

Shaping the Internet: practices that restrict users' informational access

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1. Objectives of the research

The Internet was idealized in its original conception as an open, decentralized, and generic purpose communications platform. These fundamentals allowed users to create, use and disseminate content of their free choice without the interference of intermediaries, reducing barriers to access information and knowledge.

However, since the beginning of the 21st century, there has been increasing use of traffic management practices that have provided Internet Service Providers (ISPs) with an unprecedented ability to monitor, classify, modify, degrade, and prioritize Internet traffic in real-time. More recently, with the evolution to the 5th generation of mobile communications systems (5G), the network slicing feature arose with the potential to associate critical resources in the physical infrastructure to selected users, services, or applications.

In this context, it becomes necessary to problematize the extent of the interference ISPs can exert to limit the access and circulation of information on the Internet and the solutions found by states to regulate this reality.

Therefore, the primary objectives of the proposed research are the following:

Ob1. Characterize practices that ISPs commonly use to discriminate Internet traffic.

Ob2. Analyze state regulations established to discipline these practices.

Ob3. Discuss the net neutrality principle and its influence on users' digital connectivity.

Ob4. Propose a regulatory framework that allows the coexistence of the 5G network slicing and the net neutrality principle.

From the pursuit of these objectives, two potential original contributions are expected to be delivered:

C1. A comparative analysis of state regulations established to discipline ISPs' practices that restrict the access of Internet users to applications, services, and legal content.

C2. A proposal of a regulatory framework that will enable the coexistence of network slicing and the net neutrality principle.

It is essential to disclose that traffic discrimination can have a distinct impact on the informational access of Internet users. For this reason, a comparative analysis will feature how states have handled these ISPs' practices, and an integrated framework proposal will make feasible the relationship between net neutrality and network slicing, which are concepts that point to opposite directions.

2. Review of the state of the art

The nature of network traffic management policies has changed significantly in the last two decades. The prospect of a best-effort-based routing has been replaced by a growing need for enhanced QoS to sustain the exponential growth in Internet traffic¹, due to bandwidth-hungry multimedia applications and the widespread adoption of intelligent devices, that have led ISPs to adopt strategies to differentiate the traffic on the Internet. Garret et al. (2018) also identify as motivations to discriminate specific types of traffic over others the pursuit of competitive advantages and the need to expand market share and add value to services, with the possibility of increasing profitability from both end-users and content providers.

To Molavi Kakhki et al. (2015), the concept of traffic differentiation is related to managing scarce network resources in order to provide better or worse performance to certain classes of Internet traffic. Finnie (2009) emphasizes that ISP traffic management technologies have improved in a way that allows fine-grained distinction among the digital content transported over IP networks, enabling discrimination to reach the end-user level. That is one of the reasons why Jordan and Ghost (2010) assert that traffic management practices of ISPs have become an issue of public concern.

Garret et al. (2018) note that traffic differentiation is applied to prioritize, degrade or block specific types of Internet traffic and can be based on protocol, origin, destination, payload, packet size, bandwidth, among others. The authors systematize the differentiation mechanism in four categories, according to how they affect the traffic, as shown in figure 1.

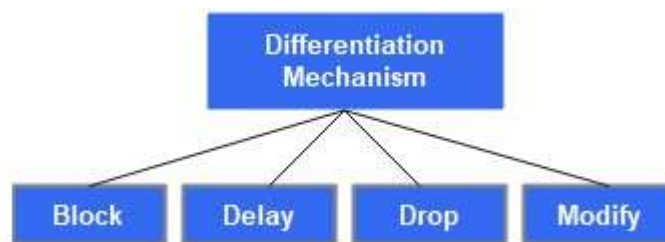


Figure 1. Traffic differentiation (Adapted from Garret et al. 2018)

The detection of traffic differentiation by ISPs has drawn significant attention among the scientific community for over ten years. One of the first studies was conducted by Beverly et al. (2007), which measured the blocking of traffic belonging to a particular application or class

¹ According to International Telecommunication Union estimates, the traffic on the mobile network will grow at an annual rate of 55% until 2030, which will represent an increase of more than 8.000% in ten years (ITU, 2015a).

of applications in their assigned TCP or UDP port. Zhang et al. (2009) developed NetPolice as a system to verify traffic differentiation in backbone ISPs by taking loss measurements from end hosts. Li et al. (2009) presented a user-level tool called POPI to detect packet forwarding prioritization in routers through an end-to-end measurement. Dischinger et al. (2010) proposed Glasnost to identify whether the ISP was performing application-specific traffic shaping of Internet users. Through DiffProbe, Kanuparth and Dovrolis (2010) focus on delay discrimination and loss discrimination by comparing latency and packet loss between exposed and control traffic. Li et al. (2019) address the impact of content-based traffic differentiation practices, deployed in operational mobile networks, by conducting a large-scale study that detected fixed-rate bandwidth limits as the most observed conduct.

