they have not as of yet been subject to government approval of prices (see §3.2) or antitrust pressure similar to that faced by the Bell System.

Bell nicely models what the monopolistic mindset looks like when applied to communications with its once slogan, "ONE SYSTEM, ONE POLICY, UNIVERSAL SERVICE."[95] As Tim Wu, a noted legal scholar in the areas of antitrust and telecommunications,[96] notes:

> The terminology is important to understand: it meant "unrivaled," not "for all." This was not "universal" as in, say, universal health care, but more nearly in the sense of the universal church. It was, as the historian Milton Mueller explains, universal service as an alternative to options, and as such it was a call for the elimination of all heretical hookups and the grand unification of telephony.[97]

The core argument that persisted for keeping American telephony monopolized for much of the twentieth century held that unruly competition would lead to harmony, and that centralized, corporate management was needed for the good of the consumer and the nation. In a 1976 public relations video, a spokesman for the company appeals to national pride when trying to describe how such a vast corporation functions: "What is important though is how all these parts work together, how they've gotta work together to keep phone service in America the best in the world."[98] The video continues:

> It's a good partnership, the Bell System. Yep, we're a monopoly for sure, but we're a regulated monopoly, which means that the government grants us permission to be a monopoly while approving the prices we charge and the services we offer to customers. Regulated monopoly works well in communications because you don't duplicate facilities and you produce real economies over the long haul.[99]

A few years later, however, the government would revoke that permission, fracturing the system into several smaller companies. Much ink has been spilled debating the (de)merits of this decision and the fallout, but none of that discourse is terribly relevant here. What is clear, however, is that the Bell System's argument of efficiencies and economies of scale is significantly less convincing when applied to the Internet. Whereas the companies of the Bell System were inseparable from the technical standards that ran the network, and multiple competing phone providers could mean incompatibilities when calling from one network to another, the Internet faces no such hurtle. As discussed in §2.1, the technical protocols that dictate the functioning of the Internet are non-proprietary—they are owned by nobody but usable by everyone. While providing reliable Internet connectivity to millions is not technically trivial, but there is no fundamental barrier to a multiplicity of providers, especially in cities where high densities can support many small competitors. While a more activist Federal Government should consider to increase competition by subdividing the oligopolistic market in the same way Bell's monopoly was shattered once the telephone became too engrained in society and the costs of monopoly control rose too high, those efforts are for now reserved for more local quarters (see Chapter 4). What the Federal Government *has* been willing to do, to *some* extent, is to try to regulate ISPs like it once tried to regulate Bell, by controlling prices and approving services.

§ 3.2 To Promulgate Rules Or Not To Promulgate Rules

As discussed, the Federal Communications Commission (FCC) is the five-member entity appointed to enact rules, which carry the weight of law, coordinate technical standards between private entities, and litigate violations of such rules and standards, and it is the FCC which the Federal Government has typically deferred broadband regulatory issues to. Much of the FCC's rulemaking over the past two decades falls under The Telecommunications Act of 1996, a product of the "light touch" regulatory environment that emerged under the Clinton Administration.[100] The thinking at the time was that the fledgling[i] Internet was too fragile to be strictly regulated, and that because no one could confidently conjecture as to the future of the network and how society would come to interact with it, any fixed regulation at that stage could stem innovation, potentially squandering a revolutionary industry (which, in fact, did turn out to blossom).

The 1996 Act specifies two relevant regulatory classifications which the telecommunications may be considered: Title I "Telecommunications Services" and Title II "Broadcast Services." The difference between these two categorizations is nuanced and technical, but can be broadly thought of as such: Title II services are "common carrier," meaning they are more closely analogous to a public utility and thus subject to more stringent regulation than those services classified under Title I, which pertains to more "enhanced" or specialized services.[101] ISPs would themselves prefer to be classified as Title I, because Title II gives the FCC more ability to restrict an ISP's decision making through "greater rulemaking and oversight authority to ensure that the providers of broadband services are providing equal access to the networks for both content providers and consumers of the service and could even go so far as to enact control over pricing of the services."[102] When the 1996 Act was passed, Internet services were considered Title II, but a subsequent Supreme Court decision rendered the classification an alterable decision of the FCC.[103] As a result, the FCC is in the position of being able to decide whether it, as a commission, would like to classify Internet services in such a way that it has stricter regulatory powers, or whether it would

i. Fledgling mass-*use* of the Internet.

like to declare the services Title I and thus preclude some of its own oversight.

The debate over the FCC's classification most recently flared up during the net neutrality debates of the mid-2010s. As discussed in Chapter 1, "net neutrality" refers to the concept that service providers should be agnostic as to the content being delivered over their infrastructure, meaning that no content is given preferential or detrimental treatment, either through connection speed or cost. The principle is very much tied to the decentralized ethos of the early network, and content neutrality is often cited as a key enabling factor to explosion of the technology industry. Although ISP efforts to throttle or block content were not widespread in the United States, the threat of such manipulation led the FCC to enact more stringent rules prohibiting such practices, but court rulings held that the FCC would need to reclassify broadband as Title II to have such authority.[104] In 2015 the FCC did reclassify all broadband service as Title II after the Obama-appointed FCC Chairman Tom Wheeler, a former telecom lobbyist, surprised many by supporting the reclassification order.[105]

Two years later, however, the FCC reversed course and voted to return to a Title I framework. Tom Wheeler and Jessica Rosenworcel, both Democrats, had resigned their positions before President Trump took office, and Ajit Pai, Trump's appointment to fill Wheeler's seat, ended up being much more loyal to the telecommunications industry (he was a former employee of Verizon) than Wheeler had. Pai adopted an argument that providers were overly burdened by the Title II regulation, which meant that they were less willing to build out their networks, which in turn meant that consumers would see fewer of the benefits of competition, especially in rural, "underserved" areas.[106] This argument may sound appealing at first, but upon even cursory review, bears resemblance to the same arguments that utilities have been using to oppose regulation for decades and is similarly fraudulent. Of particular interest to this thesis, it largely ignores the fact that within cities, cost and not access is the primary barrier (see §2.3.4), and that a "light-touch" approach does nothing to control that factor. Additionally, it completely ignores the fact that much of the buildout of America's broadband infrastructure was completed under Title I conditions (initial Title II status was not fully exercised by the FCC), and with that modicum of regulation private industry has already demonstrated that it will tend to produce the inequitable and insufficient outcomes covered in Chapter 2. Pai has further argued that many of the technology companies and other groups that argued in favor of the Title II reclassification did so because they care about the principles of a "free and open Internet" and not the actual regulations of Title II, claiming that this implies a "decent amount of common ground" and that they just needed to find the "appropriate legal framework to reach that common ground."[107] While this statement was made in a television interview and the language may not be precise or clear as one made in a Law Journal may be, it appears clear that this argument is purposefully misleading. While it may be true that the loudest advocates for net neutrality care less about the language of the legislation that powers such rulemaking, they certainly do want the rulemaking to be effective and legally enforceable. Given that the FCC has in the past tried to secure the principles of an open and free Internet *without* the Title II classification, only to be told by a US Court of Appeals ruling that such reclassification was necessary, Pai's argument must reasonably be seen as intentionally misleading. And, given his deep connections with the telecommunications industry, his actions and presence on the FCC must reasonably be seen as an exercise of the industry's control over a theoretically independent regulatory body, the executive that appoints members to that body, and the legislature that theoretically vets those candidates.

While net neutrality is not the focus of this thesis, the FCC's handling of both it and the classification of ISPs is informative of the tenuous nature of the efficacy of federal regulation over the telecommunication industry in the current decade. Yes, Pai resigned with the conclusion of the Trump Administration, and Rosenworcel (whose frustration with the FCC's lack of willingness to regulate the telecommunications industry is represented in this chapter's epigraph) took the reins to lead the Commission in the opposite direction. While this change is positive, the suddenness with which it was made is representative of the fact that regulation at the Federal level is far from independent. If anything, it is highly *dependent* on national politics, and, by extension, *dependent* on the lobbying efforts of the very companies that the regulator tries to regulate. No matter how well-intentioned the regulator, the regulatory machinery of the Federal Government is currently so deeply flawed and beholden to private interests that to trust in any national administration to solve to issues faced primarily on the local level with such mechanisms is a fool's errand.

§ 3.3 The Infrastructure Investment and Jobs Act

The Infrastructure Investment and Jobs Act became law on the 15th of November, 2021. Coming at the end of contentious negotiations and lobbying, the passage of a major infrastructure bill that would revive a country reeling from the COVID-19 Pandemic was intended as a major early accomplishment of the Biden Administration, echoing in the footsteps of Roosevelt's New Deal investments which revived the country during the Great Depression and laid the groundwork for postwar prosperity.[108] Many of the legislators pushing for broadband provisions in the act were well-intentioned—on both sides of the aisle, the importance of Internet connectivity in the new decade was affirmed, as stories shaped by the digital divide (not unlike those recounted in §2.4) were shared in popular media and as Jessica Rosenworcel (who coined the term "homework gap," see §2.4) was appointed to be the interim Chairwoman of the FCC. As noted in §2.3.1, Senators even waded into the technicalities and deficiencies of FCC Form 477 when holding hearings on Rosenworcel's appointment.

"Broadband" is the focus of Division F (a top-level chapter) of the act. Spanning 69 pages, the section is broken into six titles. Title I creates the "Broadband Equity, Access, and Deployment Program," which provides $42.45 Billion in grant funding for States to spend on physical infrastructure improvements.[109] An additional $1.5 billion for two grant programs to identify and reduce digital inequities are allocated in Title III (also known as the "Digital Equity Act of 2021").[110] Title IV allocates $1 Billion for "middle-mile" infrastructure (for example, trunk cables that run along streets but do not connect into adjacent buildings), and Title V deals with "broadband affordability" by adjusting a previously-instituted direct-to-consumer broadband stipends and mandating that ISPs provide greater transparency into their subscription rates.[ii]

The total $65 billion allocated for connectivity represents a substantial Federal investment in Internet infrastructure, and the stipulations guiding its expenditure indicate an increased *interest* in closing the digital divide. But, that said, many of the ambitious original provisions of the legislation were stricken during negotiations, and the $65 billion package is a notable decrease from the roughly $100 Billion originally suggested by the Biden administration. While the triumphs of the bill show that Federal action *can* improve connectivity at the local level, this legislation shows that telecom's lobbying efforts remain influential, and that the status quo of Internet service provision remains unbroken. While telecom did not lobby to shrink the total monetary allocation, it did successfully lobby against provisions that would have forced more competition. Because it is so recent, an examination of this legislation is suggestive, for the present and likely the immediate future, of what the Federal Government is likely to do on this issue.

§ 3.3.1 Identifying Inequity, Funding Grants, Issuing Subsidies

First and foremost, much of the language that comprises this division of the Act is in clear and purposeful acknowledgement that Internet access is "essential to full participation in modern life in the United States,"[111] that the digital divide is a serious issue that deepens existing inequalities (especially in the wake of the pandemic), and that increased competition amongst broadband providers can produce better overall service.[112] It asserts many of the same findings of chapter 2, like that high poverty rates are indicative of "high-cost" areas,[113] where it is more expensive to build out broadband infrastructure.[iii]

As is common for such sweeping legislation, the Act does not prescribe specific projects for which money will be used. The monies allocated in Title I are to be awarded as grants to

ii. Title II, which deals exclusively with Tribal connectivity, and Title VI, which deals with telecommunications workforce development, are not strictly relevant to this thesis.

iii. A slight quibble with this characterization is presented in §2.3.3, where I argue that in some cases the calculus determining infrastructure investments is more one of maximizing profits, rather than simply ensuring a break-even.

"eligible entities"—almost always States[iv]—representing a slight devolution of power and decision-making. Beyond this actual devolution which does empower more local forms of Government, the use of grants prevents responsibility for allocation being vested in the FCC, which besides being a centralized body that can be swayed easily by national politics, has a spotty history in efficiently and fairly running allocations.[114] The legislation *does* stipulate that those grants require the submission of "5-year action plans" that would require States to indicate *some* specific priorities and consult with local and regional groups, instead of developing the plan entirely within a vacuum.[115] The Act also includes a provision requiring that States "may not exclude cooperatives, nonprofit organizations, public-private partnerships, private companies, public or private utilities, public utility districts, or local governments from eligibility for such grant funds."[116] Such stipulation is likely to bring challenges to several restrictive State laws which prohibit municipal broadband networks, discussed in §4.3. Similarly, the Digital Equity Act includes recognizes the existence of disparities and encourages remedies, but also devolves much decision-making to the States, meaning that the legislation itself contains no real implementation details.

As discussed in §2.3.4, measures of "access" do not accurately represent the *usage* (or usefulness) of Internet connectivity due to a number of factors including the deeply flawed methodology that has been—and continues to be—used in measuring connectivity (see §2.3.1), subpar standards for measuring the quality of connections, and because measuring access fails to capture the impact of high costs associated with many connections. The Act *does* address each of these, at least in part. For example, States can award subgrants of the $42.45 billion granted under Title I programs to projects concerned with "data collection, broadband mapping, and planning,"[117] which can ultimately contribute to more precise data which could enable more accurate analyses. And while (as discussed in §2.3.3) the FCC is the entity legally empowered to set the definition of broadband, the Act includes a clear indication that the Legislature thinks the current definition to be wanton. Formulae for grant allocation assess need both by measuring the presence of "unserved locations" and "underserved locations."[118] The former designation is pinned to the FCC's definition of "broadband" of a connection providing 25 Mbps download and 3 Mbps upload speeds—widely considered to be insufficient for modern needs—while the latter is defined by minimum speed thresholds of 100 Mbps download and 20 Mbps upload.

The most direct actions the act takes to address issues affordability are included in Title V. First, the Act revives an Obama Administration effort to compel Internet Service Providers to make "broadband consumer labels" available for its services.[119] Prompted by consumer complaints that ISPs often suddenly hike prices and charge unexpected fees,[120] these labels are inspired by the familiar nutrition label found on food items and intend

iv. If a State does not apply for some of the money, groups of municipalities can themselves apply instead to provide consumers with clear, transparent information about their service options in a standardized format designed by a bureaucratic institution rather than a marketing agency, which the FCC claims may lead to lower prices, more competition, and a healthier marketplace in the future.[121]

The other major action in Title V is the transformation of the Emergency Broadband Benefit (EBB) Program into the Affordable Connectivity Program (ACP). The EBB was established by the Consolidated Appropriations Act of 2021 to provide a $50 per month subsidy to eligible[v] American households. The "emergency" EBB responded to was the pandemic, and having the Government effectively pay market-rate bills for Internet service was the simplest and fastest response to the immediate needs. The EBB Program, however, was poorly administered[122] and always intended to be short-lived. The ACP keeps the same basic model, of directly subsidizing market-rate Internet service for the same group of eligible Americans covered under the EBB but aims to provide "sustainable" funding on an indefinite basis, starting with a $14.2 Billion allocation.[123]

While the Act does set the monthly subsidy at $30 per month (a 40% decrease compared to the EBB),[124] there is evidence that the ACP *is* making direct positive impacts on the level of the individual. In March 2022, after the ACP began operation, Verizon announced that where its Fios service was available, Americans who qualify for the ACP benefit can receive a symmetric 200 Mbps connection in their home, with no installation or ongoing cost.[125] Normally this plan costs $20 per month, but in some markets a 300 Mbps symmetrical connection, which normally costs $40 per month, is provided to ACP customers free of charge.[126] The company also boasts that "unlike other providers who offer ACP, we are also removing hidden cost barriers, with no extra fees, no contracts and no router costs,"[127] but it should be noted that this is likely not a purely benevolent act, because if starkly exposed by the consumer broadband labels, these hidden costs and extra fees would likely tarnish Verizon's reputation.

Fios is available in sizable but limited markets, so this outcome is not universal, but other providers, including AT&T and Comcast, have begun to target plans at ACP customers which offer markedly better service at lower costs than was offered before the program.[128] The ACP is too new to fully and fairly measure even its immediate impacts on impoverished Americans, and (as is discussed in the next subsection) the mechanism by which these costs are controlled leaves much to be desired, it is reasonable to conclude that the ACP is likely, at least in the short-term, to directly and bluntly confront the issue of high costs, which as covered in §2.3.4, is a major linchpin in the yawning digital divide. At the very least, it provides immediate relief, and signals some willingness to at least acknowledge a core

v. Eligibility determined by income below certain thresholds or existing enrollment in certain existing Government Assistance Programs.

issue.

§ 3.3.2 Relief, not Reform

While the Infrastructure Investment and Jobs Act certainly is a landmark Federal investment in Internet infrastructure that signals the top-down view is far from *laissez-faire,* it does little to strongly, directly challenge the status quo of corporate control that has produced the inequities it claims to address. The shortcomings of this legislation suggest that while interest is growing, the Federal government remains unwilling to fully challenge the telecommunication industry, and that a top-down corrective for the ills arising from the industry's profit motive is unlikely to materialize in the immediate future, to the peril of American citizens. At least three shortcomings are blatant—the legislation doubles down on the false narrative that rural areas need more federal assistance than do urban ones, includes grant programs that further enrich and entrench the telecommunications oligopoly, and misses key opportunities to promote competition at the local level.

The Continuing Curse of Poor Methodology

While the Act *does* hint that the FCC's 25/3 definition of "broadband" is insufficient, the fact that the methodology it uses measures *areas* as unserved or underserved is a disappointment. As shown in §2.3.1, the aforementioned poor data quality makes it difficult to effectively target this funding where it is most needed. Even if the quality of the data is improved over the next several years, this approach is still likely to prioritize rural areas over urban ones. The infrastructure grants established by Title I can be reallocated by States with subgrants, which must be prioritized according to several characteristics of what are considered the intended "unserved service projects" and "underserved location projects." To meet these designations and therefore be more likely to receive funding from the Title I Broadband Equity, Access, and Deployment Program, projects must target areas "in which not less than 80 percent of broadband-serviceable locations served by the project are unserved [and/or underserved] locations."[129] Because there is hardly any cities in the United States where less than 20% of locations within an area have access to 25/3 broadband, almost no unserved service projects will be recognized in cities. Reconsider, for example, the case of Baltimore City. Figures 2.7 and 2.8 visually suggest that much of the city—well more than the 20% of locations threshold—have *access* to 100/25 service, meaning that all potential infrastructure projects in the city are unlikely to receive funding through this grant program. The core issue for cities, that near-monopoly control of the market in these localities has produced several decades of underinvestment in infrastructure, poor service, and high prices, is not addressed by this legislation. As one commentator notes:

> ...Considering that large swaths of suburban and metropolitan areas would

> not qualify as "underserved" (lacking access to service offering between 25/3 Mbps and 100/20 Mbps) because they are "served" by high-cost, underperforming monopoly providers, this bill can be seen as a way to ensure expanded broadband access is confined to mostly rural America, while all but ignoring the broadband challenges in non-rural parts of the country, which is where most Americans live.[130]

Subsidies to Individuals and Industry

Given that Title I's Broadband Equity, Access, and Deployment Program largely excludes American cities, much of the Act's assistance to urban areas comes from the ACP benefits it funds. While this program seeks to immediately address the prohibitively burdensome costs of reliable and sufficient home Internet connections, it does this by plugging consumption-side holes. The supply-side, however, remains largely unchanged and arguably further entrenched. Verizon's press release noting that it was making a base Fios plan free for those eligible for recipients suggests that the company is genuine in its desire to expand connectivity. While this may be true for some individuals within the corporation, this press statement and ISPs' willingness in general to accept and promote the ACP benefit is more readily explainable by its driving motive.

The ACP is *not* an example of a government setting fixed rates for a utility, as was the case for the Bell system and is for electricity service. As a subsidy, the $30 per month provided under the ACP is still income for the telecommunications industry, so the $14.6 billion allocated under Title V of the Act is money for the taking. If existing subscribers qualify for ACP, there's a chance they will choose to apply it towards a more expensive tier of service while keeping the same out-of-pocket cost, or maybe their effective monthly rate drops. Regardless, the ISP sees constant or increased profits, consumers see constant or decreased costs and better service, and the Federal Government can be contented with the fact that its expenditure has had a direct and immediate benefit for millions of Americans.

The core issue is that with taxpayers now footing the ISPs' bills, the Federal Government has effectively issued another tacit endorsement of the status quo in the telecommunications industry. It could be argued that the influx of the ACP funding into the pockets of qualified recipients can spark some competition ISPs, but a few caveats significantly strain this argument. Given that much of the United States, including its cities, already suffers from the power of local near-monopoly ISPs, and the ACP funding is intended for sustainable but immediate use, eligible individuals are unlikely to have a plethora of options when choosing where to apply the benefit.

