Response to BEREC Public Consultation on Net Neutrality Guidelines

To
BEREC
NN-Evaluation-Consultation@berec.europa.eu

From
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Subject
Response to BEREC Public Consultation on an evaluation of the application of the BEREC Net Neutrality Guidelines

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Date
18 April 2018

On March 8, 2018, BEREC invited stakeholders to participate in a public consultation on an evaluation of the application of the BEREC Net Neutrality Guidelines, in the context of the European Net Neutrality Regulation. TNO recently finished a detailed study on the alignment of the European rules for net neutrality and 5G mobile network technology. The relation between the rules and new technologies such as 5G is one of the topics addressed in the public consultation. TNO therefore offers the results of its study for consideration by BEREC and other stakeholders. Our analysis puts forward several overall messages for policy makers and industry. It also provides a detailed analysis of nine topics that will appear in the net neutrality assessments that national regulatory authorities, network operators and application providers will make. These topics are important for applications and services to be supported by 5G, either over Internet Access Services or as Specialised Services. They are also relevant for services provided over 4G and fixed networks. The approach and results of the study are summarised below. The full report is available at tno.nl[1].

TNO has initiated this study to provide a functional and factual underpinning for the policy discussion on 5G and net neutrality. The sponsors for the study reflect the multi-stakeholder environment of the 5G and net neutrality discussion: the Ministry of Economic Affairs and Climate Policy, the Authority for Consumers and Markets, KPN, T-Mobile, Nokia, Ericsson, Huawei and the industry association FME.

Summary of study

Context

The importance of mobile connectivity grows as networks and applications expand further in important sectors in society, such as mobility and transport, health, manufacturing, media and public safety. Many of the applications in these so-called verticals are expected to demand tailored mobile connectivity, for example extremely short delays, high reliability or low power consumption. With today's 4G

[1] http://publications.tno.nl/publication/34626427/NhaOCU/TNO-2018-R10394.pdf

mobile networks, it proves to be difficult for mobile network operators to meet such demands, for example, because of technical limitations or high costs. The next generation of mobile networks, commonly labelled as 5G, is developed to address the new application requirements through technologies such as network slicing and edge computing. With these new technologies, mobile operators have the technical capability to provide a range of connectivity flavours, tailored to the diverse requirements from vertical applications.

Mobile networks, including those with the new 5G connectivity features, are subject to the rules in the EU regulatory framework, The EU Regulation 2015/2120 sets the rules for net neutrality. BEREC has published Guidelines that provide guidance on the implementation of the rules. The Regulation and the Guidelines emphasize the open access of consumers to the global public internet. To this end, they contain detailed rules and guidance aimed at protecting Internet Access Services. The general rule is that Internet Service Providers (ISP)s must treat all traffic equally, which seems to be at odds with the 5G view to provide tailored connectivity to verticals and applications. In a further refinement of the general rule, the Regulation and Guidelines do offer room for traffic management and differentiation between traffic flows, subject to specific conditions. There is also the option to provide so-called Specialised Services in parallel to Internet Access Services, again subject to specific conditions.

The views among policymakers and industry on the alignment of the EU Regulation with its rules and conditions for Internet Access Services, Specialised Services, and 5G technology vary and have led to debate:

- Several industry parties fear a strict interpretation of the rules, which would in their view prevent the roll-out of tailored network services for verticals and reduce 5G to merely a faster version of 4G;
- Several policymakers expect that the Regulation and Guidelines provide the room needed for the uptake of a range of differentiated IP connectivity services and therefore cannot readily acknowledge these industry concerns.

The different views introduce a degree of uncertainty on what types of tailored connectivity will be allowed in 5G networks. This uncertainty can affect the technical and investment roadmaps of the operators and the companies in sector verticals. Industry parties and policymakers do, however, agree on the overall need for the roll-out of 5G infrastructure and applications, for business and societal reasons.

