

32. Tim Phillips, "Copper Thieves Caught Red Handed," *Capacity Magazine*, July 9, 2013.
33. Daniel R. Headrick, "Radio Versus Cable: International Telecommunications before Satellites," in *Beyond the Ionosphere: Fifty Years of Satellite Communication*, ed. Andrew Butrica (Washington: NASA, 1997), 3–8.
34. Alfred W. McCoy, *Policing America's Empire* (Madison: University of Wisconsin Press, 2009).
35. Ewen MacAskill, Julian Borger, Nick Hopkins, Nick Davies, and James Ball, "GCHQ Taps Fibre-Optic Cables for Secret Access to World's Communications," *Guardian*, June 21, 2013.
36. Craig Timberg, "The NSA Slide You Haven't Seen," *Washington Post*, July 9, 2013.
37. Erik Kreifeldt, "Informing Investment Decisions with Submarine Bandwidth Pricing Analysis," *SubOptic 2013 Conference Proceedings*, April 23, 2013.
38. Ibid.
39. Ibid.
40. Michael S. Schmidt, Keith Bradsher, and Christine Hauser, "U.S. Panel Cites Risks in Chinese Equipment," *New York Times*, October 8, 2012.
41. Laura Hedges, "Hibernia Networks Reveals New Partner for Project Express Cable Deployment," *Capacity Magazine*, May 13, 2013.

## CHAPTER 3

### "Where the Internet Lives"

#### Data Centers as Cloud Infrastructure

JENNIFER HOLT AND PATRICK VONDERAU

Emblazoned with the headline "Transparency," Google released dozens of interior and exterior glossy images of their data centers on the company's website in 2012. Inviting the public to "come inside" and "see where the Internet lives," Google proudly announced they would reveal "what we're made of—inside and out" by offering virtual tours through photo galleries of the technology, the people, and the places making up their data centers.<sup>1</sup> Google's tours showed the world a glimpse of these structures with a series of photographs showcasing "the physical Internet," as the site characterized it. The pictures consisted mainly of slick, artful images of buildings, wires, pipes, servers, and dedicated workers who populate the centers.

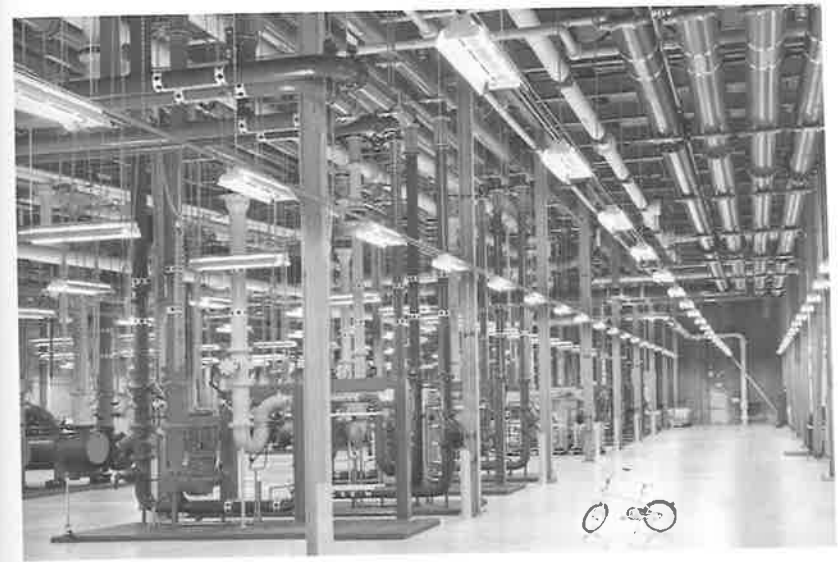
Apple has also put the infrastructure behind its cloud services on display for the digital audience by featuring a host of infographics, statistics, and polished inside views of the company's "environmentally responsible" data center facilities on its website.<sup>2</sup> Facebook, in turn, features extensive photo and news coverage of its global physical infrastructure on dedicated Facebook pages, while Microsoft presents guided video tours of their server farms for free download on its corporate website.<sup>3</sup> Even smaller data centers like those owned by European Internet service provider Bahnhof AB, located in Sweden, are increasingly on digital exhibit, with their corporate parents offering various images of server racks, cooling and power technology, or even their meeting rooms, all for wide dissemination and republishing.<sup>4</sup> Operating out of a Cold War

civil-defense bunker hidden thirty meters under the earth, Bahnhof's "Pionen White Mountains" center (its original wartime codename) offers particularly dramatic sights, complete with German submarine diesel engines for backup, and glowing, windowless rock walls protecting blinking servers stacked underground. Alongside such memorable online representations of server facilities, there is also a recent array of coffee-table books, documentaries, news reports, and other offline forms of photographic evidence that have put data centers on display.<sup>5</sup>

