Infinite growth and abundance: an unrelenting internet infrastructure ideology

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Abstract

The internet is widely perceived as a critical infrastructure to society's social and economic well-being. The mandate of its governance bodies is to make the internet work better by ensuring speed, efficiency, security, and resilience of the network and promoting values of decentralization, interoperability, and openness. Infrastructures and their governance structures set the invisible scaffolding for social life (Easterling 2014) that determines what is deemed as valuable or less important in society, as such the study of its governance is considered the study of power structures, and how they operate and change. In this paper, I build on ten Oever and Milan's (2022) argument that next to studying power over internet infrastructures, we need to study how power is exercised through them, and which worldviews are embedded and enacted through them. New governance areas, such as the network's carbon footprint, dependence on non-renewable energy sources, and pollution, provide temporary windows into what is and isn't or what must be discarded for the internet to continue to operate and expand (Liboiron and Lepawsky 2022). By examining position papers submitted to the IAB workshop on the Environmental Impact of Internet Applications and Systems I explore the sustainability agenda proposed by the internet engineering community to argue that there is a scalar mismatch between the ecological crisis and proposed solutions resulting from the failure to questions the underlying values of infinite growth and abundance of resources that underpins internet infrastructures operations. This paper contributes to our understanding of the role of internet governance in the fight for the future and straddles infrastructure studies, environment social science, and internet governance studies.

Introduction

A number of internet governance organisations develop and maintain internet infrastructure, including the IAB and Internet Engineering Task Force (IETF) which are discussed in this paper. The IAB is responsible for providing architectural oversight of internet protocols and procedures and establishing technical direction for an internet that connects people and things to ensure that the internet is a trusted medium with a solid technical foundation. It is also a committee of the IETF, a private industry-led internet standardisation body that brings together many of the most prominent Internet infrastructure companies (Cath-Speth 2021). The IETF community develops standards for a broad range of networking technologies to ensure the growth and evolution of the internet (IETF 2024). While most people probably have never heard of the IAB or the IETF, research into these governance bodies matters as they form the regimes that shape the operations of the internet, how traffic is routed, what security and safety measures are enabled, and how users access information. Social scientists have been interested in understanding the meta governance of these internet governance organizations, i.e. the visions, norms, and values that unit these distributed governance regimes to ensure the operations of the internet (ten Oever 2020) and its governance processes, multistakeholderism (ref), to offer insights into the changing power asymmetries and interest that shape the internet. These approaches have primarily looked at internet governance organizations in isolation, their internal dynamics, and, less so, external threats to the internet's operations. Little attention has been given to how the internet governance community is engaging with the ecological crisis, a term I use to refer both to the climate and the environmental crisis that has been unfolding since the Industrial Revolution. This research will contribute to these internet governance debates by exploring how the community unites and responds to external threats, defined as the environmental impact on and of the internet, by analyzing the contribution to the IAB workshop on Environmental Impact of Internet Applications and Systems.

Infrastructures are considered to set the rules that shape everyday life (Easterling 2014), its standards determine how these infrastructures function, and as such are intimately connected to power (Oever and Milan 2022). A social science approach to studying internet governance organization is thus the study of power. For this paper, I will briefly discuss how power in internet governance has been discussed so far to argue in the next section what a new materialist approach could contribute to these debates. Since the early days of the internet its governance has been characterized by private internet governance regimes that rejected government oversight (DeNardis 2009; ten Oever 2020). The once lauded multi-stakeholder nature of internet governance, technology and policy is developed and governed through debate and dialogue among different stakeholders, and has been critiqued for favouring those in power (Scholte 2020). In the case of internet governance, there is an over-representation of industry and an under-representation of public interest perspectives in these debates (Carr 2015). A dynamic that is characterized by what Perarnaud (2024) calls corporate saturation, achieved through the consolidation of power and control in the application layer and in some cases across the entire stack by the big industry players. Here, companies have gained structural power over standard-setting processes, which allows them to unilaterally develop and push certain standards (Peacock 2020; Ten Oever 2021)). To understand how power is distributed scholars have looked at counter-power and the inclusion of public interest perspectives in the debates, to find that these voices act to legitimize the existing order rather than meaningfully contribute to the governance processes (ten Oever 2020). In part this dynamic has been attributed to the fact that the institutional mandate of internet governance bodies is in line with private interests (Perarnaud 2024), their norms form barriers to include public interest perspectives in standardization processes (Cath 2021), and while these bodies are procedurally open their organizational cultures are exclusionary. “Distinct organizational cultures – from confrontational and “rough” models of collaboration to the greater respect afforded to participants who work at large corporations – can impede, undermine, and discourage civil society participation” (Cath 2022). While Cath primarily looked at civil society exclusion from standard-setting processes, the engineering community has also expressed concerns about the increased participation of individuals with an affiliation to Chinese companies, as they are considered an extension of the Chinese government, whose worldview is considered at odds with the values of the open, interconnected, and free internet (ref). These approaches have looked at the wielding of power to achieve a certain vision of the technologies themselves but fall short of understanding them as the result of overarching worldviews that aim to reproduce social order in the interest of those in power (Maxigas and Ten Oever 2023). In this research, I will turn to the environmental impact of the internet to shed light on the worldviews that unite the internet governance community.

