Network Neutrality

An IEEE European Public Policy Initiative Position Statement

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The IEEE European Public Policy Initiative (IEEE EPPI), representing leading European technologists, who are members of the Institute of Electrical and Electronics Engineers, would like to share its perspective on the development of the Telecoms Single Market Regulation, in which Network Neutrality is a key element.

Network Neutrality is a *non-discriminatory principle for Internet traffic*. It has been widely debated recently, with significant policy deliberations occurring around the world. IEEE EPPI believes that there is a need for regulation which guarantees network neutrality by ensuring a non-discriminatory treatment of both wired and wireless network traffic, and urges EU policy makers to:

1. Forbid **discrimination** based on: i) (lawful) content; ii) data source and destination; iii) user or equipment; iv) device, platform, service and application; v) adopted protocols and standards; vi) service classes; and vii) specific service within a class.
2. Allow **differentiation** for: a) reasonable and transparent **traffic management** (based only on type of service, and activated only during congestion); and b) **premium services** (i.e., services offering better quality at higher cost).
3. Ensure that increases in resources for premium services are balanced by **equivalent increases in resources** for standard (i.e. non-premium) services, so as to avoid starvation of standard services.
4. Define **minimum Quality of Service / Quality of Experience levels** for each of the main classes of Internet services and applications. These defined minimum levels must be guaranteed to all end users most of the time, and revised as technology advances.
5. Define, and revise periodically, the levels of network congestion above which traffic management is allowed.
6. Develop sophisticated monitoring tools which allow both Network Operators, and Regulating Authorities, to verify quality metrics across the network.

This statement was developed by the IEEE European Public Policy Initiative and represents the considered judgment of a broad group of European IEEE members with expertise in the subject field. IEEE has nearly 60,000 members in Europe. The positions taken in this statement do not necessarily reflect the views of IEEE or its other organizational units.

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BACKGROUND

It is difficult to describe the Internet of today—and of yesterday—as "neutral". This is primarily for two reasons:

- Present (and earlier) packet networks mostly follow the "dumb" approach to packet switching, which implies that all packets are forwarded on a first-come-first-served basis. This naturally provides better Quality of Experience (QoE) to transactional-type traffic and services (email, file transfer, web surfing, messaging, etc.) with respect to real-time traffic (voice and video). This happens because the QoE of real-time traffic is much more sensitive to the available end-to-end bandwidth during the entire service, to packet losses and to packet delay variations, than the QoE of transactional-type traffic, which is mildly sensitive only to the average packet delay.
- Rich and powerful content and service providers can today easily improve QoE by an additional investment in high-performance in-house server farms, which reduce service response times, as well as in content delivery network (CDN) services that place content in network caches closer to the end users, thus reducing delay and increasing bandwidth. This also hints to the fact that network neutrality is not only related to the operation of ISP networks, but concerns the whole Internet ecosystem.

In addition, it must be observed that with the current levels of expansion of the Internet, its user population and their generated traffic, the current overprovisioning approach, which has allowed the healthy growth of the Internet so far, may become unsustainable. This seems possible, especially if the present trend of continuing strong traffic growth remains coupled with a much slower pace in deployment of network equipment capacity, due to lagging network operator investments. This means that a more parsimonious approach to resource usage may become necessary, while keeping QoE at levels that will satisfy all users of all services.

The diversity of Internet services and applications is also increasing, ranging from selfies posted on blogs to tele-surgery, with the latter probably deserving more attention and care than the former. Moreover, in addition to lawful and useful services and applications, the Internet of today also transfers all sorts of malware, spam, and illegal content, for which filtering and even blocking is desirable, in some cases necessary, and in other cases, mandatory. Providing the same QoE to an emergency warning message that can save lives and to the packets used in a denial-of-service (DOS) attack is clearly unacceptable. Privacy and security also require differential treatment of some data.

These considerations indicate that regulation (by European Regulatory Authorities) is necessary. IEEE EPPI believes that some flexible and responsive form of regulation should be defined, which guarantees a non-discriminatory treatment of all network traffic in most conditions.

NETWORK NEUTRALITY ADVOCATES

NN advocates say that network operators should treat all data transmitted over the Internet equally, not blocking, discriminating, prioritizing, throttling, degrading, inhibiting, slowing down or speeding up, or charging differently, depending on source or destination user or equipment, type of application or service, information content type, author and owner, adopted protocols and standards, etc.

The call for NN derives from the risk that network operators might choose to block, or to charge fees for, some content, applications or protocols, while giving preferential treatment to others. This would constitute a departure from the traditionally open architecture of the Internet, possibly limiting competition and innovation, and even jeopardizing end users' fundamental rights or reducing opportunities for free expression.