But what are all these images about? What drives this excess of vision that asks us to partake in creating visibility for something that remains essentially invisible? Why do we engage in sharing views of emptied, technified spaces? At first glance, on a surface level, the visible evidence abundantly provided by Google, Apple, or Bahnhof might simply appear as a means of creating a positive public image of the data center business. Given the centralization of data in "the cloud," such pictures persuade users to experience the move of their data to corporate "warehouses" as being safe and secure, by depicting a stable and nonthreatening cloud storage environment.<sup>6</sup> Indeed, the notion of the cloud is a marketing concept that renders the physical, infrastructural realities of remote data storage into a palatable abstraction for those who are using it, consciously or not. In fact, a recent survey of more than one thousand Americans revealed that 95 percent of those who think they are not using the cloud, actually are—whether in the act of shopping, banking, or gaming online, using social networks, streaming media, or storing music/photos/videos online.<sup>7</sup>

However, explaining data-center visibility by pointing to the discourses it shapes, to the metaphorical character of "the cloud," or to the ways the cloud is rendered visible by looking "behind the scenes" of another scale economy can merely be first steps. Looking deeper will lead us to acknowledge that much of what we see in these images is also indicative of the competitive dynamics between Google, Apple, and Facebook. Picturing infrastructure means staking corporate territory, given that this infrastructure as well as the software or services it makes accessible are often proprietary and subject to disputes over interoperability issues.<sup>8</sup>

Following this line of thought, we might still take a further step and start observing the rather intense "technological dramas"<sup>9</sup> playing out in the imagery of digital infrastructure. Google and Bahnhof offer especially pertinent examples of what Langdon Winner called the "politics of artifacts": the way working systems choreograph the relationship between technologies and the people using them—and in between themselves.<sup>10</sup> And indeed, how can we overlook the polity-building processes implied in Google's infrastructure design—its



**Figure 3.1.** Douglas County, Georgia, data center. Shown here are colorful pipes distributing water for cooling the facility, and Google's G-bike, the "vehicle of choice" for transportation in and around the data centers.



**Figure 3.2.** Bahnhof data center, Stockholm, Sweden.

lively colored pipes, well-organized lines of glowing server racks in shades of blue and green, and brightly illuminated architectural spaces—as compared with Bahnhof's underground Cold War bunker setting and historical engine for backup power?

Google's data centers literally span the globe, and their images imply a seamless, universal connection, a benevolent global reach, and even a no-impact environmental presence with a corporate-designed bicycle featured in one shot

as the “transportation of choice” around the data center. Bahnhof’s website, on the other hand, advertises heavily protected security in three separate data centers (one of which is a nuclear bunker) with “TOP SECRET” stamps across the homepage. Further, there are proud proclamations and lengthy explanations about the company’s valuing the right to freedom of speech and being the host for Wikileaks, along with a link to the Ebay auction for the Wikileaks data server.<sup>11</sup> Indeed, the images of Bahnhof’s data centers speak to us about the ways that Europe’s “oldest and strongest legislations for freedom of speech and freedom of information” have been built into the very facilities servicing access to data.<sup>12</sup> In short, such images tell us about affordances and constraints turned into pipes and cables, about in-built political values and the ways the engineering of artifacts come close to engineering via law, rhetoric, and commerce. And the images also testify to the constant struggles over standards and policies intrinsic to the network economy.<sup>13</sup>

