This is a preprint of an article currently under review. The final version will differ.

Landlords of the Internet: Big Data and Big Real Estate

Abstract: The physical assets at the core of the internet, the warehouses that store and transmit data and interlink global networks, are owned not by technology firms like Google and Amazon, but by commercial real estate barons who compete with malls and property storage empires. While the infrastructural turn has brought data centers and transcontinental cables further into view in technology studies, the economic life of these massive projects has come under less scrutiny. Granted an empire by the US at the moment of the internet's commercialization, these internet landlords and their particular business model shaped how the network of networks that we call the internet physically connects, and how personal and business data is stored and transmitted. Under their governance, internet exchanges, colocation facilities, and data centers take on a double life as financialized real estate assets that circle the globe even as their servers and cables are firmly rooted in place. This article relates the history of the landlords of the internet, showing how a fundamental reconsideration of the business model at the heart of the internet changes how we understand internet governance and contemporary capitalism writ large.

Keywords: Internet history, infrastructure, real estate, political economy, big data

Introduction

At One Summer Street in downtown Boston, a squat, square building sits atop the subway. Its bottom four floors, roughly 400,000 square feet, are occupied by Macy's. Above Macy's, another 400,000 square feet house the internet. There, the Markley Groupbought the building in 1999 with a $52.1 million mortgage (SEC 2007) and expanded it in 2015 through a $240 million loan from TD Bank (Business Wire 2015). It holds the Boston Internet Exchange Point (IXP), where major traffic purveyors interlink their networks. Inside, cage after cage of servers hum in climate-controlled rooms, protected by security systems that detect fire before there's smoke, backed up by diesel-powered generators sitting on the roof—ready to kick in if the power cuts. Jeff Markley must assure his powerful tenants that their networks will run and their assets will load no matter what. Markley is a renowned art collector. His Jeff Koons balloon dog sits alongside graffiti art of Spider-Man and Iron Man guarding the Uninterruptible Power Supply machines, and commissioned Ray Turner portraits of his 100 employees and his Cavalier King Charles Spaniel, Max. Like the internet, art is a communicative medium whose physical life is determined, in the broad sense, by its double life as a durable financial asset (Taylor 2013).

From One Summer fiber optics belonging to consumer internet service providers (ISPs) like Comcast and commercial internet 'backbone' providers like CenturyLink travel up and down the coast. Some will end in a 24-story art deco building at 60 Hudson Street in Manhattan, once the headquarters of the Western Union telegraph company. Telephone cables followed the telegraph, which is. why buildings like 60 Hudson are called 'carrier hotels': Because they once physically connected one carrier's customers to another's. Announcing their lease of 30,000 square feet on the building's ninth floor at the height of the dotcom boom, Telx called 60 Hudson "the most important address for colocation on the East Coast of the United States…Telx's newest facility gives clients direct access to Time Warner, MFS/MCI, AT&T, Bell Atlantic, Nextlink, Intermedia, Qwest, Global Crossing and France Telecom" (telx, 2000). Like much of the world's most valuable real estate, the internet's key points of connection are coastal: embedded in large financial centers where cables cross oceans (Starosielski 2015).

From New York, much of the money, messages, and the fiber optics carrying them flows further south to Northern Virginia, just outside Washington, DC. Equinix has 13 data centers here, taking up almost 900,000 square feet in total and using 113 megawatts of power. This is valuable real estate. It took time for Equinix to grow this footprint. In 2003, *The Wall Street Journal* dismissed them as "a little company that runs hubs for Internet traffic -- and that has never made money" (Browning 2003). But by 2014 the leading paper of American capitalism proclaimed Equinix "the Internet's biggest landlord" (FitzGerald 2014).

If the internet is a 'network of networks' then those networks must have physical points of interconnection. These points must be housed, guarded, and maintained, lest traffic be disrupted and the global economy stall. Essentially, someone—Markley, Equinix, 60 Hudson Street Owner LLC—is collecting rent for operating highly specialized buildings, with state-of-the art climate, security, and power systems, in which tenants make their networks available for interconnection, create private connections with strategic partners, and store digital assets. The speed of streaming and the ease of the cloud only exists because of these place-based economic relations. I call firms like Equinix and Digital Realty *internet landlords.* At the core of the new economy is one of the oldest: real estate.

Since the early 1990s, the internet's physical foundations have become valuable financial assets. Assets owned and managed not by technology companies as we commonly understand them, in terms of software development, but by commercial real estate firms. Th financialization of internet infrastructure occurred through a partnership between the neoliberal state and the landlords who understand these cables, servers, and warehouses as real estate; an act of conversion that shaped the internet's commercialization, and continues to shape its growth and physical maintenance. This conversion of communications infrastructure into real estate capital is quite literal. Following their competitors, Equinix, "the internet's biggest landlord," became a real estate investment trust (REIT), in 2015. They could do so only because they had convinced US tax authorities that their tenants were not primarily purchasing specific services or technologies but were renting out space on the internet equivalent to the space other REITs rented in malls or storefronts—real estate. Decades of political and business maneuvers built to this moment. And while previous scholarship has approached the internet as a metaphorical space for social life, these transformations of infrastructure into globally circulating real estate assets show that this is no metaphor but a financial reality; albeit one inaccessible to everyday users.

This article uncovers the history of internet landlords, mapping the real estate dynamics undergirding the internet's commercialization, growth, and physical maintenance. It is based on original archival research into the business strategies of internet landlords, drawing from the business press, financial statements, promotional materials, patents, and legal proceedings. For historical and political reasons that will become clear, this sector is most fully developed in the US and so US-based internet landlords—whose footprint now extends around the globe—will be the focus of my analysis

I first review two bodies of literature that emerged to counter the utopian hype of an unbounded internet—the infrastructural turn in media studies and the economic geography of the internet—and build on them to demonstrate the concrete, material effects that emerge from this story of frictionless connection. I then discuss the primary assets owned by internet landlords, how they interact, and how that business landscape emerged historically: internet landlords privatized state infrastructure, then grew their footprint by purchasing distressed assets with private equity cash after the dotcom bubble burst,

before becoming financial instruments themselves— REITs—and thus some of the world's most profitable real estate firms. I conclude by reflecting on the conceptual problems financialized internet infrastructure poses for theories of political technologies.

Literature Review

In the airy days of the internet's commercialization, both libertarian technology evangelists and telecommunications corporations promoted the idea that the internet was an unspoiled land of immaterial communication. John Perry Barlow (1996) famously wrote his Declaration of Independence of Cyberspace to refuse proposed US regulations and declare his peers' electronic homesteads independent of any earthly government (McLure 2000). Companies like MCI repeated his refrain that there was no race, gender, class, or disability online, portraying the internet in their commercials as a vast, empty desert ripe for virtual settlers (Nakamura 2000). My history of internet landlords builds on decades of scholarship in internet studies and economic geography that highlighted the material reality of the internet in order to refute this hype and refocus debate on the intimate connections between social life online and the physical and built environment.

The recent infrastructural turn in communication and media studies uncovers the physical apparatus of signal traffic, embedding online communication in specific geographic contexts (Parks and Starosielski 2015). Starosielski's (2015) touchstone cultural history of Pacific cable networks (from telegraphy to fiber optics) describes the successive political-economic regimes that laid and fixed cable. Other scholars use communications infrastructure as a point of departure to investigate the hidden, devalued labor of their maintenance (Mayer 2011; Russell and Vinsel 2018). Close investigation of internet infrastructure then reveals not a single internet covering the globe, but different, often competing, internets borne of different state development projects (Mukherjee 2019).

Prior research into the social life of data centers specifically evidences many of these trends, but is united in its mission to bring 'the cloud' down to earth (Hwang and Levy 2015). The work of Mél Hogan and her collaborators anchors the field, ranging from demonstrations of state and corporate control of global data through control of strategic physical locations (Hogan and Shepherd 2015), to the settler-ecological thinking embedded in the tech sector's infrastructure projects (Hogan 2018). These cultural investigations of internet infrastructure show that places like data centers unsettle bedrock concepts of human communication—such as divisions between public and private (Holt and Vonderau 2015). Recalling (Stephenson 1996), newer journalistic work in this space often takes the form of a travelogue, journeys throughthe cable lines and anonymous gray buildings housing the internet (Blum 2012; Burrington 2016). Across genres, these critical investigations of data transmission and storage focus on the 'material' as category both physical—making the ephemeral concrete—and relational—marking infrastructure's ties to the social, environmental, and political landscape (Sterne 2014).

I build on this work by exploring the specific material interests of those who own internet infrastructure, in the economic sense of the term. As Anne Haila argues, "it is precisely real estate markets which transmit the effects of general economic change on space" (Haila, 1988: 79). In order to understand the social space of internet infrastructure, we must investigate its production, exchange, and circulation as a real estate asset.

This perspective has been greatly advanced by work in economic geography, which responded to utopian hype by demonstrating that internet infrastructure followed existing distributions of economic

power (Malecki 2002). Zook (2000) mapped domain name registrations to show that internet content in the 1990s largely emerged from cities with built-up media, financial, and business services sectors. Later research explored the geographic concentration of e-commerce within the U.S. (Zook 2002) and the various overlapping geographies of the global internet from cables to content (Zook 2006). Graham and collaborators built on this work address the uneven and combined development of the internet (Graham 2008; Graham and Mann 2013).