Further, much of the "competition" seen thus far in response to the EBB and ACP has manifested not in infrastructure investments, but instead in ISPs simply removing limits on existing infrastructure. For example, Verizon's free-with-ACP symmetrical 200 Mbps offering is certainly an improvement for many, but the existing fiber optic Fios infrastructure with which this offering is made available is already capable of those speeds. Those fiber optic cables are capable of delivering symmetric Gigabit speeds, so the 200 Mbps connections are themselves speed-gated and have little marginal cost for the company to install and service, easily recouped by a few months of receiving a subscriber's ACP benefit. Were Verizon frantically breaking ground to install new fiber optic cable in areas rich with potential ACP-eligible customers, one could argue that the benefit was serving to increase competition and spur private industry to expand its infrastructure. However, Verizon has largely paused its Fios expansion, and attempted to renege on arrangements to expand its network to low-income areas made with both States[131] and municipalities.[132]

The Gutting of True Ambition

The Infrastructure Investment and Jobs Act is perhaps most vulnerable to criticism for what it does not contain.

The next chapter discusses at length efforts to create real competition in the area of Internet service provision in cities through the creation of small, neighborhood- or municipality-specific network providers. These services may be run by a city or regional government, a local non-profit, or even a ragtag band of volunteers (see §4.1), but at their core they leverage the fact that the Internet *is* decentralized and nonproprietary to directly compete with incumbent ISPs by building their own networks. Because they are tied directly to the communities they serve, these entities have different motivating factors than do incumbent ISPs and are free to run operations that are less efficient and less profitable than a commercial provider (which is beholden to its shareholders), but which more personally serve the needs of their communities. As mentioned in §3.3.1, such organizations *cannot* be excluded from consideration during subgrant allocation, which itself has been described as a victory.[133]

But being specifically not excluded is a far cry from being prioritized, as those groups were when the infrastructure act was first proposed. The Biden Administration's March 2021 factsheet on its infrastructure goals noted that infrastructure grant funding (what would eventually become the Broadband Equity, Access, and Deployment Program grants) would prioritize "support for broadband networks owned, operated by, or affiliated with local governments, non-profits, and co-operatives—providers with less pressure to turn profits and with a commitment to serving entire communities."[134] The original proposal, which would have allocated a total of $100 billion for Internet infrastructure investments, was praised by many, with one headline claiming that "Biden broadband plan will be hated by big ISPs, welcomed by Internet users."[135] But by June the Administration had cut $35 billion of broadband funding from the deal and was silent on its previous efforts to prioritize public and community networks.[136] The original bill[137] introduced in the House lacked the strong language originally promoted by the White House, and amendments added by the Senate[138] failed to add it. In effect, as a commentator noted:

> . . . there's nothing in this bill that includes the more robust elements contained in . . . what President Joe Biden's initial American Jobs Plan called for: namely, a bill that addresses the affordability gap and also encourages competition in a way that favors community-centric solutions as an alternative to the corporate shareholder-focused monopoly model. There is very little in this that will help fix broken broadband markets.[139]

While, to be fair to parties involved, it should be noted that the specifics of broadband allocations and priorities were tied up in the Infrastructure Investment and Jobs Act, and thus part of a complex negotiation extending far beyond considerations of Internet access, it is also worth noting that the prioritization of these local and public networks would have added effectively zero additional cost to the taxpayers and would have required effectively no additional overhead on the part of the States, especially given that the actually enacted legislation *does* require States to consider their applications for subgrants. As is explored in §4.3, all opposition to such networks appears to emanate directly from the incumbent ISPs which would be subjected to potentially increased competition under such a scheme. Such a reaction is natural given telecom's profit motive, and it is hardly surprising to see it yield such results, given that the industry spends millions of dollars lobbying Congress per year.[140]

For a package originally likened to the New Deal,[141] this gutting of ambition falls short. President Roosevelt's pen signed into law acts that drastically expanded the role of the Federal Government in the lives of Americans and sought to use the centralized power of the nation as an advocate and an activist for the issues that impacted every individual, but which all lower forms of Government were too weak to reform, including, notably, public utilities. Biden's pen, in contrast, signed into law what amounts to a hapless compromise. With this Act, the Federal Government has failed to act in the interests of its citizens, especially the urban poor who are most vulnerable to the abuses of telecom. And, by giving up on ambitions to truly empower and deputize more local governments to implement the reforms it is unable to, it leaves those more local actors in a position where they must claw and struggle for progress they make, as will be seen in the next chapter.

Citations for Chapter 3

94. *Jessica Rosenworcel: Network Neutrality*, 35:46.
95. Wu, *The Master Switch*, 51.
96. *Timothy Wu*.
97. Wu, *The Master Switch*, 51.
98. Kallsen, *What is the Bell System?*, 3:12.
99. Ibid., 12:11.
100. Pai, *FCC chair Ajit Pai explains why he wants to scrap net neutrality*, 4:15.
101. Srago, *Why Can't You Sue Your Broadband Monopoly?*, 3.
102. Ibid., 4.
103. Ibid.
104. Ibid., 5.
105. Ibid., 4.
106. Ibid., 6.
107. Pai, *FCC chair Ajit Pai explains why he wants to scrap net neutrality*, 3:51.
108. Stein, "Patience and persistence pay off as Biden gets infrastructure deal across finish line."
109. *Infrastructure Investment and Jobs Act*, 1184.
110. Ibid., 1222.
111. Ibid.
112. Ibid., 1182.
113. Ibid., 1183.
114. Gonsalves, *The Good, the Bad and the Ugly in the Senate's $65 Billion Broadband Infrastructure Bill*.
115. *Infrastructure Investment and Jobs Act*, 1190.
116. Ibid., 1197.
117. Ibid., 1195.
118. Ibid., 1182.
119. Ibid., 1244.
120. Kelly, *FCC unanimously approves 'nutrition labels' for broadband services*.
121. Ibid.
122. Lapowsky, *Glitches and confusion are blocking some from FCC internet discounts*.
123. Gonsalves, *The Good, the Bad and the Ugly in the Senate's $65 Billion Broadband Infrastructure Bill*.
124. *Infrastructure Investment and Jobs Act*, 1242.
125. *Verizon program helps bridge digital divide*.
126. Clark, *Verizon makes Fios free for low-income customers through federal program*.
127. *Verizon program helps bridge digital divide*.
128. Clark, *Verizon makes Fios free for low-income customers through federal program*.
129. *Infrastructure Investment and Jobs Act*, 1183.
130. Gonsalves, *The Good, the Bad and the Ugly in the Senate's $65 Billion Broadband Infrastructure Bill*.
131. Brandom, *Verizon is weaseling out of its deal to bring FiOS to New Jersey's poorest regions*.
132. Reece, *New York's History with Telecommunications Lobby's Efforts to Replace Historic Municipal Franchising Regimes for Telecommunications with Centralized State Franchising, and Corresponding Influence of Regulatory Regime Upon Fios Buildout Outcomes*.
133. Gonsalves, *The Good, the Bad and the Ugly in the Senate's $65 Billion Broadband Infrastructure Bill*.
134. *FACT SHEET*.
135. Brodkin, *Biden broadband plan will be hated by big ISPs, welcomed by Internet users*.
136. Brodkin, *Biden silent on municipal broadband as he makes $65B deal with Republicans*.
137. DeFazio, *Infrastructure Investment and Jobs Act*.
138. Sinema, *S.Amdt.2137 to H.R.3684*.
139. Gonsalves, *The Good, the Bad and the Ugly in the Senate's $65 Billion Broadband Infrastructure Bill*.
140. Dellinger, *Here's How Telecom Giants Spent More Than $1 Billion Lobbying Congress*.
141. Medina, "Biden Wanted an F.D.R. Presidency. How's He Doing So Far?"

Chapter 4

Embracing Re-Decentralization

> *To me, government work, and work that attempts to serve everyone equally, is inherently political work. I think it is reasonable to try and shield from specific governmental issues like corruption, bribes, arbitrary changes, etc, but overall work like "universal internet" is transformative to society, and so will be "on the ballot" for as long as it exists.*
>
> Rob Johnson[142]

This chapter describes bottom-up efforts that have been formed out of the necessity and frustration created by the status quo of Internet service provision. Drawing from the technical and cultural elements of Internet architecture (covered in-depth in Chapter 2), these efforts rely on the fact that the Internet is inherently *decentralized,* and that, despite regulatory failures, still relatively "open" for experimentation and extension. This term is intended to more broadly capture what have at other times been referred to as "wireless community networks."[143]

First, I examine what I term "Community Network Projects" (CNPs). CNPs, for the purposes of this thesis, are non-governmental, non-commercial, non-institutional (specifically not attached to universities or schools) entities that attempt to deliver Internet service to community members. They may accomplish this through any number of mechanisms, from collectively purchasing service in order to obtain a lower rate to planning, installing, and maintaining their own network hardware.

Both the definition of "community" and the specific goals of the organization vary from case to case. Some may be sponsored by community housing organizations, with networking concerns contracted out to traditional network professionals. Some merely seek to replicate the "last mile" infrastructure traditionally offered by the private sector at a lower price. Others still adopt as a central organizational tenant an ethos of cyberlibertarianism and antagonism to the status quo. Some CNPs only rely on trained "professionals," several are run by volunteers and have specific skill-training and community-involvement objectives.

There are successful (in some cases, very successful) CNPs in suburban and rural areas, but there is a far greater variety and quantity of such projects in urban areas. As I will discuss, the density and diversity of cities offer increased opportunities for these projects to form and succeed. Differences (cultural, socioeconomic, architectural, etc.) between cities (and even neighborhoods within a single city) factor into the types of projects that can and do form, the goals of those projects, and their abilities to deliver on those goals.

Beyond CNPs, I also discuss what may be loosely termed "Municipal Broadband"—when municipalities take on the roles of network planner, provider, or operator that a CNP or incumbent ISP might otherwise. Here, I discuss both the efforts and possibilities of municipal broadband and telecom industry efforts that have attempted to prohibit it. Following from this, I more broadly discuss the notion of public ownership of Internet infrastructure, and what implications this might have on the network itself, the users of the network, and more abstractly on the relationship between individual and state.

Throughout the chapter, I discuss issues of scale. How, should any of these rebukes of the status quo take off, can we, the public, be assured that the same issues will not just reappear?

Having shown in Chapter 2 that the urban digital divide in Internet infrastructure and use is serious, and having shown in Chapter 3 that the Federal Government seems unlikely to meaningfully address this issue, this chapter takes on another meaning. Rather than just showing that CNPs and municipal broadband can work, I argue that these relatively local approaches, which claw small bits of control from the telecommunications industry, are ultimately necessary to protecting the interests of urban Americans. More than just securing lower rates and better service for individuals, such approaches can also strengthen community connections and stimulate local economies.

§ 4.1 NYC Mesh

NYC Mesh is one of the larger and more well-known CNPs in the United States. As its name suggests, the group is based in New York City, and serves as an excellent study in both the technical and human considerations in building a grassroots network. "NYC Mesh" has a dual meaning—it refers to both a physical network (consisting mainly of rooftop antennas and off-the-shelf consumer-grade wireless access points) and the community of volunteers who build and maintain that network. Despite their close involvement with the physical network, the members of the *organization* NYC Mesh are the chief proponents of this distinction. They underscore that with their network, unlike the physical Bell System of yore, which was effectively inseparable from its parent company, AT&T, the network doesn't belong to any one entity. It is through the consensus, not the command, of the community that the physical network is operated.

Both physically and organizationally, the project began at d.b.a., a bar at 41 1st Avenue, in Manhattan's East Village.[144] Despite its formation in the early 2010s—a period of acute gentrification—from its earliest inceptions the project appears to embody at least part of the counterculture ethos that defined the neighborhood decades earlier. On their website,[145] in press appearances,[146] in community presentations,[147] and in conversation,[148] NYC Mesh volunteers are unapologetic in describing their mistrust of incumbent Internet Service Providers (ISPs), clarifying that while they do indeed provide Internet service to New Yorkers, the fact that they connect users directly to an Internet Exchange Point (IXP)[i] with a minimal of intermediary networking and have strict policies regarding privacy and net neutrality means that they really can't be lumped in with the incumbents they oppose ("the telecom oligopoly in New York of Verizon, Optimum and Spectrum."[149])

While the network has grown to thousands of users who possess a wide range of viewpoints and technical expertise, "early supporters were mostly tech-liberationist types,"[150] and this thread is still clearly visible in the core of the organization.

§ 4.1.1 Nuts and Bolts of Mesh Infrastructure: "Guerrilla Wi-Fi"

Much as §2.1 was included to provide necessary technical background, this section begins with a brief overview of the technical nature of mesh networking, as in this case the technicalities of networking directly inform the structure and mission of the CNP.

What is a Mesh?

"Mesh" is an overloaded term in this area of networking, with many overlapping definitions. But, for the purposes of this thesis, I adopt a fairly basic one. Assume a network can be thought of as a collection of individuals (or their computers, phones, etc. as proxies), which I'll refer to as *node*, and the links between those individual nodes. If there is a link between individuals Alice and Bob, then we say that Alice and Bob are *directly* linked. If there is additionally a link between Bob and Caroline (and Caroline is not linked directly with anyone besides Bob), then we could say that Bob is directly linked to both Alice and Caroline and that Alice and Caroline are *indirectly* linked (through Bob). If a link between two individuals means that they have each other's contact information, then this is the same thing as saying that Alice could get a message to Bob (and vice versa) and that Bob could get a message to Caroline (and vice versa). Alice could not just call Caroline directly, but she could ask Bob to forward a message to her in a literal game of telephone. On one level, this is how all networks, including the Internet, work.

On a technical level, a network is convincingly described as a mesh network if it satisfies a few predicates:

1. There is no *central* node that all others are directly linked to,

i. An IXP is a center where multiple networks—those run by large companies like AT&T, Verizon, Google, or Apple interconnect. These sites are hubs on the Internet backbone, so when NYC Mesh connects to it, they have direct access to the "biggest pipe" of the Internet without needing to go through a commercial ISP first.

2. The network is not fragmented, meaning that any node is either directly or indirectly connected to every other node in the network,

3. Each node is directly linked to more than one (preferably to many) other nodes.

Ideally, such an architecture eliminates single point of failure. If a single node goes down (either because of technical failure, or, in the case of an authoritarian environment, because the individual operating the node has been targeted), the usefulness of the network is not impacted. This preference for decentralization is key to the Internet itself. NYC Mesh, (and practically every network calling itself a "mesh") fails to achieve this maximal decentralization, but the ideal does inform the design of the network and ethos of the organization.

Most members (individuals) of the organization have wireless routers and antennas mounted on the roofs of their buildings. A link between two members, or nodes, is accomplished by aligning antennas such that there is a direct line of sight between them. Such a connection is sufficient to create a network, which itself has many uses. But the biggest reason why people want to join NYC Mesh is because the network can carry an Internet connection.

Originally, when the organization had two nodes (one in an apartment and one in d.b.a.), the resident configured his equipment so that he could share his Internet connection with the bar by relaying it across the street. This model, of essentially sharing existing connections provided to homes and businesses by incumbent ISPs, is valid and functional, but it wasn't exactly "meshy. . . " such a system was merely an extension of one standard connection. In suburbia, it is not uncommon to find Wi-Fi repeaters set up to extend a wireless signal to a garage. In the East Village, effectively the same thing was being done, but just for a bar.

NYC Mesh's network is now much more "meshy" than it once was, but it is not a perfect or ideal mesh. Ultimately, this is a practical consideration. The organization's documentation notes that although it considers the network to be a mesh (and that "Mesh" is in the organization's name), such an advertisement should not be interpreted to extremes:

> As with all mesh networks, we must balance between becoming too much of a "star" topology vs a "mesh" topology.
>
> Neither is fully practical—Not literally every node next to each other can all connect to each other, nor can we sustain unlimited nodes connecting to one rooftop.[151]

Figure 4.1 presents an illustration of NYC Mesh's network design adapted from one of the organization's presentations. Though the diagram itself is somewhat abstract and generic, it is easy to imagine how this network topology may manifest when applied in the geography of the city. The large, black circles may represent neighborhoods or even larger areas (perhaps the entire island of Manhattan, or the *de facto* sequestered Red Hook section of Brooklyn). Inside each of these are individuals (represented N), which may be able to connect directly with other peers in the immediate area. At least one of these individuals can directly connect to one of the Hubs serving their neighborhood, which may be in a taller building or a community center with a direct fiber connection.

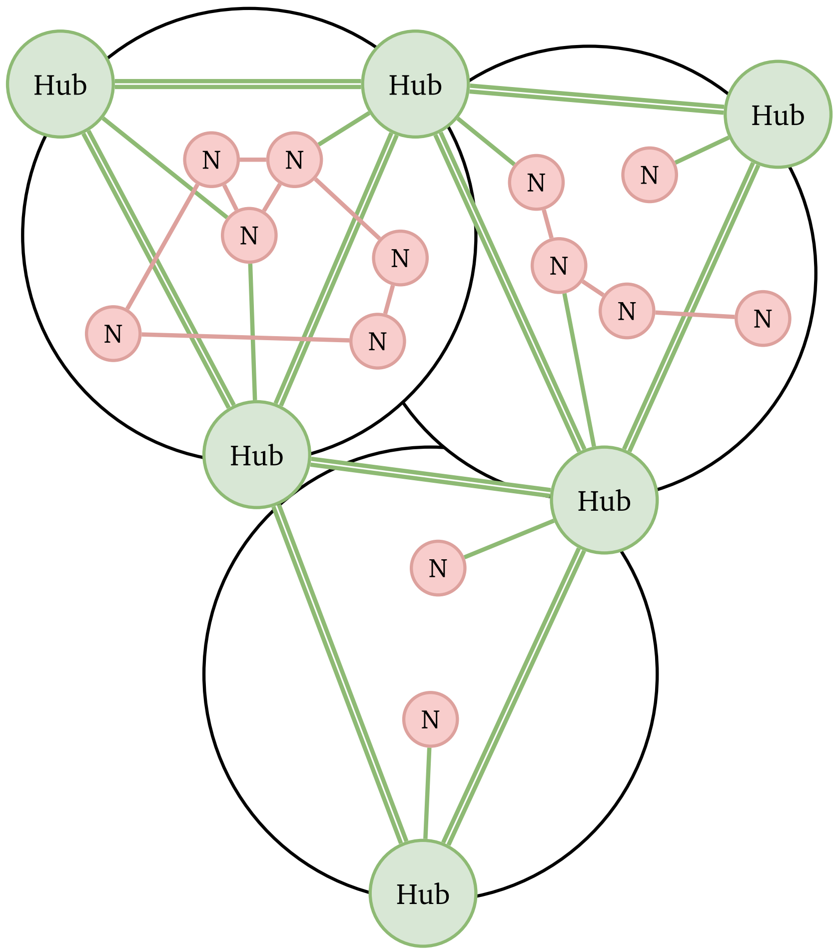


Figure 4.1: Here, each N represents an individual member or building. Individuals may be connected to the rest of the network by a direct link to a hub (which typically uses fancier equipment and has direct access to the Internet) or through intermediary peers.

At present there are 985 NYC Mesh installations and more than 4,500 individuals signed up for the organization's online communication tool. From donations, the organization pays a few thousand dollars in monthly rental fees for strategic antenna location on some tall buildings, and for the ability to "peer" with other networks in IXPs (which is how most Internet traffic flows into and out of the NYC Mesh network). Several volunteers are software developers and network engineers, so the organization has effectively no labor costs in this area. Good NYC Mesh connections can provide symmetric speeds in the several-hundred megabit per second range.

Because members of the organization own their own equipment, there *is* an up-front cost to joining. On average, the equipment for one building costs $240, and the organization asks that if you request installation help from a group of volunteers, you put up $50 for transportation expenses and incidental costs (though they are happy to have you perform your own installation), for a total of $290. NYC Mesh does offer need-based subsidies ($160 subsidized for equipment and installation) and installment plans for the equipment, and encourages groups of neighbors to invest together, amortizing the constant cost amongst them. There is no required monthly payment, however the organization does suggest a monthly donation of $20 to those who can afford it (which goes toward various expenses and subsidies).[152]

In its "Master Plan," the organization expresses that it would like to grow to the scale such that it can provide a high-quality connection to every building in the five boroughs. NYC Mesh has received grant funding from the Internet Society and Mozilla, both technology-oriented nonprofits, and is legally a subsidiary of the Internet Society Chapter of New York, in an arrangement designed to give NYC Mesh autonomy but also legal protection from some liability.

In and Of the City

The title of a 2021 profile of Daniel Heredia, an active NYC Mesh volunteer, and of NYC Mesh itself in *The New York Times* includes the term "Guerrilla Wi-Fi." While the piece touches upon the digital divide in general (discussed more in depth in Chapter 2) and New York-specific issues (such as Verizon's unsatisfactory fiber installation, discussed in §2.3.1), it also follows Heredia as he traipses across a rooftop in Brownsville, Brooklyn, crimping cables, aligning antennas, and running speed tests as he leads an installation. While firm in their opposition to the "telecom oligarchy," volunteers tend to be pleasant and softly spoken people,[153] and as an organization have developed clearly thought-out strategies for long-term growth and sustainability. Still, "guerrilla" is an apt term.