These actions can interfere with the flow of information and compromise the open and decentralized character of the Internet, impacting the users' broad and unrestricted access to content in the digital ecosystem. It is important to point out that under the aegis of a regime in which net neutrality prevails, ISP discriminatory practices can only occur in exceptional circumstances, such as preserving the integrity of the network or congestion resolution, and should be done in a reasonable manner, to the benefit of the network and its users as a whole.

In this context, in an effort to establish a theoretical background and identify research opportunities, it was necessary to segment this section into three subsections. The first one characterizes the restrictive practices of ISPs. The following subsection reveals the arguments about the potential conflict between network slicing and the net neutrality principle. At last, the third subsection presents the regulatory frameworks established by states for the isonomic and non-discriminatory treatment of Internet traffic.

2.1 ISPs' restrictive practices

Among the practices resulting from traffic differentiation, the proposed investigation will focus on the following ones: blocking, throttling, paid prioritization, filtering, and zero-rating.

Blocking is a practice that prevents the user from accessing certain content, application, or service made available on the Internet, which happens through software or hardware located at a specific control point of data traffic in the network (Hall et al. 2020). Callanam et al. (2009) point out that blocking is not a recent practice. It started from the commercial use of the Internet in the 1990s to prevent the proliferation of spam through e-mail. Blocking strategies can be differentiated according to the amplitude at which they are implemented. From a narrower perspective, the end-user can establish blocking rules on the personal computer level. As the

range is expanded, other techniques can be employed by a company, an ISP, or even the state itself, at the national level.

Throttling is the degradation or intentional delay of Internet traffic that reduces the transmission rate in the telecommunications network. Initially conceived as a traffic management measure to handle network congestion, throttling represents a limitation on informational access when it ceases to be agnostic and is directed to a particular class of applications, such as video streaming, a specific content provider, or users with a given data consumption profile (e.g., heavy users).

Paid prioritization consists of an ISP practice that provides preferential treatment for transmitting certain data packets through financial counterparts. In essence, it is related to creating fast lanes in the network infrastructure. According to the Center for Democracy and Technology (CDT), in a letter addressed to the Federal Communications Commission (FCC), paid prioritization can be defined in the subsequent terms:

“[...] as the practice of a last-mile broadband ISP charging a fee to Internet content, applications, or service providers to deliver their content, applications, or services in an enhanced or prioritized fashion to the ISP’s subscribers over those subscribers’ last-mile facilities” (CDT 2010, 1).

ISPs employ three arguments to defend the practice of paid prioritization on the Internet. The first refers to the need to manage data traffic to avoid congestion and enable efficient network use. As a second argument, ISPs argue that, without differentiation of traffic, they will not have incentives to expand network capacity and provide a better quality of service, which could hinder the development of the Internet infrastructure. The third argument is related to the view that the market remuneration model of the Internet is not balanced, since the profitability of ISPs is maintained, as a rule, through revenue from the use of the network, while content providers receive both for the provision of services and online advertising (Wang et al. 2014).

Filtering is a practice that selectively restricts informational flow on the Internet by scanning keywords, phrases, images, or strings, which can be performed on home pages, social networks, applications, electronic messages (e-mail), executable files, among others, and can be classified into three different types: inclusive filtering, exclusive filtering, and content analysis, which can be used together to meet the intended purpose. Inclusive filtering, commonly referred to as whitelist, allows users to access content that the ISP has previously approved. Oppositely, exclusive filtering establishes a blacklist of undesirable content. Content analysis, the third type, avoids lists and focuses on the specific analysis of the requested content before allowing access by the user (Hamilton 2004; Eneman 2010). Rosenberg (2001) describes

another way to filter content on the Internet by establishing rating systems, which are value judgments attributed to websites to categorize them. While filtering prevents access to certain content by scrutinizing the transmitted information, the blocking practice denies access using the IP address, Uniform Resource Locator (URL), or Domain Name System (DNS) as a resource.

Deep packet inspection (DPI) is one of the technologies used for ISP filtering, given its ability to analyze the flow of data in real-time and make decisions on how to treat the content transported over the network. Parsons (2013) points out that DPI's ability to inspect the header and payload of datagrams gives this technology significant control over Internet users' digital communication.

Zero-rating is a commercial ISP practice that assigns gratuity in data traffic associated with certain content, application, or service available on the Internet, allowing access by end-users without the bytes transmitted being accounted for in the monthly contracted allowance (data cap). It is characterized as a differentiated pricing model in which the cost of using telecommunications infrastructure is subsidized by the ISP or content provider (Garcia e Silva 2017). This practice is only feasible in plans that limit the volume of data traffic, which restricts the content users can access on the Internet, which is why it is more frequent in mobile network operators (Marsden 2016). Kak (2015) states that zero-rating puts content previously selected by ISPs on a sort of pedestal, since they attribute a competitive advantage to the providers of these contents. For the author, by making access less expensive and more attractive to users, the market power of these companies is strengthened at the cost of excluding others competitors. However, she warns that it is not only the market power at stake, as zero-rated content also compromises the diversity of information and users' freedom of choice.

