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Net neutrality in Europe and the role of broadband measurement



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“Digital technologies are going into every aspect of life. All they require is access to high speed internet. We need to be connected. Our economy needs it. People need it. And we have to invest in that connectivity now.”¹
Jean Claude Juncker, President of the European Commission, State of the Union speech 2016

Introduction: EU Leadership and the Open Internet

The EU's network neutrality rules² codified into law the technical principle of nondiscrimination that animated the creation and growth of the Internet as an open market for digital speech and commerce. These rules guard critical values of free speech, innovation, and inclusivity on an open Internet. They sit at the center of a liberal, democratic system of Internet governance.

In order to shoulder the burden of protecting the open Internet, Europe must focus on effective implementation of net neutrality regulations. That means vigilance to spot violations before they become systemic problems and speedy redress for any complaints that may arise. The National Regulatory Authorities (NRAs) in each member state may do this work by requiring self-reporting from network owners and responding quickly to consumer complaints. But a systematic, data-driven approach that does not rely on reporting supplied by the network owners would be far superior. This can be done by monitoring the performance of Europe's networks, watching out for signs of network congestion that are the hallmarks of net neutrality violations.

Anticipating this necessity, the EU's net neutrality regulations provide that all NRAs in member states should establish a performance measurement system for Internet Service Providers (ISPs) independent of the network operators. These tools are intended not simply to measure the speed and reliability of connections to ensure consumers get what they paid for. They are intended to serve as an early-detection system for anomalies in network management and traffic flow that might indicate a net neutrality violation. In the wake of the US abandoning net neutrality – which will no doubt trigger new momentum for discriminatory practices – it is all the more important for these measurement systems to be seen as a critical part of defending the open internet worldwide. European measurement systems could fill the

¹ <https://ec.europa.eu/digital-single-market/en/news/commission-paves-way-more-and-better-internet-connectivity-all-citizens-and-businesses>

² <https://ec.europa.eu/digital-single-market/en/open-internet-net-neutrality>



gap by encouraging evidence based policy decisions in the US and beyond, as India is also starting to look at similar network measurement systems to enforce their upcoming net neutrality protections.

This paper provides of an analysis of how internet performance measurement sits at the center of EU digital policy – providing oversight for both broadband deployment policies and net neutrality. With a focus on tracking network congestion, NRAs can utilize crowdsourced speed test data to hold network owners accountable and protect consumers. A summary review of how member states have begun to do this work shows promise but also indicates the need for harmonization. The final section offers recommendations for how to set up EU-wide measurement practices that are based on open code and produce open data. The successful implementation of this interoperable measurement framework will prove a critical bulwark for the EU's defense of net neutrality and simultaneously incentivize broadband buildout.

Broadband Buildout, Performance Measurement and Net Neutrality

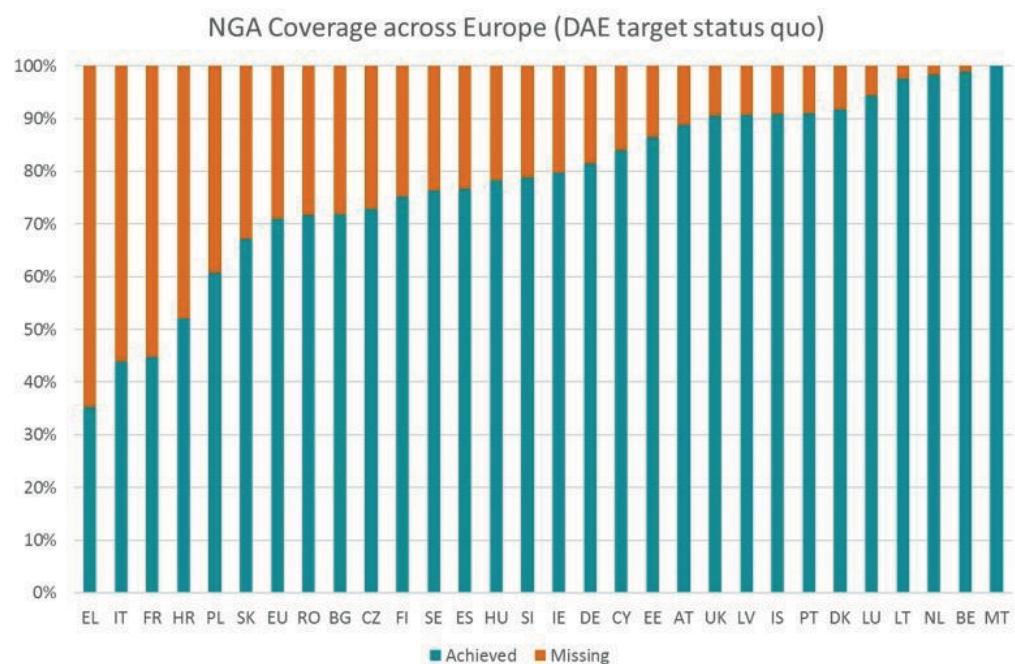
For many years, the EU has pushed forward broadband infrastructure policy as a central part of its economic agenda. To realize the promise of the Digital Single Market, member states must achieve two important and related goals: (1) build out a broadband infrastructure that grows in capacity to meet the demand of expanding online markets; and (2) guarantee that this infrastructure is non-discriminatory towards all content, applications and services to maximize innovation.³ Both of these policies will benefit from a harmonized framework of Internet performance measurement that focuses on monitoring Internet performance as experienced by Internet users. The reason is simple. A degradation in the performance experienced by Internet users demonstrates a failure to appropriately build out and invest in infrastructure. The absence of timely upgrades shows either market failure or inadequate policy to incentivize network expansion – both of which may be addressed by regulators. In addition, conditions of congestion are the scenarios in which network neutrality violations are likely to occur and require effective regulatory oversight. By contrast, networks without significant performance