Materiality matters

Susan Leigh Star called for the study of infrastructure, the ‘study of boring things’ (Star 1999), the invisible substrates that allow other aspects of society to function. She argues that we can not study a city without studying its sewer system, as such we can not study information systems without studying its infrastructures, both its material layer - the data centres, cables, routers and devices- and its immaterial layer – computational processes, policies, and ideologies (ten Oever 2020). Since this initial call for the 'study of boring things' there has been a rising academic interest in infrastructure, connecting media studies to infrastructure, which renewed the significance of its materiality. The popularization of any research approach brings epistemic problems to light.

Hersmondhalgh (2021) argued that the lack of a clear definition of what infrastructure is and isn't runs the risk that this research approach loses its analytical value, as it can be anything and nothing at the same time. This paper will use an infrastructural lens to understand how the technical internet community engages with the environmental impact associated with the operations of the internet, more specifically internet routing. Hersmondhalgh (2021) further argues that the academic interest in the immaterial layer of infrastructures, organizational cultures, norms, and standard-setting processes, has led to the marginalization of the materiality aspect of infrastructure in academic debates. Yet, as I will argue it is the materiality of infrastructures that have opened up space to theorise about the nexus between the ecological crisis and technology.

Internet infrastructures have long been viewed as immaterial (Starosielski 2015; Frenzel 2023), a cultural imagination that did not need to account for the environmental harms associated with the mining for critical raw materials, hardware manufacturing, and e-waste (Falk, Van Wynsberghe, and Biber-Freudenberger 2024; Bridges 2023), as these processes happened far away out of sight of the internet’s engineers, policymakers, and its users. Hogan (2015) turned to a new material line of inquiry to theorize about the entanglements between natural resources and surveillance systems. Water becomes more than a resource to be consumed, it is the non-human entity that unites contestation against surveillance regimes and makes infrastructures visible, material, and contestable. Similarly, other studies that looked at the relationship between non-human elements - water, energy, and land - and infrastructure have made the political entanglements of the data centres industry visible (Rone 2022; Velkova 2024; Lehuedé and Valdivia 2023). This new material approach opens up a research area that examines how the natural and social world effect each other, more specifically how non-human entities can be social agents that make things happen (Fox and Alldred 2015), as they have the potential to demand a person, a group, or an organization to act, to reproduce, or to transform. Tracing the origins of these infrastructural sites shows they do not materialise out of nowhere. They have agential properties. The emergence of infrastructural sites is part of a long-term and often nontransparent negotiation between states and companies in which favourable tax, development, and political climate should entice companies to build their physical assets on a specific territory (Brodie and Velkova 2021). In this article, I will build on the new materialist approach to argue that the internet is very much material and in a world where we are running up against planetary boundaries it is the non-human entities that make infrastructures visible and demand a response from the internet community.

Environmental considerations are a niche but slowly emerging issue on the internet governance agenda. In December 2022 the Internet Architecture Board (IAB) organized a workshop on the Environmental Impact of Internet Applications and Systems from the understanding that the industry needs to account for the energy and raw materials needed for its operations (IAB 2022). In line with a new materialist approach that ascribed agential properties to non-human entities, the technical internet community can be seen to develop a response to the energy shortages and supply chain dependencies. As such, this paper explores the entanglements between environmental impact and the internet community by gaining insight into how non-human entities unite the community and shape what sustainability approaches in its infrastructure look like to argue that these solutions are not at the right scale as they do not challenge the unrelenting internet infrastructure ideology of infinity, growth, and abundance. The choice to engage with the environmental impact is guided by Niklas and Dencik (2021) observation that it is "the formulation of new policy areas, [...], provide a window into what priorities, interests and concerns currently shape” a governance field. The process of creating a new governance area thus gives insight into the worldviews that are embedded within internet infrastructures and its governance processes. For the argument, I draw on Liboiron and Lepowsky's (2022) discard studies book to ask - what isn't or what must be discarded for the internet to continue to operate and expand? A new policy area shows what is valued and what is left out, giving insight into the politics behind its governance regimes. In their book Liboiron and Lepowsky invite us to think about the scale of the proposed solutions: "We articulate scale as a way of understanding the relationships that matter to defining an issue, and thus of locating where and how interventions might best take place" (Liboiron and Lepawsky 2022, 39). Starting from the notion that not all relationships or solutions are equal and that the problem definition will influence the possible solutions, it is imperative to ask if the technical internet governance community is addressing the right problem at the right scale.

