

University of Pennsylvania Carey Law School

ILE

INSTITUTE FOR LAW AND ECONOMICS

A Joint Research Center of the Law School, the Wharton School,
and the Department of Economics in the School of Arts and Sciences
at the University of Pennsylvania

RESEARCH PAPER NO. 23-26

Network Slicing and Net Neutrality

Christopher S. Yoo

UNIVERSITY OF PENNSYLVANIA CAREY LAW SCHOOL

This paper can be downloaded without charge from the
Social Science Research Network Electronic Paper Collection:
<https://ssrn.com/abstract=4524224>

Network Slicing and Net Neutrality

Christopher S. Yoo

University of Pennsylvania, USA

Abstract

Whether network slicing complies with the net neutrality rules currently in force in Europe and previously applicable in the U.S. presents a key issue in the deployment of 5G. In many ways, both regimes frame the issues in a similar manner, with the exceptions for reasonable traffic management and specialized services likely to play the most important roles. Both regimes also focus on similar considerations, including the requirement that measures be based on technical rather than business considerations and the distinction between measures aimed at improving the performance of the entire network or specific applications, although both distinctions are problematic in some respects. Both regimes also emphasize application agnosticism and end-user choice, with European law finding the former implicit in the latter. At the same time, European and U.S. law reflect some key differences: the regimes cover different types of entities, frame the issues in terms of nondiscrimination versus throttling and paid prioritization, take different positions on whether measures must be limited to temporary or exceptional circumstances, and place different weight on the impact of the rules on investment and on the relevance industry standards. The relatively undeveloped state of both legal regimes means that the ultimate answer must await enforcement decisions and actions by NRAs, and any subsequent judicial challenges to these decisions.

1.	Introduction.....	2
2.	Network slicing under the EU’s Open Internet Regulation	3
2.1.	Businesses as end users.....	4
2.2.	Exception for reasonable traffic management measures	4
2.2.1.	Nondiscrimination.....	5
2.2.2.	Basis on technical rather than commercial considerations	6
2.2.3.	Duration no longer than necessary.....	8
2.3.	Exception for specialised services	9
2.3.1.	Optimization for specific content or applications.....	10
2.3.2.	No detriment to IAS services.....	11
3.	Network slicing under the U.S. 2015 Open Internet Order	13
3.1.	Inapplicability to enterprises.....	15
3.2.	Bright-line rules prohibiting throttling and paid prioritization.....	16
3.3.	General conduct standard prohibiting unreasonable interference or disadvantage.....	17
3.4.	Exception for reasonable network management.....	19
3.5.	Exception for non-BIAS data (specialized) services	21

4. Conclusion	24
Acknowledgements.....	25
References.....	25

1. Introduction

The most important development in mobile broadband is the ongoing deployment of fifth-generation networking technologies (5G). First launched in late 2018, some industry observers estimate that 5G subscriptions exceeded 1 billion by the end of 2022 and should surpass 5 billion subscribers and contribute USD 1 trillion to the global economy by the end of 2030. Moreover, Developmental work on the next generation (6G) has already begun.

5G is being built around a business model that differs starkly from the one relied upon in the past. While prior generations were marketed primarily to consumers, 5G is being marketed primarily to businesses. As part of this new business model, 5G is also being deployed around a new technological approach known as *network slicing*, which enables a network to be divided into multiple subnetworks (called slices) that different users can use simultaneously in much the same manner that cloud computing allows multiple virtual computers to share the same servers.

Network slicing creates several benefits. Resource sharing allows more efficient utilization than would occur if each resource were dedicated to a single user or use case. Sharing efficiency is particularly important for technologies that, like 5G, depend on lower-powered microcells that necessarily serve fewer customers. In addition, individual slices can each be tailored to provide different levels of quality of service (QoS) to each application.

Some observers have raised concerns that enforcement officials may interpret net neutrality regulations in a way that might prevent 5G providers from pursuing network slicing. Most notably, a group of European telecommunications providers and equipment manufacturers released the so-called 5G Manifesto in July 2016 warning that regulations impeding

experimentation with the flexible, elastic configuration of resources could dampen investment and delay the deployment of in 5G (Patterson et al., 2016). The basis for this claim is easy to discern: By enabling customers to purchase higher or lower levels of resources and services, network slicing could easily be characterized as the type of pay-for-play models that net neutrality regulations are designed to prohibit.

This article assesses whether net neutrality regulations may impede the deployment of network slicing. Section 2 evaluates the effect of the EU's Open Internet Regulation. Section 3 offers its assessment of network slicing under a regime similar to the U.S. Federal Communications Commission's (FCC's) 2015 Open Internet Order, which will likely serve as the starting point for the planned reintroduction of net neutrality rules in the U.S. Section 4 concludes.

2. Network slicing under the EU's Open Internet Regulation

The EU adopted its Open Internet Regulation in November 2015 as part of Regulation (EU) 2015/2120, commonly known as the Telecoms Single Market (TSM) Regulation (which also included provisions on roaming). The Regulation calls upon the Body of European Regulators for Electronic Communication (BEREC) to issue nonbinding guidelines to inform the National Regulatory Authorities' (NRAs') implementation of the Regulation. BEREC issued its initial guidelines in August 2016 and updated them in June 2020 and June 2022.