³ The EC is convinced that net neutrality has positive implications for innovation in services and applications. <http://berec.europa.eu/eng/netneutrality>



problems have less need or reason to discriminate among different types of content and services.

What we know now about the speed/capacity of ISPs is largely based on self-reported statistics of advertised speeds provided by the network owners. Not surprisingly, they report no data about congestion. According to the figures we do have, progress towards the buildout of next generation broadband networks across member states has been uneven. The current targets are to cover all European households with access to download speeds of at least 30 megabits per second (mbps) by 2020, and 100 mbps by 2025⁴. In order to achieve these goals, the European institutions channel substantial resources into programs that build out infrastructure⁵, and monitor developments on the national level in the Digital Agenda scoreboard⁶. According to the latest figures (2016 numbers), the coverage of households with access



4 Delivering on its Digital Single Market strategy, the European Commission adopted on 14 September 2016 the policy package “Connectivity for A European Gigabit Society”, a set of initiatives and legislative proposals to place the EU at the forefront of internet connectivity. <https://ec.europa.eu/digital-single-market/en/policies/improving-connectivity-and-access>

5 The European Commission, and the European Investment Bank announced in December 2016 a Connecting Europe Broadband Fund worth 500 Million Euros. http://europa.eu/rapid/press-release_IP-16-4351_en.htm Other investments have been channeled via the so-called Juncker Plan, e.g. 150 Million Euros to build out a mobile network in Greece in July 2017. http://europa.eu/rapid/press-release_IP-17-1957_en.htm

6 <https://ec.europa.eu/digital-single-market/en/digital-scoreboard>

to speeds of at least 30 mbps in the EU lies at 71 percent⁷. These numbers appear to represent reasonable progress towards the 2020 benchmark.

However, the actual experience of European broadband subscribers may not match these performance levels. The download speeds calculated in the scoreboard above do not represent the actual speed that end users will experience – they represent the advertised speeds of the products sold in each market. Very few networks deliver maximum advertised speeds all the time; and most experience significant declines in performance during peak usage hours, i.e. the times when most people need the service and produce the most traffic congestion. This delta between advertised and actual speeds stems from the fact that transport capacity in digital networks (particularly local area networks nearest to end-users) is limited and must be shared among customers. Absent persistent infrastructure upgrades, the supply of network capacity remains steady. Demand, by contrast, is volatile and growing fast. For example, video traffic on the Internet is experiencing unprecedented growth, representing more than 70 percent of global traffic⁸. Under pressure from this volume of data, transport capacity in legacy networks (e.g. DSL) can become constrained. When this happens, demand outpaces supply, the flow of traffic begins to back up in queues at network routers, and the end-user experiences a slower connection speed. Regulators have limited visibility into how frequently the actual speed differs from the advertised speed and for what period of time during the day. Only 12 NRAs actively monitor the networks in their country⁹. Therefore, while measuring broadband buildout progress based on advertised speeds is a useful standard, it may be significantly out of step with user experience. And, critically, it may miss the indicators of congestion that are not only a red flag that network upgrades are required but also potential dangers for net neutrality violation.

7 Data from the Study on National Broadband Plans in the EU-28 (2016) suggests that roughly 71% of the European households are covered with at least 30 mbps, p.31. http://ec.europa.eu/newsroom/document.cfm?doc_id=43390.

8 Cisco Visual Networking Index (2017) S.3. Gemessen an der Datenmenge machten Videodienste im Jahr 2016 etwa 73 Prozent des weltweiten Internetverkehrs aus - Tendenz steigend. <https://www.cisco.com/c/en/us/solutions/collateral/service-provider/visual-networking-index-vni/complete-white-paper-c11-481360.pdf>

9 See question 28 on the BEREC report on the implementation of Regulation (EU) 2015/2120 and BEREC Net Neutrality Guidelines. https://berec.europa.eu/eng/document_register/subject_matter/berec/reports/7529-berec-report-on-the-implementation-of-regulation-eu-20152120-and-berec-net-neutrality-guidelines.