Methods

To gain insight into how the internet governance community accounts for the environmental impact of its infrastructure this paper offers a qualitative content analysis of the position papers submitted to the IAB workshop on Environmental Impact of Internet Applications and Systems held online in December 2022 (IAB 2022). Invitations to the workshop were extended to those who submitted a position paper to the event, as such brought together a self-selected group of people who are familiar with the IAB and have an interest in and feel the urgency to reduce the environmental impact of the internet. These issues play a limited role in the overall governance debates, the IETF community consists of 7000 active participants of which only 82 authors submitted 26 position papers to this workshop. Still, this small community will likely play a critical role in shaping the IETF's sustainability agenda. Furthermore, the sample is considered representative of the worldviews embedded within the technical internet governance community as organizers and participants of the workshop are long-standing members and contributors to the IETF community and the program committee chairs have served as IETF Chair and been IAB members. The workshop consisted of four online sessions, presentation ranged from taking stock of existing debates in the IETF, what we know about the network energy consumption, ideas for improvement, and next steps. The selected topics had to be in the scope of the IETF mandate and the speakers were known IETF contributors. This workshop approach reflects what Cath (Cath 2022, 2) identified as the nature of the IETF as being procedurally open but culturally closed, everyone who submits a position paper can participate but people set the agenda for the discussion and frame what sustainability of the internet looks like and others are discarded.

For this paper, I conducted a thematic data analysis of the 26 position papers (excl. my own contribution) submitted to the workshop. The submitted position papers range from comprehensive overview documents of the energy discussion in the IETF to short aspirational pieces on internet sustainability. The affiliation of the authors allowed me to group the position papers as contributions from industry (13), academia (8), technical community (2), an interdisciplinary team (3), and civil society (0). The industry represents the Telecom and technology industry, the technical community internet governance bodies, namely ISOC and RIPENCC, and the interdisciplinary groups are a mix of academic, industry, and civil society contributions. Of the total number of authors, only one represented civil society. The thematic analysis is based on the six steps recommended by Braun and Clarke (2006) using the qualitative open-source data coding software (Taguette). This process involves a constant moving back and forth between position papers, codes, and analysis. After an initial familiarisation of my data set, I started generating initial codes by highlighting specific data and leaving comments in the margins. This allowed me to organise my data and start to identify common themes (Boyatzis, 1998; Tuckett, 2005). After I coded all the position papers, I went back and recorded them to include insights and themes that emerged during the coding process across my entire data set. In the third phase, I grouped all codes and underlying data into a potential theme (Braun and Clarke, 2006). In a separate document, I clustered, grouped, and regrouped codes into possible themes and further refined the clusters by rereading all of them, seeing if they formed a coherent pattern, and weighing their prevalence in relation to my overall research questions. In the coding process, I looked for *[fixme add from code book]*. This approach offered insight into how this group of internet practitioners frames the nexus between environment and infrastructure, their problem statement and proposed solutions, before discussing what is missing from these technical visions of the internet to gain insight into the values and worldviews that shape internet governance bodies.