Incumbent ISPs provide a *service,* where a monthly fee paid to a telecom giant buys an installation, preconfigured networking equipment, and a terrible customer support system that is the only real mechanism for troubleshooting issues. The mass-market option, for better or worse, is a neatly packaged offering that is only identifiable by a corporate-branded router and local Wi-Fi network name. NYC Mesh also strives to offer a similar turnkey *service* for those who want or need it, but as a product of being a participatory, volunteer operation, it daylights the complexities of network engineering and installation typically discussed only internally at ISPs and implemented by specialized installers. The methods and technologies they use are, for the most part, the same as those used by ISPs—after all, the Internet is defined in technical, non-proprietary terms. Though large ISPs provide most of the service, NYC Mesh can do the same, and this means that it must deal in the technical, physical bones of network infrastructure.

The extent to which the organization deals in what may be considered the "nitty-gritty" is suggested by the detail of NYC Mesh's extensive documentation.[154] A linked slide presentation, which aims to provide an overview of the typical installation process and train volunteers with the requisite technical skills, is 105 slides long.[155] The presentation provides an overview of the group's workflow, including how it uses Slack, a popular online communication tool, and osTicket, the ticket system it uses to track installation requests.

As becomes clear early in the installation presentation, much of the process of deploying a CNP has just as much to do with the geography of the city and the types of buildings within it as it does to networking protocols. One of the first steps for anyone wishing to acquire a connection is to capture a panorama photo (usually from a rooftop, but occasionally out of a window). The reason for this photo is to establish potential Line-of-Sight (LOS) to other nodes in the network. Most connections in NYC Mesh are made wirelessly, with antennas transmitting signals over the city below. NYC Mesh can setup these antennas on rooftops dotting the city, largely without the express permission of any authority, because the antennas use *unlicensed spectrum*. Amongst its other regulatory duties, the FCC is charged with the management of the electromagnetic spectrum. The FCC demarcates certain bands as available for unlicensed use, meaning that permission is not required to operate transmitters in this range. These unlicensed ranges (2.4 GHz, 5 GHz, 24 GHz, and 60 GHz) are not harmful, but also more susceptible to interference by physical obstructions that other frequencies, FM radio, for instance. A good Line-of-Sight, a straight line between a transmitter and a receiver without buildings or lots of trees in the way, is therefore vital for a strong and reliable connection.

While NYC Mesh provides an online tool (see Figure 4.2 for an example) that uses a DoITT-provided 3-dimensional model of the city to attempt to map nodes that a building may have a LOS to,[156] a panorama is often the best way to verify these findings and account for nuances (like trees, chimneys, water towers, or other networking equipment) or new buildings that may not be captured in the model. In an effort to prevent future frustrations, NYC Mesh asks that LOS is verified before the group schedules an installation team.[ii]

Once LOS has been confirmed and an installation scheduled, a volunteer will self-select as a leader for the installation. The aforementioned slide deck disclaims that these installation leaders are responsible for assembling the required equipment and provides checklists that leaders should use. The equipment favored by NYC Mesh are reasonably cheap, unremarkable, off-the-shelf options.

ii. Given that the network is open and focused on connectivity, individuals *can* perform a self-installation and connect without explicit permission from the organization, but the group still strongly recommends that these self-installers perform a LOS check before purchasing equipment.

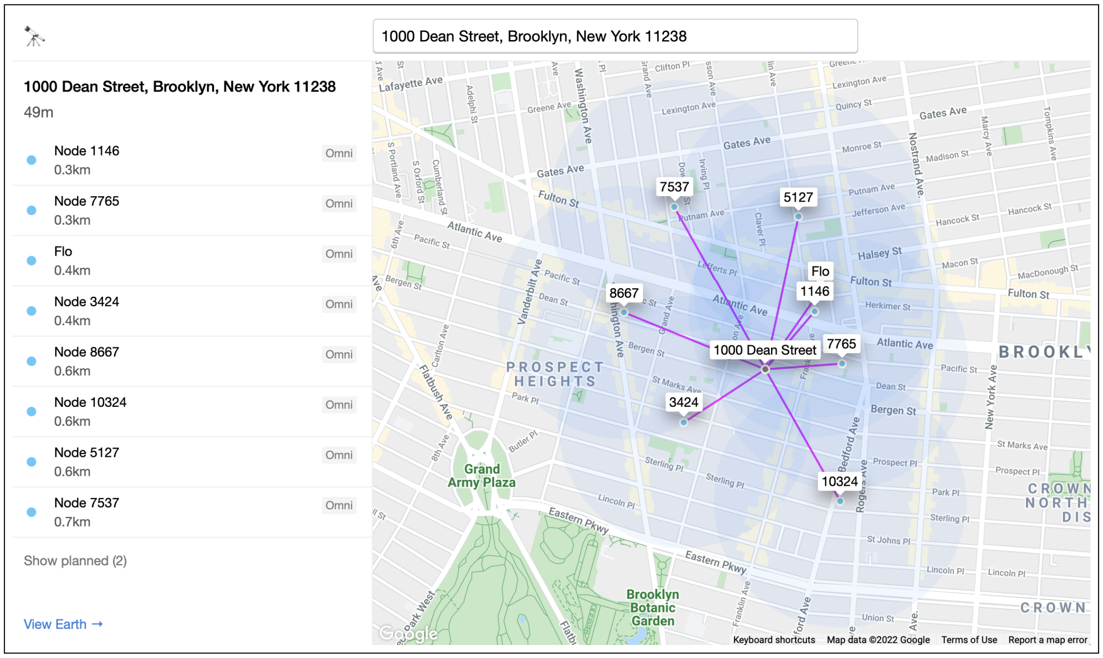


Figure 4.2: NYC Mesh's Line-of-Sight tool, for address 1000 Dean Street, Brooklyn, New York 11238.

Actual installation instructions range from the technical IT necessities to "tips of the trade" to policies and suggestions on etiquette and safety. On the technical side, there are illustrative diagrams of typical NYC Mesh setups (see Figure 4.4), instructions on how to attach or "crimp" RJ45 connectors onto the ends of Ethernet cables needed to connect components (Figure 4.3), tutorials on how to install needed firmware and configure the antennas, tips on which drill bits to use on roofs, and links to lists of subway stations with elevators (to make it easier to move equipment to the installation site, especially if installers don't have the "stair-climbing" hand trucks NYC Mesh veterans recommend).

Beyond the technical acts of creating a new network connection, NYC Mesh values installations as a form of "camaraderie and community-building."[159] After all, installers work on a volunteer basis, and in lieu of formal compensation, the hope is that installers feel rewarded by simply helping their fellow New Yorkers when they "See the joy on a new member's face when they get connected!"[160] Much in the same way people find tending community gardens or participating in neighborhood cleanups, the hope is that installers may find the acts of climbing on top of rooftops, aligning antennas, drilling holes, and crimping cables to the be a similarly welcome and fulfilling break from the typical. Indeed, the technical act of "connecting to the network" is often purposefully conflated with the social act of "joining the community." Hall, in presentations, has said "by joining, you are now part of our network. We're not like an ISP where we're giving you things, you become part of our network"[161]—a comparison not dissimilar to the that made between Internet

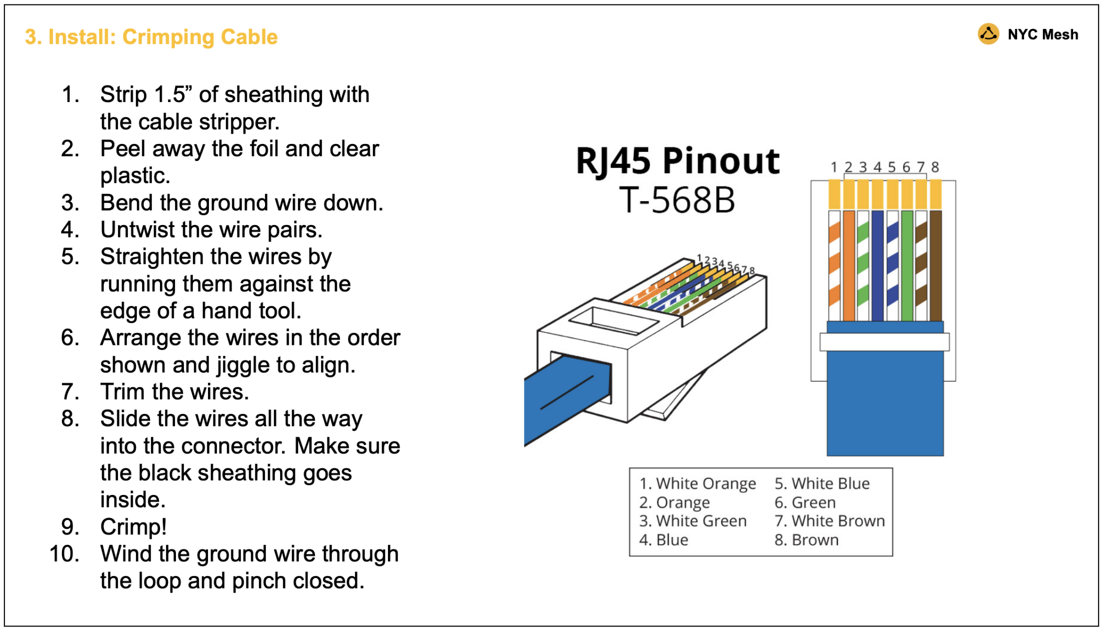


Figure 4.3: Slide 79 of NYC Mesh’s installations slide deck,[157] showing partial instructions for crimping RJ45 connectors onto Ethernet cables.

design and the Bell System (see §2.1).

Installers for incumbent ISPs are clearly employees, so the social interactions between them and the owners or occupants of the buildings they perform work for are relatively clearly defined by the contracted transaction arranged by the company. Installers show up with identification cards, in trucks with company logos, often with company-branded equipment. They have an official “look.” NYC Mesh install volunteers, on the other hand, arrive as a group of people who may be friends with one another or complete strangers. They don’t have uniforms, equipment vans, or any sort of official licensure certificate. Whereas the official nature of professional installers offers guardrails on what is and is not acceptable behavior on the part of the installer and the resident, those guidelines are largely murky, given that volunteers and residents are drawn from one of the most culturally diverse cities in the world, that volunteers aren’t paid (the $50 surcharge is meant to cover install leaders’ expenses, not serve as compensation), and that residents may not fully understand what the installers are doing. The organization has put together an “etiquette guide,”[162] which at a high level reminds volunteer installers:

> As a volunteer installer, you are the public face of NYCMesh! [*sic*] Courtesy, respect, friendliness and professionalism will give new members a great first impression of our organization and will encourage them to become active contributors to our community.

Specific recommendations range the gamut. Before the install, installers should check the

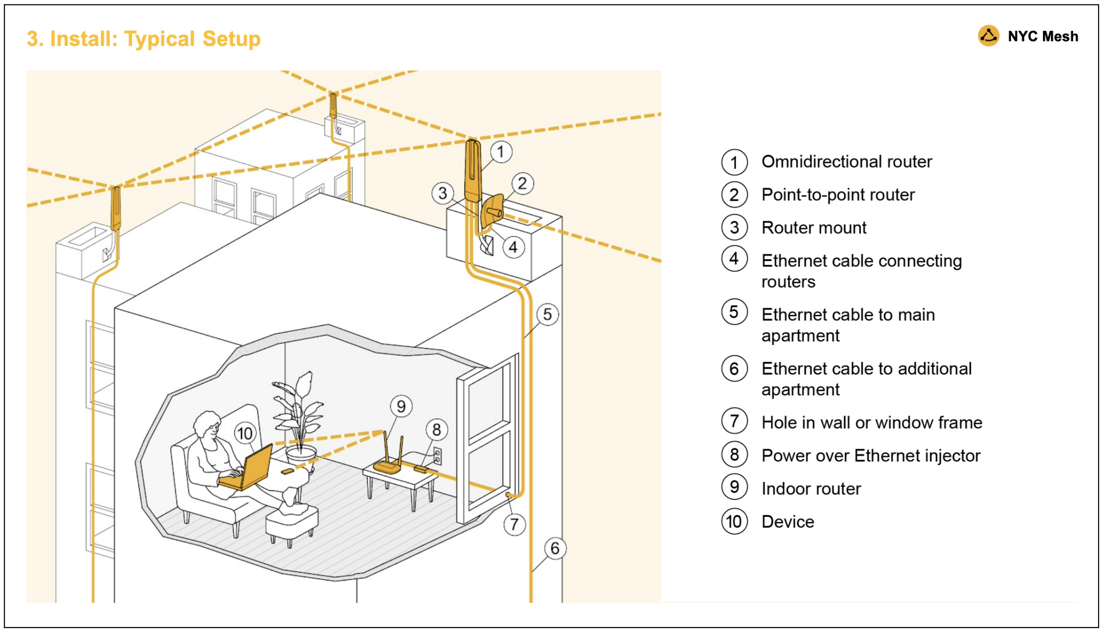


Figure 4.4: Slide 41 of NYC Mesh's installations slide deck,[158] showing the component of a typical installation of NYC Mesh.

weather forecast, get in touch with others working on the install, and check for public transit delays (if this is how they are getting to the install site). While at the site, they should be mindful of potential cultural and social differences, including "attitudes towards physical contact," wearing outdoor footwear indoors,[iii] language barriers, and differences in physical abilities that may impact who participates in the install and in what capacity. While installers should respect an installee's privacy, installers are encouraged to ask for the location of the bathroom when they arrive in case they need to use it during the install.

Though it goes without saying that NYC Mesh (the group) wants its volunteers to have a positive experience, it is also realistic about potential risks, most of which surround working on rooftops. The organization's documentation includes an entire section on site safety,[163] covering topics from fall hazards to electrical shocks to asbestos. The lack of formal, authorized training and licensure is a point of difference from the services offered by incumbent ISPs. Installers working for Spectrum or Verizon "often have safety protocols that are more stringent than" NYC Mesh's[164] and generally have a different concept of liability. Rob Johnson, a volunteer with NYC Mesh, describes this as a fundamental tension between "long term visions of a professionally supported mesh and an amateur [*sic*] one."[165]

By no means is participation in NYC Mesh an extremely dangerous activity. . . but the

iii. This is especially important because many roofs are covered with tar, which may be somewhat molten in summers and stick to the bottoms of shoes.

small amount of risk it requires members to take earns it the “guerrilla” qualification, at least in part. NYC Mesh proposes a community network, where members own their equipment. The donation of time and assumption of that small liability for participation validates the social contract members make with the rest of the NYC Mesh community. Rather than being passive consumers of Internet service, their independent and individually insignificant actions disrupt that status quo. In a small way, under this model participants embrace the ethos of decentralization inherent to the Internet itself.

§ 4.1.2 NYC Mesh Deployment

This subsection first seeks to highlight the current buildout of the NYC Mesh network and contrast that with national trends in broadband access, and then discuss how the organization is targeting expansions both based on the network’s infrastructural requirements and the desire to lessen the digital divide by serving certain populations.

Current Buildout

Given the organic, piecemeal manner in which NYC Mesh expands, it has not yet reached its goal of covering the entire city. As mentioned, the organization ultimately hopes to cover the entire City, but most of its current members live in (and thus the organization’s activity centers in) a southeastern portion of Manhattan (roughly bounded by the Brooklyn Bridge to the south, Broadway to the west, and 14th Street to the north) and in several neighborhoods in Brooklyn. The organization collects only what it considers the bare minimum of information needed to function (new members need to provide a name and email address), but this includes a location of each node. This information is needed, and ultimately public, because as one of the core tenets of the network is that others can connect to it, and therefore need to know the locations of existing nodes. This data is used by NYC Mesh to create its node map[166] and LOS verification tool,[167] and has also been used to create Figure 4.5, showing the currently installed and potential nodes in the future.

Given that relatively few (compared to the population of the city as a whole) use NYC Mesh, and because as mentioned above the organization collects a minimum of information from these members, there are not statistically rigorous and defensible measures of the demographics of the user base. One approach that provides some *very* limited insight is to perform an analysis on the relative wealth of the surroundings of each Mesh installation. Based on pre-pandemic (2019) American Community Survey data, the median incomes of the block groups containing the 927 nodes represented in the above-used NYC Mesh dataset have an average of $71,764.61, with a standard deviation of $34,780.36. Again, while this mode of analysis is inherently limited, Figure 4.6, which is based on such analysis, suggests that NYC Mesh’s installations tend to be in a more economically representative sample of

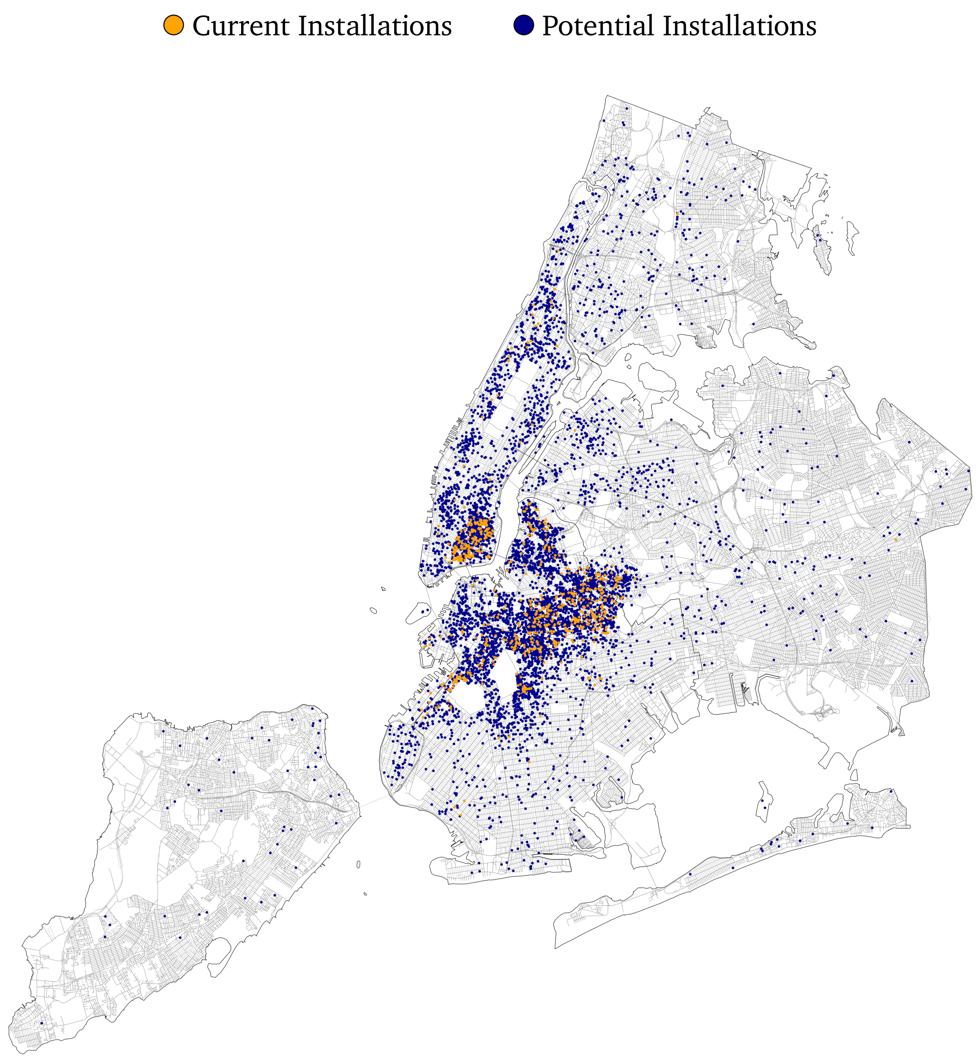


Figure 4.5: Map of current and potential NYC Mesh installations, created from NYC Mesh's current nodes data set.[168] "Current" installations refer to those nodes which have a `status` of "Installed", "Installation Scheduled", "Powered Off", or "To be scheduled". "Potential" installations refer to those nodes which have a null `status` or a `status` equal to "Interested".

the city as a whole, especially when compared to the stark divides seen in Baltimore's infrastructure deployments (see §2.3.3, and specifically Figures 2.1, 2.2, 2.3, and 2.4).