Approach and scope

TNO has taken the initiative for this study that aims at providing a functional and factual analysis of the alignment between 5G and net neutrality. The study is motivated by earlier discussions that TNO had with the Ministry of Economic Affairs and Climate Policy, the Authority for Consumers and Markets, telecom operators KPN and T-Mobile and equipment suppliers Nokia, Ericsson and

Huawei (through the industry association FME). The study approach has been proposed by TNO and accepted by these sponsors. The assessment of the alignment of 5G with European net neutrality rules is carried out according to the following steps:

- Identification and description of key connectivity requirements of future applications in three sectors selected by TNO: Media, Intelligent Transport Systems and Public Safety;
- Identification and description of the key technical options in future mobile networks for providing such connectivity, based on the 5G network functions that are being standardized by 3GPP;
- Mapping of the European Net Neutrality Regulation and Guidelines to these options, in the context of the selected application domains;
- Assessment of the alignment between the 5G architecture options and the net neutrality rules, including the indication of areas where the application of the rules is expected to be relatively straightforward and where their application can be expected to be more complex.

The analysis has been restricted to the technical description of mobile connectivity required in emerging applications and the mapping of net neutrality rules to this connectivity. This means that business and commercial aspects, the formulation of policy recommendations and suggestions for changes to the Regulation and Guidelines are explicitly out of scope of the project. The analysis has been conducted using publicly available and verifiable sources. The technical analysis of 5G technology is based on 3GPP Release 15 specifications. The net neutrality rules and their interpretation are taken from the EU Regulation and the BEREC Guidelines. In addition to these sources, we have benefitted from the information and insights provided by subject matter experts in a series of interviews.

Three use cases

For the identification and description of the key connectivity requirements in the sector verticals, three specific use cases have been developed, one for each sector. The use cases obviously have a narrower scope than the sectors they are taken from. Still, each of them introduces crucial connectivity requirements. Together, they present a variety of challenging requirements for 5G mobile networks. The use cases are:

- *Virtual Reality (VR) in media and entertainment*. The next generation of VR applications builds on the availability and growing adoption of head-mounted devices like the Samsung Gear VR and Oculus Rift. The streaming of 360-degree VR content introduces challenging requirements for bandwidth and network latency. The VR case is also relevant because of the potentially large impact on the overall network load in case of mass market adoption.
- *Critical communications in Public Safety.* Reliable mobile communications are crucial for the effective operation of police, fire brigade and medical

services during emergency situations. Until now, dedicated networks based on the TETRA standard have been used to guarantee the high service availability requirements in a broad variety of calamity scenarios. The public safety sector has recognised the need to move from dedicated standards to generic commercial technology for their critical communications. This introduces a very stringent requirement for the availability and reliability of mobile connectivity.

- *Automated Driving.* In automated driving, vehicles will maintain a certain required level of autonomy but also make use of sophisticated cloud services. Enhanced driving and manoeuvring functions typically require an environmental perception beyond the vehicle's own sensor range, such as positions and speeds of other vehicles and traffic light systems. Automated driving applications introduce stringent requirements for the reliability of the connectivity. Depending on the specific automotive function, the required network latency must be very low.

5G technology ingredients

3GPP has set several goals for its development of 5G, such as the support of higher data rates, larger network capacities and a (much) higher number of devices. Another an important goal is to introduce the technical capability for mobile operators to provide tailored connectivity to specific sectors, user groups and applications. This goal is crucial in the context of this study and it is reflected in the following key 5G technology ingredients:

- *Network Slicing*. Through (network) slicing, mobile operators can create separated virtual mobile networks on top of a single physical network infrastructure, both in the radio and the core network. Different slices can have different performance characteristics, for example in bandwidth, latency, reliability and the types and numbers of devices they can handle. Slices can also contain specific processing and storage functions.
- *Local access to Data Networks and Edge Computing*. Local access architectures aim to improve the latency and bandwidths offered to end users and applications by shortening the distance that traffic travels in the mobile network. This is done by handing over the traffic to the internet or to application servers near the location of the end user.
- *QoS differentiation*. QoS differentiation in 5G is to a large extent similar to that in 4G. It enables mobile operators to differentiate between traffic flows and introduce relative priorities. In 3GPP, several 5G QoS Identifier values have been standardised with an indication of example services for which they could be used, such as voice, real-time gaming and mission-critical data.
- *Unified access control*. Access control provides a mechanism for mobile operators to bar or allow network access for selected categories of devices. It is aimed providing coarse-grained traffic management during severe congestion situations. Examples are the option to provide access

for emergency calls only or only for devices configured for mission critical services.