Findings

The participants of the workshop are part of a small and nascent community of internet engineers who are concerned about the climate crisis. They share an understanding that ‘climate change is considered the greatest current threat to human health [WHO]’ (Arkko, Lövehagen, and Bergmark 2022) and the ‘Internet both affects and is affected by the environment and climate change’ (Robinson, Hellstern, and Diaz 2022), as such the engineering community has a responsibility to act to ensure a sustainable future. This is in line with the new materialist line of inquiry, where non-human entities have agential properties that demand a response from the community. In their papers, it is primarily the industry actors who emphasise that while the internet has a direct negative impact on the environment, it has and will significantly contribute to the transformation and greening of other sectors. ‘Arguably, networks can already be considered "green" technology in that networks enable many applications that allow users and whole industries to save energy and become more sustainable in a significant way. For example, it allows (at least to an extent) to replace travel with teleconferencing; it enables many employees to work from home and "telecommute," thus reducing the need for actual commute; [...]’ (Clemm and Westphal 2022). Departing from the assumption that the internet is instrumental in the transformation and greening of other industries, the contributors to the workshop recognize that this promise in itself can not cross out the direct environmental harms of technology. ‘Helping the decarbonization of other sectors cannot be an excuse for not addressing the carbon emissions of ICT – for our credibility we need to master both' (Arkko, Lövehagen, and Bergmark 2022). There are different ways the environmental harms are quantified, some state it as a fact ‘today, the ICT industry has a massive carbon footprint (a few percent of worldwide emissions) and one of the fastest growth rates’ (Jacob 2022) and ascribe a role to industry to minimize this footprint (Clemm et al. 2022). While others compare it to known polluters like the aviation sector (Vanderbauwhede 2022) or compare it to the data centre industry (Schooler et al. 2022). While most contributors acknowledge the embodied cost of the internet, ‘impact across their full lifecycle including raw materials acquisition, production, use and end of life treatment stages’ (Arkko, Lövehagen, and Bergmark 2022), they narrowly define the problem in terms of carbon emissions related to the operations of the internet.

Defining carbon emissions as a problem triggered a heated debate in the workshop and on the mailing list on the connection between energy consumption and the growth of the network. Industry actors emphasise that there is no correlation between 'electricity consumption and the exponential growth in the number of bits sent’ (Arkko, Lövehagen, and Bergmark 2022). Energy demands in the network have been moderate in comparison to the growth of the volume of internet traffic. Even if the community wanted to reduce its carbon emissions the lack of a shared understanding of what to count, how to count, and who should count was considered an obstacle. The size, decentralized nature of the internet, and entanglements with society and other industries make the overall impacts of ICT on the environment is complex to derive' (Arkko, Lövehagen, and Bergmark 2022), as 'quantifying and managing the emissions related to network transfer has historically been much harder, as so many intermediate actors are involved in supporting connections between two or more parties' (Adams, Salsano, and ElBakoury 2022). The lack of standardization, shared definitions of metrics, and uptake by the industry make it difficult to account for the carbon emission of the entire network (Anderson et al. 2022). The problem is not that there is too little known about the energy use and carbon emission of the network, there is also a lack of agreement on how and what to measure. Coming back to Liboiron and Lepawsky's (2022) question of which relationships matter to define an issue, it is clear that the narrow and reductionist approach overlooks the underlying values of the internet that lie at the heart of networking energy consumption. Best expressed by a small number of academic and technical community contributors; 'The Internet was designed from an "always-on" assumption; energy efficiency was only a secondary objective, if at all' (Jacob 2022), and that 'technical communities have been focused on growth, "progress" & innovation since the start of the Internet' (Manojlovic 2022).

Greening the internet

By reducing the environmental impact of the internet to that of carbon emission it is not surprising that the proposed solution relates to minimizing the total energy consumption and increasing its reliance on renewable energy sources. Participants attribute this narrow framing of sustainability to it being in the scope of the IETF mandate and 'recognize that many potential improvements are outside the scope of standards and research' (Arkko, Lövehagen, and Bergmark 2022), these lie with for example hardware manufacturers or data centre operators. In this section, I will discuss the pathways proposed by the community to decarbonize routing to argue that they approach it as an engineering problem that can be solved through technical fixes. A key and short-term intervention is considered improving the measuring the energy consumption and carbon emission of the network. It stems from the belief that "you can't improve what you don't measure" (Krishnan and Pignataro 2022), a better information position will allow the industry to take the appropriate measures to combat climate change. A mode of governance that Andrejevic describes as 'a persistent attempt to collapse the political into the technical as if the solution to societal and political conflicts were simply a matter of imperfect information' (Andrejevic, 2020, p. 101). Reducing environmental impact to an engineering problem, where the development of vendor-agnostic measurement standards will allow for the measurement of carbon emissions across the network (Clemm et al. 2022) and decarbonize through optimization. Industry actors propose a number of practical ways to make the network more sustainable, these range from introducing protocols designed that reduce the volume of data to be transmitted; removing redundant links and network equipment from the network topology, reducing the amount of time equipment or links are operational, reducing the link speed or processing rate of equipment; experiment with path-aware networking or segment routing to steer traffic along those paths that have the smallest carbon footprint (Retana, White, and Paul 2022; Clemm et al. 2022). These optimization efforts will allow the community to 'do the same' in terms of the Internet, only to 'do it more energy efficiently at scale'(Greening of Streaming 2022).

