CHAPTER 2

Fixed Flow

Undersea Cables as Media Infrastructure

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With each wave of technological development, the media landscape appears less wired. Mobile phones, tablets, and laptops enable users to access content in an array of environments, appearing to connect only intermittently to an electric or communications grid. Wireless devices are used to control media technologies at a distance, whether radios, television screens, or video games. Contact with digital systems today is marked by what Adrian Mackenzie describes as "wirelessness," an experience of being entangled with wireless technologies and services at many different places and times, along with the indistinct sensations of interference and weak connection they generate.[1] This experience even extends to the fringes of our global networks, where some newly connected locations have "leap-frogged" traditional land-line telecommunications infrastructure. If there is a spatiality to this imagination, it is one that positions signal traffic as moving up into the atmosphere and across the airwaves to visible cell towers, antennas, and satellite dishes. Cloud computing—the name given to distribution systems that store content out on the network rather than on a personal computer—draws from this aerial imagination to depict everything from storage programs to music delivery platforms as hovering above the fixed realities of the material world.

This proliferation of wireless media technologies is grounded by a large mass of cable systems. Buried under soil and pavement, snaking along the bottom of the ocean, enclosed in industrial parks and office buildings, and secluded in rural areas, the majority of Internet traffic passes through their circuits. In the United States, every time users search for information using Google, post a picture to Instagram, or dial a number on Skype, they activate a part of this subterranean and subaquatic infrastructure. These digital media companies run their platforms from large servers, often kept in remote sites. From users' laptops, the signals might move to a router, out into a local urban network, switching to a different network at an Internet exchange, speeding along a long-haul underground terrestrial backbone, through a cable station on the coast, into an undersea cable (all the while being boosted intermittently by repeaters), through another cable station, to a warehouse-like data center, and back again. Even if users ultimately encounter content wirelessly, it is often only in the last few hops between laptops and routers, or between cell towers and mobile phones that signals are freed from the grid.

Of this wired landscape, undersea cables constitute the section that makes the Internet a global phenomenon. Almost 100 percent of transoceanic Internet traffic is carried via fiber-optic undersea cables and, at times, is transmitted this way when it is moving between locations on the same continent. A number of authors—from science fiction writer Neal Stephenson to technology journalist Andrew Blum—have written about the construction of undersea systems, but the coverage of cable networks has been sporadic, and they remain, for the most part, absent from our everyday technological imagination.[2] Although undersea fiber has connected continents from the late 1980s onward, only in the last decade has it drawn substantial attention from researchers. Geographers, including Barney Warf, Edward Malecki, and Hu Wei, have documented the transition from satellite to fiber-optic dominance, brought about in the 1990s by the higher capacity and cost-effectiveness of cable systems.[3] Policy researchers have written critical reports about the vulnerability of submarine networks to major disasters, especially after cable-disrupting events such as the 2006 Hengchun earthquake.[4] Historians, inspired by the twenty-first-century turn to a technology with nineteenth-century roots, have reflected on the parallels and divergences between successive waves of cable systems.[5] In media and communication studies there has been a turn toward infrastructure; fiber-optic systems, a key component of our information distribution, have emerged as part of that discussion.[6]

Undersea cables, however, remain difficult to connect to the questions that have traditionally animated media studies about the production of sounds and images, the formal characteristics of texts, and the relationship between media content and culture. Cable researchers have documented large-scale transitions within the telecommunications industry, the influence of key institutional actors, and the relationship between fiber-optic networks and global capitalism, but they have seldom connected cable networks to the everyday politics and practices of media distribution—this is to say, undersea cables are rarely investigated as a *media* infrastructure. This might be in part because they are one of the deepest strata of the Internet—laid on the bottom of the seafloor, they appear relatively distant from the user interface and embodied encounters with media content. Signals must traverse several layers of technological systems—down through computer processors, hard drives, and routing protocols—before reaching undersea networks. Beyond this are the numerous systems on which cables themselves depend, from air-conditioning technologies to the labor of maintenance workers. Still further below are fossil fuels that provide energy for cooling and topographic forms that permit the building of transportation networks: nature, as Paul Edwards has observed, is "in some sense the ultimate infrastructure."[7]