2.2 Net neutrality and network slicing

Since the beginning of the commercial use of the Internet in the 1990s, network operators, or more precisely Internet Service Providers (ISPs), have processed information flows in line with the net neutrality principle, according to which, in a neutral network, the agents responsible for the telecommunications infrastructure should not discriminate against any traffic, whether due to the nature of its content, its location, the software or hardware used, as well as the origin or destination of the packets transmitted.

Currently, the fifth generation of mobile networks (5G) implements a new concept of a flexible and programmable network that will provide the scalability necessary to process the

exponential growth of data traffic and handle the different performance requirements for an increasing heterogeneity of digital services and applications.

5G represents not only an incremental improvement of previous generations but a technological leap in terms of data transfer rates, latency, connection density, network reliability, and energy efficiency. It is based on the virtualization of radio access, transport, and core networks, to customize multiple independent logical instances in the same physical infrastructure through one of its key enablers: network slicing.

Network slicing is defined by the Next Generation Mobile Network Alliance (NGMN) as a set of network features and functions capable of running multiple independent logical networks over the same physical infrastructure (NGMN 2016). For the International Telecommunications Union (ITU), the conceptual contour of network slicing is systematized in the following terms:

“It is an end-to-end concept covering all network and cloud network segments (access, core, transport, edge). It enables the concurrent deployment of multiple logical, self-contained and independent shared or partitioned network resources and a group of network and service functions on a common infrastructure platform. Network Slicing is a management mechanism that a resource provider can use to allocate dedicated partition infrastructure resources and service functions to users” (ITU 2020, 18).

The Internet Engineering Task Force (IETF) establishes the definition of network slicing as an approach to provide an end-to-end independent logical network, from the user equipment to multiple mobile applications, where each network slice has its Service-Level Agreement (SLA), with the arrangement of specific technical parameters according to the 5G use case (Rouki et al. 2020). Nakao et al. (2017) highlight that the main characteristics of network slicing are the individualization of network resources and the programmability of these resources, which guarantee an end-to-end quality of service (QoS) for the demands of the telecommunications infrastructure.

By creating different virtual instances, network slicing configures the different technical parameters of the network to the performance requirements of each service, application, or users' domain so that the quality of the user's experience is transparent as if they were enjoying a dedicated physical infrastructure. To Chatras et al. (2017, 219), this customization of the 5G mobile network allows recognizing network slicing as "a new sophisticated form of Virtual Private Network (VPN) technology".

The potential conflict between net neutrality and network slicing is one of the main policy challenges for implementing 5G networks (Alexiadis and Shortall 2016). Nevertheless, it has not attracted many studies so far (Kantola 2019).

Frias and Martínez (2018) analyze the tensions between the current network neutrality regime in the European Union (EU) and the combination of technologies that characterize 5G, in particular network slicing. The authors conclude that much of the potential envisaged through 5G is not feasible under a vision that imposes a paradigm of neutrality, especially because 5G networks provide anything-as-a-service through the offer of customized network capabilities at the infrastructure layer, which conflicts with the net neutrality logic that assumes that the concept of service is attached to the application layer.

To Smirnova et al. (2019), tailoring network slices to specific vertical applications or services with different performance requirements cannot be executed using a best-effort logic, which raises compatibility concerns with net neutrality regulation. Therefore, the authors propose a measurement methodology for assessing traffic management practices performed via network slices that can be used to monitor the compliance of customized QoS parameters with the non-discrimination policy established in the EU. This measurement methodology utilizes the national Internet exchange points as a standard reference where quality indicators can be obtained and compared.

Alén-Savikko (2019) understands that discrimination rather than equality runs in the core of 5G networks, which indicates that net neutrality and network slicing are contradictory concepts. Although the conflict seems evident at first glance, the compatibility in their relationship may rest in the employment of the end-to-end principle in 5G architecture. The author acknowledges that assessing net neutrality in the 5G era should not be made exclusively with a technological approach. The Internet has significant economic, legal, socio-cultural, and political implications, demanding a holistic strategy to include all dimensions of this complex issue in the discussion. Therefore, the study concludes that technological determinism² must be avoided, and net neutrality as a design principle envisioned as a matter of choice in preventing the centralization and closure tendencies of the Internet.

Kantola (2019) explores the impact of the controversy between the new paradigm of virtualized networking and the EU net neutrality regulation on network providers. The author

² Technological determinism is a theory that considers technology as an independent variable that influences social dynamics and indicates the direction of political, economic, and cultural transformations. It is attributed to seminal authors of the so-called Toronto School, such as Harold Innis and Marshall McLuhan, between the 1950s and 1960s.

considers that the normative requirement of equal treatment, except for specialized services, is creating uncertainties for the 5G investment and an unlevel playing field for the European cloud service providers, especially with regard to edge computing, concluding that the net neutrality regulation established in 2015 is out of date since the best-effort service model will not be able to integrate the digital and the physical worlds effectively.

2.3 State regulations

Several authors have explored the solutions encountered by states to discipline the isonomic and non-discriminatory treatment of digital traffic on the Internet and the regulatory frameworks established for implementing net neutrality.

