11

GLOBAL DATA GOVERNANCE BY INTERNET INTERCONNECTION

Nathalia Sautchuk Patrício

Introduction

Global data governance needs Internet interconnection. Internet interconnection policies, as well as technical protocols and standards, are an integral but still poorly understood part of data governance debates. These matters are central to interoperability, as Chapter 3 by Aguerre in this volume has illustrated. The present chapter contributes to what Sacks and Sherman characterize as a need for "deeper study and mapping of the standards landscape across categories such as internet architecture, company activities, people, and governments … as a basis for any international framework for data governance" (Sacks and Sherman 2019). I argue that polycentric lenses offer a way to foreground the typically obscure "Internet interconnection layer" and its data governance tensions. Emphasizing interconnection to deal with the mechanisms that allow the transmission of data between different networks on the Internet is a recognition of polycentric arrangements governing data globally. Ultimately, the data used by platforms from their users rely on the Internet for both data production and circulation.

Digital data travel through multiple protocols and pass through different networks (also referred to as Autonomous Systems, or ASes) as well as various physical media such as fiber optic cable and satellite radio spectrum. The definition of what is allowed (or not) to be sent is based on interconnection policies set and maintained among networks that shape the possibilities of using and retaining data across platforms. In addition, data specifically related to sender and receiver communication can be retained and updated at the interconnection level. This means that, when content is sent on the Internet, it is "inserted" in a standardized data packet, containing data related to sender and receiver. These data are read during routing processes and updated by the routers from the

DOI: 10.4324/9781003388418-14

interconnection points. Global data governance is thus polycentric: through interconnections between seemingly autonomous but highly interconnected systems that enable data to 'travel'. The interconnection of these networks on the Internet represents an important but understudied form of global polycentric data governance.

The chapter proceeds in three sections. The first section unpacks data governance by Internet interconnection. The second section then elaborates on how polycentric governance helps to understand "global data governance by Internet interconnection". Specifically, it traces the role (and interconnections) between routing policies, Internet Exchange Points (IXPs), and Content Delivery Networks (CDNs). Finally, the third section presents some considerations on challenges and future research regarding global polycentric data governance.

Data governance by internet interconnection

What are data in the digital age? This definitional question remains at the heart of existing global digital data governance debates. The term data governance first focused on the corporate environment making use of data. One structured literature review synthesized a definition of data governance as follows:

> Data governance specifies a cross-functional framework for managing data as a strategic enterprise asset. In doing so, data governance specifies decision rights and accountabilities for an organization's decision-making about its data. Furthermore, data governance formalizes data policies, standards, and procedures and monitors compliance.
>
> *(Abraham, vom Brocke and Schneider 2019)*

More recently, however, data governance debates are identifying the role of different actors and the broader social implications about data. Particularly the role of governments has contributed to *international* dimensions of data governance, including the issue of data flow between different jurisdictions (see Chapter 3, Aguerre in this volume). Government involvement is also important to Internet interconnectivity. Sacks and Sherman (2019) recognize this point in conceiving data governance as rules for how governments interact among themselves as well as with the private sector in order to manage data, understand the access and use patterns, and what should be included in the design and enforcement of standards, policies, and laws.

Others, however, insist that the Internet's network architecture is data governance. A change in the design of the networks, encompassing Internet-based services, as well as the global Internet itself, exemplifies how the politics of the Internet are affected, such as "the balance of rights between users and providers, the capacity of online communities to engage in open and direct interaction, the fair competition between actors of the Internet market" (Musiani 2013). As Musiani (2013) goes on to suggest,

> technical architecture appears as one of the strongest, if not the strongest structuring element of internet governance: what is shaped into architecture and infrastructure can seldom be undone by institutional negotiation and dialogue alone, and institutions find it increasingly complicated to keep up with "creative" governance by architecture and by infrastructure.

Musiani and collaborators (DeNardis and Musiani 2016) point to an aspect of Internet governance that is more broadly relevant to global digital data governance: the ways in which the interconnection of the network of networks operate, both through specific policies and technical implementation. The formulation and implementation of such policies *is* the key way of doing Internet governance, and not just an indirect influence. Internet governance is not just influenced by aspects of the network architecture, the very design of this architecture is a form of Internet governance. Arguably, it *is* Internet governance, something that is also central to data governance.

Building on these insights points to how the Internet layer becomes a crucial 'site' for data governance and polycentricity allows us to see and connect these sites of power. Data governance is not only influenced by aspects of Internet architecture, such as network interconnections, but also fundamentally involves the design of this architecture and implementation of network interconnection policies. Hence a key under-recognized aspect of digital data is governance *by* Internet interconnection. The likes of the 70,000 ASes that constitute the Internet today thus form an important basis not only for the understanding of the interconnections of the network of networks, but also data governance more generally.

The technical architecture of the Internet thereby forms a central structuring element of data governance. Moreover, the Internet's polycentric interconnection architecture both affects and is affected by data production and flows. What is implemented in the architectural layers of the Internet often ends up going unnoticed, as key interconnection agreements are mostly informal and even handshake agreements (Van Eeten and Mueller 2013). This informality contributes to obscurity that in turn renders change by formal institutional and governmental negotiations less, but not entirely, infrequent.