Targeting Buildings

Under ideal circumstances, the time investment to install and maintain a node is minimal. As the NYC Mesh network has grown beyond its origins, therefore, the already-connected volunteers who spearhead the organization are investing their time not just for the benefit

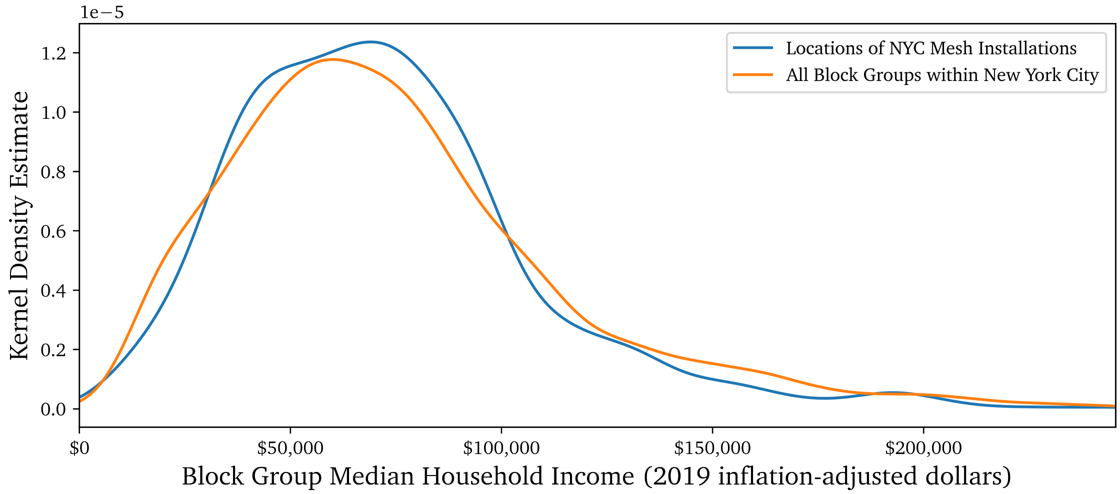


Figure 4.6: A Kernel Density Estimation plot drawn from two sets of ACS 5-Year median annual household income (in 2019 inflation-adjusted dollars) estimates (ACS detail variable `B19013_001E`[169]): one set of the block groups containing each instance of a NYC Mesh installation and another set for each block group in the City. Note, this analysis suggests that NYC Mesh's installations are geographically located in areas that are *economically* representative of the city.

of their own connections, but for the shape of the system as a whole. Given that they are group of volunteers, they have relatively few resources compared to those needed to realize the full mission of covering the city, so focus and prioritization is needed. A one-page flyer describing NYC Mesh's priorities notes that "To expand network access, NYC Mesh identifies strategically-located buildings to function as local hubs to which a surrounding community may connect."[170] Strategy, in this case, is very much concerned with the urban topography—the organization seeks to identify tall structures that can act as hubs, to bring a high-quality connection into a previously unconnected building:

> Tall structures are the only way we can expand the wireless mesh. This is by far our biggest priority. There are a few different types in the city and we need to try them all- NYCHA [New York City Housing Authority] buildings, skyscrapers, churches, schools, libraries, existing antenna masts and building coops. We need specific presentations and handouts for each of these types of structures. We are currently approaching libraries and churches. We need to build presentations for coop boards and others.
>
> Once we have a tall structure in a neighborhood we can link to apartment building rooftops.[171]

Targeting Populations

Increasingly, NYC Mesh has made a concerted effort to target growth towards underserved communities.[172] If a private developer is willing to pay to wire a new building, the organization is more than happy to help connect the building to the NYC Mesh network. But when targeting rooftops and community partnerships, the organization has been prioritizing neighborhoods most in need (there was a specific push to bring service to Brownsville, for example).

While NYC Mesh has primarily realized its network in connecting members' dwellings, the organization has not been limited by those spaces, and has expanded to businesses, community gardens, and public housing complexes. As alluded to, businesses (such as d.b.a.) can be connected to the network in much the same way that members' apartments are. There have also been efforts to promote connectivity through NYC Mesh in public spaces. The 11th Street Community Garden, for example, proudly displays a laminated sign proclaiming "We have free Wifi" and "Provided by nycmesh.net" near its front gate (see Figure 4.7). Especially for those New Yorkers who lack large cellular data plans or devices, such an installation provides a point of public access not tied to a retail business (a Coffee Shop, where one may be obligated to make a purchase) or subscription.

NYC Mesh, the organization, has also made attempts to work with large landlords and building owners, including, notably, the New York City Housing Authority (NYCHA). One realization of this effort has been the network's Saratoga Hub. The hub equipment is located on top of the NYCHA-owned building at 33 Saratoga Avenue, near the Eastern Avenue of the Bedford–Stuyvesant section of Brooklyn. The building is the tallest in its immediate area, and the panorama taken from its rooftop indicates that much of its surroundings have clear lines of sight to the Hub's antennas (see Figure 4.8).

The installation, in addition to the needed basics for establishing a signal with peer nodes, includes several wireless access points installed throughout the building. Rather than requiring each resident to request an installation, the building-scale approach provides what appears to be a "free" Wi-Fi network throughout the building that residents can use or ignore, without any need to individually contact the organization, an incumbent ISP, or NYCHA. Unlike in the case of a traditional installation on a managed building, the system's technical documentation is published and freely available—on its website, NYC Mesh lists the hardware used, details the approach installers took to mounting the wireless access points (which act as the true "last miles" by providing the signals residents connect to on each floor), and includes images of the installation and technical diagrams (see Figure 4.9).

As shown in Figure 4.10, the Hub largely lives up to its purpose, providing connections to other nodes both in its immediate vicinity and somewhat farther away. In addition to the access points it provides for building residents and the public access available at Halsey Street station, the installation also serves "large areas of the Bedford Stuyvesant and

Figure 4.7: Laminated signs (including one proclaiming free wireless Internet access provided through NYC Mesh) at the entrance to the 11th Street Community Garden in the Alphabet City neighborhood of Manhattan.

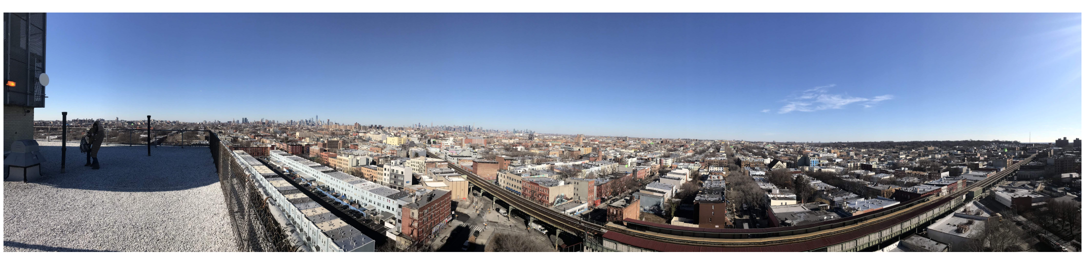


Figure 4.8: The panorama photo taken from NYC Mesh's Saratoga Hub.[173]

Bushwick neighborhoods."[175] Beyond providing access inside the building and functioning to expand the network, the installation was also used to provide free, unmetered Wi-Fi access at a nearby park and on the platforms of the Halsey Street station,[176] which is served by the New York City Subway's J train.

However, more so than with relatively small and old buildings, buildings that are large, new, and/or professionally managed tend to pose challenges for installers. The buildings

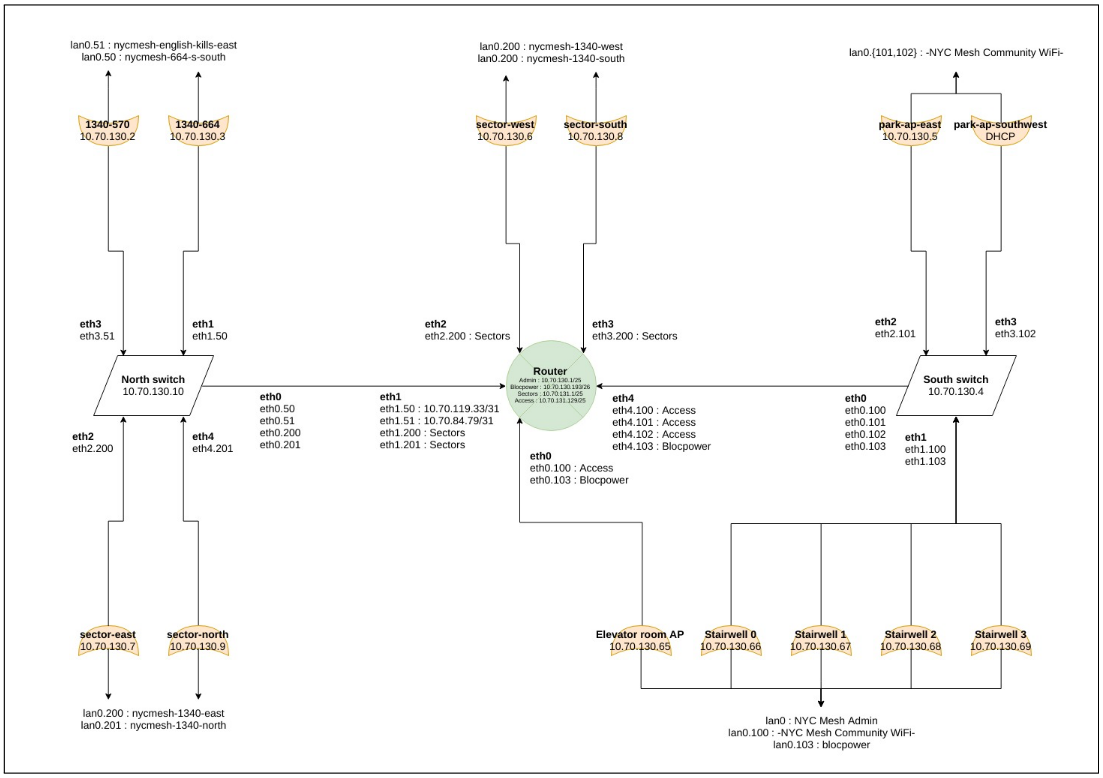


Figure 4.9: A technical diagram of the Saratoga Hub. While laden with technical information, the diagram is also firmly rooted in the physical space it has been created for. Note, for example, the elements depicting equipment located in the 33 Saratoga Avenue's elevator room and in each of the building's four stairwells.[174]

are less likely to have easy rooftop access or easy install points for the necessary equipment, or if they do such access is guarded by lock and key. The building owner may be wary of potentially liability they may face for allowing the informal, unaccredited installers to traipse around.[178] But, if building *owners* themselves ask the organization to connect it, once completed the installation (including all equipment and wiring) is owned by the building owner (rather than by an incumbent ISP).[179] Connections, of course, can be made wirelessly, but the organization can also arrange for a fiber optic connection to be made if the owner is willing to foot the installation cost and contract with an installer.[180] In addition to the Saratoga Hub, by mid-2019 NYC Mesh touted large building installations at the RiseBoro Youth Center in Bushwick, Brooklyn, the old Domino Sugar Refinery along the East River, and the Hotel on Rivington (a modern, relatively tall building surrounded by comparatively historic buildings on the Lower East Side) and had plans to expand to more NYCHA buildings as well.[181]

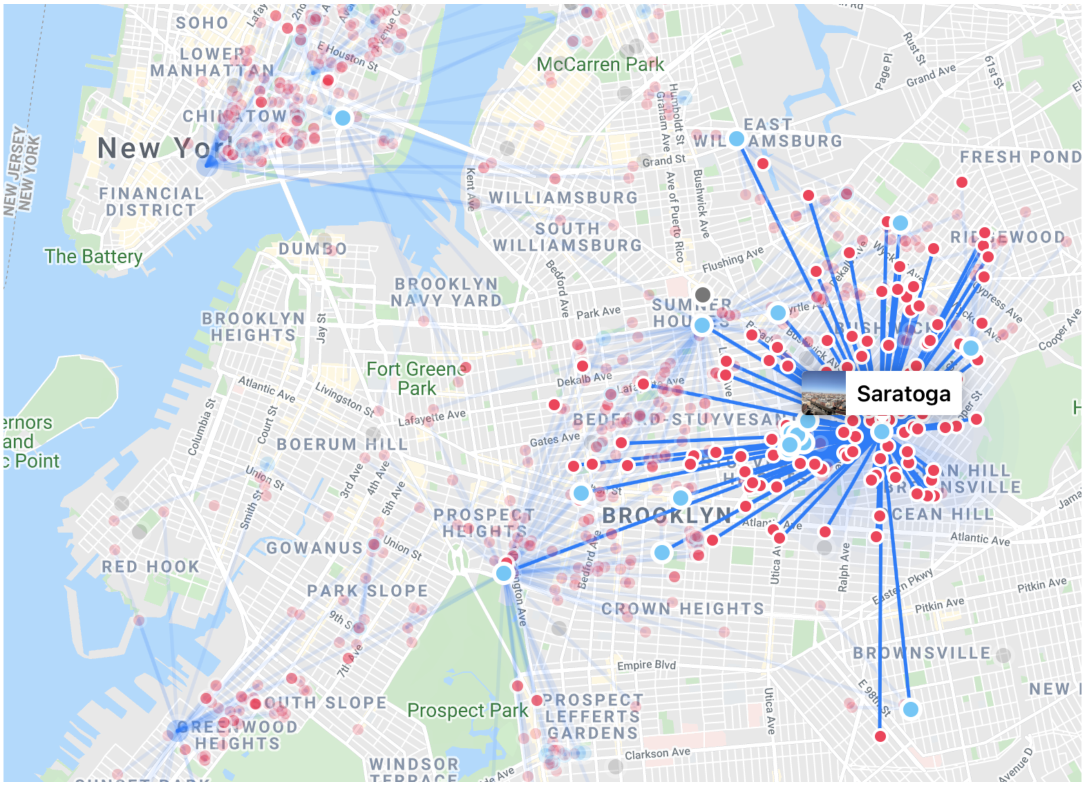


Figure 4.10: NYC Mesh's node map, showing other nodes connected to the Saratoga Hub.[177]

§ 4.1.3 Implicit hierarchy

A Master Plan Beyond Profit and Growth

As much as can be said about an organization that is inherently somewhat informal and ad-hoc, it appears that the core membership of the NYC Mesh organization truly is well-intentioned, hardworking volunteers endeavoring to improve the lives of their fellow New Yorkers. Though no organization can be perfect, NYC Mesh has attempted to bake into its culture elements that will safeguard against organizational corruption.

At a purely academic level, one may be tempted to ponder whether Robert Michel's "Iron Law of Oligarchy" may be exemplified or disproven by NYC Mesh. The oft-debated rule that "whoever says organization, says oligarchy" is refined into three claims: complex situations and systems require administration, begetting bureaucracy; that bureaucracy creates competition amongst bureaucrats, and the most effective naturally assume more power; power corrupts, and the organization supporting the bureaucracy develops a survival instinct (sometimes at peril of its original mission).[182] As discussed, organizers of NYC Mesh are transparent in the fact that the organization's "master plan" envisions a network that covers the entirety of the city, and in other presentations representatives of the organization have referred to Metcalfe's law: "the value of a telecommunications network is proportional to the square of the number of connected users of the system (n^2)."[183] Metcalfe's law was traditionally been viewed more as a "rule of thumb" and framed in terms of monetary value to users,[184] but with the goal of connectivity, and especially resiliency (recall, in a more ideal mesh, each node is connected to many other nodes, so the loss of one or many for any reason does not have any impacts on the rest of the network), it is not hard to see how members increasingly benefit when others join the mesh.[iv]

NYC Mesh's technical designs continue to be designed in the hopes of realizing the master plan, and the robust technologies which the network is based on can easily handle the scale of a city (after all, they are fundamentally the same technologies that constitute the Internet, which successfully operates at global scale). But while the technological challenges can be brushed aside, human factors cannot be. For its roughly 1,000 nodes, NYC Mesh's Slack communication tool has more than 5,000 registered members, and the support chat generally gets at least a few requests per day. A small and informal team of dedicated and knowledgeable volunteers can generally resolve issues as they arise but functioning as technical support for the entirety of New York would require not only more volunteers, but also significantly more complicated triaging mechanisms. While a few installers climbing on top of buildings is unlikely to garner many issues, scaling this up would likely attract liability concerns and other purely bureaucratic necessities. While the absolutist nature of Michel's proclamations is the subject of likely unresolvable academic debate, that this pattern *frequently* if not *always* occurs to some degree within organizations is typically accepted as fact. NYC Mesh presents an opportunity to theorize about the interplay between these two theoretical laws: does the satisfaction of Metcalfe's in the *network* force the *organization* to conform to Michel's? This question is intended as rhetorical. As NYC Mesh continues to expand, the way it thinks about and manages inevitable growing pains and the organization's role serves as an interesting case study for how, in an urban context, utility infrastructure can relate to the communities it serves beyond the impersonal delivery of incumbent ISPs.

Much of the aforementioned "master plan" relies on the installation of several new hubs throughout the city, acting as key connection points for their surrounding neighborhoods (à la the hub at 33 Saratoga Avenue, discussed in §4.1.2). This is partially due to the mechanics of mesh networking—the potential for obstruction and long distances makes city-wide nodes infeasible. But, there are other reasons to emphasize a neighborhood (or multi-neighborhood) hub model: "The populations are different, different local leaders... there's different local issues."[185] The organization, in the master plan, indicates

iv. The n^2 notation referenced in the presentation is mathematical notation indicating that the relationship is merely exponential; if an agreed-upon value *could* be assigned to each new member, the actual return function would almost certainly be *less* than the literal n^2.

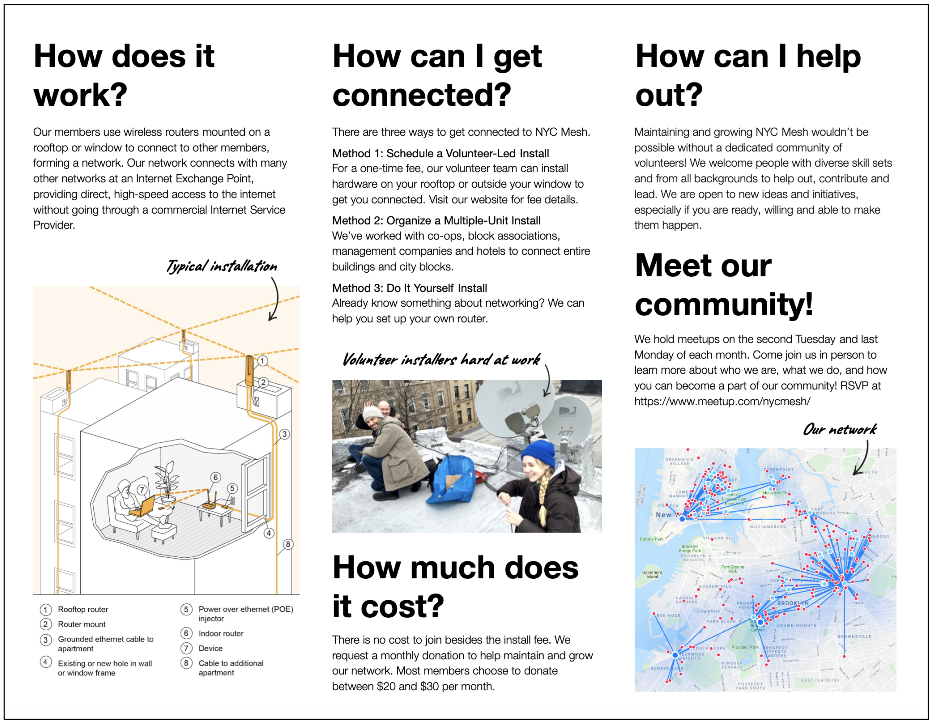
that working within existing communities and involving residents of the neighborhoods they install in are parts of their plans:

> ...You can hire different people in the neighborhood to do different things, but, when we need to be neighborhood-localized as well as across the whole city. I think that's really the only way we can grow the neighborhood successfully without having to either, you know, lay down rules from the top down, or only be concentrated in a small neighborhood. Therefore we need to adapt to something that's kind of country-wide in nature, but adapt it for New York City where we have the density so we don't have to have a, you know, one connection across a hundred miles, we can have several connections across many blocks that are diverse in their neighborhoods.[186]

In an attempt to grow neighborhoods with few social connections to existing mesh members, the organization targets installs. Sometimes these are directed towards specific, tall residential buildings (like the Saratoga Hub), but often the highest and most strategic installations are religious rather than residential, as noted by an outreach flier specifically created aimed at facilitating installations at these sites: "To reach our goal we need to install our small routers in tall structures in each neighborhood. Often the tallest structure is a church, and all over the world churches have been helping these community networks."[187] Existing and new members, of course, are encouraged to promote the network to their friends and neighbors, and many do. The organization provides multilingual pamphlets that have basic information about the network to further facilitate this (see Figure 4.11).