For each of the three use cases in this study, various combinations of the 5G technology ingredients have been used to develop several options for their implementation in 5G architectures. In a second step, the architecture options for the three use cases have been consolidated in a single 5G architecture model. This consolidated 5G architecture is the technical starting point for the assessment of the alignment of 5G with net neutrality rules.

Conclusions on alignment of 5G architectures with net neutrality rules

The technological neutrality of the Regulation allows 5G network technology itself to develop. There is no a priori ban on any 5G technology ingredient.

Our analysis underlines the importance of technological neutrality. This is a well-established principle that is adhered to in the Regulation and the Guidelines. It plays a crucial role in the analysis. What matters for the compliance with net neutrality rules is how the 5G technologies are used to support services and applications, rather than the technologies themselves. Therefore, the European net neutrality rules do not introduce a ban on any 5G technology ingredient, also not on the technologies that are being developed with the aim to differentiate between traffic flows and applications.

The assessment of the alignment of 5G with net neutrality rules depends not only on the 5G technologies, but also on the specific combination of services, applications and network architecture. It is not possible to come to an overall assessment with a single outcome on the alignment of 5G technology with net neutrality rules.

The central question in the assessment of the compliance with net neutrality rules is whether the services and applications supported by the 5G technology components adhere to the conditions and rules for Internet Access Services and Specialised Services, whichever are applicable. It is these conditions and rules that determine the room for mobile operators and content and application providers (including those from vertical sectors) in their use of 5G technology. In our analysis, slicing provides a relevant illustration of this point. Slicing is a key 5G technology that mobile operators may want to use in support of many different services and applications. The use of slicing will vary, as illustrated in the consolidated 5G architecture in the figure below.

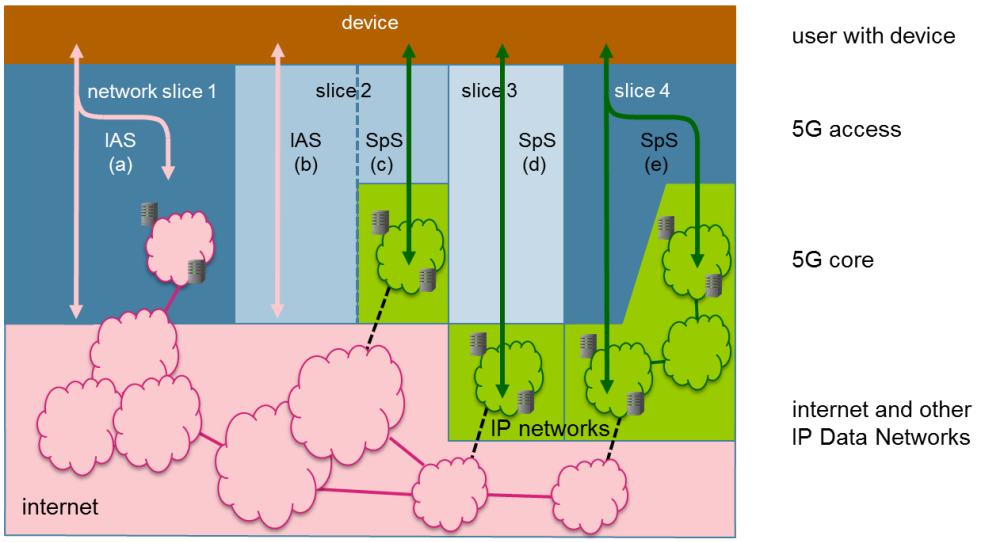

Figure: Consolidated 5G architecture view with multiple slices in a single mobile operator network, supporting Internet Access Services (IASs) and Specialised Services (SpSs).