There are two main types of network interconnection at stake in data governance: peering and transit. A peering arrangement involves two Internet providers that exchange their own traffic data with each other. That is, peering involves the exchange of traffic between two or more networks. Generally, a network has some peering policies with conditions that other networks have to meet in order to be considered as 'peers', and to exchange traffic without payment between the parties. One of the factors to be considered when establishing a peering agreement is that both networks send each other approximately the same volume of data traffic. Those policies can be open, when a network is interested in peering with any other network; or restrictive, when a network is generally not interested in new peering; or selective, when the network chooses its peering partners on a case-by-case basis (Meier-Hahn 2016; Kende et al. 2021). In a peering arrangement, a network does not allow a practice known as 'transit', which means that the peer cannot use the network as a "bridge" to achieve content in a third network. To obtain access to the entire Internet, a network needs to have many peering agreements with various networks. An alternative for many peering agreements is to make a transit arrangement. This is normally a business relationship between networks, where a fee is provided. In general, a smaller network buys traffic from a larger one, which delivers this traffic to and from its peers and any other transit arrangement it may have (Kende et al. 2021). Figures 11.1, 11.2, and 11.3 show three scenarios of network interconnection: pointing, peering, and transit agreements among networks.

Analyzing Network A, we see that it has access to data from Network B directly via peering agreement and can reach data from Network D through Network C via transit agreement. When looking at Network E, we see that it has access to networks B and D, via a peering agreement. However, Network E cannot access data from Network C and A, since it has no transit agreement that allows this interconnection.

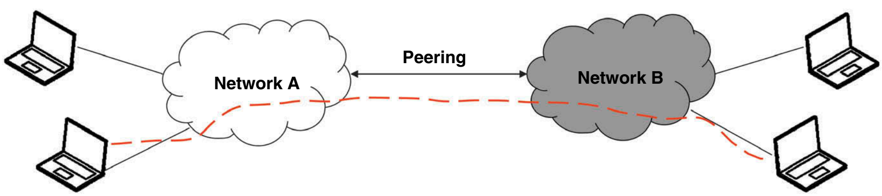

FIGURE 11.1 Peering agreement between Network A and B. Network A can reach data from Network B directly, and vice versa.

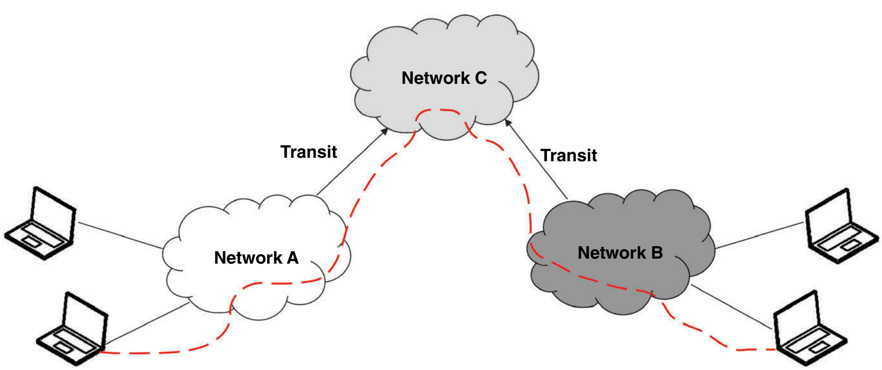

FIGURE 11.2 One transit agreement between Network A and C, and another between B and C. Network A can reach data from Network B through Network C, and vice versa.