What does it mean to describe any of these interconnected layers of digital systems—from routing protocols, to cable networks, to fossil fuels—as a media infrastructure? How can this description be made meaningful to the analysis of such distant circulations of content and made relevant to media and communications research? In this chapter, drawing from work by Susan Leigh Star and Karen Ruhleder, I offer a framework to conceptualize the relationships between cascading layers of interlinked technological, social, and environmental systems and the distribution of signals that they ultimately support. Star and Ruhleder observe in their seminal essay, "Steps Toward an Ecology of Infrastructure," that the concept of infrastructure is fundamentally both relational and contextual. They argue that a technical system becomes an infrastructure only through its use: what exists for one person as a media infrastructure might be for others an impediment to media circulation. They suggest that we ask "*when*—not what—is an infrastructure."[8] To make a parallel claim in a media-studies context: to consider technical, social, and natural systems as media infrastructures entails understanding *when* particular systems are infrastructural for mediation and how these systems differentially shape the dissemination of media culture. Analyzing cables as media infrastructures involves articulating how they invisibly contort the conditions of possibility, geographic dispersion, and cultural perception of media signals. This approach blurs any preexisting distinction between media infrastructures and other kinds of infrastructures such as shipping lines, roads, and rivers, and instead considers how flows of audiovisual content and technical, social, and natural systems are always constituted in relation to each other. At the same time, it is important to recognize limits to such infrastructural connections: though undersea cables support the circulation of media, they are not infrastructures for all kinds of media at all times, and this is especially true when we examine their diverse global contexts.

To elaborate this approach, in this chapter I chart four ways that cables emerge as media infrastructures, influential for and perceptible in audiovisual circulations. First, cables function as a resource, both real and imagined, for mediation. Fiber-optic networks are often intertwined with speculations about and economic investments in media projects and systems. Their presence serves as a rationale for the development of new media industries and practices, and, in turn, these industries and practices are called on as imagined markets in proposals for new cable projects. It is this insular feedback loop—wherein cables are seen as resources for audiovisual media and in turn media are projected as resources for cables—that enables the speculative development of large-scale infrastructural projects in the absence of any actual circulation. The second way that cables inflect media distribution is in their alteration of the temporality of information exchange, not only for the media industries, but also for individual users. As they contort the time it takes for signals to transit between locations, cables have a tangible effect on media practices such as online gaming that depend on high-speed and high-bandwidth transmission, producing what I call an "aesthetics of lag" when content is not efficiently transmitted. Third, cables implicate users within new and unseen structures of power. Depending on their geography, cables might increase the susceptibility of media to censorship or surveillance. Cable routes are places where media systems can be disrupted, where infrastructures can become entangled in local politics, and where concerns about privacy play out. Rather than extending uniformly across space, cables have often remained embedded in existing geographies, and their effects on media industries, user experiences, and the politics of circulation occur unevenly around the world. This observation brings us to the chapter's final point: cables can perpetuate imbalances in media production and consumption, an inequality that becomes most apparent in the differing cost of media access.

The examples I describe below reveal that, despite their apparent distance from everyday media practices, cables are thoroughly intertwined with media production and consumption. Yet cable systems do not simply determine the movements of media but, rather, are situated as part of a feedback loop. Network infrastructure emerges through users' everyday practices. Depending on where they are in the world and the platform they are operating from, users activate and inhabit different slices of this wired infrastructure. In some locations the content they are seeking might be stored locally, and data has to travel only a short way between its origin and destination. Other content might have to circumnavigate the globe. In their engagements with certain forms of media, and in their differential activation of infrastructure, users are unknowingly entangled in specific kinds of infrastructural development. Through this process, changes in media practices aggregate to alter the economics, practices, temporality, and geography of undersea cable systems.

