Managing Carbon and Data Flows: Fungible Forms of Mediation in the Cloud

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In order to study cloud computing, media scholars often begin with the data center and its relations to place. Its substantial size and energy requirements can be readily mustered to disprove the imagined deterritorial and environmental innocence of the cloud metaphor. Take, for example, Microsoft's data centers in Boydton, Virginia. Opened in 2010 and expanded five times since, the 1.1 million ft^2 cluster completely dwarfs the small town it adjoins. To meet the project's energy needs, greater than that of Boydton itself, Dominion Virginia Power had to lay new powerlines and build a new electrical substation at the site. Two years later, citing demand, Dominion opened a new coal power plant, pushing more fossil energy onto the grid. From Boydton, we might tell the story of this cloud through concrete and coal ash.

However, this view is at odds with consumer experiences of the cloud as well as Microsoft's own orientation to its data centers. This Virginia site is only one part of a larger global network, designed to flexibly virtualize digital information and infrastructure around the world. The company's cloud service, called Microsoft Azure, is composed of more than 50 data centers and 130 edge nodes, all of which work to circulate the story of the cloud rather than to hold it in place. To Microsoft and many of its users, Boydton will always be one vessel among many in an interchangeable system of data flows—a site of mediation predicated upon the interchangeability of one server to the next. From the global Azure network, the story of this cloud is one of cosmopolitan movement and exchange.

Significantly, this second view holds for the company's orientation not just to data and data centers, but also its global carbon footprint. Since 2012, Microsoft's operations are made carbon neutral through a company-wide carbon fee to fund renewable energy and offset purchases. Written on a global ledger, Microsoft tallies the carbon debts of Boydton and other data centers and subtracts them from a pool of purchased carbon credits generated by distant forests, wind farms, or cookstoves (DiCaprio, 2013). Within the circulatory logics of

atmospheric gas or electrical grids, place cedes to flows and virtual exchanges.

The distance between these two stories is vast and environmental media studies' tactic has often been to insist on the former over the latter. In this article I will not so much be breaking from this tendency as seeking to construct a bridge between these disparate vantage points, tracing how the place-agnostic management of cloud computing permeates corporate environmental practices that anticipate and seek to preempt green media critique. These commonalities hint at a shared, structuring logic that governs both data and carbon—one which environmental media studies must grasp before it can be effectively contested. Only by examining how these spatial strategies continually seek to reduce, refuse, and redistribute the relations between carbon and data can we best articulate how to suture them together again.

In this article I examine how fungible forms of mediation act as an aspirational ideal and management strategy within Microsoft Azure. By fungible mediation I refer to a set of semiotic strategies that serve to translate local relations into generic commodities that can be bought and sold at a distance, obfuscating the question of accountability in favor of the formal logics of accounting. This is evidenced in the rhetoric and structure of the cloud network as well as the market structures of carbon neutrality and green power purchases. This case study, drawn from corporate whitepapers and financial statements, demonstrates how Microsoft's environmental strategy is indicative of its orientation as a cloud company, not merely a belated attempt at greenwashing. I then assess the trajectory of this logic against the call for more rooted, place-based forms of accountability, both within recent challenges to carbon neutral standards and within future visions of cloud infrastructures. I conclude with the stakes and directions this suggests for media studies more broadly.

Data Center Placement

'A cloud server can have any configuration and can be located anywhere in the world'—that is in part how it gets its name (Kumar Garg & Buyya, 2012). Accessible to and from wherever there is a network connection, clouds are as diffuse as they are invisible (which is to say not if you really look, but close enough to create a convincing fiction). The parts of the cloud that have long resisted this story—the particular bodies, materials, and forms of statecraft that maintain and emplace

data centers (Parks, 2014)—increasingly do not grant the same kind of demythologizing purchase as in past decades, especially in the question of data center location. Due to the spread of fiber-optic networks beyond common metropole hubs, data centers can now be built and provisioned with high bandwidth connections from a vast range of possible regions. IT administrators often do not even have to be physically present at the site as much of their work can be done remotely. And, with the proliferation of private networks, cloud infrastructures are further loosened from previous path dependencies and public investments that once anchored the Internet in place. Especially for large companies with considerable capital, the choice of where to locate a datacenter is an increasingly flexible one.