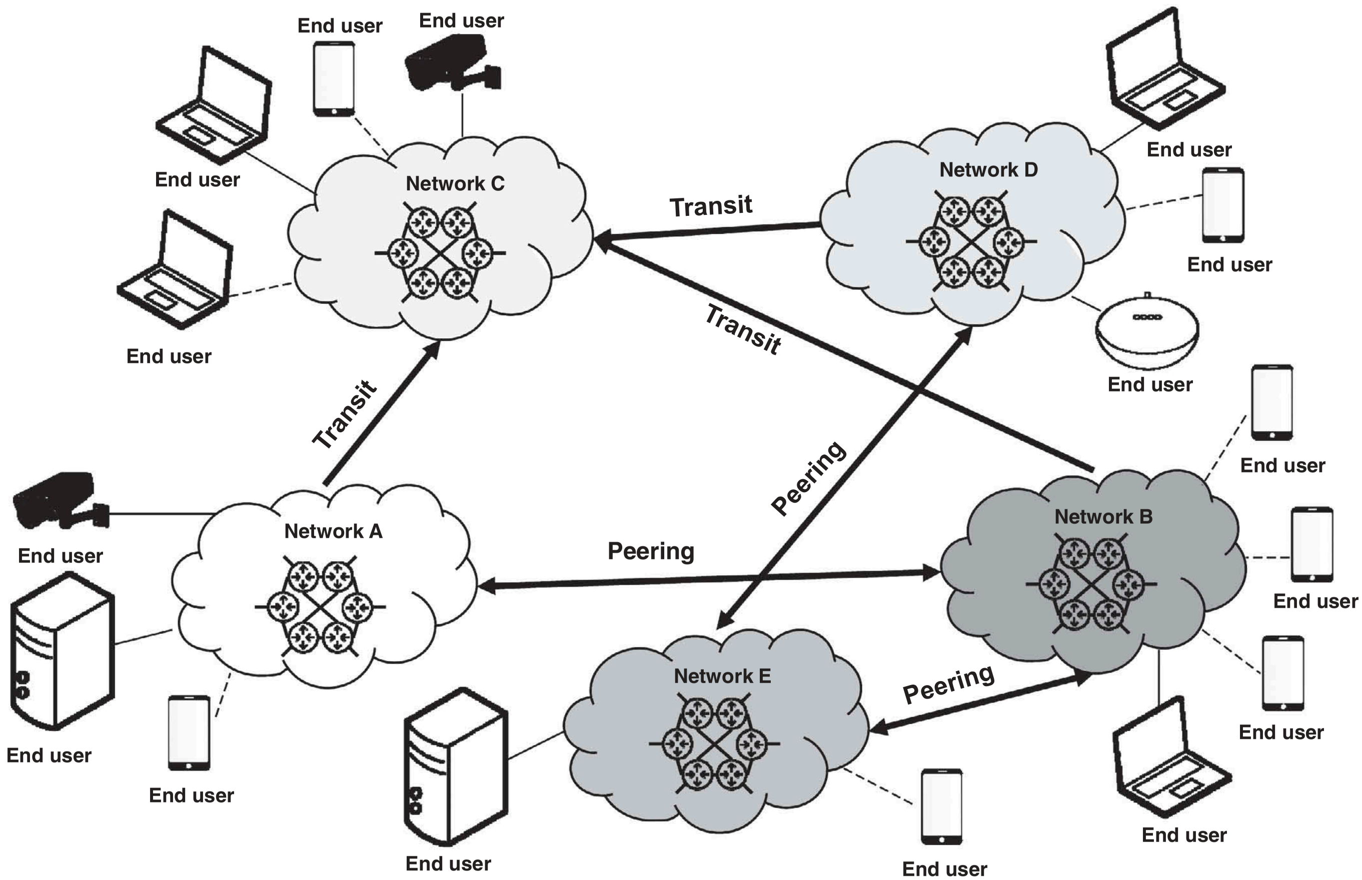

FIGURE 11.3 Example of network interconnection with peering and transit agreements. Analyzing Network A, it is possible to see that it has access to data from Network B directly via peering agreement and can reach data from Network D through Network C via transit agreement. When looking at Network E, we see that it has access to networks B and D, via a peering agreement. However, Network E cannot access data from Network C and A, since it has no transit agreement that allows this interconnection.

Although the price of transit has dropped in recent years, it is still more financially and strategically advantageous to connect via peering. Internet Exchange Points (IXPs) were created to facilitate traffic exchange between multiple networks, rather than on a bilateral basis, as well as to make the exchange more efficient. IXPs have been growing in many regions of the world and have become one of the centres of power at the interconnection level that can be clearly identified with a polycentric lens. According to the Internet Exchange Federation (IX-F), an IXP is a network facility that enables the interconnection of more than two independent Autonomous Systems, primarily for the purpose of facilitating the exchange of Internet traffic. At this point, it is important to make a distinction between Internet Exchanges (also known as peering) from bilateral network interconnection, in which one network connects directly to another. In an IXP there are numerous participants interconnected (at least three) and the data traffic passing between any pair of participating Autonomous Systems is not required to pass through any third Autonomous System, nor does the IXP alter or otherwise interfere with such traffic (Internet Exchange Federation n.d.). Figure 11.4 displays an example of network interconnection through an IXP. According to Figure 11.4, networks A, B, C, and D can access data from each other directly via IXP. However, only Network B can access data from Network E, since E is not connected to the IXP and only has a peering agreement with Network B.

Another key aspect of interconnection has to do with sharing routing tables. Interconnection means not only having physical infrastructures connected through cables or other physical media, but "logical connection" between networks. This means that network actors need to be aware of the routes that can be used to reach other networks. It is in this context that the Border Gateway Protocol (BGP) has an important role. In the RFC 1771, Rekhter and Li (1995) say that the primary function of the BGP is the exchange of network reachability information with other BGP systems. The shared information contains the list of ASes (the numbers for the networks) that reachability information traverses. Basically, it could be seen as a map of the connections among ASes, since each AS is not connected to all others and depends on the collaboration of other ASes to send and receive information to those that do not have a direct connection. It means that a connection exists between two ASes when there is a physical connection and/or a BGP connection among them (Rekhter and Gross 1995).

Having laid out the basics of interconnectivity it is now essential to note the paradigm shift in Internet interconnection. The open and public Internet as an open platform in which resources are publicly shared and permissionless innovation is fostered has gradually been supplanted by proprietary (or closed) and private networks dominated by large private cloud ecosystems, operated by a few big tech companies and an array of providers offering non-public connectivity services (Stocker et al. 2021). There remains a more public Internet, which uses interconnection mechanisms such as peering and transit, also relying on the use of IXPs, and is connected to the more private Internet, in which the

