Challenges Regarding Network Neutrality for Commercial Deployment of 5G Networks*

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Abstract

The paper aims to analyze the impact of equal data treatment applied in the European Union (EU) on the commercial deployment of the upcoming wireless standards such as 5G and beyond. The analysis of the different network neutrality involves several aspects, including engineering, social, economic and political aspects. Considering recent advancements in wireless networks like Network Function Virtualization or Network Slicing, this opens new research possibilities to analyze how various models influence aspects like the profitability of modern standards. To perform the study, a broad literature review and five interviews with the stakeholders from the industry have been done. Then, the knowledge has been segmented and interpreted so that an analysis of the net neutrality on future wireless standards has been given.

Keywords: 5G, net neutrality, network slicing, NFV.

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1 Introduction

The telecom ecosystem is coming through disruptive changes as the technologies such as the fifth-generation (5G) of the mobile standards appear on the industrial roadmaps. The apparition of these complex and innovative technologies spurs both – academia and industry – to seek new engineering and business solutions that help to uncover the underlying potential of far-reaching applications in the verticals like media (VR/AR/XR), transportation (autonomous cars) or manufacturing (Industry 4.0) [1]. However, with the higher level of technological complexity comes the difficulty to properly deal with innovations by the regulatory and then governmental bodies. Researchers already perceive 5G as one of the most difficult wireless technologies in the past decade and outline the convergence with the existing regulations as one of the potential blocking elements for keeping the deadlines and tailoring the patterns for the business models [2]. As it is common with advances in engineering, there is a need to look beyond industrial promotion to assess appropriate regulatory support. For 5G to deliver data rates of x10–x100, the capacity of x1000 or decrease in latency below 5 ms (in comparison to LTE) [2], major improvements of network engineering must be implemented. While the requirements for 6G reaches further into 1 Tbps in the throughput and <1 ms for the end-to-end delay [1].

For 5G to fulfil their performance indicators, aspects like network neutrality models must be certain. Some studies such as [3], argue that no throttling and no packets discrimination policy applied in the EU is perceived as an eventual element that can jeopardize the profitability of upcoming network and consequently seriously decrease the return of the investment (ROI). According to [4], clarity about the regulatory framework regarding Net Neutrality and Network Slicing is one of the key concerns, which needs to be taken into consideration when discussing the full commercial roll-out of new infrastructure. This view is shared by the part of the industry players. According to Ericsson's CEO, there is a dispute in the field of Net Neutrality as the company perceives tight regulations as a blocking factor for creating a dedicated network for specific purposes (slices) with specific quality of service (QoS) parameters [5]. The same view is shared by the Mobile Network Operator (MNO) side, e.g., Telenor's CEO who raises a concern that EU legislation on Net Neutrality might threaten the business cases for the telecom innovations and the full utilization of cloud-based Network Function Virtualization (NFV) and Network Slicing deployment [6]. The aim of this paper is to analyze to what extent there is a serious contradiction between

the net neutrality rules and development of 5G and beyond in total or to what extent the issue relates to specific use cases and technologies, including enablers like Network Slicing.

The work is structured as follows: Section 2 contains methodology. Section 3 outlines the literature study. Section 4 highlights the most important regulations of Net Neutrality applied in the EU. Then Section 5 explains the importance of Network Slicing. Section 6 discusses the issues related to upcoming wireless standards and Net Neutrality. Finally, Section 7 provides conclusions.

2 Methodology

The data source of the paper is based on secondary data from literature and primary data from interviews. The literature review contains state of the art academic work about the subject as well as the regulatory and industrial reports about the current state of the investigated encounter.

The primary data comes from interviews with five stakeholders that have been selected to obtain as a neutral picture as it could have been possible. Table 1 presents an overview of the interviewees:

In the discussion and analysis, the theoretical understanding and the empirical data collection are combined to identify the ambiguities and uncertainties. Consequently, the analysis explores the directions and focus of the next steps of development.

The main discussion is divided into four different domains:

- **Use Case Provision** – 5G is driven by the emergence of more diverse and heterogenous use cases as the wireless world enters new dimensions. Consequently, an answer as to whether the industry will be able to leverage upon these innovative business cases must be certain.
- **Network Engineering** – The second pillar is related to engineering and the key concern in this regard is the Network Slicing and proper enforcement of QoS, depending on the analyzed use case.