The Regulation imposes requirements on providers of Internet access services (IAS), i.e., last-mile connectivity provided to end users, mandating that IAS providers to “treat all traffic equally . . . 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” and that any agreements between IAS providers and users not limit the

exercise of these rights.¹ The ECJ has characterized this as a “general obligation of equal treatment, without discrimination, restriction or interference with traffic.”²

One key question is whether the protections provided by the Open Internet Regulation extend to businesses, who remain the most likely customers of network slicing. Moreover, the Regulation’s central non-discrimination obligation is subject to two exceptions that BEREC has recognized may be implicated by network slicing. The first is the exception for *reasonable traffic management*. The second is for *specialised services*.

2.1. Businesses as end users

The Open Internet Regulation’s protections extend to all *end users*. Although the regulation does not define the term, the BEREC Guidelines and the ECJ have both interpreted it to include businesses (including content and access providers) as well as individual consumers.³ The BEREC Guidelines recognize, specialized services such as those enabled by network slicing “might be especially important to corporate customers.”⁴ The inclusion of businesses within the definition of end users means that network slicing will likely have to comply with the Regulation’s mandates.

2.2. Exception for reasonable traffic management measures

The Open Internet Regulation qualifies its nondiscrimination mandate by specifying that the rules “shall not prevent providers of internet access services from implementing *reasonable traffic management measures*.”⁵ Although BEREC’s initial guidelines (2016, footnote 26)

¹ EU (2015, Articles 3(2), 3(3) subparagraph 1).

² ECJ, C-807/18 and C-39/19 *Telenor Magyarország*, para. 47.

³ BEREC (2022, Guideline 4); ECJ (2020, paras. 36–38).

⁴ BEREC (2022, Guideline 114).

⁵ EU (2015, Article 3(3) subparagraph 2) (emphasis added).

associated with network slicing with “services other than internet access services which are optimised for specific content, applications or services, or a combination thereof,” commonly known as *specialised services*, BEREC decided to omit this language from future guidelines because ISPs could use network slicing to provide either IAS or specialized services.⁶ As a result, BEREC’s website on 5G (n.d.) observes how a technology commonly used by network slicing known as 5G Quality of Service Class Identifier (5QI) “could be used as a traffic management measure to offer IAS complying with the rules on reasonable traffic management for the provision of different ‘categories of traffic.’”

The regulation and the BEREC Guidelines provide additional insight into what is required for a traffic management measure to qualify as reasonable, three of which have particular relevance for network slicing. First, it must be non-discriminatory. Second, it must “not be based on commercial considerations but on objectively different technical quality of service requirements of specific categories of traffic.” Third, it must “not be maintained longer than necessary.”⁷

2.2.1. Nondiscrimination

As an initial matter, the Open Internet Regulation requires that in order to be considered reasonable, traffic management measures must be non-discriminatory. The recitals that introduce the Regulation further clarify that this provision requires that the measure “should treat equivalent traffic equally.”⁸ The BEREC Guidelines explain further that while this provision permits IAS providers to differentiate among different categories of traffic, any such

⁶ BEREC (2018, 15).

⁷ EU (2015, Article 3(3) subparagraph 2).

⁸ EU (2015, Recital 9).

differentiation must be “objectively justified” and that “[s]imilar situations in terms of similar technical QoS requirements should receive similar treatment.”⁹

The Guidelines’ discussion of permissible agreements similarly makes clear that the Regulation requires traffic management measures to be “application-agnostic,” which means that “where the ISP provides more than one ‘category of traffic’, . . . the treatment of traffic within each category is independent of application.”¹⁰ For example, such agreements may charge different amounts for different aspects of QoS, including data volumes, speeds, latency, jitter and packet loss, so long as they do not discriminate based on location, content, application or service.¹¹ Application agnosticism is satisfied when end users choose the level of QoS.¹² Conversely, the QoS level applied to any application may not be preselected by the ISP based on commercial agreements by the sending party.¹³

Under these principles, whether network slicing constitutes a reasonable network traffic management measure may depend on which end of the connection requests the service. If the receiving party chooses the level of QoS from a menu of services, network slicing will likely constitute reasonable traffic management. The same may not be true if these decisions are made pursuant to an agreement between the ISP and the sending party.

2.2.2. Basis on technical rather than commercial considerations

The requirement that any differentiation among categories of traffic be based on technical rather than commercial considerations raises similar issues to those raised by the non-

⁹ BEREC (2022, Guideline 60).

¹⁰ BEREC (2022, Guidelines 32b, 34a).

¹¹ EU (2015, Article 3(2)); BEREC (2022, Guidelines 32, 34b).

¹² BEREC (2022, Guideline 34a).