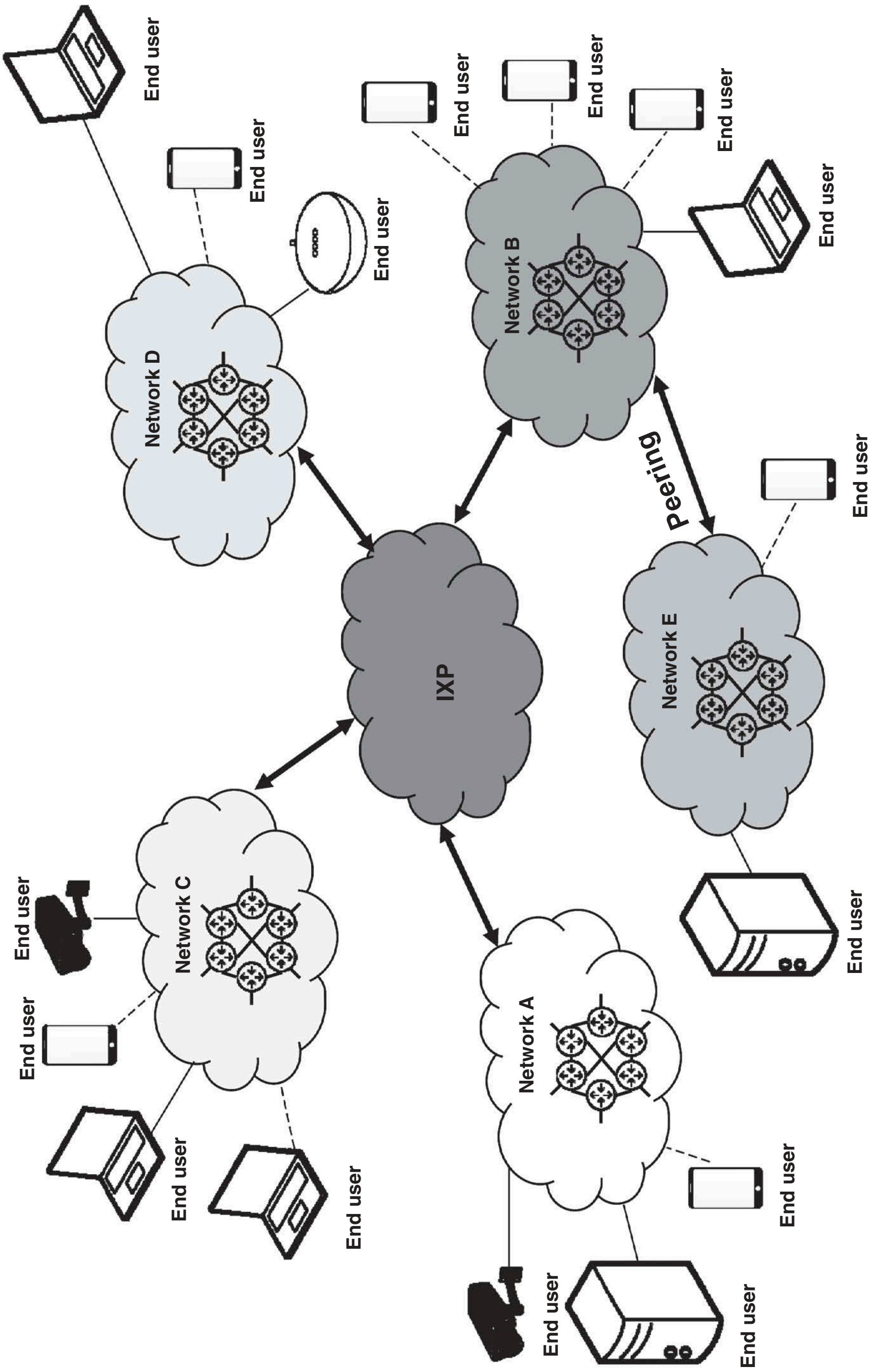

FIGURE 11.4 Network interconnection through IXP.

data distribution occurs within closed or internal networks with the massive use of Content Delivery Networks (CDNs). This paradigm shift is of vital importance for polycentric approaches in data governance as it entails a growing concentration of power centres.

CDNs have emerged to deploy and distribute data once static content is developed, such as videos (Kende et al. 2021). Cloudflare, one of the better-known companies to offer CDN, provides a service defined as "a geographically distributed group of servers which work together to provide fast delivery of Internet content" all allowing for a quick transfer of assets needed for loading Internet content including pages, images, and videos (Cloudflare n.d.). CDNs are used as a means to improve website load times, reduce bandwidth costs to content and application providers, increase content availability and redundancy, as well as to improve website security. Commonly, there are two main types of CDN: they can be independent players who distribute content (data) of other companies, and the largest content providers who develop CDNs to deliver their own content (Kende et al. 2021).

With content being closer to end users, there is a reduction in the distance data needs to travel physically between endpoints, which is manifested in fewer network borders (hops) that need to be crossed on the public Internet. There is also a growing phenomenon that are zero-hop and one-hop networks. In zero-hop scenarios, servers are deployed within networks where they terminate traffic to end users. For example, the CDN servers in this scenario are on the Internet Service Providers' own networks, allowing users to have direct access to the content. In one-hop scenarios, two networks are directly interconnected and exchange traffic. In this scenario, CDN companies are located close to the main Internet Service Providers (ISPs) and have direct interconnection with them, either through peering agreements or by being connected to IXPs (Stocker et al. 2021). Figure 11.5 illustrates the use of CDN in network interconnection. As we can see in Figure 11.5, Network A is a zero-hop network, having a CDN inside its own network, while Networks B, C, and D are one-hop networks.

Analyzing the aspects of Internet interconnection, through peering, transit, IXPs, and CDNs, it becomes possible to identify the ways that data governance takes place through the coordination of different centres of power that affect interconnection arrangements. Three cases where data governance is exercised by Internet interconnection will be explored in depth below.

The first case is of the initial IXP in Mexico. This illustrates the various challenges to the operation and the motivation for large ISPs around the world to connect to an IXP (Rosa 2021). Large ISPs generally sell data transit to smaller providers and, for them, participation in an IXP is meaningless, as they will lose an income stream by peering for free to these same networks. To force the connection of large ISPs to the IXP, Mexico enacted legislation. As a result, Mexico's largest ISP, Telmex, physically connected to the IXP in 2019. Yet, until now, Telmex has not activated the logical part of the connection, the BGP session for exchanging information about routes. The company justifies this