Although this chapter temporarily extricates cables from the broader networks of telecommunications and computation, it offers a framework for the consideration of all communications technologies, and even human, nonhuman, and natural environments more broadly, as infrastructures for audiovisual media. Technologies and environments might be imagined as resources for the generation and transmission of sounds and images, even when their capacity is not utilized. They alter the speed of distribution and, as a result, users' understanding of media temporality. They can be potential sites for media disruption, censorship, and political intervention. Though many of these technologies and environments are hidden from view, they formatively structure and imperceptibly affect our experiences of media. In turn, users activate networks in partial and unpredictable ways but at the same time can engage in a politics of infrastructure through their everyday media practices. As the following examples reveal, conceptualizing systems such as undersea cables as *media infrastructures* can help scholars to better account for investments, aesthetics, and inequalities in media, and to understand the interfaces between our experience of digital content and the technologies that make its circulation possible.

Infrastructure as Resource

Like radio towers, television channels, and postal trucks, undersea cables are a technological system that affords capacity for the distribution of words, images, sounds, and other audiovisual material. Historically these technologies have altered and expanded the possible ways that media can be transmitted. For example, in the nineteenth-century telegraph network, undersea links were a key transmission device for global news agencies such as Reuters and the Associated Press. These agencies' use of cables drastically changed the experience of readers who had previously waited months for news from abroad. The economics of the new system, however, meant that sending telegrams remained too expensive for most everyday communication. As Dwayne Winseck and Robert Pike have argued, the development of the cable network helped give rise to the first global media system, one characterized by tight connections between the companies that controlled network infrastructure and the companies that circulated content using cables.[9] In their first stage of infrastructural development, undersea systems were configured as a resource facilitating the production and consumption of news media.

Today's fiber-optic cables still play an important role in transmitting news. They enable the cheap bandwidth that makes practical the worldwide dissemination of Twitter updates and blog posts detailing global events in real time, alongside the online content of traditional news outlets. They also significantly shape the possibilities for bandwidth-intensive networked audiovisual media industries, including film and television. Immediate and reliable Internet access is critical, for example, for on-location film productions that require real-time communication. Cities that aspire to support intensive international media collaborations likewise need fiber-optic infrastructure. Cables are especially important for work that depends on digitization, including digital animation and special effects, since these high-speed links render the frequent and instantaneous sharing of high-resolution video effective and economical. In her study of *The Lord of the Rings* trilogy, Kristen Thompson discusses the importance of the "Fatpipe," a dedicated network that connected Wellington to London via both undersea cables and terrestrial lines. While the film production's domestic communications were transmitted via satellite, cables were needed to send large amounts of footage to London. The crew on both ends also used the system for videoconferencing: cables made it possible for them to simultaneously view and comment on footage.[10] Distribution resources, as Nadia Bozak argues, critically inflect the production of the image, constituting its underlying "physical and biophysical makeup"[11] and generating specific kinds of production potentials.

Once established, this physical makeup can become a catalyst for other kinds of media flows. Cables are a "precious manmade resource," according to those in the cable industry, and enhance capacities for transnational media collaboration.[12] The Fatpipe became a model and resource that was mobilized for subsequent productions, including the effects on *I, Robot* (Proyas, 2004) and *Avatar* (Cameron, 2009). In some places, nations view fiber networks as a resource to be leveraged toward the creation of new media industries and practices. After investing in a cable system (the same one that carried *The Lord of the Rings*), the government of Fiji looked for a way to generate traffic and pay off their investment. They developed information and communication technology parks, call centers, and a new initiative, "Bulawood: The Hollywood of the South Pacific," all of which depended on the cable for transnational exchange and featured its capacity in their marketing.[13]