In Microsoft's case, global breadth has long been more important than local specificity. Azure is composed of data centers based in every continent except Antarctica and further supported by a company-owned and planet-encompassing fiber-optic backbone independent from the Internet (fig 1). This cartographic reach is key to how Microsoft sells its cloud to diverse clients, offering both the opportunity to store data, host software, and virtualize infrastructure at a distance or in close proximity. Azure's customers can shop between various legal regimes in which their data can be exclusively maintained, avoided, or flexibly routed through, putting clients, like Microsoft itself, in the position of choosing between many possible global pathways for cloud services—an imaginary of mobility privileged in its flexibility.

Such a promise is further expressed in the animated figure of a rotating Earth that greets potential clients on the Azure website (fig. 2). As the planet spins and its continents fall into the penumbra of night they reveal an interlinked grid of light and geography—a distributed network through which data and energy can circulate. Situated above the clouds, these planetary flows are favored over the local or any one data center itself.

The specific placement of a given node is more primarily a client concern than that of cloud companies, who are more directly driven by variable capital costs. The physical requirements of building a data center—a large spatial footprint, proximity to cabled fiber or the ability to lay new lines, and sufficient water resources or frigid temperatures to continuously cool their racks—are relatively easy to procure at an array of global sites, especially in post-industrial or special economic zones (Bass & Clark, 2015; Stanganelli, 2017).

The first Boydton data center, for example, was brought online within a year of the deal being finalized—a rapid achievement, but also one that could easily have been replicated elsewhere. Virginia in fact had to compete with several other prospective states to secure Microsoft's tenure, offering a comprehensive package of incentives including state-subsidized fiber, millions of dollars in grants, an exemption on sales tax, and a 90% cut from its property taxes for 20 years ('Microsoft to put data center in Mecklenburg,' 2010). Local returns on this public investment look increasingly dubious as, after an initial bubble of construction labor, the workforce at the data center has been small and largely internal to Microsoft. In keeping with the company's privileging of mobility, it flies in specialist labor as needed rather than training local residents to maintain its servers (Hardy, 2016).

The cost of electricity, however, remains a unique place-based factor in such decisions (Rareshide, 2017). Because the running costs of data centers are disproportionately composed of their electrical bills, established grids with large amounts of cheap power are a necessity. In the American and Global South, cheap power most often means coal—frequently the most abundant form of energy in these geographies as well as the most carbon-intensive. In Boydton, this meant contracting with Dominion Power, who could offer extremely low commercial rates to Microsoft because of its near-monopoly in the local market, energy mix composed primarily of coal and fracked gas, and an aggressive political lobbying program to support its own pipeline projects over competitor's solar or wind ambitions. Accordingly, in Boydton and elsewhere, a direct result of the industry's fungible orientation to place has been a significant growth in carbon emissions. This externality does not just follow from the growth of the cloud but is directly shaped by its spatial logics.

Carbon Offsets

As with data, so with carbon. Besides a global map of Azure nodes and networks, Microsoft also maintains a planetary spread of offsets that span 26 countries and represent more than 2 million tons of carbon dioxide equivalents (fig. 3). This network directly supports Microsoft's cloud strategy, primarily as a way to release the company from a 2009 promise to reduce its carbon emissions by 30%. Even calculated per unit of revenue rather than as a net reduction, this target proved incompatible with the cloud's intensive energy consumption and Microsoft's doubling of its cloud capacity every six months

(DiCaprio, 2012: 4). Carbon neutrality, drawing on the logic of double-entry bookkeeping to negate the contents of one column with the contents of another, was therefore a strategy far more appropriate to the cloud's material demands.

This commonality extends to spatial relations. Like cloud servers, carbon sequestration projects can have many different configurations and can be located anywhere in the world; the carbon cycle largely operates at a global scale without regard to the specificities of place. Pulled by aerial currents, carbon dioxide and methane emissions quickly circulate and enter into a common planetary register. This holds constant across the world—whether you are in Virginia or Vietnam, we share an atmosphere and contribute to the same carbon commons (Pasek, 2018).

Because of carbon's material affordances, Microsoft can access and interchangeably act on its share of emissions from any point on the globe. The location is inconsequential from the perspective of the continuously circulating clouds. Accordingly, when Microsoft's Carbon Neutral Council meets to settle their carbon accounts, they are cosmopolitan shoppers. Their purchases should ideally be proximate to areas in which the company has an employee base (Microsoft Corporation, 2016: 24), but with offices in over 120 countries the global map is very open. Their ledger could be balanced with trees planted in Kenya, a forest saved from harvest in Madagascar, or housing insulation in Mongolia. It has been.