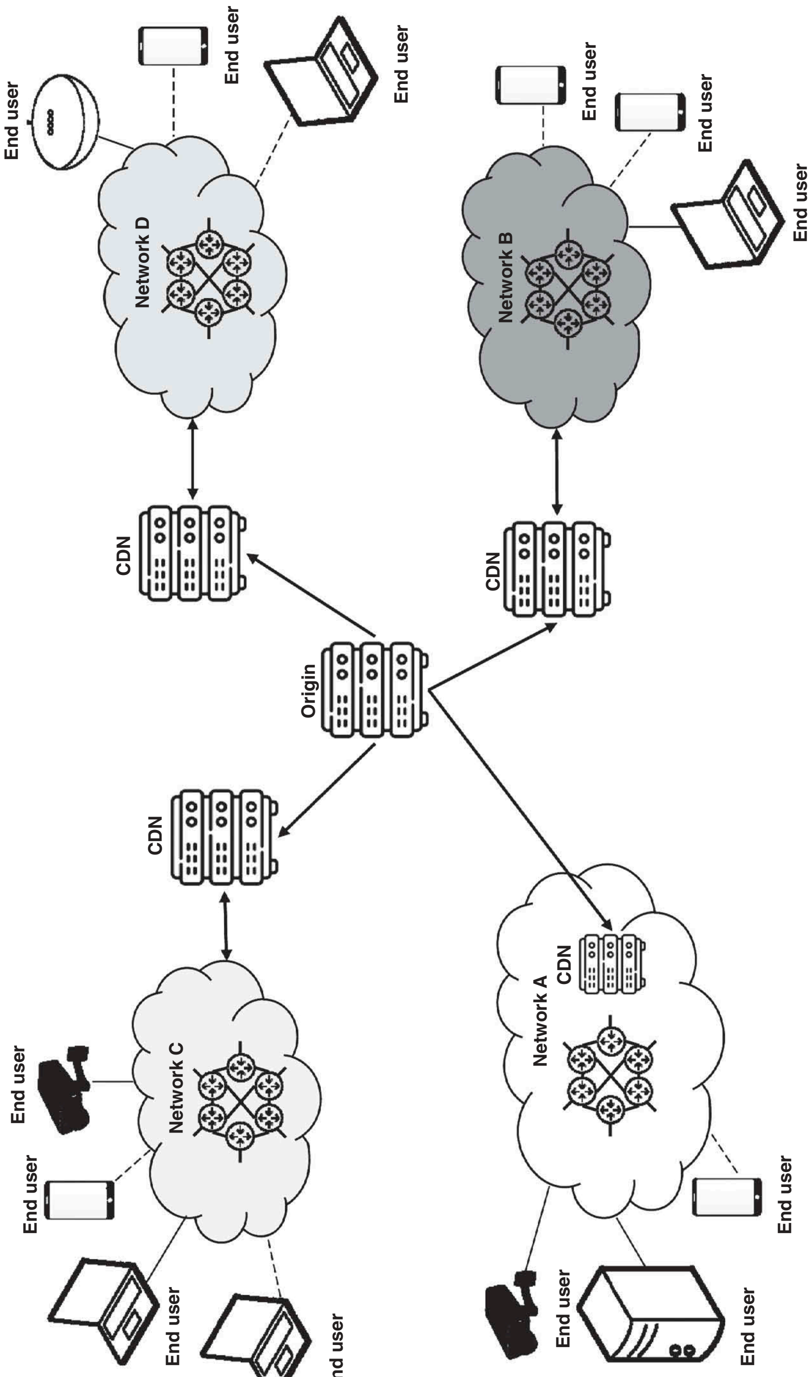

FIGURE 11.5 Network with CDN infrastructure.

lack of information exchange at the IXP for not having the route tables, since formally it is another company from the same economic group that has these tables, but does not have a license to operate in the telecommunications market. The logic is that IXP affects the population in that area, and the fewer the operators in the exchange, the smaller the network effects that this exchange can enable. Thus, participation in an IXP can be considered a form of polycentric data governance by Internet interconnection, as it influences the flow of data in the network.

A second case illustrating data governance by Internet interconnection is the use of CDNs. As discussed earlier, there are CDNs that are placed internally on the ISPs' networks as well as other CDNs that have their own networks and connect to the larger ISPs usually through a peering agreement. It remains difficult for small ISPs to participate in this type of arrangement, as large CDNs are not interested in hosting their servers on these networks or in making a peering agreement with them. Another difficulty for ISPs operating in regions where CDNs have no commercial interest in establishing their servers is that small providers end up depending on transit offered commercially by large ISPs to access the CDNs' content that is hosted on their networks or with which they have peering. In some cases, CDNs are able to connect to the largest IXPs in the country or region in which the most important ISPs may be connected. This tends to increase the operational cost of these small operators in addition to the tendency to increase the number of hops needed to reach the content, which increases the load time of content and becomes a competitive disadvantage. One solution to this scenario is shown by the NIC.br OpenCDN initiative. Through this project, CDNs have incentives to make their content available in different IXPs in Brazil. The initiative offers space in a data centre for hosting their servers, Internet traffic, and connection to the biggest Brazilian IXP in São Paulo to feed the caches, as well as connection to the IXP from several locations so that they can distribute their content locally. Local ISPs are offered the possibility to obtain the content of the largest CDNs on the local IXPs, through the provision of connectivity to the participating CDNs (OpenCDN.br n.d.).

A third example of data governance by Internet interconnection is linked with routing security. As explained earlier, BGP is responsible for sharing information related to routes, a mechanism known as 'routing announcement'. Routing announcements are statements passed from one network operator's routers to other operators' routers using BGP and contain the Autonomous System Number (ASN), a number that uniquely identifies the network, and the IP addresses associated with that network. BGP is susceptible to errors and security attacks because these announcements are highly distributed and decentralized. These problems can be caused by the intentional publication of false information about origin IP addresses or by configuration errors in routers. They happen partly because the BGP protocol does not intrinsically validate route information. With this, over time, different solutions were thought of to mitigate these problems, but without losing the flexibility and autonomy of a distributed data governance model. One of the oldest and most widely used solutions is Internet Routing Registries (IRRs), a set of databases in which network operators voluntarily share their routing policy information – including operator contact, ASN, and route – in a semi-standardized format based on the Routing Policy Specification Language (RPSL). The information published in IRRs can be used by operators to validate some route announcements and to discard others that are invalid. But there are several problems with IRRs (Kuerbis and Mueller 2017), such as the issue of encouraging the maintenance of updated information, the difficulty of verifying the authenticity and accuracy of the routing data, and the possibility of a unilateral change in the data by an operator may have undesirable and unexpected operational consequences for other networks. Kuerbis and Mueller also compare IRRs to other methods of governing routing data in a way that enhances Internet security, such as BGPSEC, the Resource Public Key Infrastructure (RPKI), and the Mutually Agreed Norms for Routing Security (MANRS). In general, the way networks engage in sharing and updating route information in IRRs or even using these other current methods is a form of data governance by interconnection.