The relationship between the establishment of a cable system and the growth of the media industries is not a simple circuit. Shifts in the cable industry, especially economic shifts, affect the way that these systems can be used as media infrastructures. The emergence of the Fatpipe itself reflected recent changes in the undersea cable world. As Thompson observes, at the time of *The Lord of the Rings* production the "Internet bubble had recently burst, and much of the broadband capacity on the Internet was suddenly lying idle."[14] As a result, the filmmakers were able to establish the network at relatively low cost. In addition, the same cables used by media industries can undermine their efforts, since they often make it easier to circulate pirated material. The relative accessibility of the Internet via the Southern Cross cable, for example, invigorated Fiji's illegal DVD distribution networks, which in turn compromised efforts to expand commercially profitable domestic film distribution.[15] While their effects on the mediasphere are quite varied—in some places facilitating large-scale digital media development, and in other cases compromising it—cables serve as an imagined resource, capacity "lying idle," which many believe must be channeled to support media industries.

Within the undersea cable industry, media consumption and production has in turn been imagined as a resource: it is seen as a key driver of traffic, a source of flow that will generate a sizeable stream of income. In the late 1990s sales pitches of the cable companies, media was touted as the reason to invest in an undersea network. A team from Alcatel Submarine Networks argued that "even if the growth in computers in the workplace eventually starts to level off, the increasingly sophisticated software—including all flavours of real-time collaborative work and multimedia applications—run on these computers will continue to generate expanding bandwidth requirements."[16] This figuring of media as both stimulus and resource for network expansion continues to permeate the industry. William C. Marra, the CEO of a company planning to lay a new transatlantic network, reported that they anticipated "explosive growth" in traffic due to the "continued market expansion of media."[17] Elsewhere, video has been described as "fueling" the demand for undersea systems—a parallel that links media to the imagined resource economies of oil, gas, and timber.[18] High-definition television is seen as an important development in particular because of the 40 percent to 70 percent more bandwidth it requires.[19] The move to "media-rich content," including streaming video, online gaming, and other forms of cloud computing, rather than voice traffic remains a rationale for the construction of new networks.[20] Cable systems are pitched to investors and often funded on the basis of such speculations about a future media environment.

Anticipating such media developments, some cable companies design specialized services to appeal to the media industries and transnational collaborations. To send content around the world for *The Lord of the Rings* productions, Telecom New Zealand developed a specialized Film Net service.[21] Hibernia Networks, which operates a transatlantic cable system, has a media division that facilitates live video transmissions for large media organizations. They have even drawn staff from the television industry to operate their Television Operating Center, built to manage the distribution of broadcasts around the world and to ensure video would be transmitted with low latency (in other words, no delay), low "jitter," and high-resolution.[22] Cables are sometimes laid with particular media events in mind: for example, the Trans-Pacific Express cable, extending between the United States and northern China, was timed to coincide with the Beijing Olympics. Companies that have historically focused on the production, categorization, and distribution of content have even begun to invest directly in cable infrastructure: Google recently laid a new transpacific cable, Unity, between Los Angeles and Chikura, Japan.

What results is a loop: media industries, governments, and other organizations see undersea cable networks as a resource to be leveraged, an open channel with unused capacity much like a highway or a set of train tracks. The presence of fiber-optic cables forms a rationale for media development: because there is potential infrastructural connectivity, expanding a media sector is a way to capitalize on existing resources. On the other hand, cable companies see the media circulations of users, of cloud computing companies, and of various other industries as a resource, a set of unruly flows that can be channeled and made profitable, much like a river or an oil reserve. Harnessing these flows will in turn, they believe, generate demand for additional networks. While cable industry rhetoric evokes the metaphors of automobility—or containerized movement—it also conjures up a scenario in which cars stand idle with no roads available, an imagination that helps to justify the building of more cables. This combination, in which cables are seen as resources for media and media are seen as a resource for cables, is key to the actual funding mechanism for today's network infrastructure.