Setenareski (2017) made an overview of net neutrality regulations in 15 countries and the European Union, showing a substantial increase in the number of legislations since 2009. The study presents the concerns of the majority of the states in guaranteeing an open and free Internet, with particular attention given to the technical aspects of network management to avoid blocking, throttling, and prioritization of Internet traffic. The author also identifies a lack of standardization in the researched normative instruments since each country had particularities in implementing these regulations.

Nguyen et al. (2020) conducted a global survey of laws and regulations regarding net neutrality in North America, Central America, South America, Asia, and Europe, comparing how each country established the net neutrality principle, with a particular focus on the zero-rating practice. As a result, the study revealed that only 7 out of the 20 countries had implemented a ban on zero-rating. The authors also notice that there are few studies about net neutrality implementation worldwide, and they are neither complete nor up-to-date.

Steveson and Clement (2010) compare regulatory approaches to Internet traffic management practices (ITMPs) by ISPs in Japan, the European Union, and the United States to evaluate how these experiences align with Canada's first regulatory effort to address network neutrality. The analysis led to seven conclusions: lack of clear jurisdiction in ITMP regulation; transparency around ITMP use is central to consumer choice; technical ITMPs must be limited and reasonable; competition is key to ensuring reasonable ITMPs; deep packet inspection raises substantial privacy concerns; traffic shaping is typically not the first remedy applied to network congestion; ITMPs may limit innovation.

Marsden (2016) focused the analysis on mobile ISPs and the practice of zero-rating through a comparative study of implementation cases of net neutrality regulation in Brazil, Chile, India,

Norway, Netherlands, Slovenia, Canada, the United States, and the United Kingdom. From the cases studied, the author proposes a descriptive toolkit for regulators to address net neutrality concerns, addressing the following elements: 1) How to engage stakeholders; 2) How to measure neutrality; 3) How to access prior knowledge in technical advice; 3) How to regulate zero-rating.

Vargas-Leon (2016) presented a panorama of enacted legislation and specific provisions about net neutrality in South America, analyzing the particular characteristics of Brazil, Chile, Colombia, and Peru. The author indicates that even after net neutrality statutes were published, ISPs continue trying to find legal breaches to allow the discrimination of Internet traffic.

In the European Union, the net neutrality policy established in 2015, under Regulation 2015/2020, was the object of analysis of various authors. Gadringer (2020) characterized the milestones to net neutrality regulation in the EU. He explains that the outcome was a soft regulatory framework portrayed by multiple stakeholders with the necessary flexibility to adapt norms on a dynamic basis. However, the trade-off to achieve a minimum agreement on the equal treatment of Internet traffic and the ban on unjustified discrimination was to grant the right to offer specialized services and paid prioritization as exceptions to the rule. Rochel (2020) unpack the debate of what net neutrality should be about in the context of the distinct challenges of traffic management measures addressed by Regulation 2015/2120. He understands that net neutrality has become a label to identify conflict of interest among users and ISPs and should be employed to prevent unjustified discrimination. The author proposes two sets of values to sustain an interpretation of net neutrality under the EU regulation; one centered on the equal protection of individual freedoms, and another centered on the Internet as an informational ecosystem. Holznagel and Hartmann (2020) emphasize the challenge of balancing commercial interests with consumer protection and how the net neutrality policy evolved from a self-regulatory model in Europe to a more proactive role of the governments. The authors analyze the main aspects of Regulation 2015/2120, with particular attention given to zero-rating practice and media plurality, highlighting the importance of net neutrality to protect end-users' freedom of choice and the diversity of content on the Internet.

From the above description of state of the art, it becomes possible to identify research opportunities related to the characterization of traffic differentiation practices commonly used by ISPs, the analysis of how these practices influence the access of Internet users to information, an extensive view of the solutions found by states to regulate net neutrality, and the cutting-edge discussion about the coexistence of 5G network slicing and net neutrality principle.

3. Research questions

ISPs play a fundamental role in enabling the digital connectivity of individuals on the Internet since they control the last mile of the telecommunications network, acting as gatekeepers of users' access to the plurality of content made available online (Van Schewick 2010). Wu (2010) calls as master key the technical ability of ISPs to control the flow of communication on the Internet from their physical infrastructure.

By controlling the last mile, ISPs can use their privileged position to limit users' access to certain content, favoring some applications to the detriment of others (Van Schewick 2016). According to Belli (2017), ISPs also have the potential to interfere with the Internet user experience and, ultimately, with their perception of reality, since certain traffic differentiation practices are used to discriminate the digital flow and restrict users from freely searching, receiving, and transmitting information and ideas.

In this scenario, technical decisions about Internet architecture and its communication protocols act as a genuine instrument of governance, a mechanism of influence of behaviors, and a vector of regulatory compliance (Reidenberg 1998; Lessig 2006; Braman 2010; De Nardis 2012).

This reality raises informational challenges since the Internet has become the leading platform for the access, production, and dissemination of information, the emergence of new applications, and the exercise of political, social, and civil rights, which imposes a reconfiguration of relations between state, government, and society.