¹³ BEREC (2022, Guideline 34c); see also BEREC (2022, Guideline 40b) (advising that content and application providers subsidizing the data used to access their offerings is impermissible).

discrimination requirement. According to the BEREC Guidelines, technical considerations are typically defined in terms of QoS requirements, such as the latency, jitter, packet loss, and bandwidth needed to support real-time applications.¹⁴ Conversely, traffic management measures are based on commercial considerations “where an ISP charges for usage of different traffic categories” or where the ISP “partners with a provider of certain applications.”¹⁵

These conclusions draw support from a series of recent decisions issued by the European Court of Justice (ECJ). The ECJ’s 2020 *Telenor Magyarország* decision held that not counting traffic associated with certain applications against users’ data caps (a practice commonly known as *zero rating*) and exempting those applications from the policy of slowing down users’ traffic once they exceeded their data limit violated the Open Internet Regulation. The Court based its decision in part because these programs were based on commercial considerations rather than objectively different technical differences for specific categories of traffic.¹⁶ The ECJ reiterated this conclusion in three decisions issued on the same day in 2021 that invalidated three other zero rating programs in part on the grounds that exempting partner applications from data caps was based on commercial rather than technical considerations.¹⁷

As was the case with non-discrimination, these rules require providers of network slicing to strike a delicate balance. From one perspective, providing access to network slices could be considered a technically justified offer of a service with a different level of QoS. From another perspective, charging for access to slice on a transactional basis could be regarded as a charge for usage of different traffic categories or a partnership with individual content and application

¹⁴ BEREC (2022, Guideline 63).

¹⁵ BEREC (2022, Guideline 68).

¹⁶ ECJ, C-807/18 and C-39/19 *Telenor Magyarország*, para. 52.

¹⁷ ECJ, C-854/19 *Vodafone (roaming)*, para. 28; C-5/20 *Vodafone (tethering)*, para. 24, and C-34/20 *Telekom Deutschland (throttling)*, para. 52.

providers, both of which would be impermissible. Network slicing's status as a form of reasonable traffic management depends on it falling into the former category.

The distinction between technical and commercial considerations suffers from a more fundamental problem. Simply put, network operators always have the alternative of improving QoS by expanding capacity rather than engaging in traffic management. Whether resolution of this choice is a matter of technical or business feasibility is thus largely a matter of perspective. Turning the distinction between technical and business considerations into a meaningful one hinges on devising a principled way to resolving this conundrum.

2.2.3. Duration no longer than necessary

Lastly, the Open Internet Regulation requires that reasonable traffic management measures must not be maintained longer than necessary.¹⁸ The Regulation's recital on the separate exception for managing congestion¹⁹ takes an even stronger position. While acknowledging that while mobile networks are more susceptible to congestion, "[r]ecurrent and more long-lasting network congestion which is neither exceptional nor temporary . . . should rather be tackled through expansion of network capacity" rather than through the exception,²⁰ reinforcing the point made earlier about the overlap between technical and business considerations.

The continual nature of network slicing likely takes it outside the ambit of reasonable network traffic management. It typically operates on an ongoing basis rather than occasionally based on necessity. Although a BEREC attempted to clarify that its Guidelines did not intend to

¹⁸ EU (2015, Article 3(3), subparagraph 2).

¹⁹ EU (2015, Article 3(3), subparagraph 3(c)).

²⁰ EU (2015, Recital 15).

prevent traffic management practices that operate continuously, “such as resource scheduling in cellular access networks, marking the QoS class of the IP packets and differentiated queuing in network elements,”²¹ the BEREC Guidelines note that traffic management measures may be put “in place . . . on an ongoing basis” so long as they “only become[] effective in times of necessity.” When traffic management measures are in effect on a permanent or recurrent basis, NRAs should reconsider if they still qualify as reasonable.²² As such, this requirement poses the greatest problems for characterizing network slicing as reasonable traffic management.

2.3. Exception for specialised services

The regulatory provision most likely to bring network slicing into compliance with the EU’s Open Internet Regulation is the exception for what are called *specialised services*.²³ As noted above, these services “are optimised for specific content, applications or services, or a combination thereof, where the optimisation is necessary in order to meet requirements of the content, applications or services for a specific level of quality.”²⁴ These include low latency services demanded by real-time applications, such as voice over LTE (VoLTE), linear broadcasting IPTV, real-time health services such as remote surgery, and new machine-to-machine communications.²⁵

As noted above, BEREC has recognized that network slicing can support both specialised services and internet access services.²⁶ As a result, both BEREC’s initial guidelines and its

²¹ BEREC (2018, 10).

²² BEREC (2022, Guideline 73).

²³ BEREC (2022, Guideline 2).

²⁴ EU (2015, Article 3(5)).

²⁵ BEREC (2022, Guideline 113).

²⁶ BEREC (2018, 15).

webpage on 5G note that network slicing may be a key enabling technology for specialised services.²⁷

Importantly, the European Commission 2023 Report recognized that the “lack of legal certainty” about what does and does not constitute a specialised service “may have a chilling effect on investments and innovation” and that “[g]reater legal certainty could therefore be beneficial to both innovators and consumers in the future.”²⁸ Three considerations play particularly important roles in determining whether network slicing falls within the exception for specialised services. First, services falling within the exception must be optimized for specific content or applications. Second, specialised services must not replace or undermine general IAS. Third, specialised services must be more than simply granting priority over comparable content, applications, and services.

2.3.1. Optimization for specific content or applications

The requirement that specialised services be optimized for specific content, applications, or services is potentially problematic for network slicing. The BEREC Guidelines’ discussion of the difference between specialized services and reasonable traffic management offers some guidance as to the precise contours of this requirement: Specifically, reasonable traffic management measures promote to the overall efficiency of entire network, whereas specialised services support QoS levels demanded by specific content and applications.²⁹

The distinction may not be as sharp as the Guidelines suggest. Improving the efficiency of the overall network improves the QoS experienced by individual applications. At the same

²⁷ BEREC (2016, Footnote 26; n.d.).

²⁸ EC (2023, 8).