Or so we may think. For what is most striking about these images is, of course, precisely that which we do not see. Google’s and Bahnhof’s images gesture toward the notion of transparency, all while working to conceal or obscure less picturesque dimensions of cloud infrastructure. We learn nothing, in Google’s case, about its mechanical, electronic, or technical infrastructure design, energy use, or network infrastructure; in fact, Google is notoriously secretive about the technical details of its servers and networking capabilities in the interest of security as well as competitive strategy.<sup>14</sup> Nor do Bahnhof’s photos tell us anything about how much this “free speech” Internet service provider’s business actually is built on unauthorized traffic—in Sweden, piracy has been key to the media and IT industries’ development, selling conduits and connectivity.<sup>15</sup> Hence, a third and final step is required: we need to acknowledge that many of the operations, standards, and devices we are trying to describe when analyzing digital infrastructure will remain hidden, locked away, or, in engineering terms, “blackboxed.” As Bruno Latour has pointed out, the mediating role of techniques is notoriously difficult to measure, at least as long as the machines run smoothly; the more technology succeeds, the more opaque it becomes.<sup>16</sup> Although Google and Bahnhof provide branded services and platforms, and thus are readily apparent to their users, their infrastructures remain blackboxed. Data centers are information infrastructures hiding in plain sight.<sup>17</sup>

This chapter discusses data centers as the material dimension of “the cloud” and as a critical element of digital media infrastructures. To render cloud computing truly visible, we need to understand the material support systems for data storage and data transmission, or the “stuff you can kick,” as described by Lisa Parks—the bricks and mortar, physical networks of digital media distribution.<sup>18</sup>

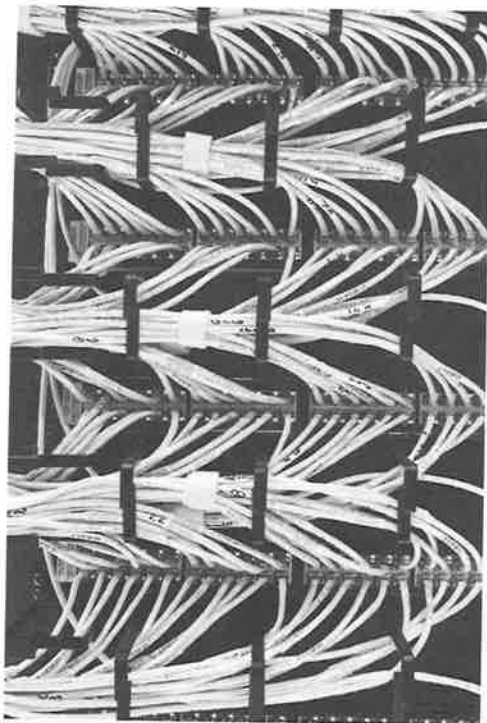
Additionally, we also need to “see” the standards and protocols, affordances and constraints built into these networks. While distribution infrastructures always have been designed to be transparent,<sup>19</sup> transparency as immaterialized in “the cloud” has turned into an all-purpose political metaphor for the fact that we are storing our data (or our company’s data) on someone else’s servers in an undisclosed location that we will never be able to see. In following media archaeology’s “non-representational take on politics,” its interest in the “non-sense of something that cannot be exchanged for meaning,”<sup>20</sup> we are turning to what Susan Leigh Star has referred to as the “boring backstage elements”<sup>21</sup> of online delivery, or, in the case of data centers, where “the cloud” touches the ground. Connecting the metaphor and imagery of the cloud to data centers and Internet topology, we aim to discern structures of power through technological and industrial analysis.<sup>22</sup>

### The Technopolitics of Hypervisibility

Data centers are the heart of “the cloud” and much of its physical infrastructure. They *are* the physical presence of this imaginary space, and yet they strive to remain invisible in many ways. They maintain a high degree of secrecy, allowing very few visitors from the outside in, and keeping their locations, operating procedures, or devices largely out of the press as a matter of security—and competition in the market. In fact, the refusal to discuss where they are located, how many there are, and other details about how and how much data is processed in these centers has led some in the industry to liken the culture of confidentiality surrounding server farms to the ethos of *Fight Club* (“The first rule of data centers is don’t talk about the data centers”).<sup>23</sup>

One notable exception to this protective veil of secrecy occurred with Google’s 2012 public relations push to promote their data centers as visible, accessible, and environmentally friendly. The images of technology on the site devoted to “revealing” their data centers offer colorful shots of computers, wires, routers, switches, pipes, and hard drives that arguably render this infrastructure much less visible when decontextualized. Indeed, it almost appears as abstract art; there is no trace of any relationship between these technological components and the processing, storing, cooling, or distributing trillions of gigabytes (now known as zettabytes) of data—or the attendant environmental implications (see figure 3.3).