Table 1 Stakeholders table

Position	Represented Group
Senior Scientist	Academia
CTO	Industry
Regulatory Advisor	National Regulatory Agency (NRA)
Strategy & Program Manager	ISP
Director	Telecom Industry Association (TIA)

- **Innovations Facilitation** – The third selected pillar is the research concerning whether the commercial deployment of the new standards and net neutrality rules will be beneficial or rather against incubating companies.
- **Infrastructure Investments** – Similarly to the previous pillar, the network investment issue is also a part of the larger Net Neutrality debate.

3 Literature Review

Even though the 5G standard is not fully deployed yet, some countries and organizations have already started to create first drafts of 6G technology and produce literature studies in this regard. One of these examples is [1] and [8] where authors discuss the aspects like key business drivers, engineering paths, core requirements and finally regulatory pillar. In [1], authors lay the foundation on key performance metrics, service classes and enabling technologies needed to guarantee the proposer quality of new, disruptive business cases. To fulfil the high level of requirements, authors list Edge AI, Integrated Terrestrial, Airborne, and Satellite Networks or Energy Transfer and Harvesting as the key engineering pillars which will help 6G to take off as a profitable endeavor.

A complementary study was done in [8], where authors indicate regulations as one of the most crucial pillars that need to be taken under consideration, especially regarding the transparent rules for frequency assignment and appropriate licensing models. According to [8], the next regulatory-oriented question is related to the ownership of personal data and its processing. This concern leads to the discussion about internet monetization and the possibility to inspect data packages by operators in the name of the agreement signed with the specific ISP. Consequently, the review of the literature in the field of future wireless standards and Net Neutrality was a second step. The paper [9] gives an analysis of the potential conflict between Net Neutrality regulation and future 5G services, particularly the issues related to virtualization. Authors explain that the possibility to lease and utilize slices by the third parties (non-telecom related companies) from the infrastructure providers (telecom-related companies) will help to build better, more complementary or new services in the network resources optimized method. One of the main discussed elements is 5G- related innovations and new use-cases. Authors notice that against net neutrality rules might threaten to achieve full innovation potential concerning enablers like cloud services, which are the key to the

disruptive digital transformation of many industries. The major contribution of [9] is the fact that the problem of imposing network neutrality will prevent fast and slow lanes but rather the significance of the technological breakthroughs, which will be essential to meet growing heterogeneous demand more efficiently and transparently.

Equally, an important study was done by the Netherlands Organization for Applied Scientific Research (TNO) in [3]. Based on the multiple sources (government authorities, industrial and standardization bodies) the authors provide the assessment of 5G/Net neutrality rules correlation. In the paper, the authors developed nine scenarios of various data flows schemes and analyzed if flows can deliver the connectivity in regard to the potential regulation interpretations. The conclusion of the paper is that the problem is not in the type of utilized 5G ingredient but, what matters is the way 5G slices support services and applications rather than the technology itself. Consequently, it is concluded that expected complex topics are unsuitable for a generic "rule of thumb" approach and require deep and detailed analysis by the national NRAs.

In a paper titled how disruptive is 5G [16], Martin Cave discusses 5G in the light of digital transformation and network virtualization. When it comes to regulation and network neutrality paper argues that these developments will likely require some review of current net neutrality regimes.

4 Net Neutrality Rules in the EU

The definition adopted for net neutrality is the one coined by prof. Tim Wu in his widely recognized and cited article [10].

"Net neutrality – Net neutrality prohibits Internet service providers from speeding up, slowing down or blocking Internet traffic based on its source, ownership or destination."

Tim Wu's paper created fierce discussions between Internet Service Providers (ISP) and content providers. The EU has adopted a supportive Net Neutrality position, which means no throttling, blocking, bottlenecking, speeding or slowing down of data in the network traffic [11]. The idea of free and non-discriminatory Internet allows content and service providers to deliver data packages on equal terms via the high-quality open Internet infrastructure. As [12] explains, equal traffic, at the same time, means that even treatment allows reasonable daily traffic management regarding justified technical limitations. In the EU, the Net Neutrality aspects are part of the Digital Single Market (DSM) Strategy, which aims to open

up digital opportunities for its citizens, businesses and enhance Europe's position as a global leader in the fields of digital marketing, e-commerce or telecommunication.