More recently, research in information and communication studies has integrated these two perspectives—media and communication studies critiques of 'behind the scenes' infrastructure, and maps of the internet's uneven economic geography—through investigations of the organizations that control the internet's choke points. Mathew's historical and ethnographic approach to the Border Gateway Protocol reveals the delicate alliances between engineers that maintain transnational flows of data (Mathew 2014; Mathew 2016). And while I detail some of my disagreements with the specifics of his analysis below, Hindman convincingly demonstrates that the costs of media distribution have risen as the internet covered the globe, cementing the power of tech giants like Google (Hindman, 2018).

My approach to internet landlords thus blends the domain interests of communication and technology studies—revealing the power behind the internet's physical infrastructure—with the historical and political-economic methods of economic geography and industry studies of internet communications. This allows us to understand the history of internet infrastructure as history of real estate politics.

A Brief History of Internet Landlords

The Shape of the Market

The internet's infrastructure evolved with its landlords. Relaying this history requires first outlining what's in internet landlords' portfolios. Some internet landlords own their buildings, giving them power to extend and renovate them as needed. Others lease the buildings, but take charge of all essential operations within them—sacrificing some control over the physical plant in order to gain some flexibility in their long-term business strategy. Depending on that strategy, internet landlords will pursue different investments in different places. Those investments take the form of three distinct but overlapping asset classes.

First, there are Internet exchange points (IXPs): public peering locations wherein multiple large purveyors of internet traffic, such as Network Service Providers or Content Delivery Networks, physically interlink so as to move traffic between their networks. In the US, IXPs are usually privately operated, one of many services offered by large commercial colocation facilities (e.g., Equinix's Ashburn facility). Elsewhere, IXPs can be run as cooperative, nonprofit, or governmental ventures. There is usually one for each major market.

Second, carrier hotels or 'colo'—short for 'colocation'—facilities. Carrier hotels began with telephone companies, places to physically connect networks. Today, tenants pay for space for their servers, bandwidth to them, and connections to other networks—whether other tenants or large traffic purveyors that have laid fiber into the building. Equinix is by far the world's largest colocation provider.

Tenants of colocation facilities provide and maintain their own servers. Rentable space can be as small as a single server, a cabinet of several servers, a cage of multiple cabinets, or even a room of their own

cages. Tenants with shared business interests (e.g., a rideshare firm partnering with a mapping startup) will use their proximity to cross-connect via fiber-optic cable. This is 'private peering.' Typically, peers will pay the landlord for the router and connection set-up, and sometimes a monthly maintenance fee. In the US, private peering in colocation facilities is more common than public peering in IXPs. In Europe, the reverse is true, though Equnix's global expansion is shifting the balance (451 Research, 2015). A roster of big-name clients with whom other tenants might wish to cross-connect—Amazon, Facebook, other parties equivalent to department store 'anchor tenants' that draw foot traffic to malls—can give the landlord additional pricing power and allow them to substantially raise rent. Equinix calls these "magnet customers" in their financial disclosures.

Finally, there are data centers. While it has become something of a catch-all term, I use data centers to describe facilities where landlords install, manage, maintain, and optimize tenants' servers; taking over the tasks that carrier hotels leave to clients. This is physical business arrangement for the cloud. Equinix's chief competitor Digital Realty focuses primarily on data centers.

A particular landlord's building, such as Markley's 1 Summer Street, may offer data center, colocation, and IXP services in one space, taking advantage of a strategic location and the agglomeration of different kinds of connections with different tenants to corner that particular local market. These agglomerations harden over time. New York's 60 Hudson Street could not simply be dropped in North Dakota and hold its value. Its network connections were built on the paths laid by previous telecommunications regimes. And it is next-door to both the center of a data-hungry industry—finance—and transatlantic internet backbone. In any location, the fixed capital investments made by existing landlords and the density of interconnections made by their tenants discourage new entrants.

While the details differ between business models, operating budgets for internet landlords are broadly similar. Some of the most important expenses are relatively stable: staffing, maintenance, and rent—especially for those landlords—like Equinix or Telx—who do not own their own buildings. Other expenses vary. Chief among these is electricity. Power is the largest single expense. The typical data center spends 40% of its annual operating budget on electricity— $7.4 million out of $18.5 million total (Pham and Donovan 2017). The largest providers benefit from an economy of scale that discourages new entrants. "The average annual data center cost per kilowatt ranges from $5,467 for data centers larger than 50,000 square feet to $26,495 for facilities that are between 500 and 5,000 square feet in size" (Sverdlik 2016). Utility expenses encourage consolidation, but so do construction costs. Like most real estate ventures, the biggest investments are paid upfront as capital expenditures. 73% of a typical data center's initial capital expenditures, $157.1 million out of $215.5 million total (12 times their annual operating costs), are spent on the equipment within the data center, with the rest spent on acquiring the land and building the facility (Pham and Donovan 2017). Larger landlords have more cash on hand, and are able to take on more debt, in order to fund construction.

These historical-economic-geographic relationships create a unique competitive landscape. Competing landlords regularly rent space in each other's buildings—Equinix is Digital Realty's seventh-largest client (Digital Realty Trust Inc. 2020). Data centers, less reliant on strategic connections to internet backbone, can be built out in a variety of locations, provided the physical building is adequately fortified, connected to utilities, etc. However, given the essential fixity of these assets and the time it takes to build them, for these firms to really expand they must usually either purchase competitors' buildings or whole companies. The leases of transnational landlords with global footprints are dominated by a small number of finance, telecommunications, and technology firms with big capital

behind them, big data within them, and big reach outside them. For example, in 2016, the last year before it was acquired by Digital Realty, 45.7% of landlord Dupont Fabros' revenue came from just Microsoft and Facebook (Dupont Fabros Technology, Inc. 2017).

How did this business model for the construction and maintenance of internet infrastructure emerge? That is a longer story that begins with the internet's commercialization in the 1990s. As a class, internet landlords were birthed by the US property state, which tasked private actors with housing the commercialized internet's network connections. Telecommunications executives and more traditional real estate investors poured into the industry during the dotcom boom. The latter came to dominate after the bubble burst, as private equity cash poured into the market. As Web 2.0 drove up the demand for data storage, the market consolidated, and internet landlords transformed their cables, servers, and warehouses from targets of financial investment to financial assets themselves—REITs.

The Property State and the First Landlords

Internet landlords are children of the 1990s. As a class, they would not exist without state efforts to encourage private investment in and private management of internet infrastructure, the outright privatization of state assets.

This legislation, privatization, and investment is the work of what Haila calls the 'property state': a set of nationally-bounded political institutions that create markets for land and property so as to integrate them into the broader economy, and which intervene in those markets so as to expand the type and amount of rents available to the parties with exclusive control over that land and property: landlords (Haila 2000; 2015; 2017). The property state transforms fixed, local real estate into liquid capital that can circulate across the globe, providing funds for local development and enmeshing those localities in global flows of capital.

Throughout the late 1960s and into the 1970s, a number of largely research-focused digital communication networks emerged around the world. In 1984 the TCP/IP communication protocol standardized communication across the various networks making up the proto-internet. But just because these networks spoke the same language did not mean they could converse. That demanded physical interconnection at a mass scale, a project of the US property state and its real estate partners.

Network providers PSINET, UUNET and CEFRNET solved this problem with the first commercial internet exchange—CIX—in 1991 (Greenstein 2017; Hussain 2003). CIX charged a flat fee for connection to its router. Each ISP that connected promised to connect to each other for free. The first CIX router was in DC, with more soon added in Santa Clara and Chicago. This pricing model for private peering appealed to both small consumer ISPs and large enterprise backbone providers. Network effects led CIX's value to skyrocket. The CIX model worked so well that in 1992 some of its founders came together to pledge their traffic to the first Internet Exchange Point, which would be built in an unassuming office building in Tysons Corner, Virginia. The Metropolitan Area Exchange—MAE East, with 'East' hinting at plans for expansion—was operated by MFS Datanet. Its switch coordinated the movement of traffic between every network that connected to it. Those networks paid for interconnection and MAE East was soon "the crossroads for fully half of all the world's internet traffic" (Blum 2012, 61). This valuable real estate made MFS Datanet the first internet landlord.

Senator Al Gore had been a champion of internet research in DC for many years, and long envisioned a commercialized internet as an "information superhighway" that would provide a logistical network to support 21st century US capitalism, just as the interstate system did for postwar US capitalism (Markoff 1990; Greene 2016). His 1991 High Performance Computing Act apportioned $1.547 billion to the NSF to upgrade ARPANET's civilian successor NSFNET in support of this mission.[1] Some of this money went to backbone upgrades—and some went to funding new regional ISPs, but much went to creating "on ramps" to the superhighway: Network Access Points (NAPs) that linked networks together (Frazer 1995). These were the first IXPs. MAE East had been so successful that the NSF used it as a model: Contracting large telecommunication providers like Sprint and Pacific Bell to build and operate four new NAPs across the country (Blum 2012, 64).

The property state's creation of the first privately-managed IXPs gives the lie to the myth of a decentralized internet. In fact, internet infrastructure was deeply emplaced, with the NAPs following regional concentrations of wealth in New Jersey, San Francisco, Chicago, and, of course, Northern Virginia (Townsend 2001). Gore and the NSF created valuable real estate. But not all prospective tenants and landlords were happy. In the NAPs, tenants connected through one central router—owned and operated by the landlord, who levied charges based on metered. This created a chokepoint controlled by the landlord, but also traffic problems: Networks were literally running out of spaces to put their wires, while smaller players struggled to afford the rates required for entry. Prospective tenants who sold internet access worried theywere directly competing with the NAP operators.