A more aspirational proposition, path-aware networking for sustainability, envisions the network to become a system that has the 'ability to adjust its behaviour in response to changes to the carbon intensity of the electricity it consumes. This can reduce the environmental impact of the system by making it better at running on cleaner energy. It can increase the power drawn from lower carbon power sources when there is an abundance of clean energy available, and it can reduce or eliminate power drawn from the grid when fossil fuels make up the majority of generation powering the electricity grid' (Adams, Salsano, and ElBakoury 2022). This solution presents the community with three engineering problems, it requires freely available and accurate information about the carbon intensity of different nodes in the network (Adams, Salsano, and ElBakoury 2022), a standard to include it in the header of IPV6, and a protocol that privileges routing traffic along greener paths in real-time. The inspiration for carbon-aware routing stems from large data centre operators who employ carbon-aware computing, shifting 'non-time sensitive computational processes to times or location where cheap green energy is in abundance' (Schooler et al. 2022; Adams, Salsano, and ElBakoury 2022). The economic incentive of carbon-aware networking is that this type of spatial-temporal computing allows companies to access cheap renewable energy sources that might otherwise go unused or cause instability in the energy grid (Adams, Salsano, and ElBakoury 2022). This aspirational solution aims to optimize how traffic is routed around the globe.

A key challenge of decarbonizing the internet is understanding where carbon reduction is taking place. When taking traffic as a unit of analysis, as is the case in carbon-aware routing, the community theorizes about the potential of routing according to clean or dirty energy sources. However, prioritizing greener nodes does not equate to the reduction in energy consumption of 'dirtier' nodes, which are powered by fossil fuel energy. Most participants acknowledge that the 'largest gains can be made when network resources can effectively be taken off the grid' (Clemm et al. 2022) or placed in sleep mode (Jacob 2022). This is known as time-variant routing, where 'a path might only become available when its carbon consumption is below an established maximum threshold or is close to zero (Schooler et al. 2022). Shutting down devices as much as possible will theoretically diminish the total volume of energy consumed by the network, but practically there are still many unknowns as to how to incorporate this into the network. 'A device's power consumption does not increase linearly with the volume of forwarded traffic' (Clemm et al. 2022), the energy costs of powering on a device are very high in comparison to keeping it running, and during its operation energy consumption is like a step function 'in which power consumption stays roughly the same up to a certain volume of traffic, followed by a sudden jump when additional resources need to be procured to support a higher volume of traffic (Clemm et al. 2022). This raises questions about how the network knows a node is in sleep mode, without pinging it and "waking it up". Participants look towards innovations in chip manufacturing that might allow for 'microsleep modes' (Arkko, Lövehagen, and Bergmark 2022) that do not unnecessarily trigger these nodes to turn on or negatively impact the latency of data moving from one point to another. Or look toward the designing of new protocols that assume devices will turn themselves off automatically (Jacob 2022). The way in which the sleep mode function is framed again hints to the optimization of energy consumption through technological innovation that retains the mission to keep the network always-on.

Alternative approaches

The contributors to the workshop engage with the nexus between environment and internet infrastructures in distinct ways; industry actors focus on carbon emissions and short-term practices that can help decarbonization efforts, and the technical community and mixed actors offer more aspirational ideas - carbon-aware networking and sleep mode utility – and propose to include other stakeholders in the debate to ensure a just transition and academic contributors theorized about building a new internet with a different architecture. It is the position paper of van der Brauwhede (2020) that drew me to engage with the question of what isn't or what must be discarded for the internet to continue to operate and expand. He is the only contributor who proposes practical solutions that address the underlying growth paradigm of the internet industry by introducing the notion of limits. ‘As a society we need to start treating computational resources as finite and precious, to be utilised only when necessary, and as effectively as possible. We need frugal computing: achieving our aims with less energy and material’ (Vanderbauwhede 2022). He argues that the industry has had very little economic incentive to reduce energy use in networking as the number of transistors and computational power on a chip doubled every two years, known as Moore’s law, and performance is seen to double for free (Vanderbauwhede 2022). However, the industry can no longer bank on this efficiency gain as integrated circuits can not be scaled down anymore, and ‘therefore, we need to do more with less’ (Vanderbauwhede 2022). From a hardware perspective, the solution needs to centre on extending the end-of-life of devices. Take for example, 'the typical lifetime for servers in data centres is also 3-5 years, which again falls short of these minimal requirements. According to this paper, the impact of manufacturing servers is 20% of the total, which would require an extension of the useful life to 11-18 years' (Vanderbauwhede 2022). The argument to reduce material consumption of network equipment has been omitted from the other contribution, while at first glance some might argue that hardware might be out of the scope of the IETF community they are in fact the consumers of hardware, and as such could decide to extend the end of life.