As a result, the research questions that this thesis will address are the following:

- Q1.** What practices do ISPs employ that discriminate the Internet traffic?
- Q2.** What is the effect of these practices on the informational access of Internet users?
- Q3.** How have states regulated these practices?
- Q4.** What is the net neutrality principle?
- Q5.** How to make net neutrality and network slicing compatible?

The connections between the proposed objectives, the research questions, and the potential contributions resulting from this thesis are illustrated in figure 2.

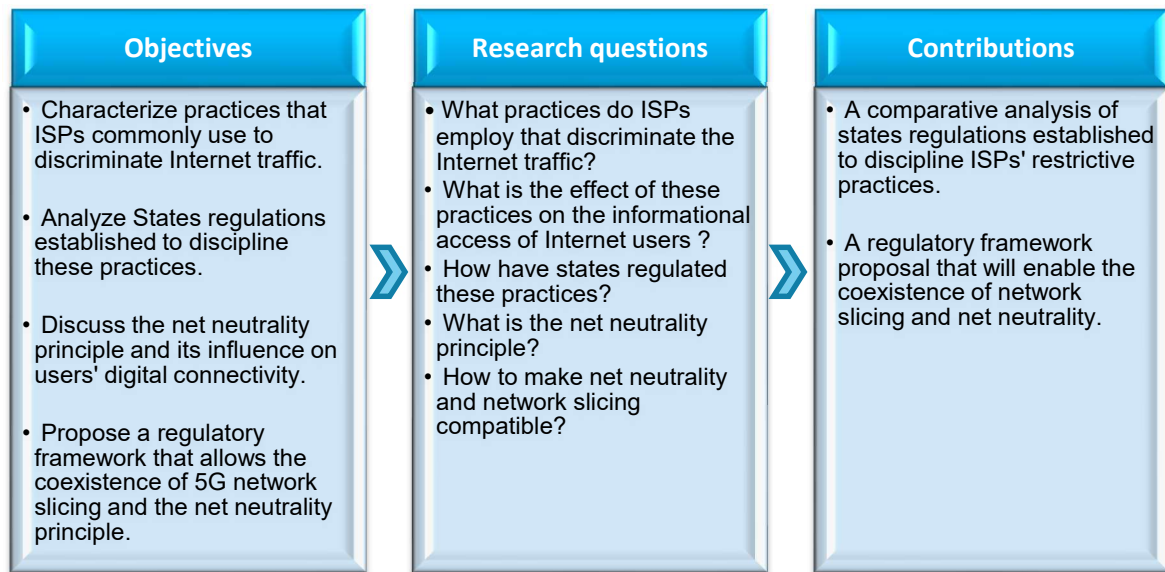


Figure 2. Thesis essential elements

4. Methodology

The methodological reference seeks to orientate and systematize the understanding of a given reality, making available to the researcher several methods that will define the trajectory traveled during the research. This decision will depend on the nature of the object, the research problem, and the theoretical lens that guides the investigation. To Goldenberg (2011, 14), this logic can be synthesized in the following manner: "what determines how to work is the problem you want to work with: you only choose the path when you know where you want to go."

Therefore, due to the essence of the proposed thematic related to the governance of the Internet, in order to achieve the defined research objectives, it will be necessary to conduct an interdisciplinary study, embodied in three dimensions of interdependent analysis, which will be structured in informational, technical, and legal perspectives, as detailed in figure 3.

Informational	Technical	Legal
ISPs practices that limit the access to information and content available in the digital ecosystem.	Aspects related to the modeling of the Internet architecture that influences the transmission of datagrams.	Laws, norms and directives that regulate practices that restrict the informational access of Internet users.

Figure 3. Dimensions of analysis

The focus of the informational dimension will be the characterization of practices imposed by ISPs that discriminate the Internet traffic, analyzing its effects on users' access to applications, services, and content.

The technical dimension will require acquiring the knowledge needed to understand how the Internet is structured and how decisions about its architecture can influence the transmission of datagrams in the global network.

The legal dimension will analyze laws, directives, court decisions, and other official documents that regulate restrictive practices of ISPs in the informational flow of the Internet. In addition to the European Union, the regulatory experiences of Argentina, Australia, Brazil, Canada, Chile, Colombia, Costa Rica, India, Israel, Japan, Mexico, New Zealand, Norway, Peru, South Africa, South Korea, Switzerland and the United States will be the object of study. These countries were selected because they already have established regulatory frameworks or are in the process of approval and implementation of normative instruments on the subject.

Combining these three dimensions will enable the configuration of a conceptual substrate that will allow understanding the interference of ISPs in the digital traffic, which impacts the informational access of Internet users.

Based on this scenario, an association of exploratory and descriptive research will be carried out with a methodological approach situated within the qualitative paradigm of investigation, using the integrative literature review and documentary research as methods to produce scientific knowledge, from which it will pursue the development of a theoretical approach that aims to describe and decode the components of a system of meanings.

Denzin and Lincoln (2006) understand that qualitative research consists of a set of practices that transform the world into a series of representations, seeking to understand or interpret the phenomena in terms of the meanings people assign to them.