As these three cases highlight, data governance by Internet interconnection takes place in polycentric ways. From the choice to connect and how this interconnection takes place (peering, transit, IXP), through to the use of CDNs and arriving at issues such as the quality and reliability of the information shared by the networks in this interconnection, there are multiple actors and centres of decision-making. The next section will elaborate on the polycentric modes of governance by interconnection. Table 11.1 gives a summary of data governance strategies and practices.

Polycentric Data Governance by Internet Interconnection

Polycentricity is useful for explaining and understanding data governance by Internet interconnection. As detailed in Chapter 3 of this volume, global polycentric governance is not tied up with any one geographical area but occurs in interactions of agencies at regional, national, and local levels defined as trans-scalarity. There are combinations of governmental, commercial, and civil society actors, sometimes acting together in a 'multi-stakeholder' institution, which is especially true in the case of Internet governance where the feature of

TABLE 11.1 Summary of data governance strategies and practices

<table>
<tr><th>Strategies to Interconnect</th><th>Interconnection Practices</th></tr>
<tr><td>Peering</td><td rowspan="4">BGP/BGPSEC,
IRR, RPKI,
MANRS</td></tr>
<tr><td>Transit</td></tr>
<tr><td>IXP</td></tr>
<tr><td>CDN</td></tr>
</table>

trans-sectorality is present. Data governance by interconnection is highly changeable over time with "continual arrivals of new regulatory bodies, as well as frequent adjustments to the structures and mandates of existing institutions" (Scholte 2017). Polycentric governance involves multiple agencies claiming competence over a given regulatory situation, which illustrates the overlapping mandates and jurisdictions. The precedence among regulatory bodies is also often not very clear, leading to contestable lines of command between those institutions and ad hoc arrangements to reconcile ambiguous hierarchies. Not only that: polycentric governance lacks an ultimate decision point, which further illustrates data governance by interconnection as Table 11.2 summarizes.

Despite the apparent disorder in polycentricity, Koinova et al. (2021) argue that norms, micro-patterns of practice, and macro-frameworks of social structure generate governance effects which make polycentricity work. Scholte (2021) reflects that polycentric governance contains three different layers of structure to ordering dynamics in this context: norms, practices, and underlying orders. Each layer of structure will now be explored in turn.

Polycentric Data Norms

Koinova et al. (2021) argue that "norms are general articulated principles that inform the process of governing". Some examples of norms are democracy, economic growth, gender equality, human rights, peace, rule of law, sovereignty, sustainable development, transparency, and accountability (Koinova et al. 2021).

TABLE 11.2 Polycentric attributes and Internet interconnection

General Attributes of Polycentric Governance	*Specific Attributes in Data governance by Internet Interconnection*
Trans-scalarity	Not confined to any one geographical area; interactions of agencies at global, regional, country, and local levels.
Trans-sectorality	Different stakeholders across spheres of activity, such as companies (ISPs, telecommunication companies, CDNs), government, technical community, and civil society.
Diffusion	No central decision-making point in a diffusion in different bodies for sharing and maintaining route information in IRRs as well as in the peering and transit policies among networks.
Fluidity	International, regional, and national bodies that have been stable for several years without major adjustments or the creation of new bodies.
Overlapping mandates	Numerous private entities, such as IXPs and CDNs, and others are not formally constituted, having only a community character.
Ambiguous hierarchies	No clear precedence among the various actors.
Absence of a final arbiter	While in some countries there is regulation that ends up imposing a national final arbitrator, such as the Mexican case mentioned above, this is largely not the case around the world.

A key norm guiding polycentric data governance by interconnection is economic growth. One of the commonly agreed goals is to encourage market competition even if, in the case of Internet interconnection, not everything can be based on competition. When looking specifically at IXPs, routing policies, and CDNs, the norm of growth is disputed. On the one hand, there is a need for the growth of non-market collaboration between networks, even among those that compete for the same market. This means both sharing data of the most up-to-date routes possible between networks, as well as having routing policies that favor peering relationships, usually with no cost, especially between market-dominant and small networks. On the other hand, there is little incentive for the biggest companies to be collaborative, such as peering with smaller networks or participating in IXPs, since they prefer to keep a paid transit relationship instead of free peering.

A related norm usually overlooked when talking about Internet interconnection is the rule of law. While there is a common conception that there are only formal laws and regulations in countries considered authoritarian and/or with a non-free economy, there are several countries considered democratic and free market that do have some regulation to encourage the interconnection of networks, with the goal of maintaining competition in this market. Meier-Hahn (2016) surveyed internet interconnection professionals and found that nine out of ten existing regulations have been encountered by more than half of these actors (see also Rosa 2021).

Polycentric Data Practices

The second type of structure in a polycentric mode of governance concerns practices. Practices are what people do either tacitly or unconsciously. Koinova et al. (2021) classify practices in four dimensions. The first, comprising routines, words, phrases, and narratives, takes on discursive dimensions. The second is referred to as behavioral dimensions and is related to routine forms of bodily interaction. Third, material dimensions have objects as common reference points for a polycentric governing complex. The last one is generally referred to as institutional dimensions of practice and covers the ways in which organizations build and execute their policy processes.