In the past, there have been occasions where the organization has worked with a neighborhood group to coordinate multiple installs along in a small area. Reflecting on the experience of working with the 700 Jefferson Avenue Block Association, a group based in Bedford Stuyvesant, Brooklyn, a volunteer NYC Mesh installer noted that such an arrangement had direct positive impact on the individual members who were connected, and produced a more stable network (from a technical perspective) and formed a basis for future expansions and volunteers:

> This install was particularly special, because for the first time we were not only connecting block residents to Saratoga Village but to each other, forming a more resilient mesh network. Now, if one antenna on the block went down, neighbors could still connect to the internet through another.
>
> ...
>
> [Kiki, Eugene, George, and Miriam are all members connected during this installation process.]
>
> Unlike Kiki and Eugene, who had upgraded their cable plan before getting frus-



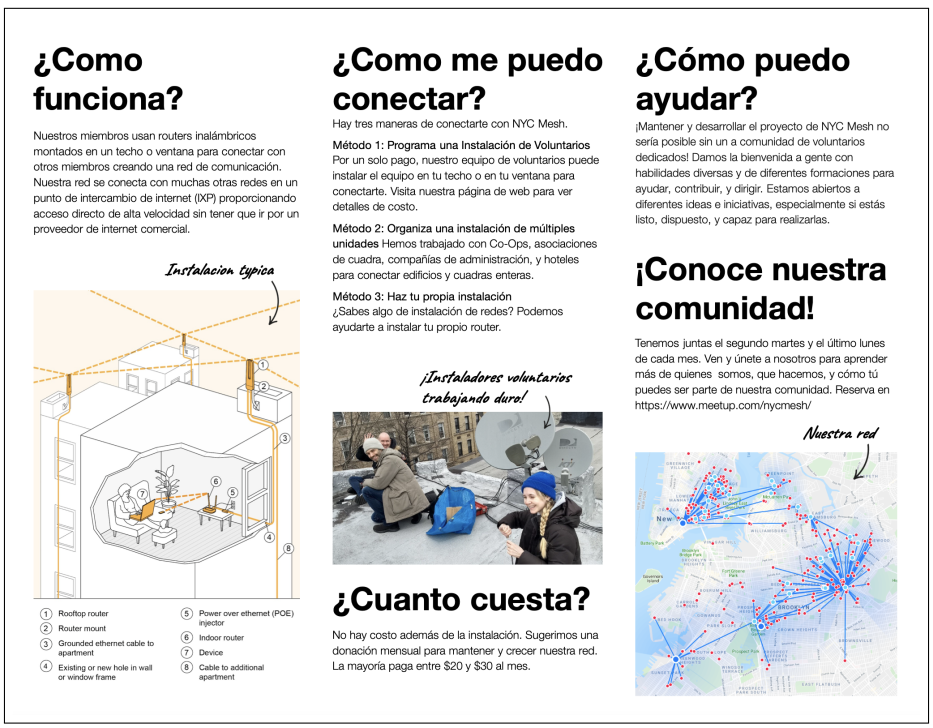


Figure 4.11: An outreach brochure created by NYC Mesh, available in both English[188] and Spanish.[189]

> trated and reaching out to NYC Mesh, George and Miriam had opted for the most basic plan. When they showed me the speeds they were getting my jaw dropped. Less than 2 Mbps down, which wasn't even enough to stream music let alone watch a movie or make a phone call! When we connected them to NYC Mesh, our first speed test yielded 51 Mbps down, more than 25 times the speed of their existing connection. You can see how happy they were when they posed for a photo with the antennas they share with Kiki and Eugene.
>
> ...
>
> Last month, Kiki invited us back again to set up a table at the annual 700 Jefferson Avenue block party. It was a blast—we met a lot of new block residents, handed out pamphlets explaining how the Mesh works, showed young people how to put an antenna together and chowed down on some delicious barbecue. And because our rooftop antennas broadcast public WiFi to the street, we were also able to help new people sign up for a volunteer-led install.[190]

Such a success, where an entire community buys in (to some extent) to NYC Mesh's model, is an early endorsement of the master plan's emphasis on neighborhood-level investment and stewardship. While not replicated on a wide scale, such an event is evidence that a certain symbiosis is possible. On one hand, the network, viewed as an entity itself, has a goal of maximizing connectivity and thus of growing. A neighborhood makes an initially moderate (installation) and small ongoing (maintenance) investment which allows the network to expand and provides a basis for even more expansion in the future. In return, individuals reap the benefits of that connectivity. More than that, though, a *community's* participation in NYC Mesh has the potential to benefit that community as an entity—it requires cooperation and familiarity between neighbors, and a degree of camaraderie between a geographically diverse group of volunteer installers and the members they help. While cyberspace is often accused of poaching social interaction from the streets and giving neighbors fewer reasons to be neighborly, NYC Mesh makes the physicality of the Internet tangible, and has the potential to strengthen "offline" social networks by involving participants in the construction of the infrastructure that delivers online social networks to their homes.

Though the NYC Mesh organization is very much one built around and in service of technology that is almost definitionally impersonal, these sorts of interactions paint it as a community of individuals in the same way the network is composed of nearly a thousand nodes. Such interactions are as varied as the volunteers. Contrast, for example, the outreach undertaken with the 700 Jefferson Avenue Block Association with a message posted by an individual calling themselves "nicolas equis" on the organization's Slack communication tool:

> hey comrades! we are helping maintain ownership of a 3-story brownstone that has been in the family since 1951!
>
> they were the first black family on the block in crown heights. they have been fighting against deed theft and, more recently, eviction for 5 years.
>
> they are currently back in the home but need to re-nest since the illegitimate slumlord threw all their things out, personal belongings, family history and all.
>
> they currently do not have wifi and I was wondering if yall would be interested in helping them set up mesh, possibly donating some material or helping us raise money for it?
>
> solidarity,
>
> nico - Brooklyn Eviction Defense[191]

In a threaded conversation, a volunteer exchanged messages with the poster, clarifying some details and discussing what may be possible. Within a day of the original post, two other members added their support, saying that they lived close to the site and would be willing to help with an installation.

Balancing Organizational Needs

Coordinators of NYC Mesh would likely argue that the organization is as decentralized as is practical. Hall, a self-described introvert, has written that "for some reason most of us are softly spoken, and louder people may have trouble fitting in. (Is this the opposite of most organizations?)"[192] They are aware that because there are no real roles or titles in the organization, technical know-how and tradition can lead to the development of an "implicit hierarchy," which they are wary of. Though the network has scaled to thousands of participants, there are still a relatively small number of individuals actively involved in the growth and coordination of the network as a whole (a few hundred at most), so issues of scale may not have fully developed yet.

In a posting in the NYC Mesh website titled "Protecting the Mesh",[193] one member outlines some of the issues that have proven inevitable in a decentralized, free network. Some of these issues are largely technical—"misbehaving or misconfigured equipment disrupting connectivity for others or spamming log files slowing support functions"—while others have more to do with the human aspects of a volunteer-run network. These fall into a few categories: a member may simply be maxing out the connection of one node (usually through file-sharing or torrenting), causing issues for nearby nodes; someone may be using the network for spam or other forms of abuse; or a member may not be honoring the Network Commons License that they implicitly agree to by using NYC Mesh (specifically, they may not be responding to requests from the organization or other potential members to use *their* node to further extend the network to another).

The current strategies to deal with these challenges vary. A core team of self-selecting volunteers who are sufficiently technically adept monitor the status of the network and reach out the members who may be using inordinate amounts of bandwidth on a regular basis (to the detriment of others) or who have misbehaving equipment. Automated abuse and copyright infringement reports of someone using the network are logged publicly and automatically in the organization's Slack communication tool, but because the organization does not track the details member activity on the network, "there is simply no mechanism for investigating which member has caused a DMCA alert or spam filter to be triggered."[194]

In extreme cases where the Network Commons License is violated, the contract does provide the organization an out from its otherwise impartial connectivity, allowing it to temporarily disconnect a misbehaving node: *"The network must allow access to any willing participant, except when doing so would jeopardize the proper functioning of the network."* Such an extreme does represent a cession of the completely pure, ideal network, and could arguably be seen as the basis for the rise of oligarchical power within the organization that, in practice if not by fiat, controls the network. Yet, an ideal network is merely theoretical, as connectivity between individuals is ultimately subject to the fallacies of human nature.

As NYC Mesh continues to expand in pursuit of city-wide connectivity, the network will likely act as a positive force in the lives of thousands of New Yorkers by strengthening neighborhood ties, creating new digital and non-digital connections between them, and, of course, providing affordable home Internet service. But it would be naïve to assume that with that increase of good would not come some additional abuse. For as much as the good as can come from decentralized, neighborhood-based organization, the bad must often be dealt with in a somewhat centralized manner, not just in mesh networks but in institutions of all shapes and sizes. How NYC Mesh, an organization inherently skeptical of control, will handle balancing these factors will likely continue to evolve. At present, however, there is no evidence that the organization and the volunteers that run it act as anything but benevolent stewards of the network. An academic debate over the satisfaction of Michel's Law notwithstanding, the strong internal culture (with remaining strains of "techno-liberationist") that NYC Mesh retains and the constantly changing cast of volunteers it attracts will likely act as some insulation against the deterioration of its core values. At any rate, it undeniably achieves lower prices and greater connectivity (of all types) than the incumbent ISPs it defiantly taunts and challenges.

§ 4.2 Other Community Network Projects

Though it is the focus of the previous section and certainly an interesting topic of study, NYC Mesh is neither the oldest nor largest CNP in operation. guifi.net,[195] for example, was founded in 2004 in Catalonia and now has more than 37,000 nodes connected in largely rural areas which have been otherwise underserved. In the context of American cities, the mission and structure of CNPs tend to reflect the needs of the community and often dovetail with existing community organizing efforts.

§ 4.2.1 Project Waves

Project Waves[196] is a CNP based in Baltimore City, Maryland. The group "was founded in 2018 in direct response to the Trump FCC's repeal of Net Neutrality,"[197] but much of its current messaging follows the theme of bridging the digital divide. Its website claims that more than 96,000 households within Baltimore City lack home internet service and that more than 24,000 Baltimore City Schools students were unable to complete schoolwork from home at the beginning of the COVID-19 Pandemic.[198] (A more detailed analysis of connection disparities in and around Baltimore can be found in §2.3.3, and §2.4 documents a sampling of the struggles faced by Baltimore students during this time). Whereas NYC Mesh is associated with the Internet Society of New York, from which it receives some protection from liability and funding, Project Waves is a project of the Digital Harbor Foundation,[199] a nonprofit which renovated a once-defunct recreation center into a youth-focused technology center, which supports it financially.

Project Waves use much of the same hardware as is used by NYC Mesh, described in §4.1.1, but as an organization is less concerned with the mesh network topology discussed previously. Whereas in a truly "meshy" network is "multipoint-to-multipoint" (all nodes or "points" connect to many others, and there are no central nodes) Project Waves prefers to describe its service as "Point-to-Multipoint."[200] Working at the neighborhood scale, the first step in a typical Project Waves buildout is the selection of a tall, high-density building. Project Waves pays for the installation of a new fiber optic connection[v] to the building (likely to be a custom installation, given the lackluster fiber availability seen in Figure 2.9). Project Waves internally wires wireless access points for the building, providing "high-speed Internet service to low- and mixed-income apartment buildings across Baltimore City, ensuring residents have access to the highest quality broadband at no cost to them. Tenants enjoy hassle-free Internet service while landlords can highlight the Waves network as an amenity within their communities."[201] From the rooftop of the apartment building, antennae broadcast the signal to surrounding low-rise houses, which can then extend that signal for nearby public access.[202] Given Baltimore City's large tracts of nearly identical rowhomes, this network typology is likely well-optimized.

v. It should be noted that NYC Mesh will happily connect buildings directly via fiber, but the relatively high cost of this option means that it is not common, and NYC Mesh's organization tends to emphasize the "meshy" wireless topology described previously more.

As of August of 2021, Project Waves reported that it connected 371 households to the Internet through its service, or a total of 960 individuals.[203] 67% of those users are reported to be Spanish speakers (a group traditionally overrepresented in the unconnected population), and the median household income of Project Waves users is reported at $13,000 per year[204] (especially relevant given the disparities in connectivity in Baltimore correlated with income, as shown in Figures 2.1, 2.2, and 2.10, and in Table 2.3).

§ 4.2.2 Red Hook WiFi

Red Hook WiFi, another CNP, differs from those discussed previously in that it is in design and operation tied to one specific neighborhood: its namesake, Red Hook, Brooklyn. Red Hook, a small enclave of Brooklyn on the New York Harbor, is separated from the rest of the borough of Brooklyn by the Brooklyn-Queens Expressway and entrance to the Brooklyn-Battery Tunnel and lacks strong public transportation connections, and as a result is often seen as a forgotten part of the city. The neighborhood, compared to surrounding areas, is relatively poor and non-White, with relatively low rates of Internet connectivity, especially within the Red Hook Houses, a large NYCHA-managed public housing development.

Red Hook WiFi is a project of the Red Hook Initiative (RHI), an organization originally founded in 2002 as the Red Hook Health Initiative with a focus on community health that has since grown to manage a community center and sponsor youth development and community building programs. By 2012, RHI had established a very limited wireless mesh network between its community center and an apartment building near to the public Coffey Park (not dissimilar from NYC Mesh's origins as a single connection between an apartment and a bar). In October of 2012, however, Red Hook's low-lying land and proximity to the Hudson River became a liability, as most of the neighborhood was inundated by 14-foot storm surges brought by Hurricane Sandy.[205] In his 2015 Master's Thesis, Houman Saberi examined Red Hook WiFi, and highlights the network's role in hurricane response:

> RHI soon became a hub for post-Sandy relief efforts, especially once the Federal Emergency Management Agency (FEMA) installed a satellite internet connection. The WMN [wireless mesh network] leveraged this connection to provide internet access across Coffey Park where residents would gather to connect to the outside world.[206]

For all the destruction Sandy wrought, it also gave the network a new purpose and identity. Rather than try to span the city, as NYC Mesh seeks to, RHI has expanded and refined Red Hook WiFi. Instead of spanning the city, it seeks to span more of the neighborhood with a specific goal of resiliency (for example, access points have been connected to solar panels, with the idea that if the electrical connection in a building is lost in an extreme weather event, Internet communications can continue for emergency purposes).[207]

And, as Saberi explains, RHI's intent is not merely the provision of connectivity, though that is an obvious goal of Red Hook WiFi. RHI uses the network as a tool for training and development by centering it at the center of its Digital Stewards program:

> RHI has launched the Digital Stewards program, which employs Red Hook young adults between the ages of 19 and 24 to install, maintain, and promote the mesh network. The stewards are hired for one year and receive training in hardware, software, and community organizing. At the end of their year, stewards are placed in jobs or internships. There are currently four stewards in the most recent cohort, with 20 who have gone through the full program. Of these 20, approximately ten of them have leveraged their experience into full-time jobs.

As such, Red Hook WiFi has many similarities to its peer CNP, NYC Mesh, but represents firmer, more concentrated intent. Ultimately, the goals of connectivity and neighborhood empowerment are largely the same, but the fact that Red Hook WiFi is specific to one place and is more willing to accept the centralization and coordination provided by RHI results in a clearer, less ambiguous version of the NYC Mesh master plan's vision for neighborhood involvement. Though Saberi's thesis, written in 2015, is now out of date, it provides insights into the growing pains faced by Red Hook WiFi, and highlights the way in which this concentration of effort was enabling it to address those challenges:

> As RHI began to establish a network of WiFi nodes post-Sandy, one of the key bottlenecks that emerged was access to private rooftops. Out of a concern for liability, many buildings owners were concerned about the prospect of young individuals clambering over their rooftops and installing WiFi nodes at the very edge of the roof. However, by early 2015, Red Hook WiFi was successful in persuading enough building owners to establish a network of 15 nodes...
>
> Another challenge that remains for the organization is evaluating the success of their efforts. For instance, the organization does not have a system in place for assessing how much time users are spending on their splash page (the page that automatically appears when users log on to Red Hook Wifi). Thus while it is unclear whether users spend time exploring the splash page and the local information posted on it, anecdotally it is thought that most users leave the splash immediately in order to browse the web or access social media sites. Given the absence of evaluation tools, it is also unclear if using Red Hook WiFi has increased users' awareness of the importance of IT infrastructure, although the focus group with the Digital Stewards provided additional insight into this question.[208]

§ 4.2.3 ONE|NB Connects

At the onset of the COVID-19 Pandemic, it became clear to some working for ONE Neighborhood Builders, a community development organization, that the lack of Internet access for residents in many of the organization's buildings in its home neighborhood of Olneyville in Providence, Rhode Island, was going to quickly become problematic. In Olneyville the same issues arose as in Baltimore, New York, and across the rest of the country: as "everything" shifted online, members of their community found themselves effectively cut out of what remaining sense of normal life remained. Children had trouble completing their school assignments, and the rise of telehealth, which could promise to meaningfully improve the wellbeing of these residents, was stunted.

Seeing this ballooning need and understanding that even the cheapest plans available from incumbent ISPs were outside of the means of many of ONE Neighborhood Builders' tenants, the director of the group, Jennifer Hawkins, resolved to simply find the money to purchase yearlong subscriptions to a high-quality connection for each of the organization's Olneyville tenants. After all, the times were unprecedented, and those connections were barriers between children being able to continue their educations, adults being able to work remotely, and the community as a whole to maintain communications.

There was, however, a wrinkle in this plan. When Hawkins approached ISPs serving the area, they told her that it wasn't merely that they didn't want to serve her tenants under such an arrangement, but that they were legally barred from doing so.[209] Though the exact legislation was never cited directly, this prohibition is likely derived from Rhode Island General Laws §39-19-10, which includes the preamble:

> Pursuant to the legislative intent that a tenant in a multiple dwelling unit shall have the freedom and right to select the provider of cable television, telephone, telecommunications, or information service to their living unit, without any restraints, limitations, or conditions imposed by a landlord, and to enable CATV operators or other telephone, telecommunications, or information service providers to offer meaningful choices to tenants of multiple dwelling or commercial units, a tenant in a multiple dwelling unit may subscribe to CATV, telephone, telecommunications, or information service. . .[210]

Such text is interpreted to mean that in a multi-unit building, a tenant must have the choice of which Internet Service Provider to contract with, and that if the landlord (ONE Neighborhood Builders, in this case) contracts with an ISP with the intent of acting as a purchaser on behalf of the tenant, this is a violation of tenants' rights, as it artificially alters choices. ONE Neighborhood Builders, of course, had entirely benevolent intent, but there have been many instances of exclusivity deals between ISPs and landlords in the past.[211]

This created an issue, as the need for connectivity was time sensitive: tenants needed

Internet access as soon as possible, so maneuvering around the bureaucracy of ISPs and the complexity of State legislation to make this arrangement work was not feasible. A simple alternative, to simply *give* tenants the monthly stipends for Internet service, may not have worked well either. As Emily Horowitz and Julia Krasnow, Community Wi-Fi Contractors assisting ONE Neighborhood Builders in the summer of 2021, explained, tenants may have uncertain or undocumented immigration statuses, and thus be wary of signing up with a traditional ISP, which often collect personal information which tenants may not possess or which may put their residency in jeopardy. Additionally, tenants may be unfamiliar with which ISPs can provide service, and the process by which they would arrange an installation.[212]

Given the immediacy of the need, ONE Neighborhood Builders felt it had few options: it would create its own network, and itself become an ISP for its tenants and community. The resultant CNP, christened "ONE|NB Connects," diverges from the goals and context of the other CNPs which have been discussed and thus serves as an excellent case through which to understand the factors that affect this type of network development.

The ONE|NB Connects network, in its current form, consists of two "hubs" which have wired connections to the Internet, along with twelve "hop" repeaters, which in tandem are used to spread the wireless signal to One Neighborhood Builders' many properties in the area. One Neighborhood Builders provides a map of the nodes of their system on their website (see Figure 4.12). While slightly hilly, Olneyville's built environment is largely characterized by two- and three-story houses with peaked roofs and similar overall heights. The fact that there are no structures in the area that are markedly taller than their surroundings means that the physical network models employed in New York (see §4.1 and §4.2.2) and Baltimore (see §4.2.1), which rely on their City's building stock to strategically place hub nodes to create many opportunities for good line of sight for wireless connections, would simply not be possible in this section of Providence. Even if such a tall structure existed, the peaked roofs common to the area would likely lead to higher installation costs and greater risk (rowhomes in Baltimore and New York tend to have nearly completely flat roofs, minimizing these factors and usually precluding the need to use a ladder).