In 5G architectures that use slicing, an Internet Access Service is always in a slice. A slice can be used exclusively to provide an Internet Access Service (slice 1). Alternatively, a single slice can be used to simultaneously provide an Internet Access Service and a Specialised Service (slice 2). A slice can also be exclusively used to provide a Specialised Service (slices 3 and 4). Thus, the use of slicing technology in a mobile operator network can bring in the rules for Internet Access Service, for Specialised Services or both, depending on the services and applications that are supported. It is not possible to come to an overall assessment with a single outcome on the alignment of slicing with net neutrality rules. This is because the topics that are encountered in the assessment and the outcome depend not only on the 5G technology, but also on the specific combination of services, applications and network architecture. This is true for network slicing, but also for other key 5G technologies such as QoS differentiation. A consequence is that mobile operators, content and application providers and national regulatory authorities will need to do further analysis to evaluate whether a particular type of (tailored) connectivity complies with the net neutrality rules.

The topics encountered in the assessment of the compliance are of varying complexity. The impact of Specialised Services on Internet Access Services *and* the objective need for optimisation in Specialised Services *are expected to have the highest complexity.*

Based on our analysis of the three use cases and the key 5G technology ingredients, we have identified nine topics that are relevant in the assessment. We have positioned these topics in the consolidated 5G architecture to show typical situations where they come into play, see the figure below.

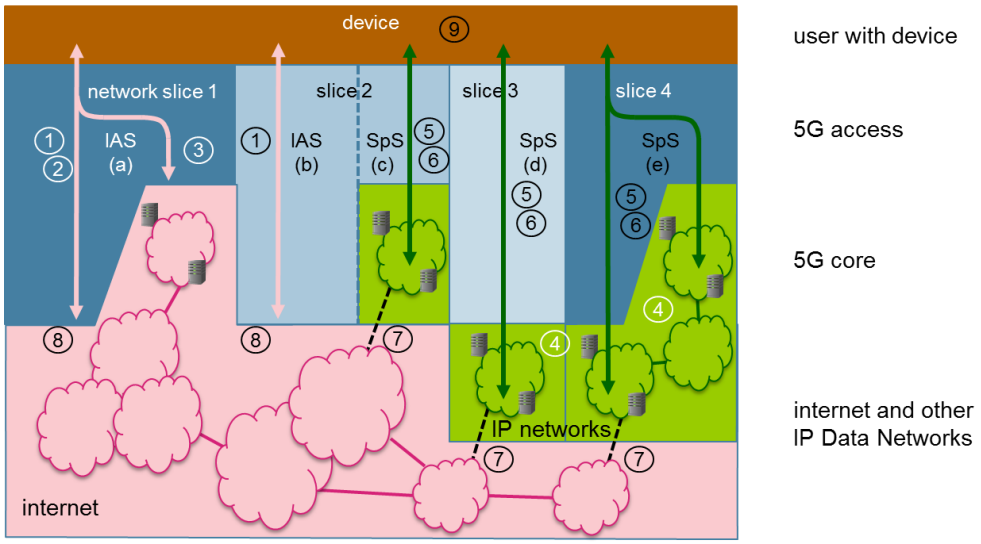

Figure: Consolidated 5G architecture with multiple slices in a single mobile operator network, supporting Internet Access Services (IASs) and Specialised Services (SpSs). The numbers indicate topics where the alignment between net neutrality rules and 5G architecture options has been investigated.

The topics are summarised in the table below, together with our expectation for their relative complexity in assessments of compliance with net neutrality rules. We define this as the relative complexity expected to be encountered by national regulatory authorities, mobile operators, and content and application providers when they analyse specific cases with more context information and (quantitative) details than the use case-inspired analysis made here. All key points mentioned in the second column in the table are discussed in the main body of this report.

Table: Topics encountered in assessment of alignment of 5G architecture options with net neutrality rules and their expected relative complexity. IAS means Internet Access Service, SpS means Specialised Service.

