



# Data centers and the infrastructural temporalities of digital media: An introduction

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## Abstract

While data centres are predominantly studied via their spatial and territorial dimensions, we investigate this critical part of the contemporary Internet infrastructures via its temporalities and their multiple mediations. With this introduction and the articles of this special issue, we collectively complement existing scholarship on critical data studies and media infrastructure by investigating the role that data infrastructure plays in shaping the temporalities of data. Focusing on data centres, the contributors analyze the vast infrastructural assemblage that supports such temporalities. The concept of timescapes (after Barbara Adam) guides us to organize the contributions to this special issue along the analysis of three infrastructural timescapes of data—socio-economic, elemental, and transitory—to reveal new facets of the politics of time in the data economy.

## Keywords

Data, data center, infrastructure, temporality, timescape

This special issue engages with the temporalities of data as mediated through a critical part of Internet infrastructures today—data centers. Current practices of automated data tracking, data processing, and algorithmic decision-making appeal to industries and

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institutions around the world today, not only as sources of “objective knowledge” about anything, but also because of their promise to transform the temporalities of knowing. The prospect of owning and using digital data has established pre-emption as “the present future” (Pentzold et al., 2020) around which media, citizens, and organizations are algorithmically assembled and classified in relation to categories of risk and economic value (Amoore, 2013; Cevolini and Esposito, 2020; Ziewitz and Singh, 2021). Understanding how data-driven knowledge production is establishing pre-emption as a mode of governing and organizing populations today has become a central question in critical data studies and adjacent fields. Scholars have illuminated the extensive cultural work of narrating, cleaning, sorting, and discarding data through which these temporalities are enacted and sustained as modes of governance (Cakici et al., 2020; Gitelman, 2013; Pink et al., 2018; Plantin, 2019; Thylstrup, 2019). Their societal implications are today associated with the reproduction of social inequalities across diverse arenas of social practice that range from health, insurance, education, and energy to everyday life. Others have started to examine how temporal regimes of pre-emption become “hard-wired” (Volmar and Stine, 2021) into digital devices and how data times remain diverse, competing, and often contradictory, despite the purported dominance of pre-emption (Douglas et al., 2021: 17; Maguire et al., 2020).

With this special issue, we extend these perspectives by calling attention to the role data infrastructure plays in shaping the temporalities of data. Temporalities of data emerge in relation to the continuous sociopolitical organization of a vast infrastructural assemblage that includes code, routing protocols, data centers, cables, people, network equipment, territories, soil, air, water, energy, and other human and non-human entities. Of all these entities, we find data centers to be particularly productive for engaging with the politics of time in the data economy. Most Internet content and data today pass through and get stored on these facilities. As we are writing this text, large and small territories on Earth’s five continents, underground, underwater, and in space are being envisioned, planned, and zoned for the construction and operation of new data centers. From Singapore to Iceland, and from Cape Town through Chile to Northern Ireland, data centers have become critical to large-scale industrial projects that render climate, energy, and the planet “knowable” and exploitable through data. The incidental failure of just one such facility has proven capable of knocking out large parts of national services, transnational online platforms, and entertainment media, interrupting the pace of data transmission and digital service provision across several continents for weeks (Rosemain and Satter, 2021). The timely operation of platform services, computation on demand, streaming video, and social media are thus critically dependent not just on software or data capture but also upon organizing and managing their timely provision from within data centers.

Despite their critical role in mediating time in the digital economies of data, scholarly work on data centers has so far approached these infrastructures overwhelmingly in relation to the politics of place (Hogan, 2015; Holt and Vonderau, 2015; Johnson, 2019; Lehuédé, 2022; Mayer, 2019, 2020; Taylor, 2017; Veel, 2017). With this special issue, we call for the importance of adding a temporal perspective to these accounts to understand the sociopolitical structuring of time in the economies of data. We find such a perspective necessary in order to balance much of the presentist- and emergence-oriented discussion on pre-emption that dominates currently the field, and connect it to broader

debates about the mediation of time through media infrastructure. Such a move allows us to see how data centers extend, suspend or transform relations of power, difference, and economic worth through the socio-material politics of mediating time. To capture these dynamics, we introduce the notion of “infrastructural timescapes of data.” Timescapes connote the rhythmicities, timings, tempos, modalities of past, present, and future, durational changes, and sequences of the multiple “scapes”—landscapes, cityscapes, and seascapes—within which technologies operate, and the conflicts that emerge in these interrelations (Adam, 1998: 10). Timescapes, according to Barbara Adam, emerge in the juncture between the multifarious temporalities of economic, geological, and lived time, and bring into purview their embodied and affective dimensions. A timescape analysis does not provide an account of what time *is*, but rather how it is produced, practiced, and how it enters multiple systems of values (Adam, 2000).