²⁹ BEREC (2022, Guideline 75).

time, providing demanding applications with the QoS that they need also typically improves overall network efficiency. The distinction thus turns on whether the measure in question benefits overall network *directly* and specific applications *indirectly* or vice versa.

Network slicing falls somewhere in between in that it is a general architecture both designed to improve the performance of the overall network and QoS-sensitive applications. Instead, it is a network-level architecture that allows multiple users to share network components based on the level of QoS needed by particular applications.

One saving grace may be the phrase at the end of definition, which adds “or a combination thereof” to the enumerated list. If interpreted broadly, this catchall could encompass generic services designed to support any arbitrary combination of content, applications, or services. However, an interpretation broad enough to encompass the type of paid, general purpose, prioritized architecture associated with network slicing risks rendering this language meaningless. The viability of network slicing might depend on the balance struck between these two opposing considerations.

2.3.2. No detriment to IAS services

The BEREC Guidelines envision the provision of both IAS and specialised services over a common infrastructure logically separated on a fixed or dynamic basis.³⁰ Such degree of contention is inevitable when IAS and specialised services share the same capacity. Thus, “[w]hen it is technically impossible to provide the specialised service in parallel to IAS without detriment to the end-user’s IAS quality, NRAs should *not* consider this competition for capacity” a violation of this provision if the provider informs end users of the potential impact on IAS and

³⁰ BEREC (2022, Guideline 110b). This is a significant improvement over early proposals that required physical separation between specialised services and IAS.

is still able to deliver the speeds promised in its service contract. Moreover, such detrimental effects are permissible when the specialised services affect only a user’s own IAS but are not permissible when they affect parts of the network shared by different end users.³¹ The recitals also recognize that variations in the number of users can make the impact on IAS unpredictable. As a result, no violation of this provision should not be found when the negative impact on IAS is “unavoidable, minimal and limited to a short duration.”³²

This language is important, because infrastructure sharing is the basis for the most important benefits provided by the Internet. Moreover, when wireless networks share the same spectrum, Shannon’s Law (1949) dictates that one usage always has a detrimental effect on other uses operating in the same area. Competition between IAS and specialised services is thus properly characterized as inevitable rather than something that is technically contingent.

The solution to allow such detriment to occur legally so long as the specialised services provider informs end users of the potential impact and is still able to deliver its promised speeds is a good one. It allows conscientious specialised service providers to manage the number of services they provide and customers they serve to ensure that they meet their commercial commitments.

* * *

Interpretations of the EU’s Open Internet Regulation thus exist that might be inconsistent with network slicing. The requirements that any practices be based on technical rather than commercial considerations and be of short duration may prevent network slicing from falling within the definition of reasonable traffic management. However, broad interpretation of content and application specificity requirements and the ability of disclosure and fulfillment of

³¹ BEREC (2022, Guideline 122) (emphasis added).

³² EU (2015, Recital 17).

contractual promises to excuse any contention between multiple services should permit network slicing to qualify as a specialised service.

3. Network slicing under the U.S. 2015 Open Internet Order

Net neutrality in the U.S. has followed a somewhat winding path. The FCC issued its first policy statement on the topic in 2005 during the Administration of George W. Bush. The agency adopted its first Open Internet Order in 2010 during the Obama Administration only to see the key provisions of that Order struck down by the courts in 2014. It revised its approach in its second Open Internet Order issued in 2015, which was upheld on judicial review in 2016. The Restoring Internet Freedom Order repealed those rules in 2017 during the Trump Administration, which was also upheld by the courts in 2019. President Biden issued an executive order in July 2021 calling for the readoption of rules similar to those enacted in 2015.³³ At this point, however, the lack of a full complement of Commissioners left the FCC deadlocked between two Democrats and two Republicans, which stymied further action on the proposal. President Biden's first nomination for the position languished before the Senate for nearly a year and a half before the nominee withdrew. The Senate Commerce Committee approved President Biden's second nomination for the position on July 12, 2023, clearing the way for a floor vote on her appointment and the eventual reenactment of net neutrality rules.

The restoration of net neutrality rules will require a new rulemaking proceeding, including the development of a new administrative record that reflects any learnings from the implementation of past regulatory efforts and any changes in the technological and business environment. That said, President Biden's specific endorsement of the approach taken by the

³³ Biden (2021, sec. 5(l)(i)).

FCC's 2015 Open Internet Order a logical reference point for predicting how future U.S. net neutrality rules might affect network slicing.

The 2015 Order enacted bright-line ex ante rules banning three practices if undertaken by providers of broadband Internet access services (BIAS), , that the FCC regarded as inherently unjust and unreasonable. The *no blocking* rule prohibits BIAS providers from obstructing access to lawful content , applications, services, and nonharmful devices.³⁴

The *no throttling* rule prohibits “impair[ing] or degrad[ing] lawful Internet traffic on the basis of Internet content, application, or service, or use of a non-harmful device.” The FCC was particularly concerned about conduct that was tantamount to blocking, imposing fees to avoid throttling, or singling out content that competes with the BIAS provider's business model, although it exonerated any slowing down of service based on choices made by end users.³⁵

The *no paid prioritization* rule prohibits BIAS providers from “favor[ing] some traffic over other traffic . . . in exchange for consideration . . . or to benefit an affiliated entity.” The goal is to prevent the bifurcation of the Internet into fast and slow lanes. The Order gave the FCC the authority “waive the ban on paid prioritization only if the petitioner demonstrates that the practice would provide some significant public interest benefit and would not harm the open nature of the Internet,” which would occur only in “exceptional cases.”³⁶

Conduct falling outside these rules would be subject to a *general conduct standard* prohibiting unreasonable discrimination or disadvantage, which would be enforced on an ex-post, case-by-case basis. In so doing, the FCC collapsed the distinction between fixed and mobile broadband included in the 2010 Open Internet Order and subjected both to the same set

³⁴ FCC (2015, paras. 15, 111–122).