The structures where this all takes place have also been hyperstylized to showcase the natural environment and seemingly make the visual argument that the landscape is even *more* beautiful *because of* the giant data center in the picture. There are portraits of lush wildflowers, mist rising above the Columbia

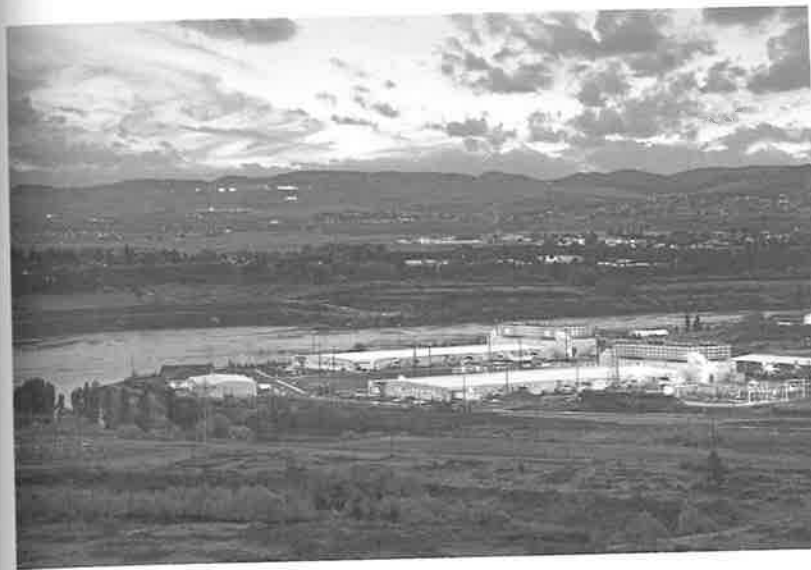


**Figure 3.3.** Ethernet switches in Google's Berkeley County, South Carolina center.

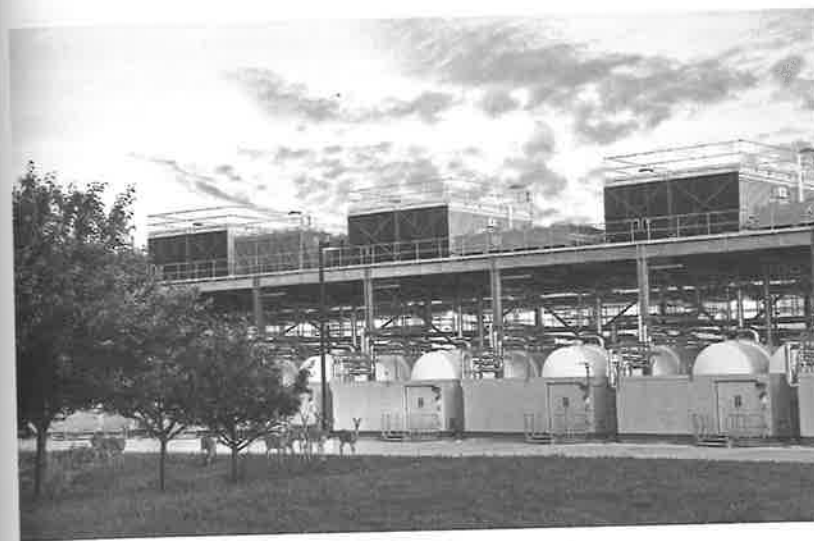
River gorge, and even deer grazing outside a data center, oblivious to the hulking steel building in their midst (see figures 3.4 and 3.5).

The main foci of the images are the expanse of sky and land surrounding the buildings. In effect, the data centers are visible but rendered practically inconsequential by the surrounding spectacle of natural vistas and wide-open spaces. Bahnhof, on the other hand, is literally embedded in the natural environment. The camouflage of the Swedish data center projects a sense of safety and security by virtue of its carefully constructed invisibility (see figure 3.6).

