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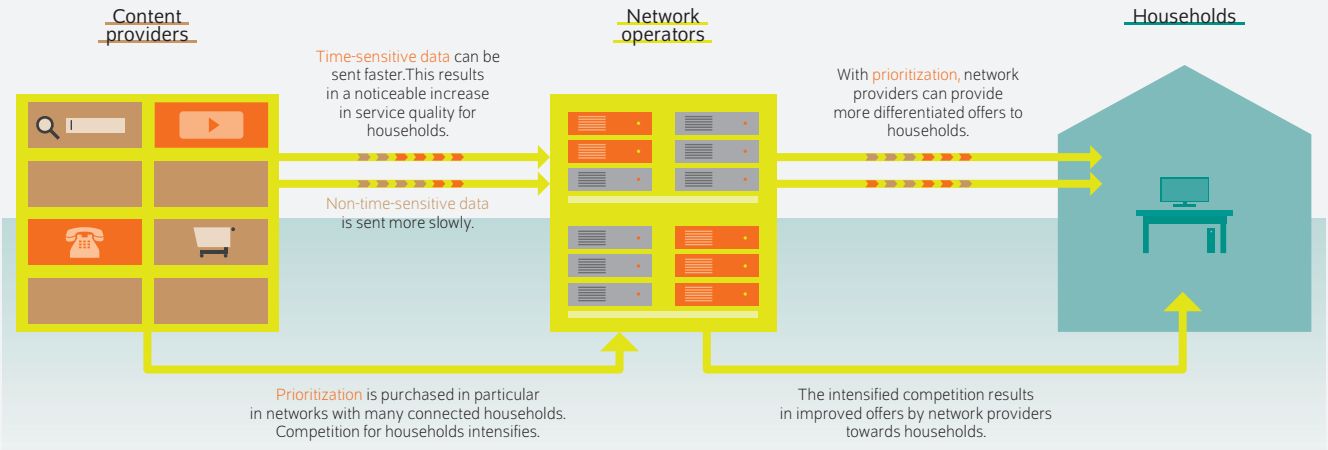
AT A GLANCE

Net neutrality: prioritization is beneficial from an economic perspective

By Pio Baake and Slobodan Sudaric

- The general possibility to prioritize data packets is beneficial from an economic perspective and can lead to a more efficient use of existing network capacity
- Competition among network operators would intensify and they could differentiate their offers more finely—private households would be the primary beneficiary
- Access to prioritization must be transparent and free from discrimination
- Modifications in the spirit of net neutrality must go hand in hand with a clear commitment to competition law and its enforcement
- The best-effort principle for data transmission was designed for non-time sensitive applications and cannot live up to the requirements of real-time applications

How households can economically profit from the introduction of data prioritization



Quelle: Eigene Darstellung.

FROM THE AUTHORS

"Prioritization would enable network operators to use their existing infrastructure more efficiently. However, freedom from discrimination and fair competition would have to be ensured, whether through explicit regulation or the consistent enforcement of existing competition laws – especially when it comes to companies of significant market power."

— Pio Baake, survey author —

Net neutrality: prioritization is beneficial from an economic perspective

By Pio Baake and Slobodan Sudaric

ABSTRACT

The principle of net neutrality was adopted by the European Union as a regulation promoting equality among all data packets in the Internet. Considering net neutrality from a purely economic viewpoint, however, the general possibility to prioritize data packets would likely lead to a more efficient use of existing network capacity. This is particularly applicable given the growth in data traffic and time-sensitive applications such as live streaming. Competition among network operators could intensify if they had the possibility to differentiate their offers more finely—and private households would be the primary beneficiary. However, modifications in the spirit of net neutrality must go hand in hand with a clear commitment to competition law and its enforcement. Access to prioritization of individual data packets must be transparent and equally available to all network participants. Network operators which also act as content providers as well as market participants with strong market positions in particular must not have the possibility to discriminate content providers.