New Rules for Monitoring Broadband

In the Digital Single Market (DSM) policy package, the EU began to take steps to remedy this “information gap” about broadband performance. The first step was bringing down national barriers of discriminatory traffic management with the open internet regulation¹⁰, widely known as the European net neutrality rules contained within the Telecoms Single Market (TSM) regulation¹¹. In order to safeguard open internet access for all Europeans, the TSM sets out expectations for the NRAs. Included in the TSM was a provision requiring performance measurement by the NRAs. According to the TSM, the NRAs “shall closely monitor and ensure compliance, and shall promote the continued availability of non-discriminatory internet access services at all levels of quality that reflect advances in technology”¹². When Commissioner Günther Oettinger announced the adoption of the TSM regulations, he made this need crystal clear: “national supervisory authorities will have to regularly monitor average speed, quality, and traffic management on the open internet”¹³. Monitoring the actual performance and quality of the digital infrastructure, or more generally broadband measurement, is a key to the success of European broadband policies and hence to the success of the DSM and Europe’s digital future.

Accordingly, the Body of European Regulators for Electronic Communications (BEREC) – the authority that oversees the development of broadband policies at the European level – has published guidelines for the implementation of the net neutrality rules¹⁴. Although it is the understanding of BEREC that the TSM does not directly obligate the NRAs to conduct broadband performance measurement (including congestion oversight) to be compliant with the TSM, the legislation encourages NRAs to establish empirical facts,

10 Press Release by the European Commission, after the vote by the European Parliament on “Bringing down barriers in the Digital Single Market” (EU 2015/2120), 27 October 2015. http://europa.eu/rapid/press-release_IP-15-5927_en.htm

11 EU 2015/2120

12 EU 2015/2120 Article 5 paragraph 1.

13 Statement by Commissioner Günther Oettinger on the announcement of the Regulation for a Telecoms Single Market, 30 October 2015. https://ec.europa.eu/commission/commissioners/2014-2019/oettinger/announcements/statement-net-neutrality_en.

14 https://berec.europa.eu/eng/document_register/subject_matter/berec/regulatory_best_practices/guidelines/6160-berec-guidelines-on-the-implementation-by-national-regulators-of-european-net-neutrality-rules.

i.e. “by a certified monitoring mechanism”¹⁵. Recently, and of utmost importance for this analysis, BEREC has announced it will develop a monitoring tool that can be used voluntarily by the member states for the purpose of broadband performance measurement¹⁶. BEREC’s proposal – quite appropriately – favors EU-wide measurement methods that are as transparent as possible, e.g. by publishing the software’s source code and making the data available for external evaluation¹⁷.

Regulatory Lynchpin – Performance Measurement

The lynchpin of effective monitoring for both broadband buildout and network neutrality is congestion measurement. Persistent congestion, along with increased levels of packet loss and latency, result in performance degradation for the end-user. These are the signals that network upgrades are overdue. This evidence will not appear in a simple report of advertised speeds. It requires a deeper form of measurement that monitors experienced speed over time – tracking the user experience across the course of an average day and then replicating that test across a large sample of users over time. Consistent evidence of performance declines in peak traffic periods – business day and evenings – should trigger two things. First, it should prompt inquiries with network operators or policy interventions to spur faster network upgrades. And second, it should bring focused oversight on congested networks to ensure that network neutrality rules are not violated.

Recurrent and long-lasting underperformance, e.g. excess network congestion, is a signal that there may be a risk of discriminatory network management in practice. Congestion management is not per se a violation of the rules – some forms are commonplace and harmless. However, if network operators are choosing to charge content and service providers for priority access to congested networks, this crosses a red line. Net neutrality rules are meant to prohibit such “paid prioritization”. Paid prioritization undermines fair competition and innovation by privileging cash-rich companies that can thrive in a market with discriminatory pricing. In addition, if network operators can

¹⁵ The TSM indicates in article 4.4 that discrepancies between actual speed and advertised speed invoke the end user’s right to trigger remedies where the relevant facts are established by a monitoring mechanism certified by the national regulatory authority (EU 2015/2120).

¹⁶ BEREC press release (13.12.2017). https://berec.europa.eu/eng/document_register/subject_matter/berec/press_releases/7544-berec-presents-one-year-of-enforcing-net-neutrality-across-europe-and-moves-forward-on-monitoring-business-markets.

¹⁷ Net neutrality measurement tool specification, p.9 (2017). https://berec.europa.eu/eng/document_register/subject_matter/berec/reports/7296-net-neutrality-measurement-tool-specification.

generate revenue by charging for access to congested routers, it creates a disincentive for investment in network capacity, exactly the opposite of the TSM goals for universal, high speed infrastructure. This is why performance measurement and the provisions of the TSM regulation are closely related to the debate about broadband policy and infrastructure buildout. Actual performance data provide evidence for NRAs to monitor whether supply and demand are staying in balance over time. This is why performance measurements enabled by the NRAs are related to the net neutrality rules in the open internet regulation, and a reason why BEREC encourages member states to conduct systematic and transparent performance measurement¹⁸. Performance measurement practices are the monitoring tools that keep all parties honest and indicate to regulators where and when problems might emerge.