In many ways, these representational strategies employed by Google and Bahnhof are emblematic of the argument Parks makes in her work on "antenna trees" and the politics of infrastructure visibility: "By disguising infrastructure as part of the natural environment," she writes, "concealment strategies keep citizens naive and uninformed about the network technologies they subsidize and use each day."<sup>24</sup> These traditions of concealment and disguise also render data centers, and digital media infrastructure generally, notoriously difficult to research by applying the toolbox of traditional media industry analysis. Two of



**Figure 3.4.** The Dalles, Oregon.



**Figure 3.5.** Council Bluffs, Iowa data center with deer in the foreground.



traditional values about media industry performance based on the understanding of media as a public good, and of media industries as being unlike all other industries.<sup>26</sup> We also expect digitally distributed media not to waste resources, to facilitate free speech and public order, to protect cultural diversity, and to be equitably accessible.<sup>27</sup> We still understand media to be socially more valuable than just household appliances or "toasters with pictures," as former FCC chairman Mark Fowler once controversially put it,<sup>28</sup> while media technologies today indeed mostly come as just that—as cheap, scale-produced hardware additions. While we somehow seem to have approved that all other industries produce not only positive but also negative externalities—that is, negative spill-over effects on third parties not involved in the industry's respective market—it appears culturally more challenging to accept the constant overflow caused by industries supplying our alleged demand for what Lev Manovich calls "the stage of More Media."<sup>29</sup>

Thus, while almost anyone in Western economies happily subscribes to the no-cost, cover-it-all promise of a search engine like Google, or to the pleasure of clicking Facebook's like button at anytime anywhere, each of these activities of course comes with consequences for the public-good idea of digital media infrastructure as being shared and sustainable: they are accompanied by rising energy demands, the generation of saleable secondary data, and the like.<sup>30</sup> This results in a situation of policy overlay or "regulatory hangover," where media infrastructures and technologies are framed and identified through an outdated system of rigid, dialectically opposed values (commercial vs. public, open vs. closed, monopolistic vs. competitive, free vs. subscription, formal vs. informal, and so on),<sup>31</sup> while our actual practices and expectations are far more expansive and play havoc with such beliefs. These longstanding and traditional frameworks for evaluating power in media industries grow increasingly limited as communication and information technologies continue to converge. Sandra Braman has explored how this consequent blending of communication styles, media, functions, and industries "disrupts habits of policy analysis," and ultimately our regulatory tools fall short of what is required to effectively maintain current policy goals. As Braman explains, this gap widens as we look at the greater landscape of policy terrain. "The distinction between public and private communicative contexts has become one of choice and will, rather than ownership, control and history of use. And we have come to understand that both non-political content and the infrastructure that carries it can have structural, or constitutive, impact."<sup>32</sup>

Hence, in order to understand how control is exerted through media infrastructure, it's rather naïve to simply ask who owns it.<sup>33</sup> It is similarly limited to assume that a society could actually opt out of globalization processes, choose

Figure 3.6. Bahnhof data center, Stockholm, Sweden.



the classical questions of mass communication research—"Which industry?" and "Whose industry?"—seem insufficient when applied to media today.<sup>25</sup>

Digital media infrastructure makes for a case in point. It is difficult to identify clear-cut boundaries between public and private interests in media infrastructures, let alone in between the various businesses providing us with access to media content; nor can we assume that "the industry" follows only one-dimensional strategic goals such as profit maximization. For instance, what we perceive as the quality and service of streamed entertainment is the effect of a complex and ever-changing web of relations that exists at global and local, technical and social, material and experiential levels, involving content as much as content aggregators, services as much as service providers, transport network operators as much as a mushrooming consumer media ecology. This is not anybody's industry in particular; its emergence and change can hardly be pictured in terms of one institution striving for market power. While traditional issues such as concentration of ownership, subsidies and tax breaks, operating efficiencies, and industry resources may remain useful categories for political economic analysis akin to what they were during the first wave of media mergers, today's structural convergence (and functional heterogeneity) of media in a global market demands a more case-based rather than one-size-fits-all approach.

Media infrastructure industries are analytically distinct from traditional media industries as they involve different actors and practices, standards and norms, expectations and tensions, but they are also deeply embedded in our historically grown media cultures. It is thus hardly surprising that some of the most hotly debated questions about digital media infrastructure today concern

between a more or less desirable market structure for its media, or push back negative externalities and just enjoy the nice ones. Yet all these reservations do not prevent us from knowing about, and intervening in, the very process through which digital media infrastructures emerge. Our premise is that infrastructures are always relational; they concern materialities as much as technologies and organizations, and they emerge for people in practice.<sup>34</sup> In order to understand today's media infrastructure, we need to study how "distribution is distributed": how it configures (legally and otherwise) the global and local, technical and social in response to a problem that needs a fix.