In Palo Alto, Jay Adelson and Brian Reid envisioned a new business model: a neutral landlord that would help tenants connect directly with each other, rather than through a central router. They would not pay for the amount of traffic sent but simply for the space they used to house their servers (Blum 2012, 69-103). In 1996, they opened the Palo Alto Internet Exchange (PAIX) in an old telephone switching office. Located in the heart of the burgeoning dotcom boom, and near the Pacific seaboard where global telecommunications firms sent cable into the US, PAIX quickly become one of the world's most important internet hubs. Adelson left his job and with Al Avery started a new company with the same carrier-neutral, rent-by-the-cage model in Northern Virginia, where fiber and land were more readily available (Equinix 1999a, 1999b). That company was Equinix, "the internet's biggest landlord." In 2010, as part of a $683.4 million acquisition of competitor Switch & Data and their 34 properties, PAIX was returned to the company Adelson founded (Equinix 2010).

The US property state created the first internet landlords and two of their asset classes. Privatization and legislation led to the creation of proto-IXPs in CIX and the NAPs. Competition with them led to Equinix's colocation model, which quickly supplanted telcom-run carrier hotels and NAPs. Indeed, some observers argue that government privatization and Equinix's success in private peering kept the European cooperative model for IXP governance from taking root in the US (Blum 2012; Chatzis et al. 2015). The commercialized internet did not just connect people to the global market through the transmission of messages, the sites that stored and transmitted those messages were themselves integrated into global circuits of financial investment by an activist property state. This transformation of servers, cables, and warehouses into valuable financial assets paralleled the US property state's creation of and intervention into other real estate markets in the same period. While the integration of housing markets with financial equity markets came to global attention in the 2008 financial crisis, the groundwork was laid in the 1980s and 1990s as the Departments of the Treasury and Housing and Urban Development crafted new regulations that encouraged the securitization of mortgages (Ashton, 2009; Gotham, 2009).

The third asset class—data centers—was similarly imbricated with the property state in its early days. Japanese firm Telehouse was an offshoot of state-owned telecommunications company KDD and an early innovator in data centers, though they did not yet have that name (KDD, 1987). "What we're going to do is house our clients' computers," Telehouse's director of marketing John K. Wagner said at the 1988 groundbreaking for their Staten Island complex (McCain 1988). Telehouse's client base was in finance. As financial services firms metastasized in the 1980s, they acquired more computational power, but operating those servers was not their core competency and downtown real estate was both too expensive and too insecure. Telehouse's London facility proved especially popular, a 1992 IRA bombing in the City scared financial services firms into seeking sturdier defenses for their digital assets—to Telehouse's benefit (Homer, 1992)

Dotcom Growth

From the mid-1990s to early 2000s, internet landlords expanded their physical footprint to support the increasing digital footprint of the commercialized Web. Two broad categories of entrepreneurs entered this gold rush: traditional real estate developers and telecommunications providers. Equinix is the notable exception. Its founders were network operators, who realized early on that that the points of interconnection they created in nondescript office buildings were in fact valuable real estate

Established real estate developers saw the dotcom boom unfolding and realized the physical infrastructure at its core would make a valuable new additions to their portfolios. For example, data center operator Global Switch Holdings was founded in 1998 by British real estate heir Andrew Ruhan, who sold a majority stake to developer Elliot Bernerd in 2000, whose firm owned London's famed Camden Market. (Davey, 2005). The Markley Group (Leung, 2000), Switch and Data (Switch and Data, 1998), QTS Realty (US Dream Academy 2020), and DuPont Fabros (Haggerty, 1999) were all internet landlords whose leadership had similar origins: Moving from malls, hotels, and office buildings to internet infrastructure in the years after the internet's commercialization because they understood the businesses to be fundamentally similar.

Other founders came from telecommunications, largely because the carrier hotels they were already operating were quickly becoming colocation facilities for internet service providers and early content networks. These were the firms running the property state's NAPs. Other new landlords started on the fringes of the telephone business. Telx's origins lay in autodialers, digital switching, and fax-over-internet offerings, but in October 2000 the firm announced they were now focusing on colocation (Telx, 1998, 2000).

Beyond the founders, there was also significant overlap between telecommunications and real estate in executive personnel and corporate strategy. Switch and Data was founded by real estate entrepreneurs but, beginning in 2000, was led by a series of chief executives who came from telecommunications firms such as AT&T, Lucent, and Verizon (Switch & Data, 2000). CRGWest, later CoreSite Realty Corporation, was created specifically to manage two valuable California buildings, but their value came from their history of onsite telecommunications networking (Miller, 2009; Tucker, 2002). When one of those buildings, One Wilshire Boulevard in Los Angeles, was sold in 2013, it was the most expensive commercial real estate transaction in LA history (Vincent, 2013).

Private Equity and the Dotcom Bust

In 2000, the dotcom bubble burst. In the years that followed, the devalued physical infrastructure supporting Web 1.0 was redeveloped to support a more profitable landlord model. Not by internet entrepreneurs, but by real estate investors—specifically private equity.

With dotcom companies going belly-up, there was little demand for the glut of data centers and colocation facilities built during the boom (Joyce, 2001). "Big Data Centers Stand Empty," the *Washington Post* declared in a 2001 headline. In Northern Virginia, perhaps then the most important market for internet infrastructure in the world, developers were pulling out of deals to build new data centers, or putting existing deals on hold. The story was the same for the big carrier hotels in New York like 60 Hudson, where oversupply meant many landlords were having difficulty finding tenants while overvalued startups in the sector went under and had their assets sold for a song (Ryan, 2001). Colocation provider Colo.com spent $400 million building out its 22 facilities across the country but went bankrupt and had its portfolio auctioned off for $44 million (Long, 2001). The sector was overbuilt. Prospects for surviving landlords were grim. In 2001, technology analysts Gartner, Inc. estimated that there would be 50 million square feet of data center real estate in North America by 2005—but only 20 percent of it would occupied (Swett, 2001).

This surplus made for a buyer's market. Investors with cash on hand at the turn of the millennium were put into an even more favorable position by low and falling interest rates, making it fairly cheap to borrow money for acquisitions and expansions. And the landlords left standing after the bubble burst were, with the support of a new set of financiers, ready to acquire these "distressed assets" and expand their footprint (DuPont Fabros Technology 2007, 82).

Private equity firm GI Partners was initially financed by the California Public Employee Retirement System (CalPERS). They founded data center giant Digital Realty in 2004 through the purchase of nearly two dozen bargain-priced data centers: "Buying data centers post dot-com crash, which is really what happened, allowed GI and CalPERS to buy at very attractive cap rates [the ratio of net property income to property value], double-digit cap rates," said Digital Realty CEO Bill Stein in 2017 (Data Center Knowledge 2017). What is private equity and why was it interested in this sector?

Private equity funds are investment firms where limited partners (i.e., wealthy individuals, pension funds) invest into a portfolio strategically targeting privately held companies. Those funds are managed by general partners, who take both a management fee and some of the returns. Private equity views portfolio companies as fungible assets that can be broken apart or put back together at will; mass layoffs, debt sales, asset stripping and deferral of pension obligations are all popular strategies for increasing a firm's value. This approach often translates to rapid cash infusions into privately held firms in the name of expansion and an eventual IPO, or the acquisition of publicly traded companies so that their assets can either be stripped off or loaded with debt that is taxed at a lower rate than other assets. That debt is then leveraged to either support the fund's other investments or grow the company's size to support a sale. This model grants general partners high rewards but little risk and encourages a short-term outlook on portfolio firms (Appelbaum and Batt, 2014).

Private equity giant Carlyle began financing data center construction in the late 1990s (Spinner, 2000). Its competitors warmed to these now-distressed assets in the early 2000s. They anticipated regular contracts with large tenants in tech, health, and finance; steady cash flow; and opportunities for expansion (Kang, 2018). Some of their peers had been burned by the collapse of telecommunications

stocks they had bought up in the wake of the industry's deregulation by the 1996 Telecommunications Act, but others saw these assets for what they were—not phone companies, but space rented to them and their peers—and jumped in (Malik, 2003). The nature of internet landlords' business means their buildings often physically consolidate competitors' holdings (i.e., Equinix and Digital Realty rent significant space from each other) but private equity proved to be a force for consolidation in at least three other ways: facilities, funding , and governance.

First, private equity created new firms to run buildings that were previously independently operated. GI Partners scooped up distressed carrier hotels and data centers at a 20-40% discount after the bubble burst, and then consolidated those 21 properties into a single company—Digital Realty—which then went public in 2004, drastically increasing the value of GI's shares and allow them to sell for a massive profit by 2007 (GI Partners, n.d.). In 2001, the Carlyle Group similarly consolidated its portfolio into a single firm named CRG West, later CoreSite Realty, which "was formed to focus on data centers as a commercial real estate niche expected to grow again once the economy recovered" (Conrad, 2007).

Second, individual private equity funds invested in multiple competing firms in the sector; centralizing the financing of internet infrastructure. While Digital Realty was their biggest venture, in 2006 GI Partners also purchased Telx Group, owner of major colocation facilities in New York and Atlanta (Miller, 2006). They sold Telx to Boston-based private equity firms ABRY Partners and Berkshire Partners in 2011 for an undisclosed sum, who then sold it back to Digital Realty proper in 2015 for $1.89 billion (Dulaney, 2015; Miller, 2011).