Infrastructures generate and sustain multiple timescapes. A long lineage of work in the fields of anthropology of technology, science and technology studies, and media studies has asserted that sociocultural temporalities and timings are produced and shaped with and in relation to infrastructure and the visions of people who design, maintain, and shape their operations (Anand et al., 2018; Appel, 2018; Jackson, 2017; Mulvin, 2017). Infrastructures shape social time and inform understandings of modernity (Edwards, 2003); they are also perceived differently on multiple scales (Hecht, 2018; Mattern, 2015). Using the example of scientific collaboration, Ribes and Finholt (2009) also show how infrastructure evolves through constant negotiations between short- and long-term goals, enacting what they call the “long now of infrastructure.” Infrastructures are thus both creatures and agents of time (Jackson, 2017), a dual relationship that evolves over the lifetime of infrastructure. The timescapes of data infrastructures are therefore not singular or linear but heterotemporal and relational (Cohn, 2016). Infrastructures not only emerge—they age, they break down, they are destroyed through prolonged “curated decay” (DeSilvey, 2017) or through quick “irruptions” of time (Starosielski, 2021), for example, a fire, an earthquake, or an event of war might “punctuate” (Guyer, 2007) carefully scaffolded temporalities.

Our approach to data infrastructures via their timescapes is further indebted to two cognate concepts. First, we analyze the timescapes of data infrastructures by foregrounding the multiple power-chronographies (Sharma, 2014) that undergird their operations. Power-chronographies, following Sharma, reject universalist claims of speed-up or acceleration and draw attention to the differentiated lived experience of time produced through the biopolitics of labor. The authors participating in this issue describe how various actors, such as local policy makers, site managers, or Internet users, constantly “re-calibrate” the temporalities of data infrastructures and themselves to expectations toward the tempos and economies of data processing. These re-calibrations of time produce differential configurations of power—such as between users of “cloud” services and the workers who sustain these services from within data centers in different parts of the world; or between consumer experiences of “uptime” of online streaming services and the masculinities that structure labor in data centers (see Taylor as well as Gonzalez, this issue).

Second, we draw on the metaphor of temporal polyphony (Tsing, 2015: 23–24) to bring attention to the cultural work done by different actors—human

and non-human—on entangling and disentangling multiple tempos, rhythms, and timelines along which data infrastructures exist. In polyphony, Tsing reminds us that multiple autonomous melodies intertwine, and the listener must pick separate, simultaneous melodies while listening to moments of harmony and dissonance, an act that requires learning to appreciate the multiple temporal rhythms and trajectories of an assemblage. Applied to the temporalities of infrastructures, temporal polyphonies reveal the mutability and transience of data infrastructures, their emergence and aging, break down, repair, and discard alongside anticipations about their growth and expansion. The concept also prompts considering the forms of care that sustain infrastructures through their polyphonic lifetimes, as well as how transitory temporalities and relations of power take shape.

We examine how temporal polyphonies and power-chronographies are shaped within three infrastructural timescapes of data that we call *socio-economic*, *elemental*, and *transitory timescapes*, which we use to organize the contributions to this special issue. Devika Narayan, Vicki Mayer, and Steven Gonzalez first explore the diverse forms of data center-related labor that sustain the sociotechnical and economic organization of power-chronographies of data. Tonia Sutherland and Gailyn Bopp, Patrick Brodie and Patrick Bresnihan, and Mél Hogan then analyze how the temporalities of data economies are shaped through power-laden interrelations with the elements, thereby extending colonial and gendered forms of domination and techno-masculinity, but also generating critical responses through artistic practices. Alex Taylor and Julia Velkova finally show how data temporalities are produced in relation to the prospect of failure and processes of aging, discard, and disposal of infrastructure.