Given the fact that such a solution is unique, and that ONE Neighborhood Builders did not have any in-house networking expertise, once the organization committed to building the network and began raising funds to do so, it took a while until they actually had it up and running. While the pandemic shuttered schools in March of 2020, ONE|NB Connects wasn't up and running until October. In an interview[214] in the summer of 2021, more than half a year after the network started operating, Horowitz and Krasnow indicated that usage of the network had been at least slightly disappointing thus far. Originally, the goal had been to connect 1,000 individuals to the network, but several months in, the organization estimated it had only attracted 200 individuals. Over the time that Horowitz and Krasnow

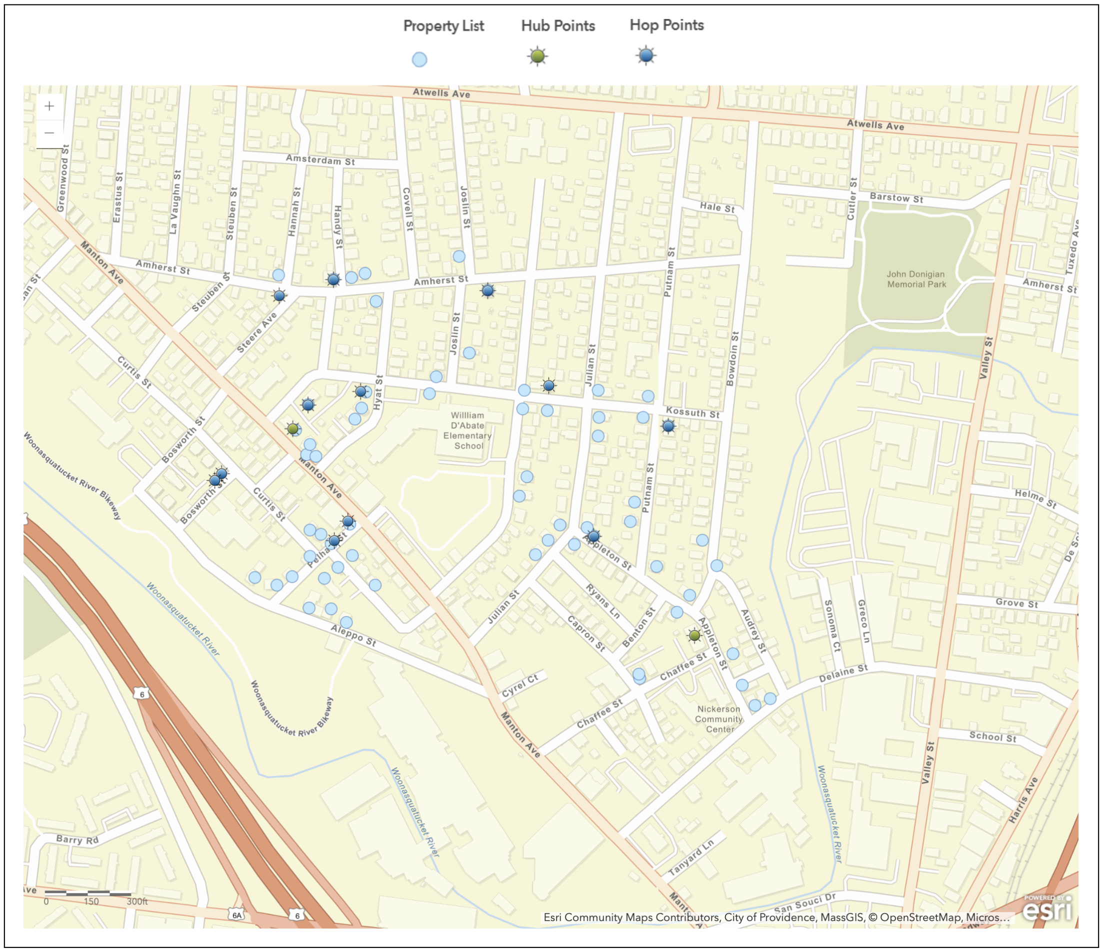


Figure 4.12: A map of the ONE|NB Connects network in the Olneyville Neighborhood of Providence, Rhode Island.[213]

had been working for ONE Neighborhood Builders, they conducted door-to-door outreach and other forms of community engagement. By the time of our conversation, they had pushed the total number of individuals who had tried the network over 1,000 (by February 2022, the network achieved 1,700 unique individuals connected[215]). On average, however, only 15-30 individuals were using the network per day, well below the intended usage.[vi]

Verizon FiOS offers a 300 Mbps connection for $40 per month per address, so if the organization *had* simply purchased this level of connection for each of its 55 properties for twelve months, it would have paid $26,400 to the ISP. While not an insignificant amount of money, this pales in comparison to the over $260,000 the organization raised in order to launch this project.[216] Even supposing ONE Neighborhood Builders had decided to

vi. They noted that this figure was likely extra low given that school was out of session for the summer, and that allowing students to connect was one of the primary envisioned uses of the network.

purchase two 300 Mbps connections per address (for a yearly total of $52,800) or even splurged on a Gigabit[vii] fiber connection ($90 per month, for a total of $59,400), they still would have spent significantly less than it cost to launch their own network. Though fairly reliable, Horowitz and Krasnow said it was unlikely to be able to compete with the reliability offered by a commercial ISP, and in order to maintain stable coverage across the network, each connected device is limited to 20 Mbps, meaning it technically falls below the FCC's already lackluster definition of broadband (discussed in §2.3.3). As such, Horowitz and Krasnow suggested that rather than looking at the network as a *replacement* for a commercial ISP, it should be viewed as a *supplement* for insufficient connectivity provided by incumbents. While otherwise unconnected residents may rely on ONE|NB connects as their sole lifeline connection, the sizable number of *under*connected residents, who had preexisting connections which were simply incapable of handling the strain of remote work and remote learning (discussed in §2.4), could use the slight extra bandwidth provided by the network to cope with situations where a connection must be shared between several individuals.

While many users, such as Harry, an Olneyville resident who uses ONE|NB Connects to access telehealth care, find the service to be valuable and useful,[217] it is undeniable that the return on investment has been disappointing. Several factors have been cited for the increasing-but-low adoption rate amongst Olneyville residents. Some residents already had paid commercial connections, so saw no need to try ONE|NB Connects. Some were simply unaware of its existence. Several residents were skeptical that it was actually free for them to use, and some, especially those with uncertain immigration statuses, feared that the network was a form of surveillance. Some were also unaccustomed to using the Internet in their homes, and unfamiliar with what they could use it for, especially in the context of the pandemic. Many of these problems arose because the organization "didn't take the time to think about, when we do this, how are we going to get the word out, how are we going to let the community know this service is available to them, how do we let them know this is safe for them to use and is indeed free, with no catch, no caveats, free as long as you're within the range of the community wifi, you're allowed to use it."[218]

Both the high cost and low initial use of the network can be attributed, at least in part, to the context in which the network was conceived. Commercial ISPs have been building their networks and businesses for decades. Red Hook Wifi and NYC Mesh have been operating since the early-to-mid-2010s, and Project Waves, though drawing significant interest during the pandemic, was originally founded in 2018. ONE|NB Connects, on the other hand, was conceived in the early and confusing days of the pandemic, by an incredibly well-

vii. Verizon FiOS advertises a 940 Mbps download/880 Mbps upload connection as "Gigabit," despite falling just short of the technical definition implied by this term.

intentioned group of people who had no real expertise with networking whatsoever. Rather than being able to grow a community of volunteers over the span of years as other CNPs had done, ONE Neighborhood Builders contracted with local network engineering firms to wire buildings, place antennas, and test signal strengths, all at a relatively high cost.

The goal with ONE|NB Connects is the same as with other CNPs: connectivity. The difference in networks that have arisen in pursuit of that goal reflect the people involved, and the situation surrounding their work. NYC Mesh has grown out of a group of "tech-liberationist types" trying to "stick it to the man (telecom)" into an organization that attempts to empower neighborhood ownership of infrastructure. It relies on a strong concentration of technically skilled individuals willing to work, *pro bono publico*, to help connect and train individuals who would otherwise be strangers. Project Waves has a similar model. Red Hook Wifi, while also constraining its bounds to a single neighborhood, has, from conception, attempted to build a community-maintained network through its stewardship program. Lacking the time, knowledge, and people, ONE Neighborhood Builders achieved connectivity slowly, and at high cost. Such deficiencies do not reflect poorly on their valiant efforts; rather, they highlight the failures of the status quo that have sparked the creation of all the CNPs that have been discussed here.

§ 4.3 Municipal Broadband and Public Ownership

§4.1 and §4.2 have examined self-appointed community groups that banded together in an effort to provide Internet connectivity in their respective cities, and in doing so, challenged the status quo enforced by incumbent, commercial ISPs. Such disruptive action, however, has not been limited to these groups: certain American municipalities have made direct and concerted efforts to expand connectivity within their borders, going beyond *laissez-faire* regulation and permitting, often with the goal of acting as a corrective measure to unequal service and high prices. Given that municipal broadband is inherently enmeshed with city (or sometimes regional) government, it is not as far on the spectrum of idealized decentralization as the aforementioned CNPs are, but they still represent a notable shift from complete deference to ISPs controlled by (multi)national corporations which have been (very) lightly regulated at the federal and state levels where, as discussed in §2.3 and §2.4, the needs of American urbanites often go overlooked. As a 2017 report by the Congressional Research Service (CRS) found, "municipal broadband" deployments, like CNPs, vary across the nation, and tend to reflect some of the needs of the municipalities they serve:

> Public entities that provide broadband service can be local governments or public utilities, for example, and may construct and manage broadband networks either solely or in partnership with private companies. Several municipal broad-

> band models have been implemented across the nation. Since each community is different and each faces unique challenges, there is no one size that fits all.[219]

Further:

> Municipal broadband (also sometimes referred to as "community broadband") is a somewhat amorphous term that can signify many ways that a local government might participate either directly or indirectly—in the provision of broadband service to the local community. Municipal broadband models can include public ownership, public-private partnership [P3], and a cooperative model.[220]

In a *public ownership* model, local government is the entity that builds, owns, and operates the network. Often, services under this model are grafted onto another entity, usually a municipal utility (city-controlled electric, gas, or water, for example), or are controlled by a direct department of city government, which in turn is controlled by a mayor, executive board, or legislative body, depending upon the local structure of government.[221] *P3s* are also varied, but typically involve government funding for certain private expansions (for example, those that the private sector may be unwilling to undertake otherwise) or access to public right-of-way or another administrative easement, or both.[222] The *cooperative* model "refers to electric and telephone cooperatives, many of which were originally created during rural electrification in the 1930s. These cooperatives, in rural areas, have begun in some instances to provide broadband service."[223]

The CRS report continues by outlining differences not only in control and ownership structures that describes schemes trading as "municipal broadband," but also in the types of service they attempt to sell. They may, according to the report, only focus on building out the "middle mile" for a locality, letting other entities provide the final, direct connections to homes and businesses. This may include the installation of "dark fiber" (mentioned previously in §2.3.2), surplus fiber optic cables that are installed to create a surplus in the present that can support future expansion without additional installation costs. Alternatively, such service may be extended through the "last mile," directly to homes and businesses. If end users are served directly, the provider of municipal broadband may only serve anchor institutions (like schools, libraries, and community centers) or function as more of a universal ISP for the area.

Leaning into "Utility"

Despite the exact implementation of a municipal broadband scheme, there are clear differences when compared to the aforementioned CNPs. Such municipal networks tend to resemble commercial ISPs to some extent: unlike with the aforementioned CNPs, volunteers do not generally install or own their own equipment. Rather, a municipal broadband provider is generally intended to look like a traditional ISP from the end user's perspective:

if the network does bridge the "last mile" rather than leaving that task to a private ISP, they generally have "normal" installers and help lines, and there is no obligation or expectation that subscribing to its services will require one to interact with or rely upon their neighbors. While CNPs tend to draw *some* attention to themselves, municipal networks tend to be "boring" utilities, unhungry for attention.

Municipal broadband, in its many forms, has been the subject of much policy debate. However, this debate has hardly been purely academic, as the influence of lobbying efforts by the telecommunications industry is readily apparent. For example, in the early 2000s Philadelphia became one of the first cities in the nation to announce plans to offer inexpensive wireless Internet as a direct municipal service, for largely the same reasons similar efforts were renewed during the COVID-19 pandemic. The response of the telecommunications industry was also similar, according to a 2004 news bulletin:

> Regional and long-distance phone companies, who sell broadband Internet to consumers and businesses, have in recent months intensified a national campaign to quash municipal wireless initiatives like Philadelphia's as dozens of cities and towns have either begun or announced such plans – from San Francisco to Chaska, Minn., to St. Cloud, Fla.
>
> Telecommunications companies are doubly worried because hundreds of other municipalities provide broadband service over cable or telephone lines.
>
> The idea of cheap, municipally provided Internet as social leveler is particularly appealing to big city politicians.
>
> "We looked at it as a way to be a city, literally, of the 21st century," said Barbara Grant, a spokeswoman for Philadelphia Mayor John F. Street. "We wanted to bridge the digital divide for residents who wouldn't have access to the Internet, particularly schoolchildren."[224]

CRS, in its report, found that the arguments in favor of municipal broadband (again, in its many forms) largely circled around giving localities a tool with which they could strive to close the digital divide, to some extent, within their jurisdiction. While the report does imply that in terms of *access* this holds greater potential for benefit in rural areas than urban,[225] this metric has previously been criticized in §2.3.1, and even given the fallacy of access-based claims, the report does not argue that there would be *no* benefit to urban residents from this perspective. Further, the report highlights pro-municipal broadband arguments that such networks can increase competition, especially above the level of 25/3 service and spur adoption of "ultra-fast" gigabit networks.[226] Of most relevance to efforts to close the digital divide, the report also highlights the potential of local control to address local disparities:

> Municipal broadband can address unmet public interest needs. Private providers tend to favor middle- to upper-income households which will generate adequate revenue. Municipal broadband entities that are publicly owned may be more likely to offer broadband to low-income households at affordable prices.[227]

Such justification can reasonably be interpreted as a rebuke of the status quo of private providers, which, as suggested in §2.3, tend to exacerbate these inequalities rather than reduce them. Such a pattern is not unique to Internet connectivity—it mirrors conflict over other utility services from decades and centuries past: "Municipal broadband follows the tradition of municipal utilities, which have been providing basic utilities such as water, natural gas, and electricity for many years."[228]

Telecom Feels Threatened

However, several arguments have been against such systems in the past, which the CRS report helpfully summarizes. One fear is that such networks, especially those that involve the installation of expensive equipment like full fiber-to-the-home network (discussed in §2.3.3), are risky, because, the argument goes, "unlike basic utilities like water or electricity, there are typically competing providers and not all customers will necessarily sign up for service."[229] Local governments may be poorly-equipped to plan and maintain this type of service, further increasing risk at taxpayers' peril. Further, opponents of municipal broadband schemes argue that such public expenditure should be spent elsewhere:

> Taxpayer money should more appropriately be directed toward basic infrastructure needs—such as roads, bridges, and water systems—that are traditionally under the purview of government. In the United States, broadband is primarily provided by the private sector. Public money that is directed toward municipal broadband is money that is taken away from other, more critical infrastructure needs.[230]

These arguments were dubious when summarized by the CRS in 2017, but in light of the pandemic, they appear clearly invalid. As has been shown in §2.3.3 (and especially for cities in Table 2.2), far from having many viable options of service providers, Americans suffer from a documented *lack* of competition in many markets, both rural and urban. While some may *choose* to forgo an affordable home Internet connection by choice, this is a very small minority. In the wake of the pandemic, when the Internet became a necessity for the continuance of many aspects of life, this argument falters further. The notion that Internet infrastructure is not "basic infrastructure" was also widely dispelled during the pandemic: both the Trump[231] and Biden[232] Administrations approved investments in improvements during the pandemic, and the Biden Administration's infrastructure bills have popularized the phrase "broadband is infrastructure."[233]

Another argument often promulgated is that it is unfair for the local government to compete with the private sector, and that incumbent ISPs, in the middle of the expensive process of upgrading their aging infrastructure, may be less incentivized to invest in areas that adopt some form of municipal broadband.[234] While the degree to which incumbent ISPs, lacking significant competition and strict regulation, may be rigorously upgrading their infrastructure, there may be some economic justification for this argument, as presented in an article largely critical of municipal broadband in the *Federal Communications Law Journal*. While the article is measured, well-researched, and academic in nature, it would be straining the definition to call the analysis unbiased and balanced. Here, the impact of lobbying and politicking reemerges. The think tank that sponsored the article, the Phoenix Center for Advanced Legal & Economic Public Policy Studies, prominently displays a glowing testimonial on its website from former FCC Chairman Ajit Pai, who himself has many glaring conflicts of interest (Pai worked for Verizon before joining the FCC[235] and was accused of continuing to represent telecommunication companies' interests while serving[236]):

> The Phoenix Center "offer[s] policymakers rigorous economic analysis and legal acumen second to none."[237]

Additionally, one of the authors of the article, while serving stints at the FCC, also spent 8 years working for two companies in the telecommunications industry (MCI WorldCom and Z-Tel Communications) immediately after leaving that post.[238] While the article may provide some useful insights into the policy minutia of municipal broadband, all of its findings are necessarily cast in shadows of doubt, not dissimilar to how members of the public interpreted a posting from an AT&T executive arguing against the reclassification of broadband, covered in §2.3.3.

However, in light especially of the CNPs discussed earlier, at least one passage from the article does illustrate clearly the narrowness of such analysis, and the presumable threat that arises from having such a close relationship between industry and regulatory bodies:

> While the controversy surrounding municipal broadband has generated a rich, varied, and informative literature on the phenomenon, what is missing is a careful economic analysis of the underlying nature of municipal broadband and its advocacy, and why we see government entry in an industry where private investment is abundant. In this Article, we try to fill that gap. As we see it, the economic essence of the municipal broadband debate can be boiled down to a simple question: *why is the municipality the only one willing to build the network?* Evidently, the answer is *"because no one else will."*[239]

Again, not seeking to discredit the article in its entirety, it's worth reiterating that the economics considered therein do hold value and may be useful in determining the appropriate course of action for a given municipality. But the cited conflicts of interest and the readiness with which such conclusions from an economic analysis suggest that Internet service truly is more than a commodity; it is a utility inseparable from daily life.

Ford, who has ties to the notably conservative-leaning Federalist Society,[240] and his fellow authors may be disinclined to accept that this inseparable nature may justify that Internet service should be a matter of such great public interest that a "*visible* hand of policy"[241] acting upon the market is warranted, but other examples have shown that this is far from the universal viewpoint. The CNPs seen earlier certainly prove the existence of an interest not captured in these arguments, as some NYC Mesh volunteers have donated up to 40 hours of their time per week to the project out of sheer desire to see the network succeed,[242] and as discussed in §4.2.3, ONE|NB Connects persists to provide connectivity *in spite of* the upward economic battle it faces.

Good Government, or the Lesser of Evils?

One of the factors not commonly discussed in the realm of municipal broadband, especially when such a scheme can be described something along the lines of "public ownership," is how government involvement changes the nature and purpose of the network itself, not just the extent of connectivity. The Internet is a *de facto* necessity for most Americans, and the promulgation of legislation calling for the increasingly public ownership of the infrastructure furthers the necessity *de jure* as well. On a technical level, the Internet is just many smaller networks connecting together, without a concept of users or companies or governments. In an idealized and simplified world, users connect to one another as autonomous entities. In a more realistic depiction, individuals delegate their connectivity to private companies. But when a representative government of a locality sponsors or owns a connection, the connectivity gains a veneer of added social meaning.

There are, of course, concerns that when vested with this responsibility and trusted to provide service, the corruptible tendency of institutions (local government in this case) will produce the same or worse inequities previously produced by the private sector. After all, local control over utilities is no guarantee that prices will be fair and infrastructure well- and equitably-maintained, as in the case of lead pipe replacement in Providence, which has been accused of giving preference to wealthier, Whiter neighborhoods.[243] Or, given that inspection of Internet traffic can be a valuable surveillance tool and intense invasion of privacy, it is not hard to imagine violations of civil liberties at the same or larger scale than have been seen between commercial ISPs and intelligence agencies in the past.[244]

While such concerns, especially those surrounding traffic monitoring, may especially chafe against the cyberlibertarian origins of the Internet, in the context of the modern Internet as it really exists (dominated by large corporations and providers), they can instead be seen as trade-offs and proponents of municipal broadband may cite them as necessary risks. As noted in §2.1, it has been remarked that network "architecture is politics,"[245] indicating that there is both power to be gained from the structure of the network and proposing a challenge to design a technical network and policy framework resistant to corruption that this power may illicit. Given human nature, it is unlikely that such a perfect network or regulatory environment will ever exist but embracing the re-decentralization of the network appears to be a growing trend. By "embracing re-decentralization," I mean the choice to utilize and celebrate the decentralized nature of the Internet by being an active participant in its architecture at some small level, rather than just consuming an abstracted connection passively. Small, conscious efforts by relatively small entities (whether it be individual CNP volunteers or municipalities) are acts of challenge against the status quo, which ultimately may go a long way towards ensuring the Internet remains focused on connectivity and insulating it from corrupting pressures by embracing local differences rather than trying to control them. In discussing this issue with Rob Johnson, a NYC Mesh volunteer who has studied telecommunication policy in the past and advocates for some form of future public ownership of networking infrastructure, he makes effectively this point:

> To me, government work, and work that attempts to serve everyone equally, is inherently political work. I think it is reasonable to try and shield from specific governmental issues like corruption, bribes, arbitrary changes, etc, but overall work like "universal internet" is transformative to society, and so will be "on the ballot" for as long as it exists.
>
> I think provision of water, for example, fits this too. We've had a good run where for 7 decades nobody's had much to say about water provision, but as the infrastrucre wares [*sic*] out, and we decide whether or not to rebuild and renew, we are facing major questions about who gets water and why. There's not a path to "simply doing it the right way and leaving the politicians out of it" because there are literally different options for what the "right way" is and the different choices have a huge impact on our society going forward.[246]

Effectively, the argument goes, the futures of society and technology are unknown, but by drawing the decisions, where possible, to the edges of the network rather than letting them continue to centralize and consolidate, society can ensure the continuation of the responsiveness and flexibility that was key to the Internet's initial blossoming, and the benefits it has since yielded society.