The term "net neutrality" refers to the principle of treating all data traffic on the Internet the same, and without discrimination with respect to application or service.[1] Historically, it is based on the "best-effort principle," which means that all data packets are treated equally when they are transmitted from provider to provider in the Internet (Box 1). Neither the sender, recipient, packet content nor purpose of the data transmission plays a role. For a long time, this principle was considered fundamental but has been under debate in the last few years. In the U.S., the debate on net neutrality has led to fluctuation in development: regulations that are tight at some points in time are loosened at others.[2]

In the EU, the debate was stilled for the time being by Regulation (EU) 2015/2120 and the complementary Body of European Regulators for Electronic Communications (BEREC) guidelines on its implementation.[3] In effect, the EU has provided for the principle of net neutrality in order to ensure that end users can access content and information and choose among services and applications freely, while safeguarding the Internet ecosystem as a driver of innovation.[4] Exceptions are permitted for traffic management measures—for example in case of a temporary network overload—and services with special quality requirements. Those include applications within telemedicine and machine controls which rely on fast, reliable data transmission.

The EU regulations are supplemented by specifications promoting network operator transparency and the duty to inform. For example, they must provide information on how their traffic management process affects the quality of the Internet access offered and how possible volume restrictions could influence the use of applications and services. The national regulatory authorities are responsible for monitoring compliance. In Germany, the Federal Network

1 See Tim Wu, "Network neutrality, broadband discrimination," *Journal of Telecommunications and High Technology Law*, 2:141 (2003).

2 Insight into the development in the U.S. is provided in an overview by Yvonne Chan (available online, accessed June 5, 2018; this applies to all other online sources in this report unless stated otherwise).

3 Body of European Regulators for Electronic Communications (BEREC), BEREC Guidelines on the Implementation by National Regulators of European Net Neutrality Rules, 2016 (available online).

4 The European Parliament and the Council of the European Union, Regulation (EU) 2015/2120, points (1) and (3) (2015) (available online).

Box 1

Best-effort principle

This principle refers to network operators agreeing to transmit all data packets as quickly and with as high a quality as possible within the framework of their transmission capacity. The principle does not guarantee complete, perfect transmission. Instead, it reflects the network operators' general intention. Originally designed for non-time sensitive applications, the principle cannot live up to the quality requirements of real-time applications.

Box 2

Examples of Federal Network Agency measures for ensuring net neutrality

Equal access: According to the Federal Network Agency, there have been serious violations of the EU regulation in the form of prohibiting the use of voice over IP (VoIP), messaging services, and/or peer-to-peer applications. The conflicts were settled by adjusting the relevant network operators' general terms and conditions of business. The same applies to measures that fall under network management with unequal treatment of various applications and services. Zero-rating offers, in which the data traffic of selected applications and services are not throttled after they exceed volume restrictions, were also examined. As a result, Deutsche Telekom adjusted its zero-rating offer for Spotify such that data traffic for Spotify would also be throttled, for example.

Transparency: According to the Federal Network Agency, the majority of the complaints it receives deal with deviations between contractually agreed and actual download speeds. With its *Breitbandmessung* application,[1] the Federal Network Agency offers browser- and app-based options to measure the quality of Internet connections. The annual report on broadband measurement for 2016/17, based on trial measurements, showed that across all broadband classes and network operators, 71.6 percent of users received at least half of the contractually agreed maximum data transmission rate for downloads. For mobile broadband connections, the value was 18.6 percent.

1 Federal Network Agency application for measuring data transmission rates (available online).

Agency (*Bundesnetzagentur*) publishes annual reports about the measures applied to safeguard net neutrality (Box 2).[5]

Network requirements became more demanding

The authors will discuss the regulations from a purely economic viewpoint in the following. Other frequently emphasized aspects of the debate on net neutrality, such as safeguarding freedom of opinion, democracy, political control, or the preventions of political misuse, are not included in the analysis.