Infrastructure and Media Temporality

While fiber-optic cables shape large-scale conditions of possibility for the institutional and industrial production of media, they also influence everyday digital media experiences. Cables and network infrastructure broadly affect media circulations by regulating the speed at which media is transmitted between locations. Fiber-optic cables enable faster signal exchange than wireless modes of communication: it takes about one-eighth the time for a signal to travel by cable between New York and London as it does by satellite. This difference matters for some communications practices more than others. A delay has less effect on most users' experience of sending and receiving email than it does on video transmission, which might be distorted by a lag in the image or audio. As a result, digital media access can be quicker and easier for users in areas equipped with fiber-optic cables and which have efficient network routing.

For applications unaffected by time delay, such as email, the geographic organization of networks does not appear to make a difference, nor is it perceptible in users' media exchanges. For time-sensitive applications and practices, however, the geography and organization of infrastructure can critically affect one's media experiences. This has been well documented by the players of massive multiplayer online games. In his study of *Counter-Strike*, a networked first-person shooter game, anthropologist Graham Candy observes the critical and perceptible role material infrastructures such as undersea cables and network servers have in shaping gameplay. For *Counter-Strike*'s players, finding a high-quality and proximate gaming server decreases any delay in their navigation of the game, allows them to play in near-real time, and gives them a tangible advantage over other teams.[23] As a result, despite their ability to join forces with other players around the world, many instead choose to play on servers closer to home. Using a distant server, being forced across excess cable links and network nodes, in contrast, gives the sensation of "lag," what Candy describes as a "visceral, emotional and physical reaction" of being slowed down, and users who "are literally feeling the bricolage of infrastructures" become angry that they cannot experience the game as intended.[24]

Lag is not only experienced by gamers but appears across media platforms, especially on those hosting digital video. Frozen images, scrambled representations, out-of-sync sound, and the seemingly endless buffering of streaming television, alongside low-resolution, compressed versions are familiar parts of the process of watching video online. Paul Benzon observes that such failures "might characterize the experience of digital video consumption as much as its promised purchase upon the cinematic."[25] These failures are often due to the efforts of users to access *too much* content, an attempt to exceed the capacity of the system. Such aesthetics of distribution are not limited to the transmission of media via cables. As Lucas Hilderbrand argues, the copying and recopying of bootleg VHS tapes, which led to their deterioration over time, marked them with a distortion and fuzziness that he terms the "aesthetics of access."[26] While the bootleg aesthetics of videotape are produced by the materiality of storage technology and playback devices, in the case of online video what I call the "aesthetics of lag" is inscribed on the image by the materiality of network infrastructure. These images register the inability of networks (and the companies that run them) to appropriately manage the distribution of content across transmissions lines, servers, and other infrastructural components. In these moments—of scrambled calls and distorted images—we can perceive the inability of signals to properly transit media infrastructure. In contrast, the low-fi aesthetics of compression are marked by the *proper* management of content for the transmissions lines, the decreasing of signal size in order to fit media infrastructure. As was true for videotape's aesthetics of access, Jonathan Sterne observes that the aesthetics of compression have even become pleasurable for some audiences.[27]

The aesthetics of lag represent one way in which media consumers come into contact with infrastructure, though this encounter tells them little about what infrastructures they are traversing or where their signals extend. On one hand, lag and distortion are not merely products of distance. One does not simply experience lag when accessing content that is far away. The long haul between continents is a speedy trip relative to the time it can take to move through an Internet exchange or a local network. In describing the microseconds it takes a signal to transit a router, Andrew Blum writes:

> compared with the amount of time it takes a bit to cross the continental United States . . . that time spent crossing the router was an eternity. It was like walking ten minutes to the post office only to wait in line for seven days, around the clock . . . powerful though they may be, [routers] were the traffic-clogged cities on a journey across the open net.[28]

Content often experiences relatively more "traffic" at off ramps and interchange points. In some places, speed is as much of an economic problem as a technological one, since companies that manage signal exchange have a financial incentive to squeeze the most traffic through the fewest possible circuits. Internet service providers and state authorities might even engage in "bandwidth throttling," the intentional slowing down of signal exchange in order to manage high-bandwidth activities on the network.[29] Due to the variability of these infrastructural geographies, it might take longer to transit some cities than to cross an entire ocean. Therefore, even though cables might visibly shape the temporality of media content, the traces that they leave rarely give users any clues about the composition of media infrastructure.