Citations for Chapter 4

142. Johnson, *Slack Direct Message with robj*.
143. Frangoudis et al., “Experimental evaluation of community-based WLAN voice and data services.”
144. *Community Wi-Fi NYC mesh continues to grow*.
145. *Frequently asked questions*.
146. *Community Wi-Fi NYC mesh continues to grow*.
147. NYC Mesh, *NYC MESH - State of the Mesh 2018*.
148. Johnson, *Slack Direct Message with robj*.
149. *Frequently asked questions*.
150. Broyard, *‘Welcome to the Mesh, Brother’: Guerrilla Wi-Fi Comes to New York*.
151. Giles, *Mesh Design*.
152. *Frequently asked questions*.
153. Hall, *Culture*.
154. *Documentation*.
155. *Installations v2020.03_Draft*.
156. *Line of Sight*.
157. *Installations v2020.03_Draft*.
158. Ibid.
159. Ibid., 3.
160. Ibid., 5.
161. *Brian Hall, NYC Mesh - from Tactical Tech in NYC*, 0:0:10.
162. Boning, *Etiquette Guide*.
163. Boning, *Site Safety*.
164. Johnson, *Slack Direct Message with robj*.
165. Ibid.
166. *Map*.
167. *Line of Sight*.
168. *nodes.json*.
169. Your friendly API robotic overlord, *Census Data API: B19013*.
170. Rasmussen, *Priorities One Pager*.
171. Hall, *Priorities*.
172. Giles, *Conversations at d.b.a.*
173. *Panorama from Saratoga Hub*.
174. Hall, *Saratoga hub*.
175. Ibid.
176. *NYC Mesh presentation at NSF Mozilla WINS Challenge Demo Day*, 1:57.
177. *1340 - Map*.
178. Johnson, *Slack Direct Message with robj*.
179. *Co-op presentation*, 8.
180. Ibid., 7.
181. Ibid.
182. Leach, “The Iron Law of *What* Again?,” 312-313.
183. *Brian Hall, NYC Mesh - from Tactical Tech in NYC*, 6:50.
184. Shapiro and Varian, *Information rules*, 184.

185. NYC Mesh, *NYC MESH - State of the Mesh 2018*, 1:05:25.
186. Ibid., 1:05:36.
187. *Church handout*.
188. *Community Outreach Brochure (English/Spanish)*, 2.
189. Ibid., 4.
190. Boning, *We're connecting a whole block in Bed Stuy*.
191. equis, *nicolas equis on Slack*.
192. Hall, *Culture*.
193. Heredia, *Protecting the Mesh*.
194. Ibid.
195. *guifi.net - Open, Libre and Neutral Telecommunications Network | guifi.net*.
196. *Free Internet Service | Project Waves | Baltimore*.
197. *Our Story*.
198. Ibid.
199. *Digital Harbor Foundation · Learn, Create, Explore, Build Community*.
200. *Home Internet*.
201. *Apartment Service*.
202. *The Project Waves Network*.
203. Skrok, "Project Waves Year One Report," 3.
204. Ibid., 5.
205. Saberi, "Urban Digital Divides and Community WiFi," 8.
206. Ibid.
207. *How a Brooklyn Community Created a Free Wireless Network After Sandy*.
208. Saberi, "Urban Digital Divides and Community WiFi," 27-28.
209. Horowitz and Krasnow, *Interview with ONB Connects*.
210. *Installation of cable television, telephone, telecommunications, or information service in multiple dwelling or commercial units*.
211. Kelly, *FCC opens apartments up to more broadband competition*.
212. Horowitz and Krasnow, *Interview with ONB Connects*.
213. *Community Outreach Brochure (English/Spanish)*.
214. Horowitz and Krasnow, *Interview with ONB Connects*.
215. *Our team discusses digital equity on national panel; vaccine clinic opens on Manton Avenue*.
216. *ONE|NB Connects*.
217. *ONE|NB discusses digital equity at NeighborWorks America symposium*.
218. Rodriguez, *Antonio Rodriguez, ONE Neighborhood Builders, talks about ONE|NB Connects*, 3:45.
219. Kruger and Gilroy, "Municipal Broadband: Background and Policy Debate."
220. Ibid., 1.
221. Ibid.
222. Ibid.
223. Ibid., 2.
224. *Lobbyists try to kill Philly wireless plan*.
225. Kruger and Gilroy, "Municipal Broadband: Background and Policy Debate," 3.
226. Ibid., 4.
227. Ibid.
228. Ibid.
229. Ibid.
230. Ibid.
231. Moore, *Trump administration prepares $1 trillion infrastructure package to boost economy*.
232. *FACT SHEET*.
233. Editorial Board, "Opinion | The Senate is right."
234. Beard et al., "The Law and Economics of Municipal Broadband," 12.
235. *Biography of Former Chairman Ajit Pai*.
236. Brodkin, *Ajit Pai accused of conflict for helping former client, a prison phone company*.
237. *Phoenix Center for Advanced Legal and Economic Public Policy Studies. Independent assessments of the economic and material implications of regulatory and economic policy in the U.S. and abroad*.
238. Ford, *George S. Ford, Ph.D.*, 1.
239. Beard et al., "The Law and Economics of Municipal Broadband," 8.
240. *George Ford | The Federalist Society*.
241. Beard et al., "The Law and Economics of Municipal Broadband," 27.
242. Giles, *Conversations at d.b.a.*
243. *Providence Water faces Civil Rights Act complaint over lead pipes*.
244. Wilhelm, *The NSA Scans 75% Of The Internet Through Telco Partnerships*.
245. Lessig, *The future of ideas*, 35.
246. Johnson, *Slack Direct Message with robj*.

Chapter 5

Conclusion: Cities as Laboratories of Networking

As noted at the end of the previous chapter, the future of the Internet, and how it will interact with society, is largely unknown. Futures of "the Internet" and "cities" are both topics which are far too large to be fully addressed by this thesis, but a general argument about urban Internet infrastructure has been presented, and can be summarized in a few bullet points:

- The Internet has become a part of modern life; strong and reliable connectivity to the Internet is not a luxury, it is a prerequisite for full participation in society.
- Though the Internet itself is non-proprietary and free to use, commercialized infrastructure controlled by an uncompetitive telecommunication industry has commoditized access and limited access. As a result, in American cities Internet access and usage is not universal—it reinforces existing disparities in income (and, by extension, racial and ethnic divides).
- Federal and State Governments have thus far been unwilling or unable to stimulate competition in the telecommunications industry, or to protect the public interest by instituting correctives to combat the undesirable impacts of near monopolization.
- Local governments and organizations can take matters into their own hands by attempting to compete directly with existing service providers. The technologies underpinning the Internet make this possible, and these smaller entities are better able to respect the needs of residents of American cities without being corrupted by the profit motive that drives the telecommunications industry.

While this thesis takes the position that actively involving municipalities and community groups in the provision of Internet service is certainly an improvement upon the status quo, this final bullet is *not* a silver bullet. Municipal broadband, as described in §3.3.2 and §4.3, faces significant challenges from incumbent providers, who have already used their extensive lobbying apparatuses to block such efforts. And, as mentioned in Chapter 4, a Community Network Project that works in one city may be ill-suited to another, and many such projects tend to rely on some degree of volunteerism, which can be tenuous at times. Such factors preclude the endorsement of any specific policy or municipal broadband scheme in this thesis.

Chapter 4 argues that while these localizing solutions involve some amount of uncertainty, the failures of the status quo make those risks worth taking. The potential reward for a city is not only the easement or erasure of the digital divide, but also the strengthening of the communities touched by these investments. Some experimentation may not yield results immediately, or ever, but it is worthwhile nonetheless.

While the potential impact on cities of their own localized networking is clear, it is worth considering, abstractly, the broader implications of such a trend. Ideally, there is only one Internet, which serves as a globally unifying medium that connects humanity across borders, cultures, and geographies to an extent which no technology previously has (although authoritarian regimes have fractured this vision to some degree).

Similarly, the issues of monopoly control of Internet service provision are not confined to cities or the United States in general. While the issues of Internet connectivity are not exclusively urban, it may be that these localized experiments, carried out in American cities, may produce results that spread, and ultimately change the status quo that pervades with the network itself. Being a largely speculative claim, there is little rigorous evidence to support this viewpoint, but two key observations may be considered. First, as covered exhaustively in this thesis, American cities are not wanting for motivation: the digital divide is a present and pressing issue that demands action. Second, basic urban theory holds that urban governments take a relatively active role in their societies, as a dense environment has the potential to create chaos more readily, and that potential for chaos must be governed constantly. As a result, cities may be more willing to accept the responsibility of providing the Internet as a basic service to its residents than State or national governments. While such an observation is not meant to imply that rural communities cannot pursue a form of municipal broadband, as many have done, it does suggest that there may be more support for and more success of this model in urban areas. Third, the density and diversity of cities is helpful for generating new models of Internet service provision and maintenance that have not been considered before, and which may prove popular. Density and diversity have long been cited as key assets of cities, because such conditions allow for increased exchange of ideas and economic opportunity, so while lacking any formal evidence, it is not inconceivable that urban interactions lead to creation of a CNP which proves to be revolutionary both inside city limits and out.

Ultimately, this view (and title of this conclusion) suggest that cities are laboratories, where networking is tested and refined. Of course, this phrasing refers to Internet infrastructure and the human structures that support it (whether it be an incumbent ISP, municipality, or CNP), but also the fact that cities do, and always have, brought together diverse inputs to sometimes create something more than the sum of parts, but always produce something unique.

Bibliography

1340 - Map. Accessed February 16, 2022. https://www.nycmesh.net/map/nodes/1340.

Abbott, Stuart. "Review of 20 years of undersea optical fiber transmission system development and deployment since TAT-8." In *2008 34th European Conference on Optical Communication*, 1–4. Brussels, Belgium: IEEE, 2008. Accessed January 9, 2022. http://ieeexplore.ieee.org/document/4729162/.

Apartment Service. Accessed February 22, 2022. https://www.projectwaves.net/waves-apartment-internet-service.

AT&T's Digital Redlining: Leaving Communities Behind for Profit. Technical report. Communications Workers of America, National Digital Inclusion Alliance, October 2020. Accessed January 9, 2022. https://cwa-union.org/sites/default/files/20201005attdigitalredlining.pdf.

Basu, Tanya. *Why the "homework gap" is key to America's digital divide*, October 2020. Accessed January 19, 2022. https://www.technologyreview.com/2020/10/13/1010243/jessica-rosenworcel-homework-gap-key-to-americas-digital-divide/.

Beard, T Randolph, George S Ford, Lawrence J Spiwak, and Michael Stern. "The Law and Economics of Municipal Broadband." *Federal Communications Law Journal* 73, no. 1 (January 2021): 99.

Biography of Former Chairman Ajit Pai, January 2021. Accessed March 1, 2022. https://www.fcc.gov/biography-former-chairman-ajit-pai.

Boning, Willem. *Etiquette Guide*, January 2019. Accessed January 23, 2022. https://docs.nycmesh.net/installs/etiquette/.

———. *Site Safety*, January 2019. Accessed January 23, 2022. https://docs.nycmesh.net/installs/safety/.

———. *We're connecting a whole block in Bed Stuy*, September 2019. Accessed February 20, 2022. https://www.nycmesh.net/blog/700jefferson/.

Brandom, Russell. *Verizon is weaseling out of its deal to bring FiOS to New Jersey's poorest regions*, September 2015. Accessed March 25, 2022. https://www.theverge.com/2015/9/14/9322481/verizon-fios-access-new-jersey-deal-loophole.

Brandom, Russell, and William Joel. *This is a map of America's broadband problem*, May 2021. Accessed January 7, 2022. https://www.theverge.com/22418074/broadband-gap-america-map-county-microsoft-data.

Branscombe, Mary. *The Network Impact of the Global COVID-19 Pandemic*, April 2020. Accessed January 18, 2022. https://thenewstack.io/the-network-impact-of-the-global-covid-19-pandemic/.

Brian Hall, NYC Mesh. New York City. Accessed February 17, 2022. https://livestream.com/internetsociety/tacticaltech/videos/165333145.

Broadband: FCC Should Analyze Small Business Speed Needs. Technical report GAO-21-494. Washington, D.C.: U.S. Government Accountability Office, July 2021. Accessed January 9, 2022. https://www.gao.gov/assets/gao-21-494.pdf.

Brodkin, Jon. *Ajit Pai accused of conflict for helping former client, a prison phone company*, August 2017. Accessed March 1, 2022. https://arstechnica.com/information-technology/2017/08/ajit-pai-accused-of-conflict-for-helping-former-client-a-prison-phone-company/.

———. *Biden broadband plan will be hated by big ISPs, welcomed by Internet users*, March 2021. Accessed March 23, 2022. https://arstechnica.com/tech-policy/2021/03/biden-broadband-plan-will-be-hated-by-big-isps-welcomed-by-internet-users/.

———. *Biden silent on municipal broadband as he makes $65B deal with Republicans*, June 2021. Accessed March 25, 2022. https://arstechnica.com/tech-policy/2021/06/biden-silent-on-municipal-broadband-as-he-makes-65b-deal-with-republicans/.

Broyard, Bliss. *'Welcome to the Mesh, Brother': Guerrilla Wi-Fi Comes to New York*, July 2021. Accessed October 20, 2021. https://www.nytimes.com/2021/07/16/nyregion/nyc-mesh-community-internet.html.

Busby, Josh, Julia Tanberk, and Tyler Cooper. *BroadbandNow Estimates Availability for all 50 States; Confirms that More than 42 Million Americans Do Not Have Access to Broadband*. Technical report. Section: Technology. October 2021. Accessed January 6, 2022. https://broadbandnow.com/research/fcc-broadband-overreporting-by-state.

Call to expand free wifi in Baltimore City. Section: Baltimore City, July 2020. Accessed January 19, 2022. https://www.wmar2news.com/news/region/baltimore-city/call-to-expand-free-wifi-in-baltimore-city.

Carpenter, Brian E., ed. *Architectural Principles of the Internet*. Request for Comments 1958. Published: RFC 1958. RFC Editor, June 1996. https://rfc-editor.org/rfc/rfc1958.txt.

Census Tracts. Accessed January 7, 2022. https://www2.census.gov/geo/pdfs/education/CensusTracts.pdf.

Church handout. Accessed February 20, 2022. https://docs.nycmesh.net/organization/outreach/church.pdf.

Clark, Mitchell. *Verizon makes Fios free for low-income customers through federal program*, March 2022. Accessed March 23, 2022. https://www.theverge.com/2022/3/15/22979619/verizon-fios-affordable-connectivity-program-forward-internet.

Co-op presentation. Accessed February 16, 2022. https://docs.google.com/presentation/d/138pbSwW5ut6ORBhX3OiqYajsMfGc8fnBKDryDqMudU0/present?usp=embed_facebook.

Cohen, Rielle. *Baltimore's 'digital divide' exacerbated by pandemic*, August 2020. Accessed January 19, 2022. https://foxbaltimore.com/news/local/baltimores-digital-divide-exacerbated-by-pandemic.

Community Outreach Brochure (English/Spanish). Accessed February 20, 2022. https://docs.google.com/presentation/d/1mKzGT6Scrkv27Hb_lb7oOLWi_fGDoIHwEBJtcxI64PQ.

Community Wi-Fi NYC mesh continues to grow, August 2019. Accessed March 31, 2021. https://www.youtube.com/watch?v=nlK-6vLt0Y8.

Conference Report On S. 652, Telecommunications Act Of 1996. Legislation 14. Washington, D.C.: House of Representatives, February 1996. Accessed January 18, 2022. https://www.congress.gov/congressional-record/1996/02/01/house-section/article/H1145-6.

Cyphers, Bennett. "The Case for Fiber to the Home, Today: Why Fiber is a Superior Medium for 21st Century Broadband":24.

DeFazio, Peter A. *Infrastructure Investment and Jobs Act*, June 2021. https://www.congress.gov/bill/117th-congress/house-bill/3684/text/ih.

Dellinger, A. J. *Here's How Telecom Giants Spent More Than $1 Billion Lobbying Congress*. Section: Consumer Tech, May 2019. Accessed March 25, 2022. https://www.forbes.com/sites/ajdellinger/2019/05/31/heres-how-telecom-giants-spent-more-than-1-billion-lobbying-congress/.

Digital Harbor Foundation · Learn, Create, Explore, Build Community. Accessed February 22, 2022. https://www.digitalharbor.org/.

Documentation. Accessed January 22, 2022. https://docs.nycmesh.net/.

Doyle, Mike, Jerry McNerney, Yvette D. Clarke, David Loebsack, Marc A. Veasey, Darren Soto, Tom O'Halleran, et al. *Legislating To Connect America: Improving The Nation's Broadband Maps*. Washington, D.C., September 2019. Accessed January 7, 2022. https://www.govinfo.gov/content/pkg/CHRG-116hhrg40987/pdf/CHRG-116hhrg40987.pdf.

Dunbar, John. *The FCC's rapidly revolving door*, February 2003. Accessed January 6, 2022. https://publicintegrity.org/inequality-poverty-opportunity/the-fccs-rapidly-revolving-door/.

Dvorak, Petula. "When 'back to school' means a parking lot and the hunt for a WiFi signal." *Washington Post*, August 2020. Accessed January 19, 2022. https://www.washingtonpost.com/local/when-back-to-school-means-a-parking-lot-and-the-hunt-for-a-wifi-signal/2020/08/27/0f785d5a-e873-11ea-970a-64c73a1c2392_story.html.

Editorial Board. "Opinion | The Senate is right: Broadband is infrastructure. Now it's time to make history." *Washington Post*. Accessed February 28, 2022. https://www.washingtonpost.com/opinions/2021/08/08/senate-is-right-broadband-is-infrastructure-now-its-time-make-history/.

equis, nicolas. *nicolas equis on Slack*, February 2022. Accessed February 22, 2022.

FACT SHEET: Biden-Harris Administration Announces 10 Million Households Enroll in Broadband Affordability Program, Thanks to Bipartisan Infrastructure Law, February 2022. Accessed February 28, 2022. https://www.whitehouse.gov/briefing-room/statements-releases/2022/02/14/fact-sheet-biden-harris-administration-announces-10-million-households-enroll-in-broadband-affordability-program-thanks-to-bipartisan-infrastructure-law/.

FACT SHEET: The American Jobs Plan, March 2021. Accessed March 25, 2022. https://www.whitehouse.gov/briefing-room/statements-releases/2021/03/31/fact-sheet-the-american-jobs-plan/.

Falcon, Ernesto. *Every State Has a Chance to Deliver a "Fiber for All" Broadband Future: 2021 in Review*, December 2021. Accessed January 10, 2022. https://www.eff.org/deeplinks/2021/12/every-state-has-chance-deliver-fiber-all-broadband-future-2021-review.

———. *The American Federal Definition of Broadband Is Both Useless and Harmful*, July 2020. Accessed January 9, 2022. https://www.eff.org/deeplinks/2020/07/american-federal-definition-broadband-both-useless-and-harmful.

———. *The FCC and States Must Ban Digital Redlining*, January 2021. Accessed January 10, 2022. https://www.eff.org/deeplinks/2021/01/fcc-and-states-must-ban-digital-redlining.

Falcon, Ernesto. *The U.S. Internet Is Being Starved of Its Potential: 2020 in Review*, December 2020. Accessed January 18, 2022. https://www.eff.org/deeplinks/2020/12/us-internet-being-starved-its-potential.