The economic analysis is based on the assumption that data traffic in both cable-based and mobile communication networks will continue to rise dramatically; it is also based on the observation that new time-sensitive applications, such as live streaming and telemedicine services or machine-machine communication, already add to or will add to the volume of data traffic. Also, developments in the Internet protocol now make it easier to differentiate between data packets and therefore handle their transmission differently.[6] On the other hand, transmission capacity in cable-based (partially copper-based) and mobile transmission networks remains limited.[7] High data traffic adversely affects data transmission and causes quality reductions in the user experience of applications and services.[8]

Internet stakeholders and approaches to prioritization

The key (economic) stakeholders in the Internet can be divided into three groups: households, content and application providers (such as Google, Netflix, Amazon, and news sites), and network operators (ISPs such as Deutsche Telekom and Vodafone in Germany) (Figure 1).[9] The latter provide connections to households and content providers, and therefore access to the Internet. In economic terms, they are the platforms upon which households and content providers interact. Connections between network operators are typically realized via direct interconnection or exchange points such as the Deutsche Commercial Internet Exchange (DE-CIX) in Frankfurt.[10]

Prioritizing the transmission of data packets for specific applications would boost their quality on the one hand. On the other hand, this would lead to potential sacrifices in quality for applications and services whose data packets continue to be transmitted according to the best-effort principle (Figure 2). Technologically, this would be based on reduced

5 Federal Network Agency, Netzneutralität in Deutschland Jahresbericht 2016/2017 (2017) (available online).

6 Examples include models of "differentiated services" where data packets can be divided into different classes and the data flow prioritized accordingly.

7 Yann Girard, Anselm Mattes, and Claus Michelsen, "Gigabit access: Germany lags behind in international comparison, but demand is also low," *DIW Weekly Report*, no. 25/26 (2018): XX (available online).

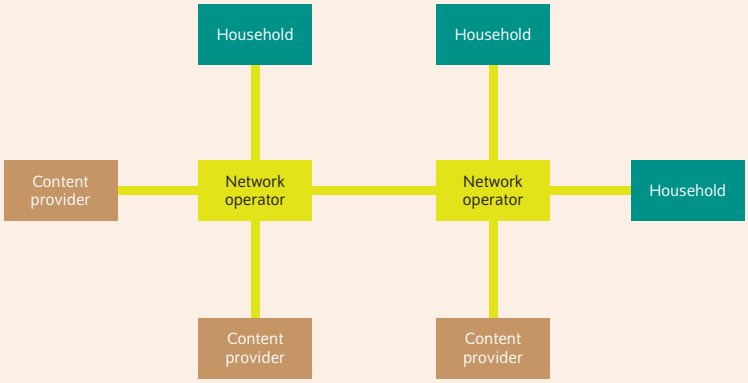
8 Quality reductions can be classified as a) latency or delays in end-to-end transmission, b) latency fluctuation (jitter), and c) the likelihood that individual data packets get lost.

9 On the following, see Pio Baake and Slobodan Sudaric, "Net Neutrality, Prioritization and the Impact of Content Delivery Networks," (computer printout, 2018).

10 In the case of direct interconnections between network operators, we can distinguish between peering and transit agreements. Peering agreements without direct payment between network operators are typically based on symmetrical data traffic. In transit agreements, network operators with high outgoing data traffic volumes pay fees to the transiting network operator.

Figure 1

Schematic representation of the key economic stakeholders in the Internet

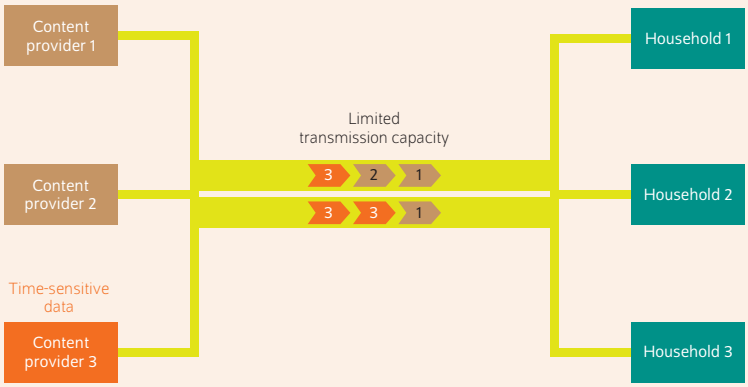


Source: Authors' own depiction.