Infrastructure and Media Disruption

The material geographies of cable infrastructures affect the trajectories of media content not only in determining when it slows down or speeds up but by establishing a matrix of locales in which circulation can be interrupted. Such was the case when, after several cable-cuts off the coast of Egypt, Internet connectivity was substantially reduced in the Middle East. Network disruptions are not an infrequent occurrence: undersea cables break every three days.[30] Many of these are due to human interference, ranging from trawlers that drag nets over the ocean floor to local infrastructural projects that dig up cables on land. Cable theft is also a problem, far more so for terrestrial than subsea links, which are largely protected by the ocean above them.[31] *Capacity Magazine* reported there were approximately ten cable thefts a day across different industries in Germany, ultimately costing the companies who owned them millions of dollars.[32] Most of these breakages cause no perceptible difference in our access to media. Nonetheless, the necessity of repair and maintenance is a cost built into the expense of operating cable systems, and across the network the threat of potential disconnection remains. Media companies who rely on cable infrastructure have a major stake in its smooth operation, and their own reliability is jeopardized if cables do not remain secure.

Cable routes are locations where media and communications are not only materially disrupted but can be actively surveilled or censored. British control of telegraph networks in the late nineteenth century gave the country the ability to intercept and censor messages, an activity that manifested especially during wartime.[33] Similarly, Alfred W. McCoy has documented how U.S. control over telegraph networks in the Philippines helped the United States to develop as a surveillance state.[34] Cable surveillance capacities are still being leveraged today. After the Edward Snowden leak of National Security documents, *The Guardian* published an article about the British Government Communications Headquarters' infrastructural monitoring and drew public attention to the surveillance of data collection at cable stations and other media infrastructure sites.[35] The National Security Agency's Upstream program also collects information as it passes through fiber-optic links.[36] Because cables extend through national territories, the media that transit them are susceptible to the monitoring capabilities and infrastructural power of these nations—even if content is not sent or received from there.

This is complicated by the fact that media traffic does not always move in a direct geographic route between locations and instead assumes a twisted economic geography. Signal traffic often follows the least expensive rather than the quickest route. In some locations it is less expensive to buy a direct circuit to somewhere with "cheap" Internet instead of buying Internet access out of one's own country, a scenario called "pipe and port" in the industry.[37] A company in Hong Kong might choose to pay $70,000 per month locally to access the Internet, or they might choose to purchase a dedicated circuit to Los Angeles ($43,800 per month) and then access the Internet there ($19,300 per month). This would make it slightly less expensive for Hong Kong companies to route all Internet traffic across the ocean to Los Angeles before going anywhere else in the world. In many places, especially in South America, the Middle East, and Africa, it is much cheaper to route Internet traffic through another country; therefore, when media is transmitted between two locations in a single country, it may cross into foreign territory. The research firm Telegeography recently reported that in São Paulo, Brazil, between 2009 and 2012, the local cost to access the Internet was 150 percent that of running traffic through Miami.[38] Essentially, this means that media exchange routed via the Internet in São Paulo, even when directed to other proximate locations, might be moving along undersea cables to Miami and back again. If the NSA is monitoring traffic in Miami, they may very well intercept email sent between two locations in São Paulo. Since more than 80 percent of the Middle East and Africa's traffic is exchanged in Europe, these transmissions also remain susceptible to remote foreign monitoring or intervention.[39]