³⁵ FCC (2015, paras. 16, 119–124).

³⁶ FCC (2015, paras. 18, 125–132).

of rules. All of these rules except for the one against paid prioritization were subject to an exception for *reasonable network management*. The 2015 Order also included an exception for what used to be called *specialized services* (now renamed non-BIAS data services).

3.1. Inapplicability to enterprises

By its own terms, the FCC’s 2015 Open Internet Order applied to broadband Internet access service (BIAS), defined to include only “mass-market retail service” providing access to substantially all Internet endpoints and their functional equivalents.³⁷ This encompassed edge providers and their intermediaries³⁸ but did “not include enterprise service offerings, which are typically offered to larger organizations through customized or individually negotiated arrangements, or special access services.”³⁹ In addition, the rules did not apply to traffic exchanged with transit providers, content delivery networks (CDNs), or backbone providers, which are better governed through the oversight of interconnection.⁴⁰

The inapplicability of the net neutrality rules to enterprises that were not edge providers meant that the rules would not have applied to many of the likely customers of network slicing. This stands in stark contrast to the EU Open Internet Regulation’s applicability to all businesses.

At the same time, the inapplicability of the rules to traffic exchange can give rise to some interesting anomalies. For example, a significant number of edge providers choose to distribute their content through CDNs (Yoo, 2010). The content from these edge providers would be governed by the oversight of interconnection, while content that edge providers chose to distribute directly would be governed by the rules contained in the 2015 Order. Which rules

³⁷ FCC (2015, paras. 25, 187).

³⁸ FCC (2015, paras. 27, 190, 193, 308, 338–340).

³⁹ FCC (2015, paras. 189).

⁴⁰ FCC (2015, paras. 29–31 190, 193, 202–203, 205, 340).

applied would have varied with the manner in which network slicing customers chose to deliver their content.

3.2. Bright-line rules prohibiting throttling and paid prioritization

Among the bright-line rules, network slicing generally does not run afoul of the rule against blocking access to any content, applications, or devices. It does, however, implicate the rules against throttling and paid prioritization.

The paid prioritization and throttling rules are two sides of the same coin. The former bars asking Internet users to pay to speed up, while the latter prohibits asking Internet users to pay not to be slowed down. The only difference is what speed level is taken as the baseline.

If the existing, best-efforts Internet is taken as the baseline, as is likely, whether network slicing would represent throttling or paid prioritization would depend on how many resources the user has decided to acquire. If the acquired services exceed the services provided by the best-efforts Internet, network slicing may be categorized as paid prioritization, as commentators in the 2017 proceeding repealing the 2015 Open Internet Order noted.⁴¹ If they fall below the baseline level of the best-efforts Internet, the fact that network slicing occurs based on end users' requests immunizes it from the throttling rule.

The distinction is made all the more important by the fact that the rules treat paid prioritization as a per se violation that is not subject to the exception for reasonable network management.⁴² The rules permit the FCC to waive the ban on paid prioritization in exceptional cases if the petitioner can show that doing so “would provide some significant public interest benefit” and “would not harm the open nature of the Internet,” a standard that the Order

⁴¹ FCC (2017, footnote 920).

⁴² FCC (2015, footnote 18, paras. 32, 215, 217).

characterizes as a “high bar.”⁴³ Revising this provision to extend the exception for reasonable network management to paid prioritization or to lower the bar necessary for waiver would remove a potential barrier to deploying network slicing.

3.3. General conduct standard prohibiting unreasonable interference or disadvantage

The Order established a general standard of conduct to govern potentially harmful practices that fell outside the bright line rules. This standard required that BIAS providers “not unreasonably interfere with or unreasonably disadvantage end users’ ability to select, access, and use broadband Internet access service or the lawful Internet content, applications, services, or devices of their choice, or edge providers’ ability to make lawful content, applications, services, or devices available to end users.” The FCC identified seven nonexhaustive factors to guide this case-by-case inquiry, many of which overlap with the considerations identified by the EU’s regulation: (1) end user control; (2) competitive effects; (3) consumer protection; (4) effects on innovation, investment, or broadband deployment; (5) free expression; (6) application agnosticism; and (7) conformance with standard practices.⁴⁴

One factor favored regarding network slicing as complying with the general conduct standard. Because the services employed in network slicing are selected by end users, it would have satisfied the factor of end-user control. That said, the Order acknowledges that “user control and network control are not mutually exclusive, and . . . many practices will fall somewhere on the spectrum from more end-user-controlled to more broadband provider-controlled.”⁴⁵

⁴³ FCC (2015, paras. 130–132).

⁴⁴ FCC (2015, paras. 135, 138–145).

⁴⁵ FCC (2015, para. 139).