## Socio-economic timescapes of data

Data processing today is crucially dependent on companies' abilities to organize their access to computation and storage capacities. "Big Tech" companies—as the largest operators of data today—have invested heavily in expanding and managing their own data infrastructure, which includes networks of data centers, ownership of dedicated fiber optic cables, strategic hires of engineers, and customized network management software. They have also commercialized this infrastructure by converting access to it into "commodity computational services" (Ensmenger, 2021). This move toward cloud computing represents, a successful revival of the relatively old technology of time sharing, through which multiple users share time on a server, transforming computation resources into a new commodity in the data economy (Hu, 2015). The implications of this new model are profound and have a global outreach. For instance, in countries, such as India, it is transforming the balance of power between telecom, media industries and the state (Parthasarathi et al., in press). It also creates conditions for software companies to gain competitive advantage by exposing the Indian software economy to global markets and overcoming issues of cost, maintenance, repair, and upgrades of in-house hardware and software (Narayan, this issue).

Key to this economy is the sociotechnical production of the *speed* of data traffic, as well as maintaining *uptime*, a measure of the time an online service is available. Speed today is increasingly dependent upon industry decisions on where to locate a data center,

to which fiber optic cables it would connect, to the physical proximity to its expected users, and to selected Internet exchanges (Rosa, 2021) as well as content delivery networks. Decisions about speeding-up data traffic increasingly rely upon finding the physically shortest and fastest path that data have to travel between two places, what MacKenzie (2017) names the “capital’s geodesic”. In sectors, such as high-frequency algorithmic trading, a speed difference of a millisecond might put a competing organization out of business and leads to the careful planning and placing of data centers in strategic locations to shorten speeds of traffic (MacKenzie, 2021). Other sectors tolerate greater differences, but speed nevertheless remains a key concern.

The industrial concern with speeding up data exchanges inscribes data center construction and operations in the long lineage of their predecessors, for example, large-scale communication infrastructures, such as fiber optic and satellite networks, the telegraph, the telephone, or the railway. These networks have historically informed dominant understandings of time and temporality with media in terms of speeding-up. Adding data centers to the list brings into purview the plurality of tempos that compose data speeds and the formation of power-chronographies (Sharma, 2014) that sustain them. Speed, following Sharma, ‘is always relational and experienced differently depending on one’s geographic location and one’s subject and social position. As Sharma eloquently writes, speed privileges some workers, consumers, and temporalities while leaving others to re-calibrate themselves. It creates power differentials between media consumers who have a “seamless” experience of online content delivery, and others who have to contend with degraded images and sound (Larkin, 2004), planned delays (Lobato, 2019), or experiences of “aesthetic lag” (Starosielski, 2015).

Power differences and temporal re-calibrations are palpable at the sites and locations where data centers are installed, and they are expressed through concerns about recruiting workers and maintaining “uptime” in data centers. Using as an example the establishment of a Google data center in Groningen in the Netherlands, Vicki Mayer in this issue describes how the temporalities of data infrastructure and labor time get entangled through long-rehearsed narratives of “economic development time, shaping the temporalities and lived experiences of prospective workers” (Mayer, this issue). The temporality of labor that surrounds data center establishment in places, such as Groningen carries the promise of linear progress and a form of modern life (Appel, 2018; Edwards, 2003). This promise risks to remain though an incomplete ‘ideal’ (Graham and Marvin, 2001), often deepening social divides and inter-regional conflicts where data centers are emplaced (Burrell, 2020; Johnson, 2019; Mayer, 2020). Depending on their social position, citizens calibrate and occupy different positions in relation to these new infrastructures. Those privileged to find a job in a data center can become an operator or security guard, and have to temporally re-calibrate their bodies to operate in stillness and silence, often alone, providing companionship and care for machines and rehumanizing the spaces they inhabit (Mayer et al., in press; Taylor, 2021; Velkova, 2020). These bodily re-calibrations to the times of machines cannot be separated from gender and identity nor from data economies as such. They manifest through performances of masculinity that become part of the labor of keeping up the ‘uptime of machines,’ as Steven Gonzalez vividly describes in this issue with focus on the maintenance work that data center operators perform.