Given the lack of information circulated about monitoring practices, cables are sites where concerns about information and media censorship emerge. For example, in his pitch for a trans-Arctic cable, CEO Douglas Cunningham noted that the Arctic Fibre system would have circuits directly between London to Japan but would not land on U.S. territory. This option might be of special interest, he suggested, for Asian or Middle Eastern telecommunications carriers that did not want their content subject to U.S. laws. Anxieties about interception surface not only around the routes and geographies of transmission but also in the public discussion of network materials and supplies. The construction of transoceanic systems is currently dominated by two companies—TE Subcom, an American company, and Alcatel-Lucent, a French company. For major intercontinental systems, any cable project will likely contract with one of the two. In 2008, the Chinese company Huawei Marine was launched and has since provided undersea cable for small-scale networks in the Mediterranean, off the coast of South America, and between Indonesian islands. After Huawei Marine signed a contract to build a prominent connection between New York and London, one of the most heavily trafficked routes in the world, the United States House Intelligence Committee released a report warning of the risks in using a Chinese supplier, suggesting that Chinese-made equipment could be used to tap content.[40] Hibernia Networks subsequently halted their work on the cable system and eventually moved to the American vendor.[41] As described in the first section, even the imagined geographies of cable infrastructure can affect the circulation of media content.

Cable Geographies and the Construction of Inequality

Every version of cable technology differentially affects the mediascape, privileging certain forms of content, access, and geographic dispersion over others. While early telegraph cables had a revolutionary influence on the distribution of news media, especially in the West, these networks did not support the dissemination of photography. While voices could be reduced to scripted dialogue and converted into Morse code, the acoustic voice could not be transmitted via cable, nor could music, audio recordings, or moving images once they emerged at the turn of the century. Even though phototelegraphy and undersea telephone cables were later introduced, the initial telegraph networks had the most widespread effect on practices that could be encoded into a text of dots and dashes and therefore were used disproportionately by the news industries that could afford them. In the process, undersea telegraph cables sped up the movement of news but simultaneously transformed the perception of what "fast" was, reducing the relative speed of visual culture and noncabled media. Media infrastructures accelerate the transmissions of certain actors and industries but always do so at the cost of reducing the relative speed of others.

Cables' transformation of media's temporality also occurs unequally across the network. In many places, those who can afford to—whether filmmakers, gamers, or bankers—can pay for a higher-quality network experience and "low-latency" routes. Peter Jackson's signals routed through the Fatpipe were not delayed as they crossed the Pacific, but other local users received sluggish Internet speeds (in many cases due to crowding on domestic systems rather than the distance of the transoceanic links). High-frequency traders on global stock markets use computer algorithms to take advantage of the slight price changes in different locations, secure trades at slightly quicker rates, and exploit short cable paths for profit. Any given company's, nation's, or individual's ability to mobilize cables as a resource, avoid lag and compression, bypass surveillance, and pay a discounted price for access depends in part on their geographic and socioeconomic position. U.S. consumers worry less about such inequalities, since most of the content they wish to use is relatively accessible, stored domestically, and linked to the user via diverse cable routes. In many places, media content speeds across the ocean only to slow or stop at the shore, making access difficult and expensive for landlocked locales. As a result, communities on the periphery of current networks face a disadvantage in a cabled era and remain more vulnerable to disconnection or monitoring.

These inequalities are not likely to be overcome in the near future. Given the scarcity and expense of undersea cables, not every location will receive one, and many will be fortunate to set up two. Many networks cost hundreds of millions of dollars; some cost over a billion. Moreover, every signal sent costs money and consumes energy. It is expensive to maintain the computers that route the signals; upgrades need to be conducted and operations staff must be hired. It costs money to power these systems, to push signals under the bottom of the ocean, and to cool off the cable stations with air conditioning. Funding is required to pay cable ships and crews to stand by in case a cable is broken and needs to be fixed. The expense of transiting such systems, given the unequal geographies they extend through, varies widely. For example, Malecki and Wei report that in 2005, the median revenue of a circuit from the United States to Nigeria and Vietnam was $44,000, compared with $21 from the United States and the United Kingdom. More recently, in 2012 it cost $19,300 per month to access 10GB of Internet content per second in Los Angeles, and more than three times as much in Hong Kong. Media simply costs more to send to and through different parts of the world. As they seek to circulate content across these differential topographies, some media producers and consumers thus occupy positions of privilege while others face disproportionate challenges.