The producers and brokers of these offsets often endeavor to mark their products with stories and images that speak to the specificity of place (Bumpus, 2011: 623). Because they sell their commodity on a global market, these strategies can drive up value and distinguish one offset from another. Co-benefits to Indigenous peoples or endangered species are unimportant to the carbon ledger but better allow for the offsetting process to seem like local manifestations of corporate concern—stories of transnational (rather than transactional) connection. From the Valdivian Coastal Reserve of Southern Chile, for example, Microsoft has purchased many tons of carbon credits generated from the counterfactual action of a logging road left unbuilt. In the process it has also, and most visibly, purchased narratives of wildlife preservation, sustainable development, and female entrepreneurship (Riordan, 2015).

However, the reality of carbon offset buying practice—with its brokers, markets, and commodity forms—suggests that this is only another example of fungible mediation. It too is a system

of quantified accounting in which environmental goods are aggregated and symbolically negated through cultural techniques that deracinate and depoliticize relations outside of the ledger. Carbon can be sequestered by a range of possible vessels in the world and offsetting is a system that does not rely on any one given connection. This, in turn, creates political and material gaps in accountability. The Valdivian Coastal Reserve is located more than 980 kilometers away from Microsoft's nearest office and no Microsoft employee seems to have ever visited. Like Boydton, it remains one of many nodes on a map, a promise of circulation, and a site of mostly unseen relations and consequences.[1]

Renewable Energy Purchases

Although Microsoft's carbon offset purchases are sizeable, they only correspond to a particular part of the company's footprint: primarily air travel. The other and much larger group of emissions derive from the megawatt hours (MWh) of fossil energy powering its data centers and offices. 'Electricity,' as Microsoft's General Manager of Energy states, 'is really the raw material of the cloud' (Lacey & Kann, 2018). Yet this material has cloudy properties, especially when coupled to forms of financialization and management that mimic the cloud's circulatory logics and resistance to place.

Electrical grids, like atmospheres, are sites of continuous flow. Electrons put on the grid will mix and move along unpredictable paths, making it impossible to trace any given electron from source to destination. From the perspective of electrical engineers and the data centers taking in and transforming that energy, one electron is the same as any other.

In order to represent and value renewable energy as a distinct commodity, economists created a new semiotic and financial instrument: the Renewable Energy Certificate (REC), equal to one MWh. RECs are generated whenever renewable electricity enters the grid, but RECs do not follow these electrons down the power line. Instead, they are sold to third parties and 'retired,' transferring symbolic ownership of the MWh's 'greenness' to the owner. When equivalent amounts of RECs are purchased and retired by a corporation as the MWh they use, the company may then legally claim that they are 'powered by 100% renewable energy,' even if this isn't what materially transpires.

The gap between semiotics and matter can grow troublingly large as RECs become increasingly fungible. When traded across national or international markets, RECs from distant grids are mustered to balance carbon accounts in sites where green electrons will never travel. In this way, regional differences in the price and supply of renewables can skew meso-level markets. Wind farms in Texas, able to generate electricity at rates low enough to compete with conventional generation on a local grid, have flooded the US market with cheap 'virtual' RECs, unbundled from relations to place (Cook et al., 2017: 40).

At industrial scales, virtual RECs do more harm than good. They allow data center companies to symbolically negate their local impacts in coal-powered regions on paper, while still materially driving up local grid demand and thereby incentivizing the maintenance or expansion of fossil energy generation (Cook et al., 2017: 40). In communities located near coal power plants, disproportionately black, brown, and low-income, this has direct consequences for public health including greater rates of asthma and infant mortality (Union of Concerned Scientists, 2017; Wilson et al., 2012). Moreover, because this strategy fails to reliably reduce carbon emissions, it further contributes to the weight of the global carbon commons and its unequal and nonlinear effects on climate change. From virtualized software to virtualized virtue, fungible mediation subordinates the urgencies of place to the logics of circulation.