Those on top of these hierarchies—policy makers and data center managers—calibrate themselves instead to the tempos and rhythms of the global flow of data, presenting the construction, expansion, and boosterism of data centers as a necessity (Mayer and Velkova, 2023). Such actors make palpable futures with data infrastructure through a variety of metrics—numbers of jobs, sizes of data center fields, megawatts of computer capacities, and future sizes of expansions, as Vicki Mayer shows in this special issue. Those left out of data center jobs might be forced instead to negotiate the changing identities of their towns and their transformed social position by curating memories and narrating them to visitors (Mayer and Velkova, 2023). By describing the power-chronographies of data labor, this special issue shows how speed continues to be a shortcut not only for capital extension but also for shaping and organizing power differentials in the economies of data through infrastructural labor. We hope that such analyses would inspire further inquiry of the differential, embodied experiences, and configurations of work that sustain the socio-economic timescapes of data.

## Elemental timescapes of data

Temporalities in the data economy are critically dependent on the continuous instrumentation and infrastructuring of the elements—water, salt, minerals, atmospheres, and soils. Data centers are strategically positioned in places where colder air, seawater, groundwater, or aquifer water can be harnessed as a “natural” coolant for warm servers (Gilmore and Troutman, 2020; Hogan, 2015; Vonderau, 2019), and where the intensity of wind or sun can power these structures with green energy (Bresnihan and Brodie, 2021). Besides merely sustaining the operations of data infrastructures, the cultural work upon the elements represents a crucial process of reworking the capacities of infrastructure to generate value, for different actors and to different ends (McCormack, 2017: 417). For example, in Nordic climates, data center operators are experimenting with selling warm air in server halls to public institutions and utilities alongside hosting their data (Velkova, 2016). The Irish state is attempting to transform peat boglands into a resource able to sustain the high-energy demands of hyperscalers (Bresnihan and Brodie, this issue). Data centers are also increasingly implicated in the governance of wind flows and the production of economic value from them as sources of “green” energy (Brodie, 2020); or to agricultural processes and food farming practices that become tied to data processing (Vesterlund, 2021). Thus, data centers organize atmospheres and elements and extract value from them, and, in turn, become used as critical infrastructure for processing environmental data and modeling climates. In these contexts, data centers mediate the “datafication of nature” (Nadim, 2021).

The technoscientific work of making elemental rhythms, environments, and atmospheres infrastructural to media is of course hardly new. Historically, the operations of media have always depended upon cultural practices of instrumenting terrestrial, atmospheric, or aquatic environments for signal transmission, remote sensing, information preservation, and economic value production (Bozak, 2012; Durham Peters, 2015; Groening, 2014; Kaplan, 2018; Parks, 2018; Schwoch, 2018; Starosielski, 2015). For example, the construction of the telegraph in the 19th century in the United States and its transcontinental expansion were crucially dependent on the production of



technoscientific knowledge about weather, landscapes, climates, and the likelihood of storms, landslides, or social unrest and then employing this knowledge to “act upon nature” through decisions for routing, maintenance, and repair of communication networks—effectively “wiring” the telegraph into nature (Schwoch, 2018). The production of technoscientific knowledge about the materiality and conductivity of air has also been part of its cultural and economic transformation into a medium of broadcast communication and value production (Connor, 2010; Horn, 2018), and later for the exertion of vertical power over territories and populations (Parks, 2018). Since then, elemental transformations and related knowledge-making practices have continued to shape the routes, transmission protocols, and paths of the exchange of information, a process that has justified continuous acts of violence and displacement of native populations and local communities, of environmental transformation, and the extension of colonialism deemed necessary for producing the material conditions for communication infrastructures, connectivity, and economic surplus value. Scholars in the fields of political ecology and anthropology have long posited how infrastructural development is always fraught with politics of power based on caste, class, gender, nation, and identity-belonging (Anand, 2017; Rodgers and O’Neill, 2012). It is also closely tied to the exertion of violence, exclusion, or new forms of population and environment governance (Von Schnitzler, 2016). This tension can become particularly untenable in contexts of military conflict, political unrest, or new infrastructure development projects (Weizman, 2019). Contributors to this special issue show that the construction, operation, and decay of data infrastructures cannot be separated from these legacies and critically detail the manifold ways in which these are being extended through mediating between the temporalities and conductive capacities of the elements, and those of digital cultures. For example, Tonia Sutherland and Gailyn Bopp describe how the thermal properties of the Pacific Ocean are harnessed by the data center industry to develop underwater data centers. They position this innovation within the long relationship between communication infrastructure and colonialism in Hawai‘i. Specifically, they reveal how the exploitation of geological assets present in underwater data centers directly conflicts with the *Aloha ‘Āina*, that is, the Native Hawai‘ian ethics of preservation of natural elements. The concern with extending colonialism through elemental instrumentation is also evident in Patrick Brodie and Patrick Bresnihan’s contribution in this issue, where they examine the ways in which carbon and data futures get aligned into a contested imaginary of sustainable living. They critically examine conservation projects of peat boglands by the Irish State and their relation to the data center industry. By doing so, they counter assumptions of Ireland’s peat as mere wasteland waiting to be saved by tech-driven “energy cultures.” These analyses show how gender, race, and colonialism are performed and reproduced at multiple temporal scales of elemental instrumenting—from maintaining the rhythm and pace of everyday circulation of air among servers to the imagining of water and earth as conductive of novel cultural forms of data infrastructures.