Studying infrastructure means studying infrastructural relations, but at the same time, infrastructure also is more than just pure matter that enables the movement of other matter, or "the thing other things 'run on.'"<sup>35</sup> As Brian Larkin has pointed out, any infrastructure's peculiar ontology lies precisely in the fact that it forms the relation between things while also being a thing in itself—"as things they are present to the senses, yet they are also displaced in the focus on the matter they move around."<sup>36</sup> Infrastructures are like lenticular prints: they always come with a switch effect ("now you see it, now you don't"), not because they would change in themselves, but because they animate our view, make us shift our categories of what they are—image of connective technologies, image of the technological objects being connected. Data centers may be described as information infrastructures hiding in plain sight in that they resemble such flicker pictures, making us want to explore the depths of what appears to be an image sliding behind another one, the spectacular spaces "behind" the cables and plugs. Yet this exploration is not entirely free or unguided; pleasure is engineered into the act of looking itself by divesting the object (rows of server racks, rooms full of water pipes, and so on) from its actual use and turning it into an "excessive fantastic object that generates desire and awe in autonomy of its technical function."<sup>37</sup> This is why it would be insufficient to study only a given media infrastructure's topology, the networks of its relations; the politics of media infrastructure is also in its imaginary. It partly rests on what Larkin calls the "poetic mode" of infrastructure—its capacity to turn us on and away from the objects being connected.<sup>38</sup>

The Google and Bahnhof images referred to above strikingly illustrate this second conceptual premise of our chapter. Infrastructural politics is not just about what is deliberately hidden from sight or is invisible; it is equally about the hypervisibility created around *some* of an infrastructure's component parts, all while most of the relations it engenders and the rationality embodied in its overall system sink deeply in obscurity. If computing has become the privileged technology of our age,<sup>39</sup> then our age is marked by this technology's materiality

(silicon, copper, plastics, and the like) as much as by a political form (liberalism) that attempts to organize users and territories through domains that seem far removed from politics. Media infrastructures are indicative of such a mode of governing that disavows itself while at the same time constantly overexposing its material designs in order to represent, for all those who want to see, how modern our possible futures and futures present have become. It is these "politics of 'as if'"<sup>40</sup> that are so overtly discernible in Google's or Bahnhof's intensely stylized images of denuded technologies. In this sense, data centers can be described as persuasive designs: as artifacts that aim to steer user behavior and attitudes in an intended direction while constraining others.<sup>41</sup> It is for these reasons that we also direct our analysis toward the very practices of conceptualizing digital media infrastructure, both in terms of imagery and topology, rather than simply looking at its social, ecological, or economic effects.

### Cloud Imaginaries and Energy Requirements

The data that is processed and stored in "the cloud" is vital to the constant flow of news, information, software, and entertainment that populates the digital media landscape. The data *about* this data has become similarly important to defining "the cloud" for the popular imaginary; as the amount of bits being utilized defies comprehension, comparisons to football fields, metaphors about cities, even representations in the form of data scaling Mt. Everest have been drawn in order to make this data and its environment "visible" or understandable in some way (see figure 3.7).

The amount of data that is estimated to be currently stored in the cloud is more than one billion gigabytes; it is also, as one industry report has characterized it, the same as 67 million iPhones worth of data.<sup>42</sup> These and other comparisons give contours (albeit often absurd ones) to the remote storage



Figure 3.7. Image from *State of the Data Center, 2011* infographic. Emerson Network Power, <http://www.emersonnetworkpower.com/en/US/About/NewsRoom/Pages/2011DataCenterState.aspx>.



capabilities and infrastructure known as “the cloud,” which, other than the aforementioned representations of data centers and their decontextualized technologies, remains largely immaterial, dimensionless, and almost impossible to even imagine. Such metaphors also serve to “contain the messy reality” of infrastructure, as described by Star and Lampland.<sup>43</sup> Yet despite these creative numerical valuations, Fuller and Goffey have articulately observed in their analysis of infrastructure’s abstractions that “empirical states of fact obtrude but tangentially on the marketing of hyperbole.”<sup>44</sup> Indeed, the more sober “facts” about the infrastructure of the cloud rarely collide with the PR-fueled sensational dramatizations and depictions most commonly circulated. Despite the corporate promotion of “cloud computing” and “cloud storage” as abstract, celestial panaceas for managing digital content, there are still considerable concrete, earthbound challenges for this cloud infrastructure as the demand for access to offsite data continues to explode.