The first discursive dimension of practices refers to the same elements present in Internet governance in general, such as the use of acronyms, the issue of bottom-up multistakeholder participation, and shared insider jokes, among others. Thinking about governance arenas at an international level more related to interconnection, there are several informal groups known as NOGs (Internet Operators Groups), which bring a sense of community to professionals working in the area (Meier-Hahn 2017). In this context, there is a discourse linked to this idea of community, for example, the sharing of good practices associated with routing, as is the case with MANRS. Other ideas that appear commonly in the discourse have to do with the fact that the more interconnections a network has, the better it is for the Internet as a whole, just as the more networks connected in an IXP, the more robust and sustainable is that IXP. Related to the IXPs there is also a discourse that they are neutral points for traffic exchange, and that they do not interfere with traffic.

The behavioral dimension of practices presents a certain ambiguity in bodies involved with data governance by Internet interconnection. Several spaces have the same dress code (more casual) and forms of deliberation that are predominantly observed in the Internet governance field in general. The NOGs have mailing lists for exchanging experiences, organize technical events with related topics, and have working groups that produce and share reports of best practices on routing and interconnection. These groups do not have the power to decide which protocols will be used in the interconnections or which policies will be adopted by individual networks, but they serve as a forum that brings together people from different networks in various regions, especially those responsible for the technical implementation of policies. There are also nodes of this network of governance bodies in which different behaviors are presented, especially when analyzing Internet interconnection in its regulatory approach. In these spaces, there is a much greater formalism, which is exemplified both in the dress code and in the forms of deliberation themselves (such as proposals and votes on laws by legislators).

There is further ambiguity in the third material dimension of governance by Internet interconnection. These arenas lack materials that are commonly distributed in other Internet governance bodies as well as in NOG meetings, such as t-shirts, tote bags, stickers, pins, and other freebies. This contrast may be explained by the fact that the Internet interconnection field rarely brings in new players, so there is less need to integrate newcomers into the community. There is still a large adherence to the use of open source or free tools. For example, for communication between the participants of a NOG, the use of mailing lists is very common. Even for the implementation of network management, several open tools are widely used. Regulatory bodies prefer to use their own solutions or those in which they may have greater control or sovereignty in relation to data. For example, some countries develop specific or customized platforms for their purpose. These practices tend to be in line with other Internet governance spaces, such as ICANN and the IGF.

The fourth institutional dimension of practices is strongly influenced by the multistakeholder discussion and presents further ambiguity in data governance by interconnection. As in other Internet governance bodies, those in which Internet interconnection debates take place end up presenting similar bureaucratic layouts, with executive boards, secretariats, and working groups. Normally, participation in these instances takes place as voluntary work on behalf of the community. Even in this context, there is no central coordination or "control" body that aggregates all the existing routes on the Internet. As discussed earlier, there are several IRRs operated by different institutions (such as private organizations, including those that offer Internet connection services, in addition to the Regional Internet Registries) as a voluntary mechanism that can be more or less reliable in the recorded data (Kuerbis and Mueller 2017). On the other hand, when analyzing the regulatory bodies around the world, they generally do not have the same structures as the other bodies of Internet governance. Nevertheless, in some countries, there is an attempt by the regulatory bodies to emulate multistakeholderism through the creation of working groups and committees with external experts serving a multistakeholder distribution, similar to those observed in other bodies.

Polycentric Data Underlying Orders

The third layer of structure in polycentric governance, underlying orders, is systemic, permeating all locations and connections in a polycentric regime. Scholte (2021) notes key aspects such as the hegemonic leadership of the leading government, capitalism, and techno-rationalism as underlying orders that permeate Internet governance.

There is an embedded view that Internet governance should be something done by private entities, with the least possible interference from national states, as it could lead to a scenario of "less efficiency", understood in this case as a network with fewer interconnections (ten Oever 2021). This reasoning can also be extended to data governance by interconnection. In relation to capitalism, it has also shaped much of what data governance is today. In addition to the points cited by Scholte in relation to commodification and surplus accumulation, there is also the private ownership of the means of production and the need for competitive markets. These characteristics are related to Internet interconnection since the vast majority of the networks are private entities and, since they have the prerogative to implement their interconnection and routing policies as they wish, one of the biggest concerns in this area is the guarantee of competition, through the interconnection access for small networks. Reflecting on the issue of techno-rationalism in the Internet interconnection debate, there is an ambiguity. On the one hand, this issue is manifested in the discourse on the existence of fundamental properties of the Internet, which comes from this vision of problem-solving through technology. However, Internet interconnection ends up taking a regulatory approach in many countries, in a way, from an assumption that technology alone is not addressing existing problems. This foregrounds that there are many centres of power addressing interconnection issues, some of them closer between them and with other Internet governance processes, others more detached and external to other Internet governance issues but that emerge as traditional centres of authority and power.

Conclusion

Internet interconnection is not an indirect influence on, but rather central to Internet governance and data governance more generally. Polycentric theorizing brings in a more nuanced lens to the different actors and mechanisms involved in the deployment of this interconnection. It helps point to and make sense of complex, varied, and fluid arrangements involving not only different actors but also technological practices. Whether networks connect through peering or transit, whether the largest ISPs participate in local IXPs, whether or not networks update routing information in IRRs or whether or not they have agreements with CDNs are some examples of how global data governance by Internet interconnection is done. As pointed out by Musiani (2013) in relation to Internet governance, data governance by interconnection is more difficult to unravel through institutional and governmental negotiation.

Future research on global data governance must consider the continually changing nature of Internet interconnection. In particular, studies must trace how the Internet has increasingly become a closed network dominated by a few companies operating large private cloud ecosystems, with particular emphasis on the growing role of CDNs in this scenario. In the same direction, the usual mechanisms of peering and transit, as well as the IXPs, have been confronted with the reality of zero-hop and one-hop networks, which end up diminishing the importance of these mechanisms and of the public Internet itself. The increasingly less distributed, decentralized, and collaborative data governance by Internet interconnection needs to be studied and linked with needs for collaboration between multiple networks and a potential shift in forms of doing data governance.