Besides unpacking the politics of power and difference that continue to shape the operations of media infrastructures, these analyses also reveal the extent to which elements are actively shaping collective temporalities of data (Yip, 2022). Like most other information infrastructures, data centers continue to be designed as if they operate outside of nature and outside of the temporalities of geological and elemental times (cf.

Edwards, 2003). The cultural work of instrumenting environments takes place in a larger timescape of technoscientific futurity. Within this timescape, actors are obliged to follow the imperative to innovate, act quickly and pre-emptively, and take risks (Puig de la Bellacasa, 2015), with little regard nor time to consider the pace of elemental rhythms and processes that operate at different timescales and require a different temporal orientation. The industrial futures of data and the elemental timescapes that sustain them are constantly in tension with each other. No matter how much effort engineers make to calibrate, synchronize, and subject environmental rhythms to the speeds and cultural demands of information traffic, winds change orientation and intensity, oceans change tidal patterns, rivers dry out, ice melts at increasing speeds, solar storms erupt, and earthquakes rearrange soils and earth layers. Such events irrupt (Starosielski, 2021) into the culturally ordered rhythms and temporalities of media infrastructures and remind us that the elements have their own paces and times and remain unruly.

Elemental irruptions call for consideration of the multiple worlds that co-exist in the elemental timescapes of data, the relations of power between them, the role of non-human agents—such as wind, geothermal forces, or seawater—in the collective production of digital time (Tan, 2015), and the modes of care for them. In this issue, we show how modernist and native ontologies—ways of being and knowing the world—co-exist in friction with the temporalities of data infrastructures.

Contributors to this special issue illuminate the need to engage with the multiple “politics of the possible” (Escobar, 2020) that currently undergird the shaping of infrastructural timescapes of data—some of which reproduce masculinity, violence, and colonialism, with others enticing relations of care grounded in decolonial modes of being in the world. These latter politics of the possible could be mobilized through native epistemologies and ontologies of care for nature and the sea (e.g. *Aloha ‘Āina*, cf. Sutherland and Bopp, this issue) or through critical data center art projects (Hogan, this issue), through which they cultivate an alternative ethics and aesthetics of care. We hope that such examples could prompt further enquiries on the politics through which the extension of colonial logics and environmental exploitation via data infrastructural futures could be suspended and oriented toward more caring, plural and inclusive futures.

## Transitory timescapes of data

More than any other temporality, the prospect of the end of the infrastructures built, of the data stored and trafficked, of disruption, erasure, and shutdown acts as a silent force that generates affects, economies, and practices shaping the transitory timescape of data infrastructure. The end of data worlds is both an everyday reality for data center workers and operators, and a well for producing new commodities, such as “preparedness” (Taylor, this issue).