FCC Fixed Broadband Deployment. Accessed January 8, 2022. https://broadbandmap.fcc.gov/.

Fixed Broadband Deployment Data: June 2020 Status V2 | Data | Federal Communications Commission. Accessed January 7, 2022. https://opendata.fcc.gov/Wireline/Fixed-Broadband-Deployment-Data-June-2020-Status-V/pp56-kd4g.

Fixed Broadband Deployment Data: June 2020 V1, April 2021. https://opendata.fcc.gov/Wireline/Fixed-Broadband-Deployment-Data-June-2020-V1/4kuc-phrr.

Ford, George S. "Challenges In Using The National Broadband Map's Data." *Phoenix Center Policy Bulletin*, no. 27 (April 2011): 21. https://ssrn.com/abstract=1800062.

Ford, George S. *George S. Ford, Ph.D.* Accessed March 1, 2022. https://www.phoenix-center.org/FordVita2020.pdf.

Fourteenth Broadband Deployment Report. Technical report FCC 21-18. Washington, D.C.: Federal Communications Commission, January 2021. Accessed January 6, 2022. https://docs.fcc.gov/public/attachments/FCC-21-18A1.pdf.

Frangoudis, Pantelis A., Vasileios P. Kemerlis, Dimitrios C. Paraskevaidis, Elias C. Efstathiou, and George C. Polyzos. "Experimental evaluation of community-based WLAN voice and data services." In *Proceedings of the 3rd International ICST Conference on Mobile Multimedia Communications*. Nafpaktos, Greece: ICST, 2007. Accessed March 27, 2021. http://eudl.eu/doi/10.4108/ICST.MOBIMEDIA2007.1772.

Free Internet Service | Project Waves | Baltimore. Accessed February 22, 2022. https://www.projectwaves.net.

Frequently asked questions. Accessed August 24, 2021. https://www.nycmesh.net/faq/.

Galperin, Hernan, Thai V. Le, and Kurt Wyatt. "Who gets access to fast broadband? Evidence from Los Angeles County." *Government Information Quarterly* 38, no. 3 (July 2021): 101594. Accessed January 10, 2022. https://linkinghub.elsevier.com/retrieve/pii/S0740624X21000307.

George Ford | The Federalist Society. Accessed March 1, 2022. https://fedsoc.org/contributors/george-ford.

Giles, Zachary. *Conversations at d.b.a.*, July 2021.

———. *Mesh Design*, January 1. Accessed November 4, 2021. https://docs.nycmesh.net/networking/mesh/.

Gonsalves, Sean. *The Good, the Bad and the Ugly in the Senate's $65 Billion Broadband Infrastructure Bill*, August 2021. Accessed March 23, 2022. https://broadbandbreakfast.com/2021/08/the-good-the-bad-and-the-ugly-in-the-senates-65-billion-broadband-infrastructure-bill/.

Grubesic, Tony H. "The U.S. National Broadband Map: Data limitations and implications." *Telecommunications Policy* 36, no. 2 (March 2012): 113–126. Accessed January 7, 2022. https://linkinghub.elsevier.com/retrieve/pii/S0308596111002266.

guifi.net - Open, Libre and Neutral Telecommunications Network | guifi.net. Accessed February 22, 2022. https://guifi.net/.

Hall, Brian. *Culture*, December 2020. Accessed January 21, 2022. https://docs.nycmesh.net/organization/culture/.

———. *Priorities*, July 2019. Accessed February 16, 2022. https://www.nycmesh.net/blog/priorities/.

———. *Saratoga hub*, April 2018. Accessed February 16, 2022. https://docs.nycmesh.net/nodes/node-1340/.

Hart, Michael. *The American Internet advantage: global themes and implications of the modern world*. Lanham, Md: University Press of America, 2000.

Heredia, Daniel. *Protecting the Mesh*, February 2022. Accessed February 19, 2022. https://docs.nycmesh.net/organization/protecting/.

Home Internet. Accessed February 22, 2022. https://www.projectwaves.net/waves-home-internet.

Horowitz, Emily, and Julia Krasnow. *Interview with ONB Connects*, August 2021.

How a Brooklyn Community Created a Free Wireless Network After Sandy, July 2018. Accessed February 25, 2022. https://www.inverse.com/article/46269-brooklyn-community-red-hook-created-a-free-wireless-network-after-sandy.

Human Rights Council, Thirty-eighth session. *Resolution adopted by the Human Rights Council on 5 July 2018*, July 2018. https://digitallibrary.un.org/record/1639840.

Hurley, Deborah, and James H. Keller. *The First 100 Feet: Options for Internet and Broadband Access*. Publication of the Harvard Information Infrastructure Project. Cambridge, Mass: The MIT Press, 1999. https://search.ebscohost.com/login.aspx?direct=true&db=e000xna&AN=9251&site=ehost-live&scope=site&authtype=ip,sso&custid=rock.

Index of /geo/tiger/TIGER2019/TRACT. Accessed January 8, 2022. https://www2.census.gov/geo/tiger/TIGER2019/TRACT/.

Infrastructure Investment and Jobs Act, November 2021. https://www.congress.gov/bill/117th-congress/house-bill/3684/all-actions.

Installation of cable television, telephone, telecommunications, or information service in multiple dwelling or commercial units., 1986. Accessed February 23, 2022. http://webserver.rilin.state.ri.us/Statutes/TITLE39/39-19/39-19-10.htm.

Installations v2020.03_Draft, March 2020. Accessed January 22, 2022. https://docs.google.com/presentation/d/1fpa24kkC5-hAwxAmz8kdTFDX0s1hxDKZ0aea4BzbN1g.

Jessica Rosenworcel: Network Neutrality, September 2018. https://www.youtube.com/watch?v=oYpJJhadsFs.

Johnson, Allison. *FCC approves $7 billion to get better equipment to remote learners*, May 2021. Accessed January 19, 2022. https://www.theverge.com/2021/5/11/22431504/fcc-emergency-connectivity-fund-schools-libraries-students.

Johnson, Rob. *Slack Direct Message with robj*, July 2021.

Kahan, John. *It's time for a new approach for mapping broadband data to better serve Americans*, April 2019. Accessed January 6, 2022. https://blogs.microsoft.com/on-the-issues/2019/04/08/its-time-for-a-new-approach-for-mapping-broadband-data-to-better-serve-americans/.

Kallsen, Loren. *AT&T Archives: What is the Bell System?*, 1976. Accessed March 19, 2022. https://www.youtube.com/watch?v=iBPTM_irIco.

Kang, Cecilia. "That Spotty Wi-Fi? There's $100 Billion to Fix It." *The New York Times*, April 2021. Accessed May 3, 2021. https://www.nytimes.com/2021/04/01/technology/digital-divide-rural-wifi.html.

Katz, Raul. *The Impact of Broadband on the Economy: Research to Date and Policy Issues*. Regulatory & Market Environment. International Telecommunications Union, April 2012. Accessed January 18, 2022. https://www.itu.int/ITU-D/treg/broadband/ITU-BB-Reports_Impact-of-Broadband-on-the-Economy.pdf.

Kelly, Makena. *FCC opens apartments up to more broadband competition*, February 2022. Accessed February 16, 2022. https://www.theverge.com/2022/2/16/22937733/fcc-broadband-competition-apartments-landlords-agreements.

———. *FCC unanimously approves 'nutrition labels' for broadband services*, January 2022. Accessed March 23, 2022. https://www.theverge.com/2022/1/27/22904705/broadband-nutrition-labels-internet-service-rosenworcel-biden-competition.

Kruger, Lennard G, and Angele A Gilroy. "Municipal Broadband: Background and Policy Debate":17.

Lapowsky, Issie. *Glitches and confusion are blocking some from FCC internet discounts*. Section: Policy, June 2021. Accessed March 23, 2022. https://www.protocol.com/policy/emergency-broadband-benefit-comcast-spectrum.

Leach, Darcy K. "The Iron Law of What Again? Conceptualizing Oligarchy Across Organizational Forms." *Sociological Theory* 23, no. 3 (September 2005): 312–337. Accessed February 17, 2022. http://journals.sagepub.com/doi/10.1111/j.0735-2751.2005.00256.x.

Lessig, Lawrence. *Code*. Version 2.0. New York: Basic Books, 2006.

———. *The Future of Ideas: the fate of the commons in a connected world*. 1st ed. New York, NY: Random House, 2001.

Levin, Blair, and Larry Downes. "Cities, not rural areas, are the real Internet deserts." *Washington Post*, September 2019. Accessed January 6, 2022. https://www.washingtonpost.com/technology/2019/09/13/cities-not-rural-areas-are-real-internet-deserts/.

Line of Sight. Accessed January 22, 2022. https://los.nycmesh.net/.

Lobbyists try to kill Philly wireless plan, November 2004. Accessed February 27, 2022. https://www.nbcnews.com/id/wbna6570011.

Map. Accessed January 26, 2022. https://www.nycmesh.net/map/.

Marsh, Joan. *Defining Broadband For the 21st Century*, March 2021. Accessed January 9, 2022. https://attpublicpolicy.com/wireless/defining-broadband-for-the-21st-century/.

Martin, Michael. *Computer and Internet Use in the United States: 2018*. Technical report ACS-49. United States Census Bureau, April 2021. Accessed October 11, 2021. https://www.census.gov/library/publications/2021/acs/acs-49.html.

Martin, Michael J R. *Deconstructing the Digital Divide: Identifying the Supply and Demand Factors That Drive Internet Subscription Rates*. Technical report 2019-15. April 2019. Accessed January 12, 2022. https://www.census.gov/content/dam/Census/library/working-papers/2019/demo/sehsd-wp2019-15.pdf.

McLeod, Ethan. *Philly, Baltimore and Detroit lawmakers calling on Comcast to expand free Wi-Fi, hotspot access*, July 2020. Accessed January 19, 2022. https://www.bizjournals.com/baltimore/news/2020/07/20/students-cities-ask-comcast-address-digital-divide.html.

Medina, Jennifer. "Biden Wanted an F.D.R. Presidency. How's He Doing So Far?" *The New York Times*, October 2021. Accessed March 25, 2022. https://www.nytimes.com/2021/10/26/us/politics/biden-wanted-an-fdr-presidency-hows-he-doing-so-far.html.

Mitchell, Christopher. *United Fiber Tackles Missouri's Most Rural*. Accessed January 10, 2022. https://muninetworks.org/content/united-fiber-tackles-missouris-most-rural-community-broadband-bits-podcast-240.

Moore, Mark. *Trump administration prepares $1 trillion infrastructure package to boost economy*, June 2020. Accessed February 28, 2022. https://nypost.com/2020/06/16/trump-administration-prepares-1-trillion-infrastructure-package/.

nodes.json. Accessed January 24, 2022. https://node-db.netlify.app/nodes.json.

NYC Mesh. *NYC MESH - State of the Mesh 2018*, January 2018. Accessed March 31, 2021. https://www.youtube.com/watch?v=ykOqIh5Mt4Y.

NYC Mesh presentation at NSF Mozilla WINS Challenge Demo Day, August 2018. Accessed February 16, 2022. https://www.youtube.com/watch?v=-E6_HA1653g.

O'Donovan, Caroline. *A Former Comcast Employee Explains Why Low-Income WiFi Packages Aren't Helping Students*, January 2021. Accessed January 19, 2022. https://www.buzzfeednews.com/article/carolineodonovan/teenagers-take-on-comcast-internet-essentials.

———. *After Defending Its Low-Cost Internet Offering, Comcast Agrees To Increase Speeds*. Accessed January 19, 2022. https://www.buzzfeednews.com/article/carolineodonovan/comcast-increases-internet-essentials-students.

ONE|NB Connects. Accessed February 25, 2022. https://oneneighborhoodbuilders.org/onb-connects/.

ONE|NB discusses digital equity at NeighborWorks America symposium, February 2022. Accessed February 25, 2022. https://oneneighborhoodbuilders.org/onenb-discusses-digital-equity-at-neighborworks-symposium/.

Our Story. Accessed February 22, 2022. https://www.projectwaves.net/about.

Our team discusses digital equity on national panel; vaccine clinic opens on Manton Avenue, February 2022. Accessed February 25, 2022.

Pai, Ajit. *FCC chair Ajit Pai explains why he wants to scrap net neutrality*, April 2017. https://www.youtube.com/watch?v=6Q5_oV4JB10.

Panorama from Saratoga Hub. Accessed February 16, 2022. https://www.nycmesh.net/map/nodes/1340/panoramas/1.

Perrin, Andrew, and Sara Atske. *7% of Americans don't use the internet. Who are they?*, April 2021. Accessed January 12, 2022. https://www.pewresearch.org/fact-tank/2021/04/02/7-of-americans-dont-use-the-internet-who-are-they/.

Phoenix Center for Advanced Legal and Economic Public Policy Studies. Independent assessments of the economic and material implications of regulatory and economic policy in the U.S. and abroad. Accessed March 1, 2022. https://www.phoenix-center.org/.

Providence Water faces Civil Rights Act complaint over lead pipes, January 2022. Accessed March 1, 2022. https://upriseri.com/providence-water-lead-pipes/.

Rasmussen, Scott. *Priorities One Pager*, January 2019. Accessed February 7, 2022. https://docs.nycmesh.net/organization/outreach/Priorities-One-Pager.pdf.

Reddick, Christopher G., Roger Enriquez, Richard J. Harris, and Bonita Sharma. "Determinants of broadband access and affordability: An analysis of a community survey on the digital divide." *Cities* 106 (November 2020): 102904. Accessed January 18, 2022. https://doi.org/10.1016/j.cities.2020.102904.

Reece, Bethany. *New York's History with Telecommunications Lobby's Efforts to Replace Historic Municipal Franchising Regimes for Telecommunications with Centralized State Franchising, and Corresponding Influence of Regulatory Regime Upon Fios Buildout Outcomes*. Technical report. Samuelson-Glushko Technology Law & Policy Clinic at Colorado Law, March 2021. Accessed September 15, 2021. https://tlpc.colorado.edu/wp-content/uploads/2021/03/Final-2021.03.18-Samuelson-Glushko-Clinic-NYC-Telecom-Regulation-Memo-1.pdf.

Rodriguez, Antonio. *Antonio Rodriguez, ONE Neighborhood Builders, talks about ONE|NB Connects*, February 2022. Accessed February 25, 2022. https://www.youtube.com/watch?v=xG9yMAiBRLU.

Roper, Chase. Tweet, January 2021. Accessed January 19, 2022. https://twitter.com/chase_roper/status/1348747736946917376.

Rosenworcel, Jessica. *Bridging the Homework Gap*. Section: Education, June 2015. Accessed January 19, 2022. https://www.huffpost.com/entry/bridging-the-homework-gap_b_7590042.

———. *Executive Session and Nominations Hearing*. Committee Hearing Room, Russell Senate Office Building, Room 253, Washington D.C., November 2021. Accessed January 6, 2022. https://www.commerce.senate.gov/2021/11/executive-session-and-nominations-hearing.

———. *Falling through homework gap*, April 2015. Accessed January 19, 2022. https://www.providencejournal.com/story/opinion/2015/04/25/falling-through-homework-gap/34696864007/.

———. *Filling in the homework gap*. Section: , Opinion & Commentary, May 2015. Accessed January 19, 2022. https://www.dailypress.com/opinion/dp-nws-oped-rosenworcel-0531-20150530-story.html.

———. *Limited Internet access a challenge for Detroit kids*, June 2015. Accessed January 19, 2022. https://www.freep.com/story/opinion/contributors/2015/03/16/internet-broadband-access/24849353/.

———. *S.Hrg. 114-228 — NOMINATION OF HON. JESSICA ROSENWORCEL TO BE COMMISSIONER OF THE FEDERAL COMMUNICATIONS COMMISSION*. Washington, D.C., October 2015. Accessed January 19, 2022. https://www.congress.gov/event/114th-congress/senate-event/LC37701/text.

Rosenworcel Hails American Rescue Plan Funds to Close Homework Gap, March 2021. Accessed January 19, 2022. https://www.fcc.gov/document/rosenworcel-hails-american-rescue-plan-funds-close-homework-gap.

Rossiter, Katy. *What are census blocks?*, July 2011. Accessed January 7, 2022. https://www.census.gov/newsroom/blogs/random-samplings/2011/07/what-are-census-blocks.html.

Saberi, Houman. "Urban Digital Divides and Community WiFi: A Case Study of Red Hook, Brooklyn." Publisher: Columbia University, 2015. Accessed July 11, 2021. https://academiccommons.columbia.edu/doi/10.7916/D8NC60QD.

Sample ACS 2019 Questionnaire, 2019. Accessed January 17, 2022. https://www2.census.gov/programs-surveys/acs/methodology/questionnaires/2019/quest19.pdf.

Shapiro, Carl, and Hal R. Varian. *Information rules: a strategic guide to the network economy*. Boston, Mass: Harvard Business School Press, 1999.

Sinema, Kyrsten. *S.Amdt.2137 to H.R.3684*, August 2021. https://www.congress.gov/amendment/117th-congress/senate-amendment/2137/text.

Skrok, Samantha. "Project Waves Year One Report," August 2021, 6. https://www.projectwaves.net/reports.

Solnit, Rebecca. "The Annihilation of Time and Space." *New England Review (1990-)* 24, no. 1 (2003): 5–19. https://www.jstor.org/stable/40244205.

Srago, Josh. *Why Can't You Sue Your Broadband Monopoly?* Technical report. Electronic Frontier Foundation. Accessed September 15, 2021. https://www.eff.org/files/2021/03/05/why_cant_you_sue_your_broadband_monopoly_by_josh_srago.pdf.

Stein, Jeff. "Patience and persistence pay off as Biden gets infrastructure deal across finish line." *Washington Post*, November 2021. Accessed March 19, 2022. https://www.washingtonpost.com/us-policy/2021/11/06/biden-infrastructure-deal/.

The Project Waves Network. Accessed February 22, 2022. https://www.projectwaves.net/about-waves-service.

Timothy Wu. Accessed March 19, 2022. https://www.law.columbia.edu/faculty/timothy-wu.

Tomer, Adie, and Lara Fishbane. *Neighborhood broadband data makes it clear: We need an agenda to fight digital poverty*, February 2020. Accessed March 25, 2022. https://www.brookings.edu/blog/the-avenue/2020/02/05/neighborhood-broadband-data-makes-it-clear-we-need-an-agenda-to-fight-digital-poverty/.

Tomer, Adie, Elizabeth Kneebone, and Ranjitha Shivaram. *Signs of Digital Distress*. Technical report. The Brookings Institution, September 2017. Accessed January 6, 2022. https://www.brookings.edu/wp-content/uploads/2017/09/broadbandreport_september2017.pdf.

Verizon program helps bridge digital divide, March 2022. Accessed March 23, 2022. https://www.verizon.com/about/news/verizon-program-helps-bridge-digital-divide.

Whitacre, Brian, Sharon Strover, and Roberto Gallardo. "How much does broadband infrastructure matter? Decomposing the metro–non-metro adoption gap with the help of the National Broadband Map." *Government Information Quarterly* 32, no. 3 (July 2015): 261–269. Accessed July 3, 2021. `https://linkinghub.elsevier.com/retrieve/pii/S0740624X15000325`.

Wilhelm, Alex. *The NSA Scans 75% Of The Internet Through Telco Partnerships*, August 2013. Accessed March 2, 2022. `https://social.techcrunch.com/2013/08/20/new-revelations-detail-how-the-nsa-scans-75-of-the-internet-through-telco-partnerships/`.

Wu, Tim. *The Master Switch: The Rise and Fall of Information Empires*. 1st ed. OCLC: ocn515402494. New York: Alfred A. Knopf, 2010.

Your friendly API robotic overlord. *Census Data API: /data/2019/acs/acs5/groups/B01001*. Accessed January 11, 2022. `https://api.census.gov/data/2019/acs/acs5/groups/B01001.html`.

———. *Census Data API: /data/2019/acs/acs5/groups/B17001*. Accessed January 17, 2022. `https://api.census.gov/data/2019/acs/acs5/groups/B17001.html`.

———. *Census Data API: /data/2019/acs/acs5/groups/B19013*. Accessed January 11, 2022. `https://api.census.gov/data/2019/acs/acs5/groups/B19013.html`.

———. *Census Data API: /data/2019/acs/acs5/groups/B28011*. Accessed January 17, 2022. `https://api.census.gov/data/2019/acs/acs5/groups/B28011.html`.

Zakrzewski, Cat, and Chris Alcantara. "Biden's ambitious broadband funding has a key impediment: an outdated map of who needs it." *Washington Post*, December 2021. Accessed January 6, 2022. `https://www.washingtonpost.com/technology/2021/12/14/bidens-ambitious-broadband-funding-has-key-impediment-an-outdated-map-who-needs-it/`.