This chapter has highlighted the analytical usefulness of exploring data governance by Internet interconnection through the characteristics of the polycentric governance, such as trans-scalarity, trans-sectorality, diffusion, overlapping mandates, and ambiguous hierarchies. While polycentric governance is important to highlight underlooked aspects of data governance at the interconnection level, it may not sufficiently explain the whole phenomenon. As such further studies are needed to build on polycentricity with other concepts and theoretical approaches in order to better understand the global data governance by Internet interconnection. How can polycentric data governance thrive at the interconnection level of the Internet is still not only a theoretical but a policy issue to be pursued.

Acknowledgements

I gratefully acknowledge the support of the Alexander von Humboldt Foundation that, through the German Chancellor Fellowship program, made the present study possible. Also, I acknowledge the Centre for Global Cooperation Research at the University of Duisburg-Essen for hosting me during my fellowship time, as well as the volume editors for their feedback on earlier versions of this chapter. A special acknowledgment goes to Carolina Aguerre and Malcolm Campbell-Verduyn for their very kind contributions and insights.

References

Abraham, R., vom Brocke, J. and Schneider, J. (2019). Data Governance: A Conceptual Framework, Structured Review, and Research Agenda, *International Journal of Information Management (IJIM)*, 49, 424–438 (ABDC: A; ABS: 2; VHB: C; ISI: 4.713).

Cloudflare (n.d.). *What is a CDN? How do CDNs work?*, (https://www.cloudflare.com/learning/cdn/what-is-a-cdn/), accessed 11 Feb. 2022.

Couldry, N. and Mejias, U. A. (2019). Data Colonialism: Rethinking Big Data's Relation to the Contemporary Subject, *Television & New Media*, 20 (4), 336–349. doi:10.1177/1527476418796632.

DeNardis, L. and Musiani F. (2016). 'Governance by Infrastructure'. In *The Turn to Infrastructure in Internet Governance*, edited by D. L. Musiana, D. L. Cogburn, & N. S. Levinson, 3–21. Palgrave Macmillan.

Internet Exchange Federation (n.d.). *Definition of an Internet Exchange Point*, (http://www.ix-f.net/ixp-definition.html), accessed 11 Feb. 2022.

Kende, M., Kvalbein, A., Allford J. and Abecassis D. (2021). *Study on the Internet's Technical Success Factors*, Report for APNIC and LACNIC, Analysis Mason (https://report.analysysmason.com/internet_success_factors/#internet-study), accessed 11 Feb. 2022.

Koinova, M., Deloffre, M. Z., Gadinger, F., Mencutek, Z. S., Scholte, J. A., Steffek, J. (2021). It's Ordered Chaos: What Really Makes Polycentrism Work, *International Studies Review*, 23 (4), 1988–2018.

Kuerbis, B. and Mueller, M. (2017). Internet Routing Registries, Data Governance, and Security, *Journal of Cyber Policy*, 2 (1), 64–81. doi:10.1080/23738871.2017.1295092.

Meier-Hahn, U. (2016). *Exploring the Regulatory Conditions of Internet Interconnection – A Survey Among Internet Interconnection Professionals*. HIIG Discussion Paper Series No. 2016–03. http://dx.doi.org/10.2139/ssrn.2740312.

Meier-Hahn, U. (2017). When Internet Interconnection Trouble Occurs, Immediate Coordination Kicks In, *Internet Policy Review* (https://policyreview.info/articles/news/when-internet-interconnection-trouble-occurs-immediate-coordination-kicks/713), accessed 11 Feb. 2022.

Musiani, F. (2013). Network Architecture as Internet Governance, *Internet Policy Review*, 2 (4). https://doi.org/10.14763/2013.4.208.

OpenCDN.br (n.d.). *About OpenCDN* (https://opencdn.nic.br/en/about/.), accessed 11 Feb. 2022.

Rekhter, Y. and Gross, P. (1995). *Application of the Border Gateway Protocol in the Internet*, Request for Comments – RFC 1772, Internet Engineering Task Force (https://tools.ietf.org/html/rfc1772), accessed 11 Feb. 2022.

Rekhter, Y. and Li, T. (1995). *A Border Gateway Protocol 4 (BGP-4)*, Request for Comments – RFC 1771, Internet Engineering Task Force (https://tools.ietf.org/html/rfc1771), accessed 11 Feb. 2022.

Rosa, F. R. (2021). Internet Interconnection Infrastructure: Lessons from the Global South, *Internet Policy Review*, 10 (4). https://doi.org/10.14763/2021.4.1583.

Sacks, S., and Sherman, J. (2019). *Global Data Governance. Concepts, Obstacles, and Prospects*. New America Foundation.

Scholte, Jan Aart. (2017). 'Polycentrism and Democracy in Internet Governance'. In *The Net and the Nation State: Multidisciplinary Perspectives on Internet Governance*, edited by Uta Kohl, 165–184. Cambridge: Cambridge University Press.

Stocker, V., Knieps, G. and Dietzel, C. (2021). The Rise and Evolution of Clouds and Private Networks – Internet Interconnection, Ecosystem Fragmentation. TPRC49: The

49th Research Conference on Communication, Information and Internet Policy. http://dx.doi.org/10.2139/ssrn.3910108.

ten Oever, N. (2021). 'The Metagovernance of Internet Governance'. In *Power and Authority in Internet Governance*, edited by B. Haggart, N. Tusikov, & J. A. Scholte, 56–75. London: Routledge.

van Eeten, M. and Mueller, M. (2013). Where Is the Governance in Internet Governance?, *New Media & Society*, 15 (5), 720–736.