It must be observed that while in the United States the issue of network neutrality is mostly considered to concern only the access network, in Europe network neutrality is regarded as a problem of all network segments, as well as of the applications running over the Internet. This is at least partly due to the fact that in several geographic areas in the US the competition among access operators is quite limited.

NETWORK NEUTRALITY OPPONENTS

Individuals or organizations who advocate a different view of network neutrality claim that some forms of differentiation, like those necessary to permit the implementation of Quality of Service /Quality of Experience (QoS/QoE) traffic management approaches, is desirable, and actually goes in the direction of providing a better QoE for all end users. They claim that reasonable network management is a key network function that cannot be discarded, and that can and should be implemented in a transparent and unbiased way.

They also claim that in case some network operator would try to block some service or content, the presence of competing operators, which offer more open services, would automatically provide a balancing effect.

It has also been suggested the further commercial growth of the Internet is possible with the feasibility of **premium services** with enhanced QoS/QoE**.** These may facilitate the emergence and the implementation of creative innovative bandwidth- and delay-sensitive Internet applications.

It is also worth noting that a portion of the ISP community claims that some service providers (like video streaming) are such heavy capacity users that they should bear a part of the cost for the increases in network capacity necessary to effectively deliver their services.

HISTORICAL PERSPECTIVE

Traditional telephone networks were based on the circuit switching paradigm, wherein neutrality meant providing similar quality of service (QoS) to all users requesting access to the telephone service, with no discrimination on the telephone call source or destination, or the content of the conversation. QoS could then be measured in terms of blocking probability (the probability that a telephone call could not be started because of the lack of available free resources in the network) and transmission quality (e.g., bit error probability for digital telephone networks).

A first change in the landscape came with the ARPANET, a packet switching telecommunication network which later turned into the Internet, and which was designed to offer electronic mail and file transfer as main services. In this setting, NN meant again providing similar QoS to all users requesting access to the available services, with no discrimination on the file (or email) source or destination, or content. In this scenario, the desired QoS corresponded to the error-free delivery of an email or a file to the intended destination with an acceptable delay.

Nobody expected the delay of a short file/email (which could fit in just one packet) to be the same, or even similar, to the delay of a large file/email, whose transmission required a large number of packets.

A further milestone in the concept of QoS was related to the invention of the World Wide Web, which came when the Internet was not yet ready for it. Indeed, in the first years of the web, the acronym WWW was often humorously called *World Wide Wait*, as the bandwidth was scarce, and the key QoS metric, delay, was reaching levels that were discouraging many from using the network. This urged network operators to deploy better technologies in the network access, as well as in the core. In this period, QoS meant correctly delivering the web page from the server to the intended client with acceptable delay, and NN meant once more providing similar QoS to all users, with no discrimination on the web page source or destination, or its content. Again, it was not expected the delay of a simple web page to be the same as the delay of a web page with much more content, possibly including figures, or embedded videos, when they became feasible.

Today, the Internet has evolved into a complex multi-service network, where traditional services, like email, file transfer, and the web (each of them in increasingly sophisticated versions), coexist with a wide gamut of innovative services, like VoIP (voice over IP), IPTV (IP television, both video on demand, VoD, and live TV), and live streaming. More services are around the corner, with the introduction of the IoT (Internet of Things) and of the remote control of complex equipment (e.g., tele-surgery). In this complex and varied scenario, QoS metrics cannot be the same for all services. For example, for a group of services (mostly the earlier ones, like email, file transfer, and the web, with the addition of messaging and access to social networks) delay is still the key QoS metric. On the other hand, for the class of real-time voice or video services, including live streaming, the key QoS parameters are related to the bandwidth available between the source and the destination, the packet loss rate, as well as the packet delay (both its average and its jitter, the latter being the variability of the delay of the many packets that are necessary to implement the service).

In such a complex scenario, the meaning of NN has become much less obvious, since different services require different QoS and QoE, naturally measured with different metrics. In the years of abundance, when resources were plentiful for all the Internet stakeholders, the issue of QoS (and of NN) was disposed of with the “overprovisioning” approach: network operators would install in the network much more bandwidth than actually necessary, thus making network algorithms unconstrained by scarce resources, and providing minimal delay and plenty of bandwidth for everybody. Problems remained only in the access segment (especially for mobile users), where bandwidth is limited by physical constraints. When resources become scarce, congestion arises, and the different QoS and QoE objectives can be met only with an algorithmic approach (i.e., network management).

In the present situation of strong traffic growth and declining resource abundance, the problem of NN has become a very controversial issue around which the debate is quite heated.

THE SOCIO-ECONOMIC CONTEXT

Technological considerations are important to discuss NN. However, NN is clearly not just a technical issue. Economic and personal interests of users and strategic interests of governments, including security at all levels, are all at stake and are all intricately interwoven. Moreover, the NN landscape is continuously changing, as information technology (IT) is a field in which innovation continuously alters the economic, social and technological picture.

