

Disruptive Network Applications and their Impact on Network Neutrality

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Abstract— Network Neutrality principle states that in order to preserve the openness of the Internet, the end users should have equal access to all the content on the Internet, and the Internet Service Providers (ISP) should be prohibited from discriminating or blocking the content from any of the application providers. The Network Neutrality issue is important as it can have a considerable impact on the future Internet design principles and associated laws and policies. While the supporters of Network Neutrality, including the users and content providers, argue that non-blocking and non-discrimination should be prohibited by law, the opponents, including the ISPs, claim that such rules can prove to be a disincentive for them to invest in the network upgrades. In this paper, we provide a brief review of the Net Neutrality policies, focusing on the content provider discrimination. In addition we discuss some of the latest disruptive network applications being used in the Internet, such as zero rating apps, Over-the-Top applications, etc., and their impact on the Network Neutrality.

Keywords— Network Neutrality, Future Internet, Zero-rated Applications, OTT Applications, Streaming Media.

I. INTRODUCTION

Over the last few years, the traffic management strategies of various ISPs have led to a wide debate over the Internet Neutrality issues. It is of importance due to the political and technical aspects associated with it, and due to the impact it can have on the future Internet policies and design principles. The Net Neutrality controversy has been triggered by numerous events such as the case of Comcast blocking [1]. Other events include the introduction of the internet.org by Facebook [2] and other zero rating offers such as Airtel-zero [3], the case where France telecom asked apple and Google to pay for the rise in the network traffic due to their content, and the slowing down of the video content delivery over their network by the British Telecom. Currently, the lawmaking bodies in different parts of the world including the United States, Europe, Canada and Japan, India etc are engaged in the process of framing the laws and regulations for enforcing the Network Neutrality [4].

Network neutrality principle states that Internet users are entitled to service that does not discriminate on the basis of source, destination, or ownership of Internet traffic [5]. Although some minimum priority or preferential treatment can be provided to different applications based on their requirements, there should be absolutely no differentiation based on the content or application provider.

The supporters of network neutrality, including the application and content providers and the users, allege that the internet was designed with the aim of transferring the packets from source to destination, in the best effort manner, without any kind of discrimination or paid prioritisation. They argue that if net neutrality is not enforced lawfully, the last mile service providers might charge the content providers differently for providing different levels of QoS, and might also block certain applications and content which can hinder the innovation and growth of new internet applications. On the other hand, the opponents, including the ISPs, assert that if they are not allowed to charge differentially for providing enhanced QoS then they may not be able to invest in the network infrastructure, and equal treatment of all the content can also lead to security issues in the Internet.

In the current work, we focus on the content provider discrimination by the ISPs, and provide a brief review of the important factors to be considered for framing the Net Neutrality laws. In addition, we provide an insight to the latest issues and trends in the Internet, such as zero-rating, multi bit rate streaming, OTT applications, etc., and their impact on the Net Neutrality. The rest of the paper is organized as follows: Section II provides a brief review of various regulation policies that have been proposed in the literature; Section III includes the description of some disruptive network applications and their impact on the Network Neutrality and Section IV concludes the paper.

II. NETWORK NEUTRALITY POLICIES AND REGULATIONS

Since the past few years, there has been a remarkable development and innovation in the field of networking and communication. This has led to the convergence of various heterogeneous technologies, capable of supporting multiple

applications such as voice, best effort data (email, blogs, etc.), streaming media, peer-to-peer applications, etc. over the same networking infrastructure. The tremendous growth in Internet traffic due to widespread adoption of smart devices, and the use of data hungry apps, further led to the adoption of unreasonable traffic management policies by the ISPs. This led to a number of events such as the introduction of the internet.org by Facebook [2] and other zero rating offers such as Airtel-zero [3], the case of Comcast blocking [1], the case where France telecom asked apple and Google to pay for the rise in the network traffic due to their content, and the slowing down of the video content delivery over their network by the British Telecom, which triggered the Net Neutrality debate and lawmaking in many countries.

An acceptable network neutrality law should be an objective combination of the political and technical aspects, while taking into consideration the minimum Quality of Experience (QoE) requirements of the end user. In this section, we will review some of the proposed network neutrality rules, followed by our suggestions for framing the net neutrality related laws.

A. Proposed Rules and Regulations

From the technical perspective, the networks have advanced enormously over time, and are hence capable of hosting different types of applications such as voice, video, and data services over the same infrastructure. According to the Cisco VNI [6], the data traffic has increased exponentially since the past few years, and it has been predicted that this trend will continue in the future. Hence, the competing ISPs should be able to satisfy the growing demands of the end users in terms of some minimum performance requirements for different applications without any kind of blocking or preferential treatment of the traffic based on its origin. Hence, the network neutrality rules should take both these factors into consideration.