The ways that cloud infrastructure is regulated present one significant challenge. Currently, it is almost a legal impossibility to discern, for example, the jurisdiction and often the sovereignty of the data that is processed, stored, circulated, and transmitted by the millions of data centers all over the globe.<sup>45</sup> It is also extremely difficult to regulate various players in the distribution chain of data from storage to consumer, including Content Delivery Networks (CDNs) and Internet Service Providers (ISPs) that have “peering” agreements. Various interconnection points along the distribution chain are notoriously opaque in their reporting of costs, speed, and connection quality. Regulators also lack the metrics and tools necessary to effectively monitor any anti-competitive or anti-consumer behavior in this industry because of the lack of transparency on the part of the companies involved.<sup>46</sup> This arena would benefit from some genuine visibility, as it is often marginalized in the landscapes of infrastructural concerns.

The amount of energy required to power and cool data centers remains chief among those concerns. These facilities are one of the fastest growing consumers of energy, and they are expanding rapidly. In fact, Google’s investment alone during 2013 on expanding their centers represents the largest investment in data center infrastructure in the history of the Internet.<sup>47</sup> The resulting energy needs of “the cloud” are indeed astronomical: a single data center can require more power than a medium-size town.<sup>48</sup> According to a recent Greenpeace report examining the energy consumption of data centers and the various components of “cloud power,” if the cloud were a country, it would have the fifth largest electricity demand in the world.<sup>49</sup> It has also been estimated that data centers can waste 90 percent of the power that they pull off the grid, and their carbon footprint will likely surpass that of air travel by 2020.<sup>50</sup> The definition

of “wasting” power has been debated in this context—a recent *New York Times* investigation found that, on average, data centers were using only 6 percent to 12 percent of the electricity powering their servers to perform computations. The rest was essentially used to keep servers idling and ready in case of a surge in activity that could slow or crash their operations.<sup>51</sup> However, the reserve power is an insurance policy against disaster (in other words, an outage that cuts off all access to the cloud services that largely support the global economy). The value in having this insurance built into the design of data centers is apparently worth the cost to those who own them, revealing much about the logics of cloud infrastructure, which—much like nuclear power plants—are rooted in excess, redundancy, and contingency, governed by the looming specter of worst-case scenarios.

Thanks to these requirements, the proximity to affordable electricity and energy sources are a paramount consideration when determining where to build and locate data centers. The average temperature and climate are also increasingly being factored in to such decisions as more companies try to take advantage of “free cooling” or the use of outside air instead of energy-intensive air conditioning to cool the massive racks of computer servers and prevent them from overheating (which essentially causes the cloud to “disappear”). Lower temperatures outside present significant cost savings inside, as at least half of a data center’s energy footprint has historically come from the energy required to keep the servers cool.<sup>52</sup> As a result, there is a growing interdependency between the developing topography of cloud infrastructure and energy politics. Google is at the forefront of this complex relationship, as the company uses roughly one million servers in what has been estimated to be dozens of data centers.<sup>53</sup> Their data center in The Dalles, Oregon, sits on the Columbia River and uses renewable hydropower to run the center. Google is also becoming a growing power “broker”—investing more than \$1 billion in clean-power projects (solar plants, wind farms) in order to buy and sell clean electricity and reduce its carbon footprint. Ultimately, the goal is to send more clean power into the local grids near its data centers, “greening” the cloud infrastructure.<sup>54</sup> In the meantime, the company has taken their role as infrastructure provider to new heights, adding *literal* power to the array of global platforms, services, and data centers they provide in order to keep the cloud functional, on their own terms.

The North Carolina “data center corridor,” which runs through about seven rural western counties between Charlotte and Asheville, is another case in point highlighting the evolving relationship between infrastructure and energy politics. With major sites owned by Google, Apple, Facebook, Disney, and AT&T, among others, it has emerged as a major hub for cloud infrastructure.<sup>55</sup>

In addition to the tax breaks offered by the economically depressed state, there is an abundance of low-cost power, water for cooling, and a climate that allows for "free cooling" most of the time. However, North Carolina has one of the "dirtiest" electrical grids in the country: it only gets 4 percent of its electricity from renewable sources such as solar, wind, or water; coal and nuclear provide 61 percent and 31 percent of the state's power, respectively. Data centers as an industry have become increasingly targeted by environmental activists for their enormous consumption of (nonrenewable) energy, and as a result, there has been a marked attempt by major cloud-computing companies such as Facebook, Google, and Amazon to promote their cloud infrastructure as embracing clean, green power.