Finally, private equity consolidated corporate governance of internet infrastructure. Digital Realty's CEO from its founding until 2014 was Michael Foust, a founder of GI Partners. The fund thus kept a hand in the company even after it sold off its last shares in 2007 (Miller, 2014). Seaport's co-founder, William Luby, was chairman of Switch and Data's board from 1999 until 2010, when the company was acquired by Equinix Inc. (the deal that returned to PAIX to its founders). Luby then joined Equinix's board and remained a member as of March 2019. If landlords own the internet, then private equity owns them in turn.

The Cloud Boom

After the dotcom bubble burst, private equity wagered that depreciated assets would soar in value once demand rebounded. They were right. By 2006, rents were rising, slack in the market had disappeared, and internet landlords were reaping the rewards of a new boom in internet advertising revenue. "The demand right now is such that anybody who has a data center has a very valuable piece of property. Whereas three years ago, you couldn't give them away," Ron Hughes, president of the California Data Center Design Group, said in 2006 (Bednarz, 2006).

Google's 2004 IPO marked the beginning of the Web 2.0 boom, though it would take a while to accelerate (Conrad, 2007). User-generated content was key to this growth and the subsequent demand for internet landlords' space. Selfies need a physical home, even if it's one users never see. After September 11th, large firms also increasingly sought secure back-up locations for their data. During this period, internet landlords began serving an increasingly smaller pool of enterprise clients. In 2006, 57.5% of The Markley Group's rent revenue from their One Summer Street facility in Boston—mixing IXP, collocation, and data center in one space—came from just two clients: WillTel and Qwest (CWCapital Commercial Funding Corp. 2007)

User-generated content was the public face of the internet boom. Communication was supposedly being democratized; the 2006 TIME Person of the Year was, of course, "You." But the infrastructure undergirding the boom was increasingly under the control of a few large companies. For landlords that had survived the downturn and reaped private equity investment, this was a period of intensive growth. In November 2005, Equinix had a waiting list for its space 20 companies long. Since 2003, they had increased their physical footprint by 50%, expanding existing facilities, buying six new ones, and seeing 30% year-over-year revenue increases. Landlords were shortening the length of their deals—from four or five years to one or two—and doubling rents (Marsan, 2005). Growth continued through these boom years. And landlords sought to secure these gains by restructuring their companies as a specific kind of investment vehicle, making clear in the process that to them the internet was just another piece of commercial real estate.

REITification

I was surprised to learn that, besides Equinix, all of the largest US-based wholesale data center or colocation providers—Equinix, Dupont Fabros, CoreSite, CyrusOne, QTS Realty, and Digital Realty—were incorporated in the mid-Atlantic US state of Maryland—and Digital Realty had just acquired Dupont Fabros. The Washington, DC metropolitan area is an important market, but the real reason for their common corporate home has more to do with the property state and the process of financialization that swept through this sector following the Web 2.0 boom. These firms, including Equinix, are all structured as Real Estate Investment Trusts (REITs), basically a mutual fund for specific classes of rent-collecting properties. Because of friendly regulations, two-thirds of all REITs are registered in the Old Line State—though the real count is likely closer to eighty percent because a parent company will often have several subsidiaries—and they make up about half of all publicly-traded companies incorporated in Maryland (Sherman, 2015).

As the economy picked up after the dotcom crash, internet landlords increasingly structured their corporations as REITs. This is the point at which internet infrastructure gains a clear double life as a liquid financial asset. A 2016 Digital Realty earnings presentation argued that their historic growth rate exceeded that of other REITs like Public Storage, Simon Property Group, and AvalonBay Communities because, compared to storage units or malls, data centers were "sticky": Tenants invested a great deal of fixed capital in the site and so were loath to leave (Digital Realty, 2016).[2] Thus it is not just private equity investment that makes the wires and cages at the internet's heart a part of finance's airy heights, it is the transformation of that space into a specific kind of financial asset. No simple process of abstraction, this financial restructuring actually required a head-on confrontation with the corporality of our networks: In order to secure their status as REITs, internet landlords had to prove that the internet was a physical place you could own, manage, and lease, like an apartment building or a storage unit. There is no metaphor here, no virtual "cyberspace" abstracted from "real" life. It is a legal and financial fact that internet landlords lease (and leverage) internet real estate, and that those physical pieces of their network also circulate the globe as bundled securities.

The US property state created REITs in 1960 as a special tax status for real estate-owning trusts, in order to encourage small investors to take part in postwar urban renewal, and then expanded the category to include more assets like internet infrastructure in the 1980s and 1990s. Dividends from REITs have no federal corporate income tax assessed as long as 1) 90% are paid out annually, 2) 75% of assets are in real estate, and 3) 75% of income are rents from 'real property.' It is a very good deal but one initially

only available to a small group of traditional US real estate investors—with a total market capitalization of only $1.5 billion in 1972.

The creation of a market for internet infrastructure occurred within the US property state's broader transformation of the commercial real estate market . In this way, it is important to read something like Al Gore's High Performance Computing Act of 1991—which created the first IXPs as 'on-ramps to the information superhighway'—alongside real estate regulations in legislation like the Tax Reform Act of 1986, the Technical and Miscellaneous Revenue Act of 1998 and the REIT Modernization Act of 1999. Collectively, these bills lowered the barrier for REIT status, made it easier to maintain that status, let REITs provide services to tenants and create taxable subsidiaries to operate properties as businesses, and, most importantly, allowed REITs to diversify into other sectors. The first timber REIT was created in 1999, followed by REITs that owned billboards, casinos, nursing homes, private prisons, self-storage facilities, hotels, and, of course, internet infrastructure. In 2016, REITs' collective assets were worth $1.8 trillion (Gravelle, 2016).

The expansion of REITs made it easier for global investors to put money into local malls or warehouses without themselves owning or operating it—especially once REITs started to be publicly traded. In this way, "REITs contribute to the financial fluidity of property (fixed capital) by disembedding the process of investment from the procuring of local knowledge necessary to assess risk. In doing so, REITs help to transform real estate into a liquid commodity by enabling investors to buy and sell interests in diversified portfolios of properties on an instantaneous basis" (Gotham, 2006: 265). Property states outside the US followed suit after regional economic crises: Asian REITs appeared after the 1997 crash, with Eurozone REITs following after the dotcom crash. These property states used REITs to bring undervalued, distressed assets back into global circulation and to bring global cash into local real estate markets after local investors had been wiped out. The US followed the same pattern. Internet landlords began their transformation into REITs after scooping up assets devalued through the dotcom crash. REIT investment surged more broadly—into apartments, malls, nursing homes and other spaces— after the 2008 crash, helped along by historically low interest rates (Waldron, 2018).

"Desperate for income, investors can't get enough high-yielding REITs — and Wall Street is rushing to supply them," a *Wall Street Journal* columnist wrote (Zweig, 2012). Internet landlords saw an opportunity here. Digital Realty was first in 2004. DuPont Fabros followed in 2007, CoreSite in 2010, CyrusOne and QTS Realty Trust in 2013, and Equinix, already public, converted itself to a REIT in 2015. In 2016, S&P Global Ratings said that REITs "tend to outperform in low-interest rate environments and when the economy is on the up-and-up," and REITs had done better than U.S. stocks and U.S. government bonds over the previous decade. S&P listed Equinix and Digital Realty as two of the top three performing REITs over a 10-year span (Yeatts and Juge, 2016).

But Equinix's REIT conversion, announced in 2012, was never assured. It required a philosophical confrontation with the nature of property and the internet. Tax regulators at the US Internal Revenue Service (IRS) chose the Equinix case as the point where internet landlords had to prove that the internet was a place, one that could be divided up and rented out. This was the fight Equinix had to win in order to transform their global portfolio of data centers and carrier hotels, all those concrete warehouses filled with caged servers, into liquid, globally circulating financial assets.

Underlying the rise of data center REITs was the assumption that their facilities fit an elastic legal definition of "real property": land, improvements on land, permanent structures, or structural features of

buildings. In 2013, the IRS temporarily halted REIT rulings as it conducted a review of eligibility standards. Equinix stock fell, their prospects unclear. After all, servers and cages—which housed tenants' assets—were not land, permanent structures, or structural features of buildings. They were modular, regularly upgraded, reassembled and moved. And tenants' contracts looked more like service agreements than the leases signed by a store in a mall, agreeing to standardized payments for things like security and parking and rated payments for heating, cooling, and interconnection. At the time, "Equinix's own customer contracts expressly state[d] that they are service agreements, not leases of real property, and that space is 'licensed'" (Citrome, 2014: 207). Because power and climate control are at the core of landlords' value proposition, one tax analyst argued that "these server farms and data centers operate more as unregulated utilities than as real estate landlords" (Boos, 2015).

Equinix said that none of these features were accessory to their business but central to their sector's product offerings: data storage and transmission. Essentially, they argued that while the internet was much larger than any one of their facilities, tenants would not be able to work on or through the internet without renting space from landlords and the support that came with it. Their local properties were rentable pieces of this global, networked whole. The IRS eventually agreed, ruling that "tenants' IT equipment is not functional unless it is connected to and exchanging data with the network existing outside the Centers" (Internal Revenue Service 2014, 2).[3] Coincidentally, Equinix's lobbying expenditures in 2014-15 were greater than that of prior four years combined(Center for Responsive Politics, 2020).

They were now officially a real estate investment trust, and likely saved around $150 million per year in taxes as a result of the conversion (Troianovski, 2012). On top of soaring demand, these friendly financial terms drove more investment into the sector—leading to massive sales like that for One Wilshire in LA. In 2020, the five internet landlords structured as REITs were worth a collective $110 billion—with Equinix and Digital Realty making up the vast majority, $98.7 billion (Hoya Capital Real Estate, 2020).