According to [12], the approved Net Neutrality regulations constitute a major accomplishment in achieving a more digitalized, modern and better ICT environment in Europe. EU's position in the framework of the DSM and Net Neutrality has followed the adoption of Regulation 2015/2120 of 25 November 2015 by the European Parliament and the Council. According to Article 3, paragraph 3 of the [11]:

"Providers of internet access services shall treat all traffic equally, when providing internet access services, without discrimination, restriction or interference, and irrespective of the sender and receiver, the content accessed or distributed, the applications or services used or provided, or the terminal equipment used."

Article 3, paragraph 3 prohibits any traffic differentiation, segmentation or filtering. The European Regulators for Electronic Communications (BEREC's) guidelines outlines the provision of interpretation on how Specialised Services (SpSs) shall be delivered. The following term is one of the keys in the overall picture of the discussions on Net Neutrality and Network Slicing. However, Internet Access Service (IAS) should first be defined. According to Article 2, paragraph 2 of the [1] regulation:

"Internet access service means a publicly available electronic communications service that provides access to the internet, and thereby connectivity to virtually all endpoints of the internet, irrespective of the network technology and terminal equipment used."

Article 2, paragraph 10 of the BEREC Guidelines [13] provides the interpretation of the expression publicly available:

"Electronic communication services or networks that are offered not only to a predetermined group of end-users but in principle to any customer who wants to subscribe to the service or network should be considered to be publicly available. Electronic communication services or networks that are offered only to a predetermined group of end-users could be considered to be not publicly available."

Following that, the Guidelines provide crucial insights regarding the importance of the SpSs. Accordingly to Article 3(5) of the BEREC Guidelines [13]:

"Providers of electronic communications to the public, including providers of internet access services, and providers of content, applications and services shall be free to offer services other than internet access services

which are optimized for specific content, applications or services, or a combination thereof, where the ***optimization is necessary*** *in order to meet requirements of the content [. . .]."*

This part is crucial as the need for optimization is one of the key uncertainties identified during the interviews. The description is further developed by paragraph 101 in the Guidelines by the characterizations of SpSs:

"These providers are free to offer services referred to in Article 3(5), which BEREC refers to as specialised services, only when various requirements are met. Article 3(5) provides the safeguards for the provisioning of specialised services which are characterised by the following features in Article 3(5) the first subparagraph:

- *they are services other than IAS services*;
- *they are optimised for specific content, applications or services, or a combination thereof*;
- *the optimisation is objectively necessary in order to meet requirements for a specific level of quality."*

Following that, paragraph 110 provides a limitation within the SpSs by stating:

"If assurance of a specific level of quality is objectively necessary, this cannot be provided by simply granting general priority over comparable content. Specialised services do not provide connectivity to the internet and they can be offered, for example, through a connection that is logically separated from the traffic of the IAS in order to assure these levels of quality."

5 The Importance of Network Slicing

One of the main trends in telecommunication is Slice-aware RAN (Network Slicing), which means that depending on the network congestion, the operator can redirect and reorganize the resources the way needed. In other words, Network Slicing is the ability to deploy distinguished services across the network via particularly tailored layers of the system. The next-generation radio systems will be able to operate at various logical network partitions (i.e. slices) with appropriate isolation and predefined parameters, which serve a particular application purpose or service category [14]. However, what network partitions (i.e. slices) with appropriate isolation and predefined parameters, which serve a particular application purpose or service category [14]. However, what happens in the scenario where, e.g., media services consume the data committed for ultra-low latency cases? This is one of the

exemplary scenarios, where data from one source is throttled because there is a lack of data in other use cases. It is a well-known argument, presented by [3], that industry poses a question whether the implementation of the Network Slicing is a violation of equal data treatment policy adopted by the EU in Regulation (EU) 2015/2120 of the European Parliament and of the Council of 25 November 2015, where according to Article 3, paragraph 3, no data throttling is allowed [11]. It is important here to acknowledge the sense of confluence because Net Neutrality and wireless standards are comprehensive concepts, where Network Slicing is their common point.

6 Discussion and Analysis

This section aims at presenting the discussions and findings based on the interviews and state of the art literature studies.