An ideology based on infinite growth and an abundance of resources

The contributions to the IAB workshop on the Environmental Impact of Internet Applications and Systems provide a useful indication of the different priorities and interests that shape the sustainability debate in internet governance and the underlying values that enable these governance regimes. Ten Oever and Milan (2022) argue that the ability to change the world is what makes the study of internet governance organizations and standards processes a study of power. The authors built on Weber (1978) and Peet (2007) to argue that internet infrastructures are not merely defined by the power struggles in the market, state, and citizen nexus but shaped by ideology, the dominant social norms and values that allow power holders to justify their position and actions (Beetham 1991). When we bring the natural world in conversation with the social world it becomes clear that no matter what ideology governs a society - capitalist, communist, or socialist – nature is primarily been seen as a resource for extraction, albeit to serve a different purpose and interest (Russ 2022; Riofrancos 2023; Buller 2022). The new materialist approach analytically moves away from this unidirectional view of nature to a bidirectional one, where the natural world and social world effect each other. The submission to the workshop illustrates that external threats, the ecological crisis, have mobilizing potential, however, the relationship is not equal, non-human entities can not influence the responses, it is the humans who dictate the conversation and open or foreclose certain futures. In this section, I will excavate the values that shape internet infrastructures by engaging with the scalar mismatch between the ecological crisis and proposed sustainability and discussing not what is but what isn’t or what must be discarded for the internet to continue to operate (Liboiron and Lepawsky 2022). I will argue that the sustainability solutions are inadequate as they do not challenge the values of infinite growth and abundance of resources that is embedded within infrastructure ideologies (Maxigas and Ten Oever 2023).

In priming the discussion with the caveat that the internet is crucial for the decarbonization of other industries, the internet engineering community not only bank on a future promise that technology will save us, but they also emphasize its innovative potential and make its operation indispensable to achieve a sustainable future. Justifying extraction and pollution by aligning themselves with the dominant social norms of progress where the internet and new technologies are seen as crucial to social, economic, and environmental well-being (Jansen and Thorne 2024). Subsequently, the problem becomes reduced to carbon emission and the lack of reliable and comparable information about it, omitting to respond to the multitude of entanglements between the ecological crisis and internet infrastructure (Falk, Van Wynsberghe, and Biber-Freudenberger 2024). This siloing of the problem offers solutions that focus on efficiency and optimization measures, which can be considered tech determinist, short-term, and reductionist, as it approaches carbon emission as an interesting engineering problem and not a political or economic problem. This narrow problem statement excluded values that are central to the degrowth movement, limits to growth and reduction of use of natural resources (Kerschner et al. 2018).

Limits to growth is directly add odds with the values that have shaped the internet. Metcalfe's law dictates that when networks grow, the cost for each new node increases linearly but the value of the network increases exponentially (Swann 2002). Thus, the value of an infrastructure, and the services that run on top of it, are believed to be intrinsically connected to its market share and the volume of users, nodes, and data. When the internet grows it grows in multitude, designed to be "always-on" the internet is built for redundancy to prevent loss of connection and services. For example, packages route in multitudes across different paths, networking equipment is configured for peak load and with a backup option, and emergency power supplies are designed to keep everything, also non-essential services, running at all times. Even if there is sufficient capacity left in a network, data centre, or assemblage of submarine and terrestrial cables, its infrastructure will be expanded. Some contributors acknowledge there will be a staggering increase in the overall energy use of the ICT due to the growth of new Internet services; the expansion of the network to new geographical areas; and a rise in users and connected objects. Yet, the discussions on the framing of the problem and on the mailing list (ref) around Jevon's paradox show that there is a deep sense of tech exceptionalism that guides thinking on sustainability, as if internet infrastructures are not subject to the dominant economic order or limits to material resources. Jevon's paradox argues that since the industrial revolution, technological efficiency gains have not reduced but increased the overall consumption of natural resources, as all usable capital, time and energy is reinvested again and again (Alcott 2005; York and McGee 2016). When the problem definition excludes this economic reality, solutions end up being short-term and too narrow, addressing the symptoms and only some externalities of extractive economies.