Decades of scholarship have treated the internet as a metaphorical space of social activity, such that, e.g., US teenagers' migration from messy MySpace to polished Facebook could be understood as an instance of suburban white flight (boyd, 2012). But Equinix's struggle with regulators shows that the internet is indeed a rentable space and that this is no metaphor, but a financial reality. However, this geography is not readily accessible to everyday consumers logging on to Facebook or Netflix. It is strictly a transaction between Facebook and Netflix, who rent space, and Equinix or Digital Realty, who lease it. Everyone else is just passing through their property.

Consolidation and the Threat of Big Tech

Today the industry is marked by a consolidation of both supply and demand. The latter threatens the business model of many landlords. Some tenants have grown so powerful as to buy their own space, rather than renting. Despite this threat, all signs point to internet landlords remaining in control of internet infrastructure because they are able to control the real estate market for it; where tech giants are simply adding resources to support their core business.

First, supply. The number of internet landlords has shrunk through acquisitions. The high costs of construction, the lower cost of power for large landlords, and the difficulty large tenants face in moving their customized assets between landlords meant that the bar for new entrants was always high. But the

largest internet landlords have acquired smaller rivals, their war chests stuffed with profits from Web 2.0 demand, private equity investment, initial public offerings, and REIT-based tax avoidance. This growth can be intensive, allowing them to offer new services to old tenants. Digital Realty acquired telx for $1.89 billion in 2015 so that the datacenter giant could also provide colocation services (Dulaney, 2015).

This growth can also be extensive, expanding their footprint and their tenant base. Because their assets are fixed in place and competitors can squat on prime real estate—especially for colocation and IXPs—acquisition is essential to landlords' growth. One smaller landlord may claim most of a regional market. A larger competitor will feel that acquisition is the quickest route to regional power. Another contributor has been the recent desire of large telecommunications providers to sell off their data centers. Equinix's recent acquisitions combine these trends. The 2015 acquisition of UK-based Telecity for $3.6 billion, combined with their existing properties, created the largest datacenter and colocation provider in Europe (Zekaria, 2015). This push continued east with the acquisition of Zenium's Istanbul data center in 2017 (Equinix Inc., 2017). After opening a colocation facility in southern Florida "to act as a bridge," Equinix began a $500 million spending spree on Latin American properties that included the $225 million purchase of ALOG in Brazil (Verge, 2014) and the $175 million purchase of three Mexican data centers (Equinix Inc., 2020). Their Latin American portfolio was rounded out by the purchase of 29 Verizon colocation facilities for $3.6 billion, a sale that included properties in Colombia and Miami and 600 new enterprise customers (Hufford, 2016).

Second, while the demand for internet landlords' properties has skyrocketed, more and more of that demand has come from has fewer and fewer tenants. Large technology firms—Netflix, Microsoft, Amazon, etc.—who have powered financial markets to new heights during an era of secular stagnation account for much of the demand. This trend began during the post-dotcom era—recall that 57.5% of the Markley Group's Boston 2007 revenue came from Qwest and WillTel alone—but has accelerated of late. Today, Digital Realty takes in 53.2% of its revenue from its 20 largest customers, with 9.6% coming from an unnamed "Fortune 50 Software Company", and 63 of its 225 data centers were occupied by a single customer in 2019 (Digital Realty Trust Inc., 2020). The purchasing power of these "hyperscale" customers is so great that they now dictate the design and layout of new data centers, forcing smaller tenants to adjust their assets to fit. (Fulton III, 2019).

Internet landlords worry about losing significant revenue if these tech giants decide to build space instead of rent. In their annual reports for 2018, four of the five publicly traded data-center REITs—Digital Realty, CoreSite, CyrusOne, and QTS— offered similar warnings about the risk of key customers opting to build or expand their own data centers. Digital Realty cautioned that "our customers may choose to develop new data centers or expand their own existing data centers or consolidate into data centers that we do not own or operate, which could reduce demand for our newly developed data centers or result in the loss of one or more key customers." Equinix was alone in not offering such a warning. Their business model focuses on colocation rather than wholesale data storage, so they are less vulnerable to threats from tech giants.

This fear is justified. Tech giants have been on a data center building spree. For consumer software firms like Facebook and Apple, this is largely meant to house their own assets, or the data of users sending pictures, messages, and other media. Enterprise firms like Amazon and Microsoft build for themselves, and for the cloud infrastructure they provide to businesses. Facebook has been building its own data centers since 2010; the manager of their first one said "We're much more able to control our costs by doing it this way" (Letzing, 2011). Apple announced in December 2018 that it would spend $10

billion over the next five years on expanding existing data centers in the US and building new ones. (Apple Inc., 2018). Google, Amazon, and Microsoft have each announced similar multibillion-dollar facilities expansions.

Some scholars use these building sprees as evidence for big tech's control of the internet's infrastructure from top to bottom, from the consumer-facing Web to the servers and cages storing and moving our data—the stack (Bratton, 2015). Hindman (2018) correctly describes Google's massive fixed capital investments as an example of how internet-based markets tend towards concentration, because of network effects and economies of scale. But just because firms like Google and Facebook dominate the headlines and the stock market, it does not mean they are close to dominating the stack. Different pieces of the stack exist in different markets with different incentives, different restrictions, and different competitors. Because of this, the parties that benefit from centralization will differ at different points of the stack. The bottom of the stack is run by landlords, not software developers, and will be for a while yet. They are simply better at real estate.

Landlords' current advantage against big tech can be roughly measured in two ways: their physical footprint and the reach of their network. At the end of 2019, Google had "19 data center campuses around the globe, with 11 in the United States, 5 in Europe, two in Asia/Pacific and one in South America" (Miller, 2019). In comparison, Digital Realty has 225 data center facilities—147 in the US, 3 in Canada, 41 in Europe, 19 in Latin America, 10 in Asia, 5 in Australia— totaling 36.6 million rentable square feet (Digital Realty Trust Inc., 2020). Even if every Google data center is among the world's largest, totaling more than a million square feet, they still would not touch Digital Realty, who, while the world's largest data center operator, is but one landlord.

What about the breadth of their footprint? We can roughly approximate this by the number of network connections. Equinix, the world's leader in private peering—although, again, just one landlord profiting from colocation—is perhaps the better comparison here. In July 2020, according to industry tracker PeeringDB, Google had 231 public peering points and 121 private peering points, spread across the world in various landlords' facilities. At Equinix's Ashburn, Virginia exchange alone, there are 282 peers.

At the base of the internet, there is not software developers, but landlords. A tremendous amount of money and innovation may go into Google's networks and data centers, but for the most part they do that work inside cages they rent from another party—not ones they build themselves. Of Googles 231 public peering points, 22 are housed in Equinix facilities. Equinix similarly holds 35 of Google's 121 private peering points. As for the data centers themselves, while tech giants—especially Google and Amazon—do invest in their own data centers for their own needs—rather than leasing them out, as landlords do—their relationship with internet landlords is largely symbiotic: "The cloud and internet giants lease more than 70 percent of their hyperscale data center footprint from commercial data center operators" (Sverdlik, 2019). The symbiosis is unsurprising, since their profit sources don't conflict. Google isn't in real estate. They're in advertising specifically and—like Amazon and Facebook and some parts of Microsoft—distribution more generally. Tech giants don't lease out physical space, though they own a tremendous amount of it. Their data centers are largely for their own use.

The future remains unwritten. Digital Realty CEO Bill Stein, told a REIT investor forum that he expects each tech giant to go through cycles of building before returning to leasing because "What we do for cloud providers that they can't do for themselves is that we build on a very cost-effective basis" (FD

(Fair Disclosure) Wire, 2017). Ratings agency Moody's notes that a build/lease mix is normal for a given company in a given year: Building secures core assets for the long term, while leasing assists speedy growth (Moody's Investors Service, 2017). Given these caveats from the sector's leaders and regulators, and the entrenched landlord power the history above has revealed, I suspect that big tech's recent building spree largely parallels landlords'. Both benefit from the profits in and investment into a broad area that, unlike much of the global economy, is still growing and, like much of the global economy, is a prime target for financial speculation. For now, as far as the infrastructure at the bottom of the stack goes, this is still the landlord's internet. It is they, and not big tech, who are collecting rents at the internet's physical core.

Conclusion

The physical points of interconnection that knit together the network of networks we call the internet are built and maintained by landlords. They understand themselves to be competing with other real estate empires dealing in storage units, or malls, or apartments, or nursing homes. They extract rents from tenants who send and store large amounts of data, in order to compete with other, heavily-financialized real estate corporations. This market was created by the neoliberal property state during the internet's commercialization, before growing in the dotcom boom, maturing in the bust as private equity bought up devalued assets, and expanding rapidly through Web 2.0. Their status secured through their transformation into REITs, internet landlords have today expanded across the globe, to the point where the only challenge to their power comes from their most powerful tenants—and even that threat looks unlikely to materialize. Their global reach comes not just from physical networks of warehouses and cables but the IRS-approved reality that those facilities are in fact a rentable part of the internet *and* a financial asset that circulates between global investors far removed from the physical location.

It could be otherwise. Specific people made specific decisions at each point along the way to a landlord's internet. And alternatives are still visible today—at least for some infrastructures. In Europe, Asia, and Africa, the IXPs that connect large traffic purveyors are often run as non-profits, industry co-operatives, or government agencies. Different models of capitalism circulate as well. China Telecom and Unicom, both publicly traded but majority-owned by the Chinese government, remain two of the top five largest providers of colocation services and datacenter space in the world (Sverdlik, 2017). They are still landlords but, unlike their American competitors, not REITs. However, the momentum is clearly with the American real estate developers, dominant as they have been since the internet's commercialization in the 1990s.