The Future of Fungibility in the Cloud

These place-agnostic corporate strategies are not effectively challenged by a critical emphasis on carbon numbers or impacts. Microsoft itself has anticipated, and to some extent internalized, such critiques. Instead, we should emphasize place-based relations. This may be counterintuitive from a climate perspective, in which global registers, mediated through quantitative benchmarks like parts-per-million CO_2 or average degrees of warming, are both necessary abstractions and urgent indices of collective threat (Heise, 2008; Knox, 2014). However, when corporations also operate as globe-spanning systems of circulation, predicated on fungible forms of storage and flow, carbon is too easily ensnared in forms of thinking and action that fail to effect new and better relations across the carbon cycle.

Such place-based critiques are already producing change. Greenpeace's several years long campaign to highlight the links between clouds and coal has spurred action, first in corporate commitments to pursue energy efficiency, and more recently the far more difficult target of powering data centers with 100% renewable energy, directly provisioned within the regional grid that powers each server (Cook et al., 2017: 37). Most significant players in the sector are now pledged to this goal and have intensified local green power purchases accordingly. This shift in local energy mixes is more efficacious in turning the carbon tides, both within and beyond the walls of the data center. This happened in Virginia, with a direct power purchasing agreement in 2018 that will bring over 300 MW of solar power production online, with more than half of those RECs pre-purchased by Microsoft. These actions materially drive a transition to a low-carbon energy system for all consumers across the grid, with corresponding public health benefits and green jobs.

However, the transition from a place-agnostic orientation to one of local specificity and responsibility are neither complete nor secured. In many regional markets Microsoft and other cloud companies struggle to provision local renewable energy because of legal or effective utility monopolies. In some instances unconventional private partnerships are struck to underwrite the cost of constructing a solar plant for a for-profit, predominantly fossil-powered energy provider in exchange for pricing guarantees and all the RECs produced by the facility. This happened with Dominion in 2016, moving capital and market value back into the monopoly's corner. And so, steps forward mix with steps backwards, muddying the waters.

In other locations, such as Australia, renewable energy is available but at a premium that Microsoft is not currently willing to pay. Their gamble is that these markets will continue to bend on their own towards renewables such that new remedies to meet the company's targets will independently emerge over time. However, as governments continue to fall short on adequate regulations to drive uniform and swift decarbonization, and as falling prices for renewable power in turn threaten returns on supplier investment, such an outcome is far from guaranteed (Lacey & Kann, 2018).

In the face of uncertain or intransigent markets, there is always fungibility and its potential to favor flows over place. This logic continues to structure future imaginaries of cloud computing, even in its most green and optimistic forms. Microsoft's Project Natick, for example, seeks to reimagine the

data center as a flexible fleet of aquatic containerized servers, cooled and potentially powered by ocean currents, and easily deployed around the world without the need to secure heterogenous local building permits, labor, or land (Cutler, Fowers, Kramer, & Peterson, 2017) (fig. 4). Aspirations to remove the cloud from complex social territories and into the placeless space of the sea are an intensification of the same strategy of withdrawal and erasure that drives carbon neutrality. It may also amount to a new form of fungible exchange: trading atmospheric and terrestrial disruptions for aquatic ones.

Conclusions and Directions

This essay has argued that media studies should attend not only to the cloud's externalities, but also the management strategies common to externalities and data alike. Microsoft's data center placements, carbon offset purchases, and green energy buys are all structured by fungible mediation. It is this orientation that must be contested.

Staying with the trouble (Haraway, 2016) and focusing on relations across the carbon cycle could make cloud computing an asset to decarbonization efforts rather than a problem to be approached through the logics of visibility or negation alone. Now that data centers are where they are, a new fight for place-marked forms of accountability can begin, superseding calls for better accounting. Holding Microsoft to places like Boydton—insisting that all data center infrastructures be paired with local solar and wind power—would mean more green jobs in the semi-rural spaces of the cloud, supporting a just transition away from fossil fuels and belatedly recouping some of the region's lost public return on investment. In this respect, the story of the cloud is less one of new technologies than a well-worn pattern of corporate infrastructural expansion defiant to local contexts and concerns, followed by local attempts to extract concessions and develop political possibilities in the wake of such developments (Appel, 2012; Easterling, 2014). The goal of such politics is different from traditional environmentalisms that insist on the isolation of the local from global forces of circulation. Mindful of the carbon commons (Pasek, 2018) and the weight of infrastructure already on the ground, another politics is possible—a blue-green alliance that seeks to circulate place differently, holding each node accountable to the communities and ecologies in which they are located and refusing any substitutions.