Whether the factor favoring application agnosticism cut in favor of or against the legality of network slicing would have depended on the way this factor was interpreted. It is true that network slicing is inherently application aware and designed to configure resources based on the specific needs of particular applications. However, the FCC could have followed the EU's position that providing end users with a menu of options each with a different level of QoS did not represent favoring one application over another and thus constituted application agnosticism.

Two factors were more ambiguous. By enabling deployments that would not have otherwise been possible, network slicing arguably promoted both competition and innovation, investment, and broadband deployment. Indeed, network slicing marks a transition away from a one-size-fits-all model towards more tailored experiences that better serve end users' needs. At the same time, the 2015 Order reflected a concern that content- or application-based differential pricing may depress innovation. If successful, network slicing could also drive out other firms, which could stifle competition, innovation, and investment.

The overall economic impact of net neutrality represented a key point of contention during the proceedings leading to the 2017 Restoring Internet Freedom Order. Indeed, the FCC took advantage of studies analyzing the 2015 Open Internet Order as a natural experiment that showed that the imposition of strict net neutrality rules reduced investment and innovation.⁴⁶ Academic studies have largely drawn the same conclusion.⁴⁷ Similar studies analyzing the impact of the 2017 Restoring Internet Freedom Order are similarly likely to play a key role in any future regulatory proceeding to restore the net neutrality rules. Furthermore, evidence that

⁴⁶ FCC (2017, paras. 87–98).

⁴⁷ Briglauer et al. (2023, 538) (surveying the empirical literature, noting that all available contributions find that net neutrality regulations have a negative impact on network investment, and conducting a study finding that net neutrality regulations exert a significant and strong negative impact on fiber investments).

5G is emerging as a viable alternative in the home broadband market⁴⁸ suggests that intermodal competition may be increasing the level of rivalry in the BIAS market and that it is likely to reach an equilibrium with multiple players. It also emphasizes the key role that ensuring that net neutrality rules do not unduly hinder the deployment of 5G may play in facilitating entry by new players into a home broadband market that would benefit from more competition.

The factor focusing on conformance with industry standards represented something of a work in progress. A number of standards bodies are currently developing specifications applicable to network slicing. As these standards emerge, compliance with them would strongly militate in favor of compliance with the general conduct standard. The fact that these various factors point in different directions means that resolution of these conflicting considerations would have had to await further guidance from the FCC.

3.4. Exception for reasonable network management

The Commission acknowledged that network management practices may be “necessary for broadband providers to optimize overall network performance and maintain a consistent quality experience for consumers while carrying a variety of traffic over their networks.” Thus, consistent with the FCC’s 2005 Policy Statement and 2010 Open Internet Order, the 2015 Open Internet Order included an exception for reasonable network management.⁴⁹ As noted above, this exception did not apply to the rule against paid prioritization.

The text of the exception included two guideposts for determining what constitutes reasonable network management: First, the measure must have had “a primarily technical network management justification” and may “not include other business practices.” The attempt

⁴⁸ T-Mobile (2022).

⁴⁹ FCC (2015, paras. 32–34, 214–224).

to draw a distinction between technical and business justifications raised the same issues as the EU's attempts to draw a similar line between technical and business considerateness. Second, the Order required that to be reasonable, a network management technique must be "primarily used for and tailored to achieving a legitimate network management purpose, taking into account the particular network architecture and technology of the broadband Internet access service."⁵⁰

The Order offered further guidance as to the exception's scope by acknowledging that it included network management practices primarily used to "ensur[e] network security and integrity, including by addressing traffic that is harmful to the network" as well as practices "tailored to . . . addressing traffic that is unwanted by users." Practices designed to "alleviate congestion" were likely to be considered reasonable network management so long as they did so "without regard to the source, destination, content, application or service," operated "only during times of congestion" and were "based on a user's demand." Other factors favoring being regarded as reasonable network management included end-user control and application agnosticism.⁵¹

The 2015 Order diverged from the EU's Open Internet Regulation in one respect when it refused to limit reasonable network management to techniques employed during temporary and exceptional circumstances. Instead, creating such a specific definition risked obsolescence and limiting BIAS providers' flexibility to experiment with new management techniques. In addition, case-by-case review also allowed sufficient flexibility to allow them to take into account "the additional challenges involved in mobile broadband network management" as well

⁵⁰ FCC (2015, para. 215). The 2015 Order elaborated that a BIAS provider seeking to invoke this exception "must first show that the practice is primarily motivated by a technical network management justification rather than other business justifications." Note that comparing "technical network management justification" to "*other* business justifications" acknowledges that technical justifications are simply one type of business justifications.

⁵¹ FCC (2015, paras. 220–221).

as “the greater need to apply network management practices . . . more often to balance supply and demand while accommodating mobility.”⁵²

This guidance suggested that the analysis of what constitutes reasonable network management would have resembled the analysis under the general conduct standard. For example, the fact that network slicing is controlled by end users would have favored its legality, while its lack of application agnosticism would have cut in the other direction.

Whether network slicing would have qualified as reasonable network management under the 2015 Order is unclear. On the one hand, enforcement officials would have likely regarded network slicing as motivated by business rather than technical justifications. On the other hand, end user control and the refusal to limit reasonable network management to temporary and exceptional circumstances would have leaned in the opposite direction. Lastly, network slicing is both a generic platform and a means for providing QoS to specific applications that pushes at the limits of the traditional vision of reasonable network management. Network slicing would benefit from greater clarity on the circumstances under which network management can operate as a platform for all applications on an ongoing basis. Omitting the distinction between business and technical justifications or at least providing better guidance as to how that distinction would be struck would also be helpful.