As long as we've had internet, different communities have wished for different internets; that it would be cheaper, faster, cleaner, bigger, smaller, more accessible, private, democratic, open, preserved, or forgetful. Each of these values represents a need of some people somewhere, currently unmet. But the landlord's internet is not produced for need; it is produced for exchange. That contradiction is of course immanent to the commodity form, but it is perhaps most visible in matters of real estate where the use value is often an obvious matter of basic human needs—habitation—such that the exchange value's distinction from those needs becomes quite clear. Our cities' homeless need housing, and many a luxury condominium or hotel stands unfilled.

Those seeking other internets may take heart in histories like the above. That landlords built the internet implies it could be unbuilt or rebuilt. But the ease with which the property state handed over the internet, the initiative enterprising landlords took in its early days, and the breadth of their present empire shows

that while it may still be different in the future, it seems it could only be this way today. A neoliberal American property state commercialized the internet. Today, real estate holdings make up the majority of global assets and the last president of that property state was a real estate baron (Stein, 2019). In this environment, who would control the internet's core if not landlords? How would that core be produced and distributed, if not as real estate? These are not individual decisions serving individual needs, even the needs of a particular class, through their design. It is something more foundational. "If artefacts have politics, it is not just because they are a congealment of the choices of situated individuals, but because they are produced in the context of a determinate pattern of social relations which are structured in particular by the capital relation" (Endnotes 2019, 138).

We have seen the capital relation deep in the internet's bones. It gives us a "determinate pattern" of internet infrastructure produced for exchange by landlords, instead of serving the needs of the people. Indeed, landlords' IXPs, colocation facilities, and data centers take on a whole double life of exchange, circulating not just as property rented to tenants but assets securitized as REITs. This presents a chicken-and-egg problem common to social studies of technology with emancipatory ends, though here at a grand scale: What sort of struggle could birth another internet? Is it a matter of design or a matter of fighting the landlords who determine today's designs? But if we understand the built environment as a grand capitalist project, then these potential sites of struggle—built design, social power—appear not as separate paths but a unified contradiction immanent to the actually existing internet.

It is a problem that, again, becomes easier to see if we remember we are dealing in real estate. It is not true that different kinds of housing will resolve our housing crisis on their own; just as it is not true that a people's internet will emerge simply through better cables or protocols. The landlords would stomp out their fledgling competition. But neither are these designs mute instruments wielded in struggle. We need more public housing and fewer luxury condominiums for fairer housing, and their construction reduces the power of wealthy real estate barons who build homes for profit rather than habitation—a choice they do not make freely either! The questions this study I hope opens up for those who seek other internets are simply these: What will that fight look like, where will it take place on the landlords' internet, and how will our data centers or carrier hotels look at the end of it? Answering these in advance may be impossible, because the terrain changes with the struggle. The point is that an internet produced for our needs can only emerge from conflict within the internet produced for exchange, that its construction cannot be separated from the conflict with its present owners. At its literal foundation, this means going through the landlords.

Notes

[1] It is in this sense, of government funding for privatizing the internet, that Al Gore really can be said to have created, if not "invented", the internet. For more on this history, see Greene (2016, 2021).

[2] It is important to note that ratings agencies draw the opposite conclusion from the same data: Data center REITs are a *riskier* investment than malls or storage units, because the properties cannot be quickly 'flipped' into alternative uses in the case of a downturn. Indeed, the fixity of these assets was what led to their sharp depreciation after the dotcom crash, allowing today's internet landlords to scoop them up on the cheap.

[3] Private Letter Rulings are anonymized such that the party requesting the ruling cannot be identified. However the contents and timing of this ruling, and the subsequent industry reporting on it, makes it almost certain that was addressing Equinix.

References

451 Research (2015) *Interconnection 101*. August. Available at: https://forum.equinix.com/insights/451-research-interconnection-101/cloud-it-services (accessed 3 July 2020).

Appelbaum E and Batt R (2014) *Private Equity at Work: When Wall Street Manages Main Street*. Russell Sage Foundation.

Apple Inc. (2018) Apple to build new campus in Austin and add jobs across the US. Available at: https://www.apple.com/newsroom/2018/12/apple-to-build-new-campus-in-austin-and-add-jobs-across-the-us/ (accessed 3 December 2020).

Ashton P (2009) An Appetite for Yield: The Anatomy of the Subprime Mortgage Crisis. *Environment and Planning A: Economy and Space* 41(6).

Bednarz A (2006) Demand fueling data center building boom. Available at: https://www.networkworld.com/article/2309797/demand-fueling-data-center-building-boom.html (accessed 29 October 2020).

Blum A (2012) *Tubes: A Journey to the Center of the Internet*. Harper Collins.

Boos PE (2015) Runaway REIT Train? Impact of Recent IRS Rulings. Available at: http://www.taxhistory.org/www/features.nsf/Articles/FFF8F863CF33DB1E85257E1B004BAD8F?OpenDocument (accessed 10 November 2020).

boyd danah (2012) White Flight in Networked Publics? How Race and Class Shaped American Teen Engagement with MySpace and Facebook. In: Nakamura L and Chow-White PA (eds) *Race After the Internet*. Routledge, pp. 203–222.

Bratton BH (2015) *The Stack: On Software and Sovereignty*. MIT Press.

Burrington I (2016) *Networks of New York: An Illustrated Field Guide to Urban Internet Infrastructure*. Melville House.

Center for Responsive Politics (2020) Equinix Inc Lobbying Profile. Available at: https://www.opensecrets.org/federal-lobbying/clients/summary?cycle=2018&id=D000064717 (accessed 10 November 2020).

Chatzis N, Smaragdakis G, Feldmann A, et al. (2015) Quo vadis Open-IX? *ACM SIGCOMM Computer Communication Review* 45(1): 12–18.

Citrome LG (2014) Data Centers and Reits: Is There Real Estate in the Cloud? *New York University Journal of Law & Business* 11(1): [vii]-246.

Conrad K (2007) Data centers hot once again in the Bay Area. *East Bay Times*, 8 January. Available at: https://www.eastbaytimes.com/2007/04/01/data-centers-hot-once-again-in-the-bay-area/ (accessed 28 October 2020).

CWCapital Commercial Funding Corp. (n.d.) Cobalt CMBS Commercial Mortgage Trust 2007-C2. SEC. Available at: https://www.sec.gov/Archives/edgar/data/1350935/000095013607001856/0000950136-07-001856.txt (accessed 30 October 2020).

Data Center Knowledge (2017) Digital Realty CEO Bill Stein: How to Survive a Market Meltdown and Come Out on Top. The Data Center Podcast. Available at: https://www.stitcher.com/s?eid=50902168 (accessed 20 October 2020).

Davey J (2005) Reubens set to buy Multiplex's stake in data firm. *The Times of London*, 16 December.

Delaney KJ (2000) The French Connection. *Wall Street Journal*, 25 September. Available at: https://www.wsj.com/articles/SB969572008549306791 (accessed 15 July 2020).

Digital Realty (2016) First Quarter Earnings Presentation. Available at: https://s22.q4cdn.com/864880006/files/doc_presentations/DLR-1Q16-Earnings-Presentation.pdf (accessed 10 November 2020).

Digital Realty Trust Inc. (2020) Form 10-K 2020. Digital Realty Trust Inc. Available at: http://d18rn0p25nwr6d.cloudfront.net/CIK-0001297996/f458b632-f38f-49b4-b9c8-56828ff041b8.pdf (accessed 3 December 2020).

Dulaney C (2015) Digital Realty to Buy Telx for $1.89 Billion. *Wall Street Journal*, 14 July. Available at: https://www.wsj.com/articles/digital-realty-to-buy-telx-for-1-89-billion-1436872669 (accessed 11 November 2020).

DuPont Fabros Technology (2007) *Initial Public Offering Prospectus*. 18 October. Available at: https://www.sec.gov/Archives/edgar/data/1407739/000119312507221619/d424b4.htm (accessed 20 October 2020).

Dupont Fabros Technology, Inc. (2017) Form 10-K Annual Report. Available at: https://sec.report/Document/0001407739-17-000044/ (accessed 2 November 2020).

Endnotes (2019) Error. *The Passions and the Interests* 5: 115–160.

Equinix (1999) Cisco, Microsoft Fund New Company To Create First Internet Business Exchange™ | Equinix, Inc. Available at: http://investor.equinix.com/news-releases/news-release-details/cisco-microsoft-fund-new-company-create-first-internet-business (accessed 15 July 2020).

Equinix (2010) Equinix Completes $683.4 Million Acquisition of Switch and Data, Strengthening Its Leadership in Data Center Services | Equinix, Inc. Available at: http://investor.equinix.com/news-releases/news-release-details/equinix-completes-6834-million-acquisition-switch-and-data (accessed 15 July 2020).

Equinix Inc. (2017) Equinix Acquires Istanbul Data Center from Zenium. Available at: https://www.equinix.com/newsroom/press-releases/pr/123579/equinix-acquires-istanbul-data-center-from-zenium/ (accessed 11 November 2020).

Equinix Inc. (2020) Equinix Completes US$175 Million Acquisition of Three Data Centers in Mexico. Available at: https://www.prnewswire.com/news-releases/equinix-completes-us175-million-acquisition-of-three-data-centers-in-mexico-300984094.html (accessed 11 November 2020).