Creswell (2007) highlights the interpretive nature of qualitative research and that the researcher's personal history plays an essential role in the choices made, from which filters the data through a unique lens contextualized in a specific socio-political and historical moment.

According to Minayo (2002), qualitative research answers very particular questions with a level of reality that cannot or should not be quantified, since it works with the universe of meanings, motives, aspirations, beliefs, values, and attitudes.

Therefore, it can be inferred that the qualitative approach seeks to understand complex relationships rather than explain them through the isolation of variables, making this research modality a subjective act of knowledge construction.

In this manner, the qualitative methodology becomes adequate to achieve the objectives and answer the questions established in this research proposal. The path selected is justified by the interdisciplinary nature of the discussion, which involves perspectives tangential to the fields of Information Science, Telecommunications Engineering, Informatics, Law, Public Policies, and Market Regulation.

Under the qualitative framework, the present study will employ the conjunction of integrative literature review and documentary research as methods to obtain the necessary depth to understand, from the highest level of knowledge attainable, the unfoldings that involve the practices of ISPs which restrict the flow of information on the Internet.

Traditionally used in the health area, the integrative review is a specific method that seeks to critically select and evaluate relevant research to collect and analyze data from these studies. Broome (2006) points out that the integrative review summarizes the past of empirical or theoretical literature to provide a more comprehensive understanding of a particular reality.

Torraco (2005, 356) defines the integrative review as “[...] a form of research that reviews, critiques, and synthesizes representative literature on a topic in an integrated way such that new frameworks and perspectives on the topic are generated”.

It is essential to accentuate that integrative review can also be incorporated into other areas of knowledge, considering its potential to systematize preexisting scientific knowledge and visualize possible research opportunities (Botelho 2011).

To Elsbach and Knippenberg (2020, 1), this potential is evidenced in the following terms:

[...]integrative literature reviews are among the most useful vehicles for advancing knowledge and furthering research in a topic domain. Integrative literature reviews are strongly anchored in a representative description of a field, but add new insights via a critical analysis and synthesis of the field's literature.

In order to develop an integrative review, it is necessary to observe a succession of well-defined steps detailed in figure 4.

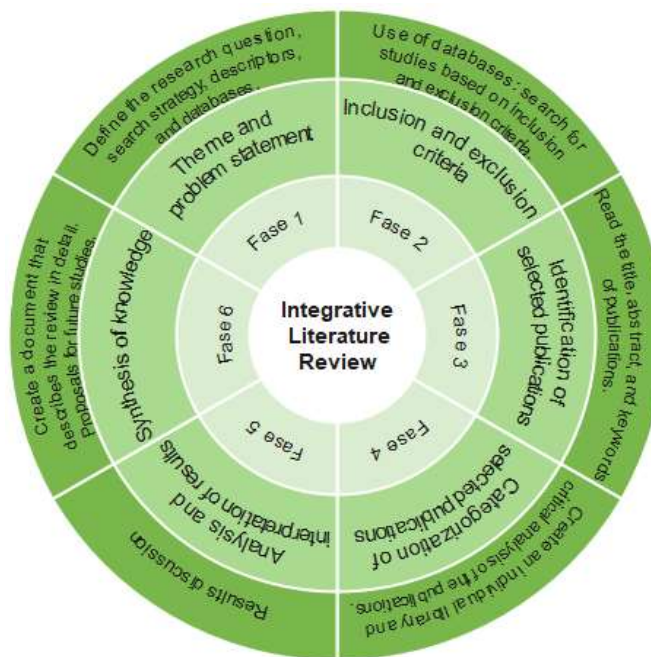


Figure 4. Phases of integrative review (Adapted from Botelho et al. 2011)

The first phase of the integrative review begins with identifying the theme and the definition of research questions, which should be transparent and objective, from which the descriptors are defined, and the search strategy is designed.

In the second phase, the inclusion and exclusion criteria are established, and the search in the database is initiated to identify the publications that will be included in the research. Broome (2006) remarks that the search movement in the literature is not always linear. The selection of articles begins more broadly, and funnels as the researcher returns to the initial research questions.

The identification of the selected studies is performed in the third phase of the integrative review. To this end, the titles, abstracts, and keywords of all publications pinpointed by the search strategy are carefully read to verify their suitability to the study's inclusion criteria.

In the fourth phase, the categorization of the selected studies will be executed to summarize and document the information extracted from the scientific articles.

In regard to documentary research, it is a method that employs technical procedures to explore and understand the content of documents of various types and obtain meaningful information to understand a specific social reality.

Sá-Silva et al. (2009) point out that the use of documents in research should be appreciated because it is a precious source for the researcher, given the significance of the information that can be extracted and retrieved to understand the object of study.

The analysis of documents in scientific research has attributes that distinguish it from bibliographic research, particularly the source used to produce knowledge. While the study of documents utilizes primary sources, which have not yet received any analytical treatment, in the bibliographic research, the sources are secondary and cover the entire repository of publications that have already been made public on a given subject.