3.5. Exception for non-BIAS data (specialized) services

Like the EU’s Open Internet Regulation, the 2015 Order carved out an exception for services that the Commission called “non-BIAS data services,” which the FCC previously called specialized services. These services shared capacity with BIAS and generally possessed three

⁵² FCC (2015, paras. 218, 222–224).

characteristics: (1) They were “not used to reach large parts of the Internet.” (2) They were “not a generic platform—but rather a specific ‘application level’ service.” (3) They “use[d] some form of network management to isolate the capacity used by these services from that used by Broadband Internet Access Services.” Prominent examples included “facilities-based VoIP, . . . Internet Protocol-video offerings, . . . e-readers, heart monitors, . . . energy consumption sensors, . . . automobile telematics, and services that provide schools with curriculum-approved applications and content.”⁵³

The Order opted to permit BIAS providers to offer non-BIAS data services while closely monitoring their development. In so doing, the FCC pledged to bring enforcement actions against non-BIAS services that provide providing the functional equivalent of BIAS, are being used to evade the open Internet rules, or are undermining investment, innovation, competition, or end-user benefits, particularly with respect to over-the-top services. Engaging in ongoing monitoring seemed the best way to “continue to drive additional investment in broadband networks and provide end users with valued services without otherwise constraining innovation.”⁵⁴

Consider also the three defining characteristics of specialized services described above. First, whether they allow users to reach large parts of the Internet varies with each implementation. Some network slicing operations may provide access to a large number of Internet endpoints, while others may not.

Second, the requirement that services be an application-level service rather than a generic platform is somewhat indeterminate. As noted above, network slicing falls outside the traditional distinction between measures designed to support specific applications that typify

⁵³ FCC (2015, paras. 207–209).

⁵⁴ FCC (2015, paras. 207, 210–211).

specialized services and measures that promote the efficiency of the overall network associated with reasonable network management in that it is both a generic platform and an architecture designed to provide differential QoS to the applications that need it.

Third, the use of network management to isolate the capacity used by specialized services from BIAS appears could be construed to require a degree of resource dedication that would be inconsistent with network slicing. Indeed, the ability to multiplex infrastructure without having to dedicate any capacity to a specific service is one of the key aspects that has made the Internet so successful.

Clarifications that non-BIAS can include flexible services targeted at multiple applications and does not require the dedication of resources would greatly reduce the risks of deploying network slicing. Indeed, the ability for multiple applications to share the same resources has long been one of the primary sources of the benefits created by the Internet. The net neutrality rules make sure that they do not prevent consumers from benefitting from the new technical capabilities that allow the sharing of resources in ever-more tailored and efficient ways.

* * *

Network slicing's status under the 2015 Open Internet Order is uncertain. The applicability of the rules to edge providers but not to enterprises means that they would apply to the practices of some firms but not others. The conversion of the nondiscrimination rule into rules against throttling and paid prioritization made the level of services provided relative to the baseline of the traditional best-efforts Internet critically important, particularly in light of the inapplicability of the exception for reasonable network management to paid prioritization. Both the seven-factor test for determining compliance with the general conduct standard and the guidance regarding reasonable network management were both somewhat ambiguous. The

exception for specialized services would have perhaps been the most promising basis for upholding the legality of network slicing, but the fact that it can fairly be characterized as both a generic platform and a means for providing enhanced QoS to applications that net it means that its precise outcome is a matter of interpretation and somewhat dependent on the particular use.

4. Conclusion

Both Europe's Open Internet Regulation and the impending revival of net neutrality rules in the U.S. have important implications for the innovative technologies and business models expected to support 5G. It is likely that 5G will connect a significantly larger number of devices and that those devices will place demands on the network that are increasingly diverse. The idea that the increasing diversity of demand will require increasingly differential treatment rests in uneasy tension with the principle of equal treatment of traffic underlying network neutrality.

The foregoing analysis identified the key interpretive issues that will determine the legality of network slicing under these provisions, focusing on the parallel provisions on reasonable traffic management and specialized services. Many of the other issues are quite similar to those raised in Europe. These include the requirement that measures be based on technical rather than business considerations and the distinction between measures aimed at improving the performance of the entire network or specific applications, both of which are problematic. Both regimes emphasize application agnosticism and end-user choice, although European law found effectively equated the two by finding application agnosticism to be implicit in end user control.

At the same time, the approaches taken by Europe and the U.S. have diverged in important respects. Whereas the European rules treat all businesses as end users protected by the rules, U.S. law reserved such treatment to edge providers while offering a more general

exemption for enterprises. The focus on throttling and paid prioritization in the U.S. instead of nondiscrimination means that compliance depended on whether the requested slice exceeded or fell below the baseline represented by the best-efforts Internet. Moreover, the U.S. rules refused to adopt the emphasis on whether measures are applied only under temporary or exceptional circumstances reflected in European law, while U.S. law included a focus on investment and industry standards that European law lacks.