Net Neutrality Oversight – Current Practices

As an EU regulation, the open internet rules apply to all EU member states. Therefore, the NRAs have to ensure compliance with the rules as laid out in the TSM. On an annual basis, the NRAs publish reports about their oversight activities. The first of these was recently submitted, providing significant insight into how member states are overseeing net neutrality rules today. There are three key points worthy of review here. The first is how regulators police acceptable deviation from strict nondiscriminatory traffic management, so-called “reasonable network management practices”. The second is the enforcement of rules regarding contractual conditions for internet access services, such as transparent customer information, complaint management, and clear specification of the quality of service, including the actual speed (as opposed to the advertised speed). The third reflects the early stages of the type of network performance measurement that BEREC has recommended for all NRAs.

Policing Reasonable Network Management

The EU net neutrality rules stipulate that all providers of internet access services are prohibited from blocking or throttling of services on the internet. They are also barred from engaging in business practices that monetize discrimination in traffic management. Nonetheless, the rules allow for “reasonable management” of network traffic. There are three exceptional circumstances in which prioritization of traffic is permitted: compliance with

¹⁸ BEREC Guidelines to the net neutrality rules (2016), p.37 rc 162 et seq. https://berec.europa.eu/eng/document_register/subject_matter/berec/regulatory_best_practices/guidelines/6160-berec-guidelines-on-the-implementation-by-national-regulators-of-european-net-neutrality-rules.

legal obligations, maintenance of network integrity, or temporary congestion management in exceptional situations¹⁹. BEREC has later clarified in their guidelines to the net neutrality rules what ‘temporary’ and ‘exceptional’ means²⁰. In a nutshell, BEREC allows for prioritization to mitigate congestion in cases of a sudden and unpredictable increase in demand for network capacity. However, the equivalent categories of traffic, e.g. video content, are to be treated equally under all circumstances, and the discriminatory measure can only be sustained for as long as necessary to resolve the exceptional event.

The most common approach among the member states to monitor these net neutrality provisions is to request information from ISPs. In total, 23 out of 28 NRAs have requested information about traffic management from ISPs. The incentives for the providers to share information about questionable network performance and their traffic management practices, however, should be viewed with some skepticism. Without active network measurement practices, NRAs are in a poor position to evaluate the veracity of claims about network performance and congestion management. In general, providers understand operational network information as a business secret. Therefore, additional monitoring measures, such as technical network monitoring, are needed to check the providers’ commitments. According to BEREC, five member states currently include technical network monitoring to conduct oversight of reasonable network management practices²¹.

Customer complaints and remedies

For monitoring the net neutrality obligations, the NRAs are often dependent on end-users filing a complaint to draw attention to unlawful practices. To support consumer rights (and thus also aid the NRAs), the TSM establishes a baseline for transparency towards the end-user. The TSM requires that ISPs put in place transparent, simple and efficient procedures to address

¹⁹ http://berec.europa.eu/eng/netneutrality/traffic_management.

²⁰ Guidelines on implementation by National Regulators of European Net Neutrality Rules, p. 22. https://berec.europa.eu/eng/document_register/subject_matter/berec/regulatory_best_practices/guidelines/6160-berec-guidelines-on-the-implementation-by-national-regulators-of-european-net-neutrality-rules.

²¹ BEREC report on the implementation of Regulation (EU) 2015/2120 and BEREC Net Neutrality Guidelines (2017), p.12. https://berec.europa.eu/eng/document_register/subject_matter/berec/reports/7529-berec-report-on-the-implementation-of-regulation-eu-20152120-and-berec-net-neutrality-guidelines.



customer complaints, and to draw attention to the remedies available to the customer in case of poor service or other breach of contractual terms.

The problem remains that discriminatory traffic management practices may go unnoticed, or end-users might be oblivious to the consumer protections in the law, how to spot violations, and how to avail themselves of the remedies available to them to ensure their right to an open internet access. Therefore, NRA managed performance measurement practices are an essential counterpart to verifying the conditions of ISP contracts and holding them accountable by signalling to consumers when they have a right to file a complaint. In all member states, the ISPs are obliged to provide detailed information about the quality and performance of the internet access service in the terms of service. If the NRA has performance measurement tools, end-users as well as the NRAs themselves can then cross check whether the data collected from real world measurement is consistent with the terms of the contract.

According to the national net neutrality reports, 23 NRAs currently monitor customer complaints. The vast majority of the complaints concern discrepancies between actual and advertised speed or other quality aspects of internet access services. Only five percent were directly labelled as related to net neutrality issues²². However, a discrepancy between actual and contractual speed is per se related to net neutrality as it points to network congestion and underperformance. Actions to remedy consumer harm in light of these complaints are largely dependent on independent verification – that is, an external performance measurement tool. According to the TSM, such discrepancies in actual and advertised speed would trigger the “remedies available to the customer in accordance with national law” only where “facts are established by a monitoring mechanism certified by the national regulatory authority”²³. Without being able to establish evidence about poor service, many customer complaints are filed in vain. Currently, only four member sta-

22 BEREC report on the implementation of Regulation (EU) 2015/2120 and BEREC Net Neutrality Guidelines (2017), p.27. https://berec.europa.eu/eng/document_register/subject_matter/berec/reports/7529-berec-report-on-the-implementation-of-regulation-eu-20152120-and-berec-net-neutrality-guidelines.