FD (Fair Disclosure) Wire (2017) Digital Realty Trust Inc at REITWeek: NAREIT's Investor Forum - Final. Available at: https://advance-lexis-com.proxy-um.researchport.umd.edu/document?crid=72527e78-7361-408d-aa5f-4cc6ba1e7ca5&pddocfullpath=%2Fshared%2Fdocument%2Fnews%2Furn%3AcontentItem%3A5NRN-5G81-JB20-G22V-00000-00&pdsourcegroupingtype=&pdcontentcomponentid=254610&pdmfid=1516831&pdisurlapi=true# (accessed 3 December 2020).

FitzGerald D (2014) Equinix Inc., the Internet's Biggest Landlord. *Wall Street Journal*, 29 October. Available at: https://www.wsj.com/articles/equinix-inc-the-internets-biggest-landlord-1414451918 (accessed 2 July 2020).

Fulton III S (2019) Hyperscale Cloud Platforms Changed Data Center Design and Function. Here's How. Available at: https://www.datacenterknowledge.com/design/hyperscale-cloud-platforms-changed-data-center-design-and-function-heres-how (accessed 1 December 2020).

GI Partners (n.d.) Digital Realty | Real Estate | GI Partners. Available at: https://www.gipartners.com/real-estate/investment/digital-realty (accessed 28 October 2020).

Gotham KF (2006) The Secondary Circuit of Capital Reconsidered: Globalization and the U.S. Real Estate Sector. *American Journal of Sociology* 112(1). The University of Chicago Press: 231–275. DOI: 10.1086/502695.

Gotham KF (2009) Creating Liquidity out of Spatial Fixity: The Secondary Circuit of Capital and the Subprime Mortgage Crisis. *International Journal of Urban and Regional Research* 33(2): 355–371. DOI: https://doi.org/10.1111/j.1468-2427.2009.00874.x.

Graham M (2008) Warped Geographies of Development: The Internet and Theories of Economic Development. *Geography Compass* 2(3): 771–789.

Graham M and Mann L (2013) Imagining a Silicon Savannah? Technological and Conceptual Connectivity in Kenya's BPO and Software Development Sectors. *The Electronic Journal of Information Systems in Developing Countries* 56(1): 1–19.

Gravelle JG (2016) Real Estate Investment Trusts (REITs) and the Foreign Investment in Real Property Tax Act (FIRPTA): Overview and Recent Tax Revisions. R4421: 15.

Greene D (2016) Discovering the Divide: Technology and Poverty in the New Economy. *International Journal of Communication* 10. 1212-1231.

Greenstein S (2017) *How the Internet Became Commercial: Innovation, Privatization, and the Birth of a New Network*. Princeton University Press.

Haggerty M (1999) From the Ground Up. *Washington Post*, 25 October. Available at: https://www.washingtonpost.com/archive/business/1999/10/11/from-the-ground-up/0b6a6fba-9b87-4958-acd7-85eff005d553/ (accessed 8 September 2020).

Haila A (1988) Land as a Financial Asset: The Theory of Urban Rent as a Mirror of Economic Transformation*. *Antipode* 20(2): 79–101.

Haila A (2000) Real Estate in Global Cities: Singapore and Hong Kong as Property States. *Urban Studies* 37(12): 2241–2256.

Haila A (2015) *Urban Land Rent: Singapore as a Property State*. John Wiley & Sons.

Haila A (2017) Institutionalization of 'The Property Mind'. *International Journal of Urban and Regional Research* 41(3): 500–507.

Hindman M (2018) *The Internet Trap: How the Digital Economy Builds Monopolies and Undermines Democracy*. Princeton University Press.

Hogan M (2018) Big data ecologies | ephemera. *ephemera* 18(3): 631–657.

Hogan M and Shepherd T (2015) Information Ownership and Materiality in an Age of Big Data Surveillance. *Journal of Information Policy* 5. Penn State University Press: 6–31.

Holt J and Vonderau P (2015) Where the Internet Lives. In: Parks L and Starosielski N (eds) *Signal Traffic: Critical Studies of Media Infrastructure*. University of Illinois Press, pp. 71–92.

Homer S (1992) Back-up for everything but bombs. *The Independent*, 20 April. Available at: https://advance-lexis-com.proxy-um.researchport.umd.edu/document/?pdmfid=1516831&crid=6bd05ece-53d2-42b2-acf8-6761bb11ad11&pddocfullpath=%2Fshared%2Fdocument%2Fnews%2Furn%3AcontentItem%3A3T4F-KB20-005H-822H-00000-00&pdcontentcomponentid=8200&pdteaserkey=sr0&pditab=allpods&ecomp=gb63k&earg=sr0&prid=d4372815-759b-4a0d-92da-7928e4c6c229 (accessed 15 July 2020).

Hoya Capital Real Estate (2020) Data Center REITs: The New Digital Office. Available at: https://seekingalpha.com/article/4353274-data-center-reits-new-digital-office (accessed 10 November 2020).

Hufford DF and A (2016) Equinix to Buy Some Verizon Data Centers for $3.6 Billion. *Wall Street Journal*, 6 December. Available at: https://www.wsj.com/articles/equinix-to-buy-some-verizon-data-centers-for-3-6-billion-1481034980 (accessed 11 November 2020).

Hussain F (2003) Internet: eXchange Points, Peering. In: *Farooq Hussain*. Available at: https://farooqhussain.us/home/internet-exchange-points-peering/ (accessed 14 July 2020).

Hwang T and Levy K (2015) 'The Cloud' and Other Dangerous Metaphors. Available at: https://www.theatlantic.com/technology/archive/2015/01/the-cloud-and-other-dangerous-metaphors/384518/ (accessed 9 February 2021).

Internal Revenue Service (2014) Private Letter Ruling-137176-13. Available at: https://www.irs.gov/pub/irs-wd/201423011.pdf (accessed 10 November 2020).

Journal ESBR of TWS (2003) Tech-Stock Surge Brings Back A Hint of the Late-1990s Frenzy. *Wall Street Journal*, 22 August. Available at: https://www.wsj.com/articles/SB106150301076796100 (accessed 2 July 2020).

Joyce A (2001) Big Data Centers Stand Empty. *The Washington Post*, 23 May.

Kang J (2018) AT&T Revives Sales Process for Data-Center Business. *Wall Street Journal*, 2 February. Available at: https://www.wsj.com/articles/at-t-revives-sales-process-for-data-center-business-1517530555 (accessed 9 September 2020).

Lawson D (1987) City: Japanese giant keys in to Docklands. *The Sunday Times*, 27 December. London. Available at: https://advance-lexis-com.proxy-um.researchport.umd.edu/document/?pdmfid=1516831&crid=0406dfa4-6bce-4b3f-a687-2947037329bb&pddocfullpath=%2Fshared%2Fdocument%2Fnews%2Furn%3AcontentItem%3A41BB-V1W0-00YJ-Y0N7-00000-00&pdcontentcomponentid=332263&pdteaserkey=sr0&pditab=allpods&ecomp=gb63k&earg=sr0&prid=a5afb621-e92f-4451-899b-7e861ac5e932 (accessed 15 July 2020).

Letzing J (2011) Facebook Data Center Is Boon for Oregon Town. *Wall Street Journal*, 21 January. Available at: https://www.wsj.com/articles/SB10001424052748704881304576094222157412808 (accessed 3 December 2020).

Leung S (2000) Telco Hotels Lure Investors, Worry Cities. *Wall Street Journal*, 16 August.

Long J (2001) Trading Desk: Collocation Finds a Market on Bid-Ask Bulletin Board. Available at: https://www.channelpartnersonline.com/article/trading-desk-collocation-finds-a-market-on-bid-ask-bulletin-board/ (accessed 20 October 2020).

Malecki EJ (2002) The Economic Geography of the Internet's Infrastructure. *Economic Geography* 78(4): 399–424.

Malik O (2003) The operators: a handful of brave souls are buying distressed telecom assets in the hope of building future empires.

Markley Group Secures $240 Million in New Financing (2015). Available at: https://www.businesswire.com/news/home/20150421005028/en/Markley-Group-Secures-240-Million-New-Financing (accessed 2 July 2020).

Markoff J (1990) Creating a Giant Computer Highway. *The New York Times*, 2 September. Available at: https://www.nytimes.com/1990/09/02/business/creating-a-giant-computer-highway.html (accessed 15 July 2020).

Marsan CD (2005) Web hosting costs soar. Available at: https://www.networkworld.com/article/2316100/web-hosting-costs-soar.html (accessed 30 October 2020).

Mathew AJ (2014) *Where in the World is the Internet? Locating Political Power in Internet Infrastructure*. Dissertation. UC Berkeley.

Mathew AJ (2016) The myth of the decentralised internet. *Internet Policy Review* 5(3). Available at: https://policyreview.info/articles/analysis/myth-decentralised-internet (accessed 3 July 2020).

Mayer V (2011) *Below the Line: Producers and Production Studies in the New Television Economy*. Duke University Press.

McCain M (1988) Commercial Property: The Teleport; Moving Ahead Off the Beaten Path in Staten Island. *The New York Times*, 3 January. Available at: https://www.nytimes.com/1988/01/03/realestate/commercial-property-teleport-moving-ahead-off-beaten-path-staten-island.html (accessed 15 July 2020).

McLure H (2000) The Wild, Wild Web: The Mythic American West and the Electronic Frontier. *The Western Historical Quarterly* 31(4). Western Historical Quarterly, Utah State University: 457–476.