Network operators provide the infrastructure through which consumers in the households have access to applications and services of the content providers.

Figure 2

Schematic depiction of a transmission of data packets according to the best-effort principle



Source: Authors' own depiction.

The time-sensitive data packet has to wait until transmission capacities are available: Households loose the potential additional benefit of the time-sensitive service.

transmission capacity for non-prioritized offers (Figure 3) or the delayed transmission of data packets through various exchange or connection points in the network (Figure 4).[11]

Prioritization leads to more differentiated offers

Within the framework outlined above, the debate around net neutrality and prioritization can be reduced to one question: should network operators be allowed to offer content providers the possibility of a prioritized data transmission?

From the viewpoint of content providers, prioritized transmission is an alternative to best-effort transmission by network operators. The alternative would be optional. The more the quality of a content provider's offer is influenced by transmission quality (e.g. time-sensitive applications)—and the more households and customers can be reached via the network of the respective network operator, the more valuable the prioritization alternative becomes.

From the perspective of network operators, prioritized transmission becomes an instrument for differentiating among content providers with different time-sensitive applications and services. The basis for differentiation is self-selection: content providers can decide whether or not they will pay to prioritize their data packets. The greater the number of households that are connected to a network, the more profitable prioritization becomes. In other words, the greater the number of households that can be reached, the higher the demand for prioritized transmission.

This creates an incentive for network operators to increase the number of connected households by reducing subscription prices. Without prioritization, this incentive does not exist.

Households would be the beneficiaries of prioritization

It seems obvious that network operators would take advantage of the prioritization option if they were permitted to do so. Which content providers opt for prioritization depends on how time-sensitive their offers are. Since only offers with sufficiently high added quality would be prioritized, indicating a higher willingness to pay for said prioritization, the selection process would be efficient. Households would not only enjoy the benefit of higher quality if offers were prioritized. They could also count on increased competition for their subscription.

The outcome is, however, ambiguous with regard to the consequences for network operators and content providers. Network operators would earn more income as a result of prioritization, but on the other hand they would have less

11 For the new 5G mobile communication standard, a division into logical networks (network slicing) with different quality characteristics is under discussion. Delayed transmission can be mapped by queuing models such as the MM1 model. In these models, prioritization increases the (average) processing or waiting time for non-prioritized data packets, while this effect becomes smaller if the total available capacity is large. Pio Baake and Slobodan Sudaric (see above) used an MM1 model.

income due to more intense competition for household subscriptions driving subscription prices downward. Altogether, the situation could put network operators in a so-called prisoner's dilemma: each operator would benefit from prioritization, but if they all do so their profits decrease.[12]

The effect on content providers is also twofold. The providers that do not prioritize will lose out due to reduced transmission quality, while those whose applications are time-sensitive will benefit.

Investment incentives for network operators could rise

Regardless of the detrimental effect regarding non-prioritized applications, prioritization would increase static efficiency overall. It is in the interest of network operators to make their networks as attractive as possible to households. They can achieve this by adjusting the prioritization price schedule for content providers in a way that increases the average quality of all applications.

A similar argument applies to the incentive for network operators to invest in their network infrastructure. The frequently voiced presumption that implementing prioritization would reduce incentives to invest[13] proves to be shortsighted, since it overlooks the reciprocal effects between the number of subscribing households and demand for prioritization on the part of content providers. Investing in the network increases transmission capacity and the appeal of the network. If the number of subscribing households increases as a result, this will increase demand for prioritization—a positive effect from the perspective of network operators that is impossible to benefit from under strict net neutrality.[14]