23 Article 4.4 EU 2015/2120.



tes have certified a monitoring mechanism that could be used to trigger any remedy available to the customer²⁴.

In contrast, three countries have introduced additional remedies especially for contracts about internet access services²⁵. For example in Croatia, a country that already has certified a monitoring mechanism, an end-user can now exit the contract without additional costs if speeds are below the defined minimum as set down in the contract. Recently, the British regulatory authority has also considered a similar consumer protection.

Early Stage Technical Monitoring Practices

In order to establish the facts for a successful consumer complaint, the end-user needs to be able to test the actual quality of the internet access service. To this end, some NRAs offer broadband monitoring tools to the public (usually in the form of a speed test). There are many reasons why broadband performance, and hence the user experience, is degraded. It is not always easy to say what exactly causes Netflix, Skype, or any website or service to perform poorly. In general, however, congestion on the ISP networks or within the home network is the phenomenon that limits user experience the most frequently²⁶. By analyzing crowdsourced performance data, the NRAs get insights into where and when congestion happens, and how this might affect the user experience.

Congestion normally happens when too much data is requested by too many users at the same time, e.g. during peak network usage times. The degradation of performance due to congestion in a network will be experienced as lower download speeds, jitter or excessive buffering due to higher round trip times or packet retransmission rates²⁷. Typically, performance fluctuations due to congestion can be seen across all types of Internet activity. Some applications such as voice over IP or online gaming, however, are very sensitive to these fluctuations. User complaints about broadband performance often focus on these kinds of services.

One recent example of end-users experiencing poor service was monitored in the United Kingdom. The BBC reported that a popular internet access provider, Virgin Media, faced difficulties supplying all of its customers with suf-

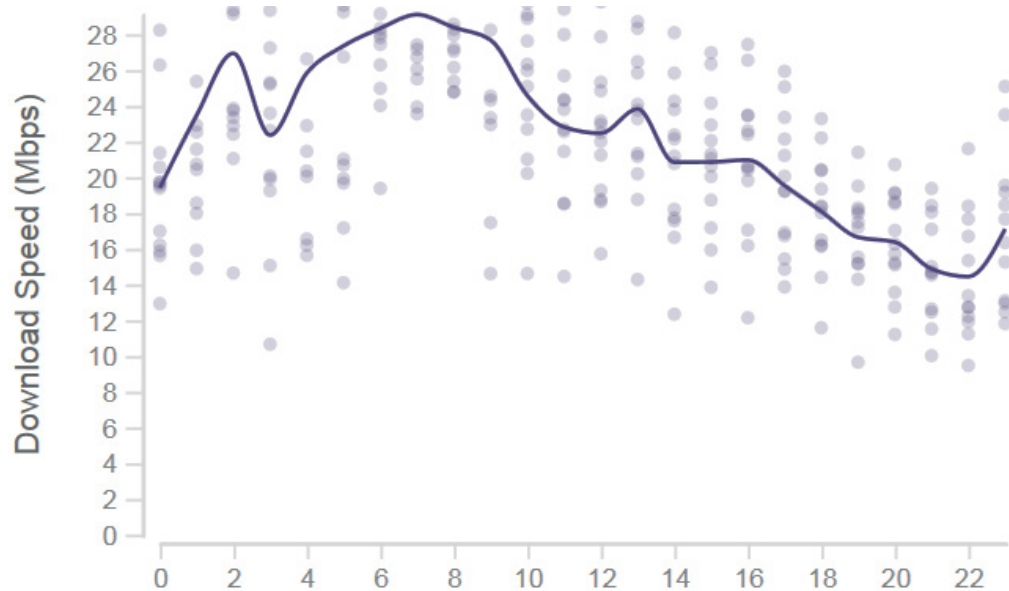
²⁴ Croatia, Cyprus, Germany, and Italy

²⁵ Croatia, Italy, and Latvia

²⁶ http://people.csail.mit.edu/wlehr/Lehr-Papers_files/Bauer_Clark_Lehr_2009.pdf.

²⁷ More about the values can be found here <https://www.measurementlab.net/learn>.

efficient network capacity to meet the service levels promised to subscribers. At times, “some customers were receiving just three percent of the speeds promised”, the BBC news report says²⁸. Technical monitoring tools played a crucial role to establish evidence in this case.