Use Case Provision

The first question asked to the stakeholders was related to the purpose of the imposition of the pro-net neutrality policy in the EU. As it was stated by the representative of ISP and TIA, pro-net neutrality policy has been implemented to protect service/content providers from being blocked if their services competed with products offered by MNOs. The first and main example of such practice was blocking Skype, which offered a service similar to voice connectivity offered by MNOs. However, the current market situation is different. Customers buy network subscriptions to have access to products offered by giants like Google, Apple, Netflix of HBO, rather than for services offered by MNOs. In addition to that, the ISP representative outlines the fact that when Net Neutrality was imposed, there was no Network Slicing. Therefore, the current rules have been invented in a different world, for different technology regimes and services. Currently, when the telecommunication industry moves into more critical infrastructure, technological innovations may outpace the regulations in some cases.

Consequently, the main question of this paper arises – Can we regulate the 5G standard with rules applied for the purpose of protecting the customers' choice and companies like Skype? The state of the art analysis shows that the applicability of Net Neutrality rules for the upcoming standards can be inadequate. The ISP representative's arguments in this discussion are the following: a) Confusion aspect – the current regulations/guidelines do not provide clear structure, which can help the industry manage a profitable

business endeavor, b) A new approach towards wireless standards – specified by 3GPP network architecture allows accommodating more diverse use cases, beyond typical upgrades from 4G, and c) Outdated regulations – current rules were developed to protect the content/service providers from MNO throttling.

The first argument was also emphasized by the Telecom Industry Association (TIA). During the interview, it was explained that from the industrial perspective there is a high degree of uncertainty. The upcoming standards demand a lot of investments and investors do not have certainty for a business plan or services, which can decrease the amount of the potential investors, reflected in the statement from TIA: 'It is not for us as attractive to invest in as in a market where you do not have these rules'.

Concerning the FCC's against-net neutrality regulations, according to the interviewee from academia, the rules strongly relate to the commercial agreements between ISPs and service/content providers. The ISP representative fully approved current FCC activities, as 'the against-approach has nothing to do with blocking or throttling and service/content providers. The ISP representative fully approved current FCC activities, as 'the against-approach has nothing to do with blocking or throttling anyone' and also 'it is more about developing networks more in line with the needs of society'. However, the telecom industry looks different in the US. One of the main reasons why FCC introduced against-net neutral rules was the lack of infrastructure investment in the rural areas from the ISPs' side. The European market is extremely competitive. The argument that there is no proper broadband connectivity is not as relevant as in the US. Moreover, there is an aspect of the immaturity of 5G and only after the commercial deployment it can be assessed which approach is more profitable.

Furthermore, a scenario was created and asked during the interview. The scenario was about the ultra-low latency connectivity, throttled because of the degradation of other services: "Who would be responsible in the accident scenario where because of the lack of the capacity and net neutrality restrictions, the operator could not deliver the high-priority connectivity?". The answers from the respondent are outlined in the following.

The response from the representative from academia: 'Who gave a guarantee that it will work? Operator? Car manufacturer? Road operator? Depends on the arrangements they have. This shows why it is not trivial to come to this use case, which depends on high reliability. Similarly to the accidents with Tesla, where the autopilot did not see the pedestrian and the accident happens. Maybe in the future, there will be a regulation, which deals with this.' The representative from ISP also started by elaborating on the

scenario: 'Would you label the mission-critical application on that? Then it needs to come with the responsibility of the operator as well. Which of course will be reflected in the price of the slice.' The respondent from TIA focused on the surgery example: 'If you have surgery in the hospital, I am sure that no one would argue that making the SpS would be jeopardized by the net neutrality rules. In practice, this is a good scenario to discuss, but in reality, it would not happen. Then again, we have this uncertainty element here.'

The responsibility in this scenario is questionable and there is no clear answer. As the ISP representative adds: 'Then again we have this uncertainty element here, which strengthen the insecurity aspects outlined before. Considering the huge economic losses (i.e. smart grid or autonomous cars accident) or customers' accidents, this example should be answered clearly and in a unified way if the net neutrality rules would work properly.'

The EU regulation review performed in section IV highlights the need for optimization. Following that, Article 16 states:

"National regulatory authorities should verify whether and to what extent such optimisation is objectively necessary to ensure one or more specific and key features of the content, applications or services and to enable a corresponding quality assurance."

[7] argues that the NRA may require operators to show that the required level of quality cannot be assured over the IAS. As a result (because of timing, costs, innovations, administration burden) it might hamper the fast deployment of 5G.