From the conjunction of integrative review and documentary research methods, it will be possible to comprehend the impact of ISPs' practices on the informational access of Internet users and examine the regulatory solutions found by state to regulate these practices.

The research time frame will be from 2005 to 2021, that is, the last 16 years. The origin will be from the beginning of the 21st century because it coincides with the first documented records of restrictive practices by ISPs, extending to the present day, which testifies the implementation of the fifth-generation of mobile networks (5G).

The choice of databases will include publications indexed in digital databases that cover the three dimensions of analysis, specifically Scopus, Web of Science and Google Scholar. As a complement, manual searches will be carried out on the Internet Governance Forum (IGF) and European Dialogue on Internet Governance (EuroDIG) conferences websites, from 2015 to 2021, since they are reference events on topics related to the governance of the Internet.

Also, the digital repository of master's dissertations and doctoral theses that are available at the Brazilian Digital Library of Theses and Dissertations (BDTD), Plataforma RENARTES, and DART-Europe will be subject to analysis.

Laws, regulations, regulatory instruments, court decisions, and other official documents will be obtained directly from websites of government, courts of justice, and regulatory agencies.

The descriptors that will be used as inclusion criteria were defined according to the dimension of analysis, using words and expressions in english and portuguese, in consonance with the list specified in figure 5.

Informational dimension	Technical dimension	Legal dimension
Information gatekeepers; ISP blocking; blocking of digital content; Internet throttling; connection throttling; Internet filtering; information filtering; paid prioritization; fast lanes; zero-rating; network slicing; open Internet access.	End-to-end principle; best effort; quality of service; net neutrality; Internet architecture; next generation networks; software defined networking; network function virtualization; 5G network; Internet traffic differentiation.	Internet policy; open Internet; neutral Internet; Internet regulation; net neutrality regulation; net neutrality policy.

Figure 5. Definition of descriptors

5. Expected publications

The strategy for publication should consider the characteristics of the presented research proposal that has a substantial interdisciplinary approach. Accordingly, future academic work should prioritize peer-reviewed publications that address topics related to Internet governance, informational flow on digital platforms, telecommunications policy, technological convergence, net neutrality, and information policies for the Internet, in order to establish a good match between the PhD research and the interests of the journal/conference and its readership/participants.

With that in mind, it was defined as a feasible target to submit four scientific articles during the attendance of the Doctoral Program in Digital Media at FEUP/UP, that will add up to the previous bibliographic produced by the candidate in the thesis thematic.

Bibliographic production

Marques, R. M.; **Garcia e Silva, H. B.** Adeus a utopia digital da era da informação: o sonho acabou. In: Bastos, Manoel Dourado; Figueiredo, Carlos; Santos, Anderson. (Org.). 30 anos da Economia Política da Comunicação e o Brasil pós-golpe. 1ed. São Cristovão: ULEPICC, 2020, p. 95-113.

Garcia e Silva, H. B.; Marques, R. M. Falsa percepção de gratuidade: a prática do zero-rating e o Marco Civil da Internet. *Transinformacao*, v. 31, p. 1-10, 2019.

Garcia e Silva, H. B.; Marques, R. M. Restrições ao acesso informacional: a neutralidade de rede e a prática do zero-rating na governança da Internet. *INFORMAÇÃO & SOCIEDADE (UFPB. ONLINE)*, v. 28, p. 169, 2018.

Garcia e Silva, H. B.; Marques, R. M. ; Kerr Pinheiro, M.M. . Política de Informação para a Internet: regulação do zero-rating na União Europeia. In: Fabrício Bertini Pasquot Polido; Lucas Costa dos Anjos; Luíza Couto Chaves Brandão. (Org.). *Tecnologias e Conectividade: direito e políticas na governança das redes*. 1ed. Belo Horizonte: Instituto de Referência em Internet e Sociedade, 2018, v. 1, p. 87-101

Garcia e Silva, H. B.; Leite, H. O.; Kerr Pinheiro, M.M. . A dualidade das cidades inteligentes: melhoria da qualidade de vida ou controle informacional? *INFORMAÇÃO & SOCIEDADE (UFPB. ONLINE)*, v. 26, p. 47-54, 2016.

YEAR	TITLE	SCIENTIFIC DIFFUSION	STATUS
2021	5G and governance through technology	EPTIC Journal (ISSN 1518-2487)	Accepted
2022	Clash of antagonists: net neutrality and network slicing	To be defined	
2023	Comparative analysis of state regulations on ISPs' restrictive practices	To be defined	
2024	Regulatory framework proposal	To be defined	

Figure 6. Planned submissions during the PhD.

6. Activity plan

A doctoral thesis's elaboration, defense, and conclusion require rigorous planning of the steps to overcome, mainly due to the complexity of the activities that need to be executed at this level of academic research. Therefore, a specific segmentation of the activity plan is proposed for each year dedicated to the PhD.