Facebook's newest data center in Luleå, Sweden, is powered entirely by hydroelectric energy. The company has also added detailed pages on their carbon and energy impact, as well as real-time graphic representations of its power and water usage for two data centers in Oregon and North Carolina. The "dashboards" monitor and visualize the centers' Power Usage Effectiveness (PUE) and its Water Usage Effectiveness on dedicated Facebook pages.<sup>56</sup> Apple has gone beyond visualizing their energy usage to pioneering efforts to engineer their own clean energy for their data centers in North Carolina and beyond. In 2012 the company built the world's largest privately owned solar-panel farm to power their Maiden, North Carolina, data center, and they are currently working on another for their facility in Reno, Nevada. Apple's stated goal is to use 100 percent renewable energy at all of their data centers, and by the end of 2012 they were 75 percent there.<sup>57</sup> According to Google's website, roughly one-third of the power the company uses to power its data centers is clean power.<sup>58</sup>

In addition to these digital media industry giants taking on power generation, they are also privatizing the infrastructure for data centers, even those that serve the public sector. Amazon Web Services hosts cloud services for the CIA, the Department of Defense, and the Federal Reserve, to name a few major government clients. Infrastructure so critical to the functioning of our society being privatized and consolidated in the hands of a few major providers has serious potential to end up like the market for ISPs: highly concentrated, consolidated, largely unresponsive to consumer demand or regulators, and operating well outside the parameters of what could ever be labeled "in the public interest." Unmitigated concentration of course also brings with it severe global economic, legal, and political consequences for the free flow of data around the world. Additionally, it begins to invite more centralization of infrastructural authority, which is a troubling move in the direction away from the original end-to-end architectural principle of the Internet.

## Mapping the Cloud

Speaking of digital media infrastructure involves imaginaries as much as to-topologies. Put differently, and by taking up a distinction introduced by media archeologist Wolfgang Ernst, it involves speaking of signs as much as of signals: an assessment both of our networks' semantic surfaces and of the data traffic itself.<sup>59</sup> Concerns about the sustainability of infrastructure are thus reflected in the overly stylized representations of data centers as much as they are embodied in the Internet's architecture. While the "data about the data" and the visibility created around newly built data centers are meant to mark a turn away from the old days of resource-inefficient corporate client-server computing and toward the net as global public utility,<sup>60</sup> data traffic itself tells different stories. As a complex engineered system, the Internet includes material, technological, and entrepreneurial arrangements through which telecommunications and ISPs manage flows of traffic.<sup>61</sup> Turning to the Internet's architecture, we have to differentiate between three different levels in order to identify how and where this flow of data gains political (and environmental) implications. The most obvious layer of Internet architecture consists of overlay networks such as the World Wide Web, email, or peer-to-peer. Beyond that is the interdomain level; the Internet is made up of tens of thousands of loosely connected networks called Autonomous Systems (AS) employing different business models and profiles (so-called Tier 1 providers, retail services, business services, network access, Web hosting, and the like). The third layer of architecture is the Internet's physically meaningful topology, that is, the way it builds connectivity at the router level.<sup>62</sup>

Since it is difficult to assess the relational dimension of digital media infrastructure for a large and diverse country like the United States, we instead turn to a "small world"<sup>63</sup> like Sweden to elaborate on this issue. Sweden suggests itself as a case in point not only because of its media ecology's limited size but also because of the country's above-standard broadband penetration and the fact that streaming video currently dominates data traffic.<sup>64</sup> Apart from being integrated into services such as Facebook or Google, video can be accessed through on-demand platforms, and its ubiquity accounts for a major change in digital media infrastructure when it comes to the first or "user plane" of the Internet. Sweden is indicative of a global overprovision of over-the-top (OTT) video on-demand services, offering non-authorized but culturally accepted streaming (for example, sweafilmer.com) and downloading (The Pirate Bay) platforms alongside digital public service broadcasting (SVT Play) and advertising-based, transactional, or subscription streaming services (Netflix, Viaplay, Voddler,