Miller R (2006) GI Partners Buys telx, 56 Marietta. Available at: https://www.datacenterknowledge.com/archives/2006/11/22/gi-partners-buys-telx-56-marietta (accessed 28 October 2020).

Miller R (2009) CRG West Rebranding as CoreSite. Available at: https://www.datacenterknowledge.com/archives/2009/06/22/crg-west-rebranding-as-coresite (accessed 9 September 2020).

Miller R (2011) Telx Acquired by ABRY, Berkshire Partners | Data Center Knowledge. Available at: https://www.datacenterknowledge.com/archives/2011/08/08/telx-acquired-by-abry-berkshire-partners (accessed 17 February 2021).

Miller R (2014) Foust Resigns as Digital Realty CEO, Stein Takes the Helm. Available at: https://www.datacenterknowledge.com/archives/2014/03/17/foust-resigns-digital-realty-ceo-stein-takes-helm (accessed 29 October 2020).

Miller R (2019) Google Building More Data Centers for Massive Future Clouds. Available at: https://datacenterfrontier.com/google-building-more-data-centers-for-massive-future-clouds/ (accessed 3 December 2020).

Moody's Investors Service (2017) Rising demand boosts prospects for US data center REITs. *Moody's Sector In-Depth: REITs-US*.

Mukherjee R (2019) Jio sparks Disruption 2.0: infrastructural imaginaries and platform ecosystems in 'Digital India'. *Media, Culture & Society* 41(2): 175–195.

Nakamura L (2000) 'Where do you want to go today?': Cybernetic tourism, the internet, and Transnationality. In: Kolko B, Nakamura L, and Rodman GB (eds) *Race in Cyberspace*. Routledge, pp. 15–26.

Parks L and Starosielski N (eds) (2015) *Signal Traffic: Critical Studies of Media Infrastructures*. University of Illinois Press.

Pham N and Donovan M (2017) *Data Centers: Jobs and Opportunities in Communities Nationwide*. U.S. Chamber of Commerce Technology and Engagement Center. Available at: https://www.uschamber.com/sites/default/files/ctec_datacenterrpt_lowres.pdf (accessed 17 November 2020).

Russell AL and Vinsel L (2018) After Innovation, Turn to Maintenance. *Technology and Culture* 59(1). Johns Hopkins University Press: 1–25.

Ryan V (2001) Space for rent: Downcycle hits telco real estate in New York. *Telephony*, 15 August.

Sherman N (2015) For some businesses, Maryland is actually very friendly. *The Baltimore SUn*, 9 April. Available at: https://www.baltimoresun.com/business/bs-bz-reit-haven-20150904-story.html (accessed 2 November 2020).

Spinner J (2000) 'Tech Hotels' Check In; As Demand Soars for Data Centers In Urban Settings, D.C. Holds Out. *The Washington Post*, 12 October.

Starosielski N (2015) *The Undersea Network*. Duke University Press.

Stein S (2019) *Capital City: Gentrification and the Real Estate State*. Verso Books.

Stephenson N (1996) Mother Earth Mother Board. *Wired*, 1 December. Available at: https://www.wired.com/1996/12/ffglass/ (accessed 3 February 2021).

Sterne J (2014) 'What do we want?' 'Materiality!' When Do We Want It?" Now!". In: Gillespie T, Boczkowski P, and Foot KA (eds) *Media Technologies: Essays on Communication, Materiality, and Society*. MIT Press, pp. 119–128.

Sverdlik Y (2016) What is the Data Center Cost of 1kW of IT Capacity? Available at: https://www.datacenterknowledge.com/archives/2016/08/23/what-is-the-data-center-cost-of-1kw-of-it-capacity (accessed 17 November 2020).

Sverdlik Y (2017) Here are the 10 Largest Data Center Providers in the World. Available at: https://www.datacenterknowledge.com/archives/2017/01/20/here-are-the-10-largest-data-center-providers-in-the-world (accessed 21 December 2020).

Sverdlik Y (2019) Analysts: There are Now More than 500 Hyperscale Data Centers in the World. Available at: https://www.datacenterknowledge.com/cloud/analysts-there-are-now-more-500-hyperscale-data-centers-world (accessed 3 December 2020).

Swett C (2001) Sacramento, Calif., Draws Data Centers, But Where's the Business? *Sacramento Bee*, 15 July. Available at: https://advance-lexis-com.proxy-um.researchport.umd.edu/document?crid=f4dbf6a0-e0cd-4ae9-8f2d-afd57b6ec508&pddocfullpath=%2Fshared%2Fdocument%2Fnews%2Furn%3AcontentItem%3A43J0-CX90-0109-G0RV-00000-

00&pdcontentcomponentid=169235&pdmfid=1516831&pdisurlapi=true (accessed 20 October 2020).

Switch & Data (2000) Switch & Data Facilities Names Patricia L. Higgins President and CEO. Available at: https://advance-lexis-com.proxy-um.researchport.umd.edu/document?crid=46990b1d-4f07-4680-809d-dc240905939a&pddocfullpath=%2Fshared%2Fdocument%2Fnews%2Furn%3AcontentItem%3A41N8-X820-00RH-40PG-00000-00&pdcontentcomponentid=7924&pdmfid=1516831&pdisurlapi=true (accessed 9 September 2020).

Switch and Data (1998) First National Co-Location Network Opens. *Business Wire*, 8 November. Available at: https://advance-lexis-com.proxy-um.researchport.umd.edu/document/?pdmfid=1516831&crid=ce325a2b-58e4-4ca0-b46e-a745f8ad7b00&pddocfullpath=%2Fshared%2Fdocument%2Fnews%2Furn%3AcontentItem%3A3TCB-X980-007D-M4MV-00000-00&pdcontentcomponentid=7924&pdteaserkey=sr0&pditab=allpods&ecomp=tzg2k&earg=sr0&prid=c9bf34c8-9aaa-4081-be58-4bf6ae23e8ef (accessed 9 September 2020).

Taylor M (2013) Financialization of Art. *Capitalism and Society* 6(2): 1–22.

Telx (1998) About Telx. Available at: http://www.telx.com/about.htm (accessed 9 September 2020).

Telx (2000) telx Develops New Business Model; Expands Colocation Expertise for Future Profitability. Available at: https://advance-lexis-com.proxy-um.researchport.umd.edu/document?crid=57daae2a-f71c-4c1f-9e19-1108ef23b006&pddocfullpath=%2Fshared%2Fdocument%2Fnews%2Furn%3AcontentItem%3A41G5-X700-00KH-728K-00000-00&pdcontentcomponentid=8054&pdmfid=1516831&pdisurlapi=true (accessed 9 September 2020).

Townsend A (2001) Network Cities and the Global Structure of the Internet. *American Behavioral Scientist* 44(10): 1697–1716.

Troianovski A (2012) Here's a Way to Cut Business Taxes: Tech Firms Become Real Estate Trusts. *Wall Street Journal*, 11 October. Available at: https://online.wsj.com/article/SB10000872396390444657804578048880778578720.html (accessed 10 November 2020).

Tucker DM (2002) Inland California Becomes Attractive to Firms Wanting Backup for Vital Data. *The Business Press*, 28 January. Available at: https://advance-lexis-com.proxy-um.researchport.umd.edu/document?crid=3c164ff6-cc3a-41db-936b-0f4d1a46ff5a&pddocfullpath=%2Fshared%2Fdocument%2Fnews%2Furn%3AcontentItem%3A451S-PSJ0-01CV-H0XV-00000-00&pdcontentcomponentid=169235&pdmfid=1516831&pdisurlapi=true (accessed 9 September 2020).

Verge J (2014) Equinix Buys Rest of Brazil Data Center Provider ALOG. Available at: https://www.datacenterknowledge.com/archives/2014/07/25/equinix-expands-in-brazil-data-center-market-with-100-alog-ownership (accessed 11 November 2020).

Vincent R (2013) One Wilshire sells for record $437.5 million. *Los Angeles Times*, 18 July. Available at: https://www.latimes.com/archives/la-xpm-2013-jul-17-la-fi-0718-property-report-20130718-story.html (accessed 9 September 2020).

Waldron R (2018) Capitalizing on the State: The political economy of Real Estate Investment Trusts and the 'Resolution' of the crisis. *Geoforum* 90: 206–218.

Yeatts T and Juge E (2016) Ahead of GICS Change, a Review of REIT Outperformance. Available at: https://www.spglobal.com/en/research-insights/articles/ahead-of-gics-change-a-review-of-reit-outperformance (accessed 10 November 2020).

Zekaria S (2015) U.S. Data Giant Equinix Buys Telecity. *Wall Street Journal*, 29 May. Available at: https://www.wsj.com/articles/data-giant-equinix-agrees-deal-to-acquire-telecity-1432885737 (accessed 11 November 2020).

Zook M (2006) The geographies of the internet. *Annual Review of Information Science and Technology* 40(1): 53–78.

Zook MA (2000) The Web of Production: The Economic Geography of Commercial Internet Content Production in the United States. *Environment and Planning A: Economy and Space* 32(3): 411–426.

Zook MA (2002) Hubs, nodes and by–passed places: a typology of e–commerce regions in the United States. *Tijdschrift voor economische en sociale geografie* 93(5): 509–521. D

Zweig J (2012) In a Low-Rate World, Everything Is a Real-Estate Play. *Wall Street Journal*, 26 October. Available at: https://online.wsj.com/article/SB10001424052970204005004578080882499199060.html (accessed 10 November 2020).