Finally, this case study in turn invites reflection on the stakes and theoretical claims of studies of the cloud more broadly. A focus on fungible mediation reveals a different picture of the cloud than one by data alone, or by data and environment figured as separate and conflictual forces. Consequently, in addition to understanding these infrastructures as imbricated in a return to territorial forms of power (Hogan, 2015; Hu, 2015), we must also note when circulatory forms of management complicate this story. This not only situates the study of the cloud in relation to prior histories of networks (Starosielski, 2015) and globalization (Tsing, 2005), but also highly local and contingent struggles for energy democracy and a redistribution of power within and mediated by the grid (Lennon, 2017). Such a focus, consequently, bridges environmental media studies and the political economy of media—a view from the ground and a view from the clouds.

Note

1. The carbon offsets generated in Valdivia derive from The Nature Conservancy (an American non-profit)'s decision to cancel the construction (and thus deforestation) of a logging road planned by the Reserve's former owners. The purchase of the land and its donation to the Conservancy was made possible through a large donation from BHP Billiton, a multinational mining and petroleum company, who in turn gained social license and narrative value in the exchange. Local Indigenous communities, and the stories of their transformation into water-protecting, women-empowering, eco-entrepreneurs, are retellings of the management strategies The Nature Conservancy has adopted in an attempt to dissuade people from continuing practices of logging or cattle grazing that are not compatible with the nonprofit's conservation ideals. It is thus not only carbon and data that are disguised and reimagined in circulation, but also a wider range of social relations and neo-colonial power. This point is further developed in my dissertation research.

Figures

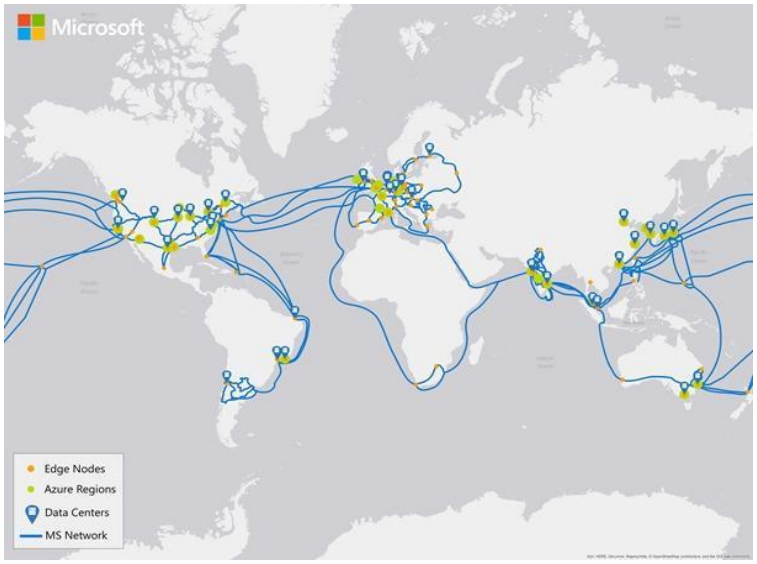

Fig. 1: The Microsoft Global Network, available from https://azure.microsoft.com/en-us/blog/how-microsoft-builds-its-fast-and-reliable-global-network/

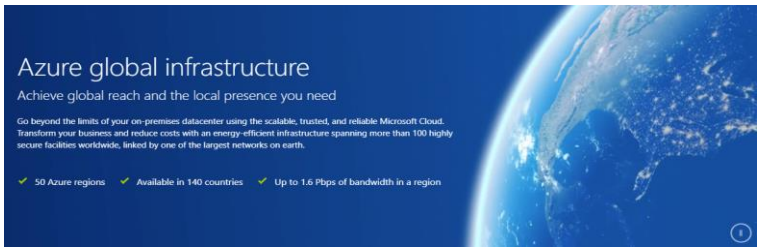

Fig. 2: Microsoft Azure Splash Page, https://azure.microsoft.com/en-us/global-infrastructure/

Fig. 3: The Microsoft global carbon offset community project portfolio (Microsoft Corporation, 2016: 19)

Figure 4: Artist's illustration of Project Natick. Josh McKible for *IEEE Spectrum*, 2017.

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