IEEE EPPI believes that IEEE's motto "Advancing technology for humanity" can be a useful starting point for any discussion about NN, since the Internet has become an extraordinary new tool for billions of human beings, who rely on it to improve their standard of living in all aspects of life.

Permanent improvement of Internet access, of its ubiquity, quality and performance, of the diversity and versatility of services, as well as better costs, should be the driving goals of any policy. To achieve this, innovation is the main tool: it makes more powerful infrastructure available and new services possible, at better cost. All political debates about NN, together with their economic facet, must be examined while keeping in mind the need for a favorable ground for innovation. The global interest of individuals and of societies and the necessity of permanent innovation must find a sustainable path of economic feasibility.

We believe that players having a role in the overall Internet and IT economy must be in a position to collect revenues which are sufficient not only to survive, but also to invest in innovation, be it R&D, or new infrastructure. At the same time, they must be incentivized to avoid rent-seeking behavior at the expense of R&D and infrastructure investments as well as rent-seeking behavior made possible by the ownership of the infrastructure. In the Internet economy, players and business roles can split into infrastructure manufacturers and operators on one side, and service providers on the other (although some infrastructure operators also enter the value added services market, and some big service providers are developing their own infrastructures, trying to be on both sides of the game).

In the time of voice-only telecommunications, the networking components were largely predominant. As innovation has advanced technology, the definition of "infrastructure" has evolved to encompass edge computing platforms, from mobile devices and PCs to server farms, content delivery equipment (Internet caches), networking components, etc. Today, new "facilities" have been added to the Internet infrastructure, with new players supporting them. In particular, large computing platforms at one edge of the network (server farms & cloud computing platforms, content delivery equipment) and small ones at the other (PCs, mobile devices) can be considered part of the infrastructure.

The increasingly more complex Internet infrastructure would be meaningless without ever more sophisticated services. Indeed, the development of services has been made possible thanks to what could be called the basic fact of the Internet economy: the ratio performance/cost of infrastructure is always rapidly increasing. Or, seen from a customer perspective, for the same buck, you get better performance while time flies.

This has a number of consequences: a service not requiring ever increasing resources will take a progressively smaller share of the improving infrastructure, and as a consequence its value will collapse e.g., voice, which represented 99% of telecommunication infrastructure usage before the Internet, represents now a very small fraction of the overall data flow. Hence, all stakeholders must invest in infrastructures related to their business role in relatively short cycles to just keep their revenue levels. When technology has improved basic equipment performance by a factor of 2, making some investment to improve some infrastructure accordingly just maintains revenue level.

It is a common mistake to assume that better performance over time increases the value of equipment. Yes, it increases customer's experience, but not value in monetary terms, if it does not improve faster than what basic technology improvement provides in the same time. This means that the root of the debate around NN lies in the complex relation between increasing "demand" in infrastructure performance, drawn by the creativity in new services, technological advances lowering infrastructure cost, on the one hand, and revenues (in particular market growth), and investments granted to, and by, infrastructure players on the other. It turns out that this relation is sometimes favorable and sometimes detrimental for infrastructure operators. Besides, infrastructure players can be more or less efficient in their operations, and arbitrage more or less between rent seeking and investment planning. Moreover, revenues drawn from "traditional" services generally vanish after some time.

This volatility of the economic conditions, together with difficulty or inability to plan for their changes, explains the current situation, wherein particular telecom operators report difficulties in ensuring a sustainable business model. They track the causes of this difficulty to the imbalance between the evolution of usage and performance demand on one side, and their revenues on the other, sometimes omitting to mention their "obligation" to invest at a similar pace as technological advances. In order to fix their problem, they ask to be paid for the "performance demand excess". One way to do this is to charge this "excess", supposedly due to innovative services requiring bigger resources, on the basis of Quality of Service (QoS) levels. It must also be considered that the emergence of new services may push from time to time to revisit part of the technological roots of the Internet itself, because some new services require new basic networking functionalities[1]; this is related to QoS issues, and represents a potential source of innovation and of new revenues for all the players along the value chain.

It is important to observe that in a rapidly evolving IT market the present situation could rapidly change, and the current imbalance, as perceived by infrastructure players, could be modified in one way or another. For example: i) major technological innovations in networking could take place (e.g., with the adoption of drones), which would drastically change the business conditions of a networking operator by lowering both CAPEX and OPEX on the basic infrastructure provisioning side; ii) the demand on the service side could struggle, for a number of reasons: market growth of the advertising revenues of large Internet service operators slowing down; rate of technological innovation in computing platforms slowing down, or rising barriers to new service providers.

[1] For example, video streaming or voice-over-IP (VoIP) require the control of the data flow between the emitter and the receiver; or "worst case" delivery delay must be controlled for safety-related services, e.g. in Cyber Physical Systems (automated transportation, smart energy, e-health).