The end of data infrastructures can come in many forms. Geopolitical conflict can cause the quick shutdown or prolonged dismantling of a data center. Take, for instance, the hyperscale data center of the Russian Internet company Yandex in Finland. In operation since 2016, the data center has become a critical thermal urban infrastructure in the town of Mäntsälä, a small Finnish town close to Helsinki (Velkova, 2021). As Russia invaded Ukraine in the spring of 2022, the data center lost legitimacy and caused anxiety



among the local Finnish community, which has since been trying to force its dismantling—by cutting off its power supply and forcing the facility to run on diesel for months, and by planning its disconnection from the thermal grid of the town (Noponen, 2022). Besides geopolitics, cycles of planned obsolescence also influence data centers' temporality. The lifespan and presence of data centers is constantly evaluated in relation to the aging of the servers that they host and the transforming geopolitical and economic conditions of their operations, continuously leaving open the possibility of relocating as capital demands (Velkova, 2019). Unplanned disasters, such as a fire, can destroy a building in minutes and suspend all services connected to it for weeks thereafter, as happened when a data center located in Strasbourg in France spectacularly burned down in the midst of the COVID-19 pandemic (Rosemain and Satter, 2021). The ongoing impetus of the industry to shift to "edge computing" and place data centers in distributed and modular ways closer to end users further propels the motility—and related ends of life—of data centers. These contexts remind us that media infrastructures age, break down, and are eventually shut down. Sometimes they leave spectacular ruins—large abandoned buildings that have been prematurely closed (Brodie and Velkova, 2021)—at other times, they might leave more subtle ruins in the form of data traces of past structures, or empty spaces part of a civic defense military infrastructure (Velkova, this issue).

These processes are not unique to data infrastructures and can be traced back, at least, to the abandoned roads and aqueducts of the Roman empire. With the constant roll out of "better" or "newer" digital infrastructures, a huge range of communication infrastructure is constantly pushed into states of devaluation, irrelevance, dismantling, or decay. Older transnational fiber optic cables are being retired, satellite debris cluster in orbit and undersea, and telephone landline networks are being taken down. This special issue inscribes data centers in this long lineage of communication infrastructure decay and orients thinking toward the politics through which data worlds age and die. The end of data centers, as contributors to this special issue show, might produce "cloud ruins" (Brodie and Velkova, 2021), forming diverse landscapes of ruination in the built environment that emerge with datafication, or it could nurture the formation of new commodities in a digital economy scared of its own collapse. For example, relying on the analysis of data centers in bunkers, Alex Taylor reveals how data center and cloud back-up providers position these facilities—and the "data preparedness" they provide—in relation to their past function (protecting against nuclear attack during the cold war) and the constant threat of data loss or information technology (IT) failure in the future. Preparedness for failure becomes a commodity derived from anticipations and fears of the immanent failure and loss of digital data, Taylor shows.

The transience of data centers calls for thick empirical accounts of the politics of aging and the decommissioning of data infrastructures, as already shown by concepts, such as "broken world thinking," (Jackson, 2014) "repair-into-decay" (Cohn, 2016), and "dandelion economics" (Parks, 2012). Contributors to this special issue suggest how these can be further enriched with temporal inversions of infrastructure that reveal the fragility and uncertainty of data futures (Velkova, this issue). Mapping the contours and economies of an aging data infrastructure is a tremendous task that remains to be pursued by scholars of critical data studies and media infrastructure studies to address the politics and economies of discarding data and infrastructure.

The eight contributions to this special issue track the practices through which the infrastructural timescapes of data are shaped and oriented toward the future, toward their operations in the “extended present” (Nowotny, 1996), or toward historical temporalities of colonialism as they unfold undersea, underground, overground, and in different parts of the world. In assembling this special issue, we have been informed by a concern with the diversity of scholarly work, perspectives, and epistemologies. The contributors to the issue are scholars of different races, genders and nationalities and at different career stages. Their work, collectively, reflects a commitment to feminist, decolonial, and historical approaches through situated knowledges (Haraway, 1988) and partial perspectives to disentangle the politics of time and power relations at the infrastructural roots of the data economy with care and sensibility to differences. The issue also highlights the value of interdisciplinary approaches to media infrastructure, interfacing anthropology, media studies, political ecology, and human geography. We recognize, however, the disproportionate attention to cases from Northern contexts, and we hope that future work will bring more studies from other geographical contexts. We are convinced that such a multi-situated and interdisciplinarity perspective is imperative to creating more inclusive and nuanced critical understandings of the infrastructural and temporal politics of datafication.

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