Topic	**Key points identified in analysis**	**Relative regulatory complexity**
1. Multiple IASs with different traffic management settings	• Interpretation of *sender and receiver* in Art 3.3 of the Regulation • Note: assumption needed in remainder of analysis - it is allowed to have multiple IASs with different traffic management settings for a given end user	low
2. QoS differentiation within IAS	• Applications with multiple different traffic flows • Transparency through standardised traffic classes or other methods • Dependency of ISP on other entities for assignment of traffic flows to traffic categories • Duration of QoS differentiation	medium to high

Topic	*(continued from previous page)* **Key points identified in analysis**	**Relative regulatory complexity**
3. Local access to the internet	• (potentially:) IP interconnection of local networks	low
4. Public and private services and associated networks	• Size and scope of predetermined group of end users in private service	low to medium
5. Objective need for optimisation in SpS	• Determination of IAS for benchmark in case of multiple IAS offers • Variation of IAS performance between geographical regions and operators • Services comprising multiple traffic flows	high, except if SpS requirements are clearly much stricter than achievable over IAS.
6. Impact of SpS on IASs	• Multiple IASs affected by one SpS, within and outside the slice used for the SpS. • Isolation of the effect of the SpS on IAS from other effects occurring in mobile network at the same time • Complexity of network and capacity management in mobile network with many services and applications in general	high
7. SpS and connections to the internet	• Connectivity to internet from SpS through separate IAS • Connectivity between different legs between end user device and internet	low
8. Connectivity to limited number of internet end points	• Evaluation whether sub-internet service is acceptable for providing connectivity in specific situations	medium
9. Access control	(no issues if use is restricted to network congestion in emergency situations)	low

In our analysis, we found that several topics which appear to be complex at first sight, such as *Specialised Service and connections to the internet*, become relatively straightforward to assess once the details of the architecture options and the Regulation and the Guidelines are carefully combined. We expect that the low to medium complexity topics lend themselves to the formulation of “rules of thumb” within national regulatory authorities, mobile operators, and content and application providers. They can be formulated based on internal analysis or, at a later stage, be derived from the outcomes of earlier cases assessed by national regulatory authorities. Other topics such as the *impact of Specialised Service on Internet Access Services* can be expected to remain relatively complex. There are no fundamental problems that prohibit their analysis. However, the complexity of these topics is likely to make them unsuitable for a generic “rule of thumb” approaches. They require a case-by-case approach. The complexity depends on

the level of detail that national regulatory authorities, mobile operators, and content and application providers pursue in their analyses.

The topics encountered in the assessment are relevant for services and applications provided over mobile and fixed networks in general. They are not exclusively related to 5G technology.

A final observation is that the topics identified as relevant in the assessment are not exclusively related to 5G. They can also present themselves in the analysis of services and applications provided over 3G, 4G and pre-5G networks. As the Regulation and Guidelines are to a (very) large extent technology neutral, the analysis of the topics would be largely similar. The topics can be expected to be more relevant in 5G networks though, as 5G technology provides more extensive support and flexibility for tailored mobile connectivity aimed at specific sectors or user groups. The topics can also present them in fixed networks.

Recommendations

Our first recommendation is to clearly distinguish between 5G architecture elements on the one hand and the net neutrality concepts of Internet Access Service and Specialised Service on the other. One should keep a technology-neutral view and not attempt to define a one-to-one mapping between the two. Two important examples of this are:

1. A slice is not the same as a specialised service. Slicing can be used to support an Internet Access Service, a Specialised Service or both.
2. The application of QoS differentiation is not limited to Internet Access Service. QoS differentiation can be used as a method for traffic management within an Internet Access Service. However, it can also be used to assure the quality of Specialised Services. A prominent example of the latter is the VoLTE architecture in 4G networks.

Our second recommendation is that subject matter experts at national regulatory authorities, mobile operators, and content and application providers build upon our approach and findings in their assessments. We expect that the consolidated architecture model provides a good starting point to structure the overall discussion on services and applications over 5G networks and their compliance with net neutrality rules. For the analysis of specific services and applications, the three-step approach applied to the use cases in this report is recommended:

1. Determine the connectivity requirements of the services and applications in the use case.
2. Develop the 5G architecture options to support the connectivity requirements. The 5G technology ingredients described in this report are expected to play an important role here.

3. Evaluate the alignment of the combination of services, applications and architecture options with net neutrality rules. Here, the analysis of the specific topics made in this report can probably (partly) be reused.

Mobile operators, content and application providers and national regulatory authorities can use this approach to develop their own individual analysis. These steps can also be used to structure the discussion among stakeholders and come to a shared analysis. Such a shared analysis would be beneficial for providing clarity and reducing uncertainties that industry may encounter in its development of roadmaps for 5G networks and applications that rely on tailored connectivity.