This graph was produced with performance data from several thousand Virgin Media customers in the United Kingdom, captured through customer speed tests using a software provided by the global research platform Measurement Lab. It shows that over the course of a day, the actual download speed fluctuates quite substantially. In the early morning hours, the download speed approaches 30 mbps, but the performance in the evening drops to just 14 mbps. This difference of roughly 50 percent of actual speed over the course of a day may explain why many customers reported bad experiences using the internet during peak usage times. This pattern of diurnal congestion rates is typical of most broadband networks, although this is a particularly striking example because of the range of performance degradation.

Broadband Measurement Landscape in Europe

While some countries have provided broadband measurement tools to the customer for a long time, such as Sweden (2007) or Italy (2010), others have just begun to measure actual speed, such as Romania (2014) or Slovakia (2017). Some member states, such as Luxembourg and Poland, have indicated that they seek to develop a broadband measurement tool for end-users in 2018. In total, 14 NRAs currently offer a public broadband measurement

²⁸ <http://www.bbc.com/news/technology-40504354>.



tool. Generally, broadband measurement helps the NRAs to keep track of supply and demand of network transport capacity over time. The NRAs use broadband measurement to track the deployment of infrastructure upgrades as well as to protect customers by monitoring the difference between actual and advertised speed and to investigate complaints that may connect network congestion with net neutrality violations.

Among the 14 NRAs that have already introduced monitoring tools, some have developed their own tools whilst others deploy tools from commercial vendors or open source projects. Although all tools may have the same purpose – measuring the actual quality of service – there exists a broad variety in the methods and technical standards applied. In order to be able to compare the quality of service across Europe, however, we need broadband measurement that allows for international comparison.

The results of broadband performance measurement differ significantly between various tools depending on the technical standards and methods, e.g. how the actual speed gets calculated or where/how the measurement server is connected to different networks. These variations do not make one method invalid – or even necessarily suggest one method is dramatically better than another. They are all relative metrics, tracking the trends and patterns of quality of service over time to the same group of end-users. However, because of this variation, it is important that information about the technical standards and methods of the measurement system are well documented and available to the public for external evaluation. Unfortunately, only a few NRAs currently provide a thorough technical description of the monitoring tools they offer.

Open source projects are most promising for conducting scalable broadband measurement because they are transparent, cost effective, and harmonize standards across Europe while ensuring high levels of modularity²⁹. Currently, eleven NRAs cooperate with open source projects, such as the Nettest project initiated by the Austrian regulatory authority or the global network research platform Measurement Lab. Nevertheless, the deployment of an open source tool needs to be accompanied by technical documentation that describes the underlying methods not only on a technical level, but also to

²⁹ <https://opensource.com/article/17/8/enterprise-open-source-advantages>.



the general public. The Austrian NRA offers a good example with its open source tool³⁰.

Another best practice with regard to open source performance measurement is the publication of anonymized results as open data, accessible to the public. The publication of performance measurement data is an invaluable resource for the research community. A number of NRAs already publish broadband data. In total, 12 states publish at least partially performance data produced with their monitoring tools, though in different formats and levels of granularity.

BEREC recently announced that it would develop an open source and open data monitoring tool that NRAs can use voluntarily for the purpose of monitoring performance in the context of the net neutrality rules³¹. On this basis, NRAs can either build an entirely new measurement system or complement existing ones with an additional tool that has EU-wide comparability. According to the national net neutrality reports, ten NRAs have stated their interest in participating in the development of a European broadband measurement system³². In the long run, BEREC measurement tool ought to become a platform enabling NRAs to share knowledge, experience and expertise, and foster further researching in the area of measuring quality of internet access services³³.

Interconnection and Net Neutrality

In addition to looking at performance measurement in the last mile of access networks, EU regulators should include points of interconnection into their broadband monitoring policies. These are the points at which local area networks (access networks that provide service to the end-user) receive and hand-off traffic with transport networks that deliver data to the broader internet. The European net neutrality rules focus only on discrimination in the