Activating the Network

When circulating media through networked systems, users occupy a particular slice of infrastructure. Their decisions about how and what to produce, consume, and distribute implicitly support different modes of infrastructure development. To communicate with each other, users in countries with advanced digital infrastructure have an array of options: SMS, email, telephony (mobile or land line), and video. Each of these takes up a certain amount of space on undersea networks and reflects particular modes of technical and industrial organization, and this can make a significant difference in cases where bandwidth is limited or expensive. To choose to send a short text message is to be frugal with bandwidth, whereas to transmit video is to be excessive. While the economic and technological relationships between media practices and the development of actual cable networks is complex, if enough users send text messages instead of supporting high-bandwidth media, this would alter the economic model of the cable industry, which is built on projecting media as an ever-expanding resource to be capitalized on. This could in turn make it more difficult for these companies to secure loans to build infrastructure. On the other hand, if users included high-definition video in all communications, this would instead precipitate the speculative futures that private cable companies profit from. As users determine how to consume media and what they are willing to pay, they support and inhibit particular cycles of infrastructural development.

In their movements through content and platforms across different parts of the network, users also activate different media geographies, participating in the unequal distribution of signal traffic. This is perhaps most perceptible in the shift to cloud computing—the move toward a reliance on media stored elsewhere. Keeping one's data in the cloud entails an increasing reliance on undersea cables (and other international communications infrastructure) to connect to content that may have previously been locally available. For example, by using Dropbox to store files instead of keeping them on a local hard drive, one might very well become susceptible to the surveillance of foreign countries, their economic decisions, and policies about privacy (or lack thereof). There are very few ways to be able to determine one's actual entanglements with such systems: there is no information given about the specific data centers one's media is held in or the cables it transits, never mind the ways in which it might be surveilled. The user is not a rational agent who can locate herself in relation to such infrastructures; rather, she is a posthuman subject that extends across the network in multiple, unpredictable ways, intertwined with developments that are beyond any individual's knowledge or control.

Although this chapter has focused on undersea cables, the relationships described here hold true for a range of digital media infrastructures. Internet exchanges, the place where media signals are transferred between networks, have become rationales for media development. The massive expansion of data centers has been shaped by changes in user practices. Terrestrial links, which include both national long-haul networks as well as local city networks, are sites where cables can be disrupted. And it is the server, rather than the cable system, that gamers want to be closest to in order to decrease lag. Cable systems are partial infrastructures, and they exist in an ecology that is social and technical, human and nonhuman. To grasp how digital media circulations are shaped by and inflect Internet infrastructure, undersea systems must be considered in relation to these other network components as well as the protocols that facilitate movement across them.

Analyzing undersea cables as media infrastructure draws our attention to the ways that seemingly nebulous digital circulations are anchored in material coordinates. By following the routes of our transmissions, we can understand how cables are viewed as and transformed into resources for media industries (or conversely, do not become resources): cable infrastructure both reflects investments in particular sites and increases these locations' capacity for flow. We might also better conceptualize the experience of temporality on networks in different geographic locales alongside their variable susceptibility to disruption, censorship, and interference by different forces and actors, whether the laws of countries or the technological protocols of corporations. Finally, we might better gauge how individual and collective media use paves and occupies particular pathways for distribution, generates economic circulations for some companies over others, and conditions the access of all users. An analysis of cables as media infrastructure ultimately connects the physical dimensions of these network technologies to the broader dissemination of media cultures.

Notes

1. Adrian Mackenzie, *Wirelessness: Radical Empiricism in Network Cultures* (Cambridge, Mass.: MIT Press, 2010), 6.

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