Reduction of the use of natural resources, beyond the energy consumption for routing, is mostly entirely left out of the debate. The contributions to the workshop focus primarily on the operational cost, energy use and carbon emissions needed for routing, and omit to engage with its embodied costs, extraction and pollution related to mining, manufacturing, transport, and disposal of hardware. Disregarding the material reality of routing perpetuates a worldview in which there are no limits to the resources needed to power internet infrastructure. Ideologically, this view is reinforced by the importance society places on digitization. Take for example, the European Commission's regulatory discussion on critical raw materials (ref), which aims to bring the supply chain closer and decrease the dependency on China, to ensure there will be enough resources for its digitization objective and Europe's tech industry. Practically, the profit and capital that circulates in the internet industry gives them a competitive advantage over other industries (ref).

Conclusion

[still needs to written]

References

Alcott, Blake. 2005. “Jevons’ Paradox.” *Ecological Economics* 54 (1): 9–21. https://doi.org/10.1016/j.ecolecon.2005.03.020.

Bridges, Lauren. 2023. *Geographies of Digital Wasting*.

Brodie, Patrick, and Julia Velkova. 2021. “Cloud Ruins: Ericsson’s Vaudreuil-Dorion Data Centre and Infrastructural Abandonment.” *Information, Communication & Society* 24 (6): 869–85. https://doi.org/10.1080/1369118X.2021.1909099.

Buller, Adrienne. 2022. “The Value of a Whale: On the Illusions of Green Capitalism.” In *The Value of a Whale*. Manchester University Press. https://www.manchesterhive.com/display/9781526166036/9781526166036.xml.

Carr, Madeline. 2015. “Power Plays in Global Internet Governance.” *Millennium: Journal of International Studies* 43 (2): 640–59. https://doi.org/10.1177/0305829814562655.

Cath, Corinne. 2021. “The Technology We Choose to Create: Human Rights Advocacy in the Internet Engineering Task Force.” *Telecommunications Policy*, Norm entrepreneurship in Internet Governance, 45 (6): 102144. https://doi.org/10.1016/j.telpol.2021.102144.

———. 2022. “Loud Men Talking Loudly: Exclusionary Cultures of Internet Governance.” Amsterdam: critical infrastructure lab. https://criticalinfralab.net/wp-content/uploads/2023/06/LoudMen-CorinneCath-CriticalInfraLab.pdf.

Cath-Speth, Corinne J N. 2021. “Changing Minds and Machines: A Case Study of Human Rights Advocacy in the Internet Engineering Task Force (IETF).” PhD, Oxford University. https://corinnecath.com/wp-content/uploads/2021/09/CathCorinne-Thesis-DphilInformationCommunicationSocialSciences.pdf.

DeNardis, Laura. 2009. *Protocol Politics: The Globalization of Internet Governance*. Mit Press. https://books.google.com/books?hl=en&lr=&id=Secqz0XQJIsC&oi=fnd&pg=PR7&dq=De+Nardis+2009&ots=S79dYTw5GN&sig=PcK4JCe0NCaUk9WNuAA6I-SoaH4.

Easterling, Keller. 2014. *Extrastatecraft: The Power of Infrastructure Space*. Verso Books.

Falk, Sophia, Aimee Van Wynsberghe, and Lisa Biber-Freudenberger. 2024. “The Attribution Problem of a Seemingly Intangible Industry.” *Environmental Challenges* 16 (August):101003. https://doi.org/10.1016/j.envc.2024.101003.

Fox, Nick J., and Pam Alldred. 2015. “New Materialist Social Inquiry: Designs, Methods and the Research-Assemblage.” *International Journal of Social Research Methodology* 18 (4): 399–414. https://doi.org/10.1080/13645579.2014.921458.

Frenzel, Janna. 2023. “Data Rush: How ‘Green’ Computing Is Opening Up a New Frontier in Arctic Norway.” In *Disturbed Ecologies: Photography, Geopolitics, and the Northern Landscape in the Era of Environmental Crisis*, edited by Darcy White, Julia Peck, and Chris Goldie. transcript Verlag.

Hesmondhalgh, David. 2021. “The Infrastructural Turn in Media and Internet Research.” In *The Routledge Companion to Media Industries*, edited by Paul McDonald, 1st ed. London: Routledge. https://doi.org/10.4324/9780429275340.

Hogan, Mél. 2015. “Data Flows and Water Woes: The Utah Data Center.” *Big Data & Society* 2 (2): 205395171559242. https://doi.org/10.1177/2053951715592429.