Unfortunately, the regulatory language and the nonbinding interpretive guidance provided by BEREC and the FCC do not completely resolve the permissibility of network slicing under these rules. Ultimate resolution of these issues will have to await the deployment of 5G, enforcement decisions and actions by NRAs, and any subsequent judicial challenges to these decisions. Those who would like to see consumers enjoy the benefits of 5G can only hope that enforcement authorities and courts will enforce these provisions with enough flexibility to give innovation the room to experiment that it needs to thrive.

Acknowledgements

This work builds on analyses initially published as Yoo and Lambert (2019) and Yoo and Keung (2022). Fred Yu provided expert research assistance.

References

Biden, Jr., J. R. 2021. Executive Order 14,036 on Promoting Competition in the American Economy. *Code of Federal Regulations* 3:609–624.

Body of European Regulators for Electronic Communications. (2016). BEREC Guidelines on the Implementation by National Regulators of European Net Neutrality Rules, BoR (16) 127.

- . (2018). BEREC Opinion for the evaluation of the application of Regulation (EU) 2015/2120 and the BEREC Net Neutrality Guidelines, BoR (18) 244.
- . (2020). BEREC Guidelines on the Implementation by National Regulators of European Net Neutrality Rules, BoR (20) 112.
- . (2022). BEREC Guidelines on the Implementation by National Regulators of European Net Neutrality Rules, BoR (22) 81.
- . (n.d.). 5G. <https://www.berec.europa.eu/en/open-internet/5g>.
- Briglauer, W., Cambini, C., Gugler, K., and Stocker, V. 2023. Net neutrality and high-speed broadband networks: evidence from OECD countries. *European Journal of Law and Economics* 55(3):533–571.
- European Commission. (2023). Report from the Commission to the European Parliament and the Council on the implementation of the open internet access provisions of Regulation (EU) 2015/2120, COM(2023) 233 final.
- European Court of Justice. (2020). Joined Cases C-807/18 and C-39/19, *Telenor Magyarország Zrt v. Nemzeti Média- és Hírközlési Hatóság Elnöke*, ECLI:EU:C:2020:078 (15 September 2020). <https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:62018CJ0807>.
- . (2021a). Case C-854/19, *Vodafone GmbH v. Bundesrepublik Deutschland*, EU:C:2021:675 (2 September 2021). <https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:62019CJ0854>.
- . (2021b). Case C-5/20, *Bundesverband der Verbraucherzentralen und Verbraucherverbände v. Vodafone GmbH*, EU:C:2021:676 (2 September 2021). <https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:62020CJ0005>.

———. (2021c). Case C-34/20, *Telekom Deutschland GmbH v Bundesrepublik Deutschland*, EU:C:2021:677 (2 September 2021). <https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:62020CJ0034>.

European Union. (2015). Regulation (EU) 2015/2120 of the European Parliament and of the Council of November 25, 2015, laying down measures concerning open internet access and amending Directive 2002/22/EC on universal service and users' rights relating to electronic communications networks and services and Regulation (EU) No 531/2012 on roaming on public mobile communications networks within the Union. *Official Journal of the European Union* (L 310), 1-18.

Federal Communications Commission. (2005). In the Matter of Appropriate Framework for Broadband Access to the Internet Over Wireline Facilities, Policy Statement. *Federal Communications Commission Record* 20(17):14986–99.

———. (2010). In the Matter of Preserving the Open Internet, Report and Order. *Federal Communications Commission Record* 25(21):17905–18098.

———. (2012). Internet Access Service: Status as of June 30, 2011. https://apps.fcc.gov/edocs_public/attachmatch/DOC-314630A1.pdf.

———. (2015). In the Matter of Protecting and Promoting the Open Internet, Report and Order on Remand, Declaratory Ruling, and Order. *Federal Communications Commission Record* 30(7):5601–6000.

———. (2017). In the Matter of Restoring Internet Freedom, Declaratory Ruling, Report and Order, and Order, *Federal Communications Commission Record* 33(1):311–848.

- Patterson, G., et al. (2016). 5G manifesto for timely deployment of 5G in Europe.
<http://telecoms.com/wp-content/blogs.dir/1/files/2016/07/5GManifestofortimelydeploymentof5GinEurope.pdf>.
- Shannon, C. E. (1949). Communications in the presence of noise. *Proceedings of the IRE*, 37(1), 10-21.
- T-Mobile. (2022). 2022 The State of Fixed Wireless. https://www.t-mobile.com/news/_admin/uploads/2022/12/2945098_CCD_State-of-Fixed-Wireless-Access_Infographic-Report_REVW_v18_RGB-2.pdf.
- Yoo, C. S. (2010). Innovations in the Internet's architecture that challenge the status quo. *Journal on Telecommunications and High Technology Law* 8(1), 79–99.
- . (2016a). Modularity theory and Internet policy. *University of Illinois Law Review*, 2016(1), 1-62.
- . (2016b). Wireless network neutrality: Technological challenges and policy implications. *Berkeley Technology Law Journal*, 31(2), 1410-59.
- and Keung, T. (2022). Net neutrality, network slicing, and the deployment of 5G and 6G. In E. Bohlin and F. Cappelletti (Eds.), *Europe's future connected: Policies and challenges for 5G and 6G networks* (pp. 65–71).
- . & Lambert, J. (2019). 5G and net neutrality. In G. Knieps & V. Stocker (Eds), *The future of the Internet: Innovation, integration and sustainability* (pp. 221–245).