30 https://www.rtr.at/en/tk/netztestfaq_allgemein

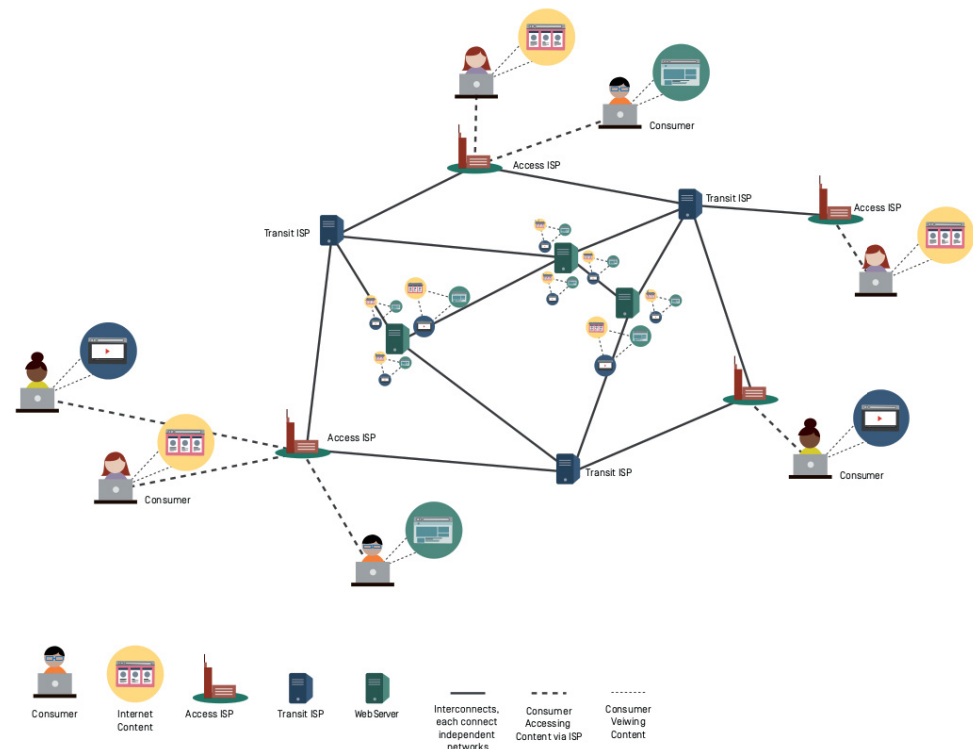
31 BEREC press release (11.10.2017). https://berec.europa.eu/eng/document_register/subject_matter/berec/press_releases/7333-press-release-berec-moves-forward-on-future-monitoring-of-mobile-and-net-neutrality-issues-and-publishes-a-statement-on-nras-competencies.

32 BEREC report on the implementation of Regulation (EU) 2015/2120 and BEREC Net Neutrality Guidelines (2017), p.29. https://berec.europa.eu/eng/document_register/subject_matter/berec/reports/7529-berec-report-on-the-implementation-of-regulation-eu-20152120-and-berec-net-neutrality-guidelines.

33 BEREC net neutrality measurement tool specification (05.10.2017), p.4. https://berec.europa.eu/eng/document_register/subject_matter/berec/reports/7296-net-neutrality-measurement-tool-specification.



access networks. This approach to net neutrality prohibits providers of internet access services from offering paid prioritization of traffic within the local access networks – the so-called last mile – but it neglects the possibility that problems might occur at the interconnection point.



As the graphic above demonstrates, the interconnections points where transport networks hand off traffic for delivery to end users along the access networks are a central feature of the internet's architecture. There is strong reason to believe that business disputes between transport and access network operators may result in de facto net neutrality violations. Recent disputes in the U.S. internet economy gave a first impression of the potential harm to consumers. For example, in 2013 and 2014, a dispute between Netflix and the six largest ISPs in the U.S. resulted in a major drop in broadband speeds for all traffic delivered over the transport network handling Netflix traffic – Cogent Communications. Cogent handles not only Netflix traffic, but also content and services from approximately 10 percent of internet addresses worldwide. This dispute lasted for many months, leaving unwitting consu-



mers with a quality of service well below broadband speeds and disrupting the functionality of many services in tens of millions of households³⁴.

Notably, this discriminatory reduction in broadband speed resulting in substantial consumer harm did not happen on an access network, but rather at the interconnection point with the transport network. The largest American ISPs were demanding compensation from Netflix for increased traffic flows from its increasingly popular service. Netflix declined, citing pre-existing agreements for carrying traffic. The ISPs retaliated by restricting the amount of bandwidth available at interconnection points to handle traffic inbound from the Cogent transport network, which was carrying Netflix traffic³⁵. As a result, the capacity at the exchange points was insufficient to handle the amount of data delivered by Cogent. This resulted in overloaded networks, especially during peak times in the evening, and hence major congestion at the points of interconnection. For end-users, the primary result was that Netflix and other high-bandwidth services such as videoconferencing were non-functional during peak usage hours. But for those content and service providers that also relied on Cogent for transport to access networks, the result was even worse. Their services were similarly restricted and the quality of service degraded, and they were neither part of the business dispute that caused the problem nor even aware of it until months into the controversy. As a result of this incident, the American regulatory authority included points of interconnection in their open internet monitoring policies and required exchange of traffic to be “just and reasonable”³⁶. On this basis, stakeholders were allowed to file complaints for the regulatory authority to investigate.

Well aware of this interconnection dispute, the EU opted nonetheless to exclude interconnection from its net neutrality regulation. In an assessment of interconnection development in the EU and its relationship to net neutrality, BEREC concluded that disputes between various service providers happened only rarely in the European internet market and were solved in relatively short time without regulatory intervention or extended consumer harm³⁷. However, since this conclusion was reached, the American regulato-

34 Landmark EU and US Net Neutrality Decisions: How Might Pending Decisions Impact Internet Fragmentation?, p.4 (2015) <https://www.cigionline.org/sites/default/files/no18.pdf>.

35 Landmark EU and US Net Neutrality Decisions: How Might Pending Decisions Impact Internet Fragmentation?, p.4 (2015). <https://www.cigionline.org/sites/default/files/no18.pdf>.