Jansen, Fieke, and Michelle Thorne. 2024. “Predatory Delay and Other Myths of ‘Sustainable AI.’” In *Redirecting Europe’s AI Industrial Policy: From Competitiveness to Public Interest*, edited by Frederike Kaltheuner, Leevi Saari, Amba Kak, and Sarah Myers West. AI Now.

Kerschner, Christian, Petra Wächter, Linda Nierling, and Melf-Hinrich Ehlers. 2018. “Degrowth and Technology: Towards Feasible, Viable, Appropriate and Convivial Imaginaries.” *Journal of Cleaner Production*, Technology and Degrowth, 197 (October):1619–36. https://doi.org/10.1016/j.jclepro.2018.07.147.

Lehuedé, Sebastián, and Ana Valdivia. 2023. “Outsourcing Environmental Damage: The Life Cycle of Digital Eco-Imperialism.” In *Environmental Internet Studies*. Philidelphia. https://www.conftool.org/aoir2023/index.php?page=browseSessions&print=yes&form_session=416&presentations=show.

Liboiron, Max, and Josh Lepawsky. 2022. *Discard Studies: Wasting, Systems, and Power*. Cambridge, Massachusetts: The MIT Press.
Maxigas, and Niels Ten Oever. 2023. "Geopolitics in the Infrastructural Ideology of 5G." *Global Media and China* 8 (3): 271–88. https://doi.org/10.1177/20594364231193950.
Niklas, Jędrzej, and Lina Dencik. 2021. "What Rights Matter? Examining the Place of Social Rights in the EU's Artificial Intelligence Policy Debate." *Internet Policy Review* 10 (3). https://doi.org/10.14763/2021.3.1579.
Oever, Niels ten. 2020. "Wired Norms: Inscription, Resistance, and Subversion in the Governance of the Internet Infrastructure." PhD, Amsterdam: University of Amsterdam. https://nielstenoever.net/wp-content/uploads/2020/09/WiredNorms-NielstenOever.pdf.
Oever, Niels ten, and Stefania Milan. 2022. "The Making of International Communication Standards: Towards a Theory of Power in Standardization." *Journal of Standardisation* 1 (July). https://doi.org/10.18757/jos.2022.6205.
Peacock, Sylvia E. 2020. "Politics, Public Goods, and Corporate Nudging in the HTTP/2 Standardization Process." *Sage Open* 10 (4): 2158244020971611. https://doi.org/10.1177/2158244020971611.
Riofrancos, Thea. 2023. "The Security–Sustainability Nexus: Lithium Onshoring in the Global North." *Global Environmental Politics* 23 (1): 20–41. https://doi.org/10.1162/glep_a_00668.
Rone, Julia. 2022. "The Politics of Data Infrastructures Contestation: Perspectives for Future Research." *Journal of Environmental Media* 3 (2): 207–14. https://doi.org/10.1386/jem_00086_1.
Russ, Daniela. 2022. "'Socialism Is Not Just Built for a Hundred Years': Renewable Energy and Planetary Thought in the Early Soviet Union (1917–1945)." *Contemporary European History* 31 (4): 491–508. https://doi.org/10.1017/S0960777322000431.
Star, Susan Leigh. 1999. "The Ethnography of Infrastructure." *American Behavioral Scientist* 43 (3): 377–91.
Starosielski, Nicole. 2015. *The Undersea Network*. Durham: Duke University Press. https://books.google.com/books?hl=en&lr=&id=NtGqCAAAQBAJ&oi=fnd&pg=PT7&dq=starosielski+2015+undersea+network&ots=Ih7SFZCcU1&sig=fGsWo2o0RbnIYEYH4ksEBvI_FDY.
Swann, G. M. Peter. 2002. "The Functional Form of Network Effects." *Information Economics and Policy* 14 (3): 417–29. https://doi.org/10.1016/S0167-6245(02)00051-3.
Ten Oever, Niels. 2021. "'This Is Not How We Imagined It': Technological Affordances, Economic Drivers, and the Internet Architecture Imaginary." *New Media & Society* 23 (2): 344–62. https://doi.org/10.1177/1461444820929320.
Velkova, Julia. 2024. "Dismantling Public Values, One Data Center at the Time | Reimagining Public Values in Algorithmic Futures | University of Helsinki." University of Helsinki. February 19, 2024. https://www.helsinki.fi/en/researchgroups/reimagining-public-values-in-algorithmic-futures/whats-new/dismantling-public-values-one-data-center-at-the-time.
York, Richard, and Julius Alexander McGee. 2016. "Understanding the Jevons Paradox." *Environmental Sociology* 2 (1): 77–87. https://doi.org/10.1080/23251042.2015.1106060.