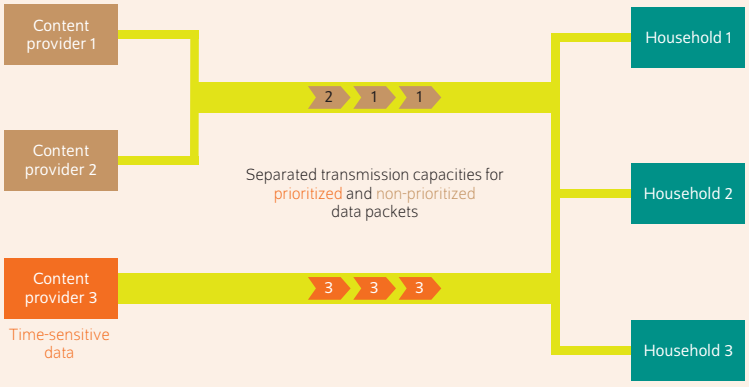
Competition and non-discrimination are essential

Our previous argumentation assumed that prioritization would be offered as an extra option alongside pure best-effort transmission. This implies that the process would be free from discrimination and all content providers would have the same prioritization options for their data traffic. It also assumes that there is competition among network operators for household subscriptions.

The last point depends both on the number of network operators and the quality of information households receive as they decide which network operator to subscribe to. Here, the transparency obligations which are part of the EU regulation play an important role. If households have clear

Figure 3

Schematic depiction of a transmission of data packets with prioritization (separation of transmission capacities)

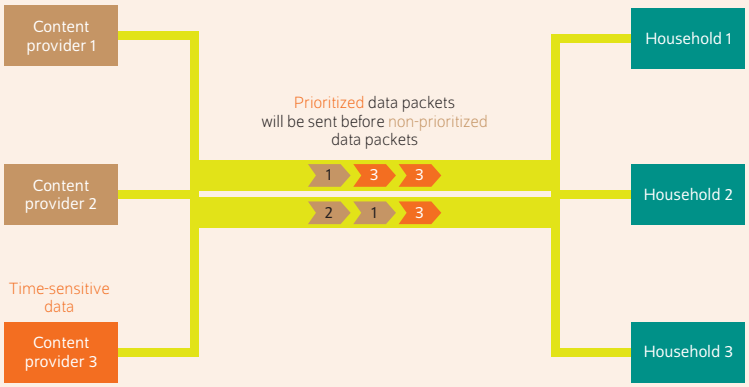


Source: Authors' own depiction.

A part of the available transmission capacity is reserved for time-sensitive data packets: These can now reach households without having to wait for non-prioritized data.

Figure 4

Schematic depiction of a transmission of data packets with prioritized transmission



Source: Authors' own depiction.

Time-sensitive data will be sent before non-prioritized data to ensure a smooth performance of time-sensitive applications. The transmission of non-prioritized data is delayed.

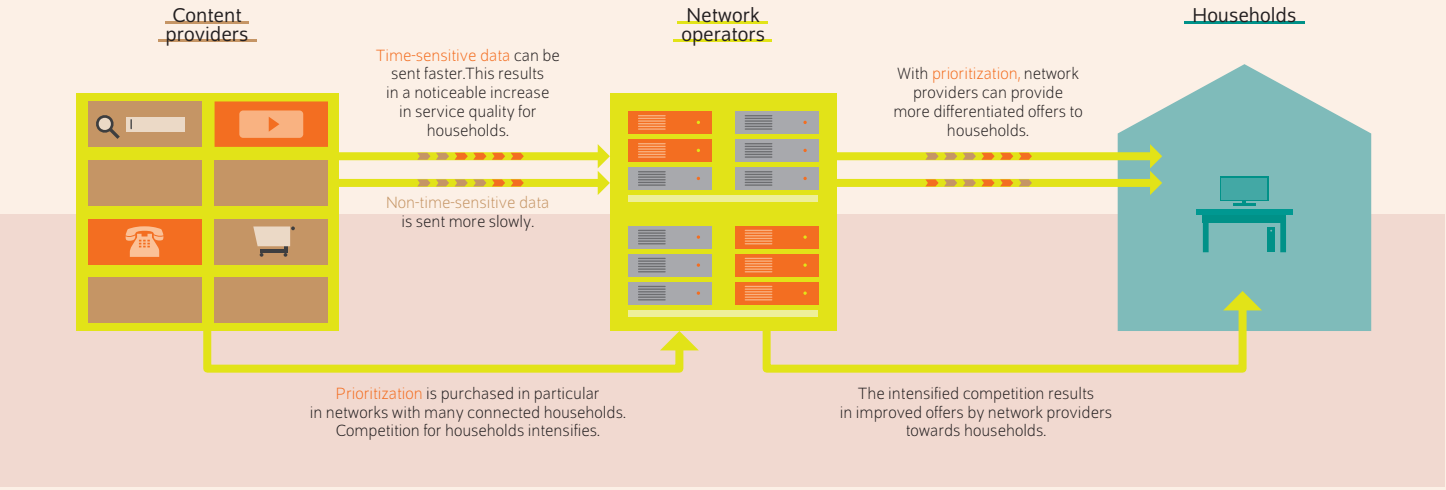
12 For more on this finding, see Marc Bourreau, Frago Kourandi, and Tommaso Valletti, "Net neutrality with competing internet platforms," *The Journal of Industrial Economics*, 63(1) (2015): 30–73.