Comments on Article 16 on the EU Net Neutrality regulations showcased many different cases, which might pose challenges for a fully profitable 5G investment. The representative from academia argues that the comparison between IAS and SpS is problematic because regular network services parameters can vary over time and from location to location. ISP highlights that Net Neutrality rules today do not provide clear guidelines on how to discriminate if the service requires special treatment. location to location. However, as mentioned above, even in the current regulatory regime based on Net neutrality there is a possibility to have specific requirements on SpSc. Another important thing is that in our discussions with industry players views were contradicting the above conclusions by stating that 'there are no contradictions between Network Neutrality regime and the above scenario, as there are rooms in the current regime to deal with these specific issues'. Therefore, further research is needed to see if SpSc rules or other specific rules in the current regime can be applied in this scenario and the scenarios like this and that network neutrality regulation can go hand in hand with the

development of 5G also in these very conflicting scenarios. Further research can also shed light on the need for adjustments in some of the rules in regulation in light of the new developments within 5G.

Network Engineering

Following the previous debate about the purpose of Net Neutrality and questioning the full 5G use cases by the upcoming standard, the next domain, Network Engineering, raises the questions with respect to the meaning of the parameters.

"How should operators prove that the service deserves special treatment? While discussing the alignment with Net Neutrality rules – should we look more for the type of requirements (for example latency or data rates) or the specific value, which will determine if particular use case should be prioritized?"

On the one hand, both academia and TIA perceive the argument that the parameters can change over time and location. On the other hand, academic representative explains that value itself is important while TIA is convinced that the specific value is not an indicator for the net neutrality problem. Rather than parameters, TIA claims that the regulator should look into aspects like market competition. The overall impression is that stakeholders perceive the complexity of assessing the importance and the role of the parameters and their specific values while discussing compliance with net neutrality.

Innovations Facilitation

As mentioned in section III, according to [8], the problem is not about imposing Net Neutrality but if the technology will fulfil the demand of more diverse use cases. Consequently, a question about the relevance of innovations was asked. The representative from industrial explained that the market waits for 5G use cases, rather than cases based on LTE. The importance of innovations might change when factories or cars will utilize the new standard. Following that statement, the representative from academia explains that the main core of the debate is the lack of resources and consequently the necessity to discriminate.

Infrastructure Investment

Against-net neutrality proponents argue that extra fees will contribute to network investment. Considering the fact that 5G is a non-usual upgrade

from 3G to 4G and a broader change, which is perceived to open many new businesses, can against-net neutrality regulations help MNOs to achieve a safer, more robust network with faster ROI and better financial results.

Answers provided by the stakeholders emphasized a wide spectrum of counterarguments. First, it must be noticed that as long as the market is competitive, monopolistic behavior activities will be constrained. As a result, ISPs, in order to deliver the highest possible quality, will have to adjust their business models to build robust network architecture. Secondly, current content/service providers are in a position to claim their demands, as the customers buy the network subscription to use their products, rather than MNO connectivity. Finally, the start-up environment would expect to have access to the 5G network at a low cost, rather than spending resources on reaching the customer.

7 Conclusions

Net Neutrality was imposed in the EU to protect content/service providers from being throttled if their services competed with MNOs' services (Skype example). The situation is even more intensified by the emergence of video streaming services like Netflix, HBO and also here 'providers of internet access services shall treat all traffic equally, when providing internet access services, without discrimination, restriction or interference, and irrespective of the sender and receiver', as stated in the regulation mentioned above. Therefore, the Net neutrality rules can have their validity and legitimacy in some use cases also in 5G and probably also in the upcoming 6G.

However, the Net Neutrality regulations were created in a different technological regime as when Net Neutrality was imposed, there was no network slicing. Consequently, the EU regulations in the field must be discussed in light of the new wireless standard. The new standards will not be typical upgrades but faster, yet broader and will accommodate more use cases (including life-critical ones), and part of the regulation may be adjusted to cope with the new developments.

The most recent update of Net Neutrality was done by FCC, which dismantle equal data treatment in the US and proposed more transparent and clearer structure on how to manage network traffic [15]. In contrast, the EU's rules are not clear enough (like Article 16) and as a result, according to some of the important market players, it might increase the uncertainty aspect and in the end decrease the number of investors.

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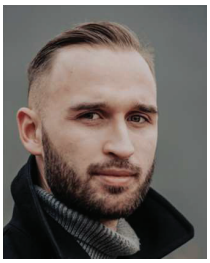
Biographies



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