The work to be done will lead to the following thesis structure:

- Chapter 1 – Introduction
- Chapter 2 – Internet architecture and connectivity
- Chapter 3 – ISPs' restrictive practices
- Chapter 4 – Panorama of state regulations
- Chapter 5 - Regulatory framework: net neutrality and network slicing
- Chapter 6 - Conclusions and future work

In the first academic year, it is necessary to complete 60 credits of mandatory and optative courses required by the Program's curricular component and submit a scientific article for publication. These scheduled activities were accomplished, as shown in figure 7.

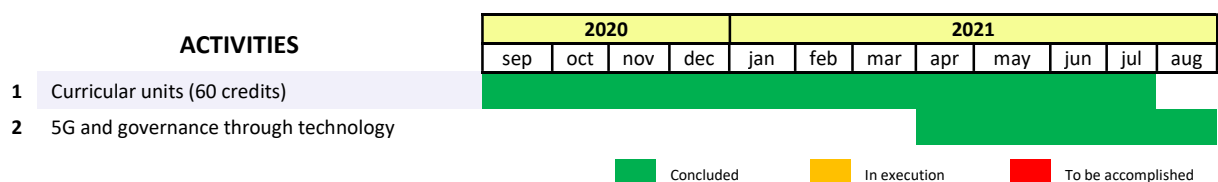


Figure 7. First-year activities

The second year will initiate with Activity 3 in order to qualify the thesis plan. Then, to take advantage of an opportunity window established by the review of the European Union net neutrality guidelines, scheduled to happen in 2022, Activity 4 will address the analysis of the contradictory concepts of network slicing and net neutrality; as an output, an article is expected to be submitted. Finally, in Activity 5, a draft of chapter 1 will be written, addressing the thesis introduction and its methodology.

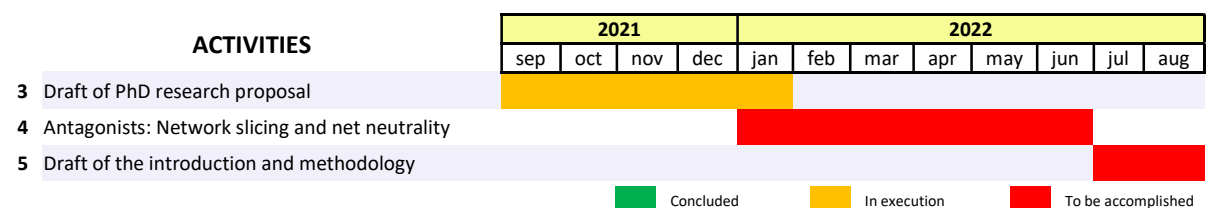


Figure 8. Second-year activities

The third academic year will involve the elaboration of chapters 2, 3, 4 and 5 of the doctoral thesis. Activity 6 will address the technical aspects of Internet and telecommunications networks architectures, and it will constitute the basis for chapter 2. In Activity 7, the ISPs' practices that restrict the information flow on the Internet will be characterized using the previously acquired technical knowledge, which will integrate chapter 3. In Activity 8, the panorama of state regulations established for net neutrality and network slicing will be analyzed, forming chapter 4. Activity 9 will propose a regulatory framework for the coexistence of net neutrality and network slicing, and it will be the foundation for chapter 5. Finally, submitting a scientific paper was also set as a milestone.

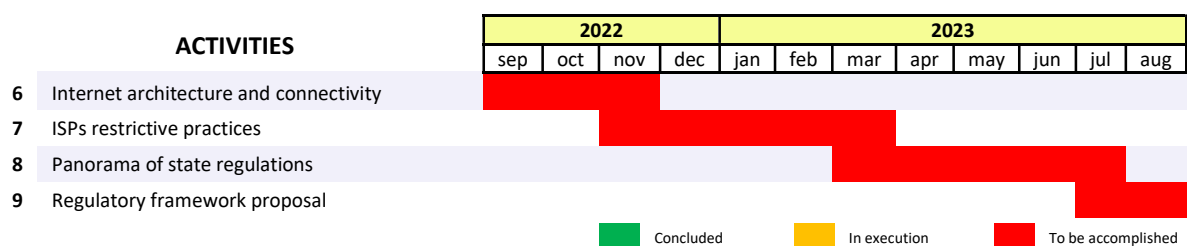


Figure 9. Third-year activities

The final year will be dedicated to writing the results/conclusions and reviewing the texts produced in order to finalize the doctoral thesis by January/2024. The PhD defense is planned for May/2024.

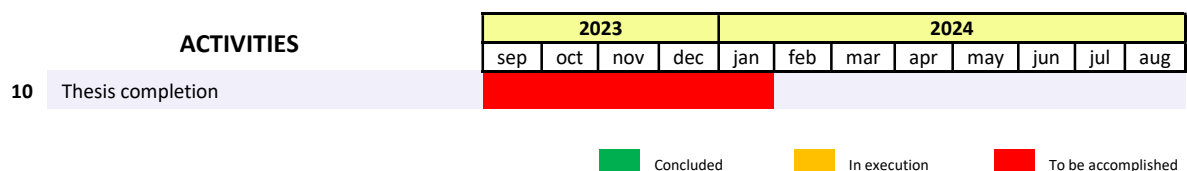


Figure 10. Fourth-year activities

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