13 See for example Federation of German Consumer Organisations, Fünf Mythen zur Netzneutralität, (2015) (available online).

14 Other studies arrive at similar results regarding network operators' incentive to invest. See Jan Krämer and Lukas Wiewiorra, "Network neutrality and congestion sensitive content providers: Implications for content variety, broadband investment, and regulation," *Information Systems Research* 23(4) (2012): 1303–1321. Others had inconclusive findings, see Jay Pil Choi and Byung-Cheol Kim, "Net neutrality and investment incentives," *The RAND Journal of Economics*, 41 (3) (2010): 446–471.

Figure 5

Households profit in several ways from the possibility of prioritization



Source: Authors' own depiction.

Better offers by network operators as well as improved time-sensitive applications and services by content providers give additional benefits to households.

information on the transmission quality they will receive, whether or not content providers offer prioritization and the extent to which they actually use it, prioritization will intensify the competition among network operators. The possibility to offer prioritization, allows network operators to further differentiate their offers which are available for all market participants in the same way.

The demand for non-discriminatory prioritization offers can be viewed as a safeguard against misuse. This applies to content providers with strong market positions and vertically integrated network providers, which offer applications and services alongside Internet subscriptions, and thus act as content providers at the same time. The less intense the competition between content providers, the easier it will be to grant exclusive contracts for prioritized data transmission to the disadvantage of competing content providers. The same applies when network operators offer their own content and give their data preferential treatment.

To avoid this risk, regulations must stipulate non-discriminatory offers for prioritization and consistently enforce existing competition laws.

It is difficult to say how prioritization would affect content provider innovation. On the one hand, the increase in transmission quality from prioritization could be the basis for new business models that rely on providing highly time-sensitive applications. Autonomous driving or telemedicine are only two of the applications that could benefit. On the other hand, we must be aware that data traffic prioritization could lead to a decrease in best-effort transmission quality if network capacity remains constant. Content providers that continue to rely on best-effort transmission could be faced with additional challenges as a result.

Conclusion: prioritization is economically beneficial. Effective competition is essential

In view of limited network capacity and constant technological innovation, theoretical considerations show that exemptions from the principle of net neutrality such as prioritization of data traffic could be economically beneficial. Prioritization would enable network operators to use their existing infrastructure more efficiently. At the same time, competition for household subscriptions would become more intense and network operators would have greater incentive to expand and improve their networks. However, freedom from discrimination and fair competition would have to be ensured, whether through explicit regulation or the consistent enforcement of existing competition laws. It is essential to guarantee equal access to the differentiation options for everyone in order to ensure equal opportunity among content providers. Transparency and traceability is also essential for competition to function properly, whether this involves the definition of specialized services, network operators' offers of differentiation options, or providing private Internet connections.

Pio Baake is deputy head of the Competition and Consumers Department at DIW Berlin | pbaake@diw.de

Slobodan Sudaric is a research assistant at Humboldt-Universität zu Berlin | sudarics@hu-berlin.de

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DIW Berlin — Deutsches Institut für Wirtschaftsforschung e. V.
Mohrenstraße 58, 10117 Berlin
www.diw.de
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