36 FCC net neutrality rules paragraphs 194-206

37 BEREC (2012) An assessment of IP interconnection in the context of Net Neutrality, p.60. https://berec.europa.eu/eng/document_register/subject_matter/berec/reports/1130-an-assessment-of-ip-interconnection-in-the-context-of-net-neutrality.



ry authority has wholly rescinded its oversight of interconnection and restored the vulnerabilities that led to the congestion disputes of 2013-14.

Nevertheless, BEREC has also acknowledged that disruptions at points of interconnection could lead to a dire situation in which entire segments of the internet are unavailable to end-users. BEREC therefore recommended that NRAs seek to better understand the interconnection market, for example, through data-gathering and performance measurement practices³⁸. This instruction suggests that it would be wise to conduct performance measurement analysis based on measurement points that are located upstream from interconnection points. This measurement architecture ensures that the typical experience of Internet users – calling data from servers that cross multiple networks before reaching the last mile ISP – is replicated in the performance data.

Conclusion

The cornerstones of European broadband policy lie in the deployment of next generation networks and the guarantee of network neutrality. Both of these require internet performance measurement to implement effectively. The direction for NRAs to establish these measurement tools is in the law, and BEREC has set out guidelines and will soon develop a standardized open source tool. In the meantime, several NRAs have already begun to experiment measurement and to use results in enforcement practices. Alongside reporting requirements from ISPs and swift review of user complaints, the addition of performance measurement tools brings additional value to scrutinize patterns of network congestion. These are promising conditions to establish a harmonized metric for monitoring internet performance EU-wide.

There is no single, best way to conduct internet performance measurement. However, there are a number of features that will optimize results for the NRAs and for the public. These include:

- **Certified Measurement Tools:** Although half of EU member states offer publicly available speed tests, only four have certified these tools. And without the results about actual performance from a certified tool, consumers may not be able to pursue a claim success-

³⁸ BEREC (2012) An assessment of IP interconnection in the context of Net Neutrality, p.61. https://berec.europa.eu/eng/document_register/subject_matter/berec/reports/1130-an-assessment-of-ip-interconnection-in-the-context-of-net-neutrality.



fully against a network operator for failure to deliver on advertised speed.

- **Performance Measurement:** Measurement tools should feature speed-test functionality that give users and NRAs a clear record of download and upload speeds. But they should also track congestion by logging round-trip times and measuring fluctuations in speed over the course of a day, week, and month. The more frequent the congestion, the more NRAs should be investigating to determine the cause and to police consumer harms.
- **Open Source:** Measurement tools should operate with open source code and clear technical documentation so that they are available for review and scrutiny by the research community and all stakeholders.
- **Common Standards:** All NRAs should utilize at least one measurement tool that is standard across all member states and reports using the same metrics. This will ensure comparable results and harmonize policy responses.
- **Open Data:** The data from NRA performance measurement should be publicly available to maximize transparency and enable the research community to utilize the data and support the work of the NRAs.

There is a long way to go to achieve these goals. At present, there are a variety of measurement tools in use across multiple NRAs. But they use different methods, and very few include documentation about methods and technical standards. As a result, the data are not easily comparable. BEREC's announcement that it will develop a common measurement tool based on open source software and transparent documentation is very welcome. Ten member states have already signaled interest to join the development process. It remains crucial to push for full adoption of this program and insist that the data produced should be publicly available for use by the research community.

Once broadband performance measurement is harmonized across Europe, the costs for monitoring net neutrality rules will sink and consistent patterns for oversight and enforcement will prevail. Performance data produced by a public broadband measurement system based on clear standards and transparent methods and published by the EU will be an asset not only for all member states, but also for service providers and end-users alike. This constitutes a systematic broadband measurement policy necessary to safeguard the open internet.



Disclaimer

This publication is intended to give an overview of the European broadband measurement landscape, and the author does not claim completeness. The main underlying sources were reports that the countries had to submit to the Body of European Regulators for Electronic Communications (BEREC) until 31. July 2017 about their progress implementing the Telecom-Single-Market (TSM) regulation, and BEREC's summary. In addition to that, the author compiled information from the national regulatory authorities' (NRA) websites, news articles, and interviews. In the event that information is missing or misrepresented, for instance due to translation errors, please contact the author so that the text can be updated accordingly.



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About the Author

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Björn Boening leads the Measurement Lab EU project. Together with other experts, he coordinates the construction and further development of an independent open source platform for internet performance measurement. The measurement tools developed for this purpose are used worldwide by government agencies, scientists, companies and numerous Internet users to inform themselves about the state of the Internet connection.

Björn studied Political Science and Law at LMU Munich and Public Policy at the Hertie School of Governance in Berlin. During his studies he conducted research and worked for the World Bank, the Munich Security Conference and the Allianz insurance group among others. As a data analyst, he worked voluntarily in various non-profit projects. Prior to his studies, Björn passed an officer training at the German Air Force.



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