A number of such rules have been proposed in the literature, including [4], [7], [8], [9], etc. In [4], the network neutrality rules are classified as: all or nothing approaches, case-by-case approaches, and more nuanced rules. In the first category, either all the forms of discrimination are banned, or allowed. However, both of these have certain flaws. While banning all kinds of discrimination is over restrictive and can hinder the evolution of the network, allowing all discrimination defeats the purpose of the rule as it would allow blocking. The second set of rules discussed in this paper follow the case-by-case approach and bans the discrimination that is harmful under the antitrust standard, that is anticompetitive, or the one that is unreasonable. Such approaches might fail to cover some important aspects of discrimination, as the decision about what is considered as harmful or unreasonable is left on the future. In contrast the more nuanced rules clearly indicate in advance about which type of differential treatment is allowed and which is not. In this paper, it has been stated that, although the Network Neutrality debate is often framed as a debate against the quality of service, this is in fact not the case.

While most of the existing proposals follow an all or nothing approaches and ban discrimination and blocking, the author proposes that a more nuanced approach can be followed. Such rules should allow some, but not all forms of Quality of Service, with additional rules differentiating between acceptable and unacceptable forms of Quality of Service. The proposed rules allow any kind of application-agnostic discrimination but ban all application-specific discrimination.

In [7], it has been asserted that unreasonable traffic management techniques should be banned. It provides a framework that can be used to clearly differentiate between reasonable and unreasonable traffic differentiation techniques. It also emphasizes that the ISPs should be prohibited from blocking or charging higher prices from competing content providers, in order to give preferential treatment to its own application offerings.

Apart from the above proposal, the law making bodies from different parts of the world, including Brazil, India, Chile, Canada, Netherlands, U.S., etc. are currently in the process of framing Network Neutrality rules and policies [10]. One significant example is the Federal Communications Commission (FCC) [8], which started in October 2009, when they proposed rules for open internet and asked for reviews. Adopted on February 2015, the FCC's Open Internet rules state that: 1) there should be no blocking of the legal content, applications, or services, 2) there should be no content or application based throttling of the internet traffic by the ISPs, and 3) there should be no provision for providing preferential treatment to a certain set of traffic over the other. In short, their main aim is to safeguard the open and unrestricted access to content available online, without the ISPs being allowed to treat the lawful content in a differential manner. Another example is Europe [9], where the Council of Ministers and European Parliament approved the first version of the telecom package in 2009, allowing the national telecom operators to ensure some minimum quality of service to the end users, and to transparently provide QoS information to them.

B. Guidelines for Network Neutrality Regulation

In this section, we will discuss some of the important factors that a neutral network should reflect and also describe different levels of net neutrality violations that can be implemented by the ISPs, with an aim of providing guidelines for network neutrality regulations and violation detection mechanisms.

Although there is no standard definition of network neutrality, its main aim is to provide open and unrestricted access to the content available on the Internet, and the ISPs should be prohibited from treating any kind of lawful content in a preferential manner. There should be no discrimination based on the content provider or origin of the application. Therefore, an exhaustive network neutrality law should take the following factors [4], [11], [12], [13] into consideration. These factors have been summarized in the Figure 1.

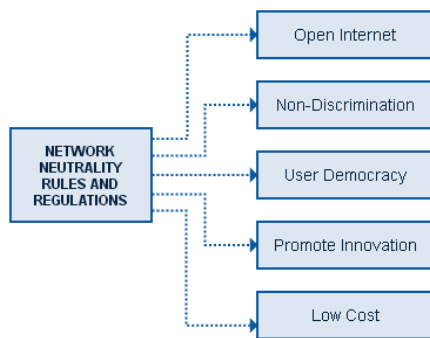


Figure 1. Important Factors for Defining Net Neutrality Laws

- **Open Internet:** The end users rely on the ISPs for the access to internet, hence in a neutral network, the users should have the right to access all the lawful content present on the internet, whenever they want, and there should be no blocking or throttling the access to any content.
- **Non-Discrimination:** There should be no paid prioritization of the content available online, depending on its source/ origin. There can be some intrinsic prioritization to provide minimum level of quality for different application types (based on the header information, without any deep packet inspection), but not on the basis of the application/content providers. Any kind of traffic management technique that is used should be completely transparent to the end user.
- **User Democracy:** The users should be independent to choose the applications and content they want to access, without any kind of permission from the service providers.
- **Promote Innovation:** A neutral network should aim at preserving the inherent features of the Internet that has supported the application level innovation since the past. Equal opportunity should be provided to the newer start-ups and the big players such as Google, or Yahoo, by providing equal access and identical quality of service to the content coming to and from these sources.
- **Low Cost:** If all the content on the Internet is treated equally and the ISPs are not allowed to charge higher from the content providers contributing to the maximum traffic, then this might result in an increase in the cost for the end users as it's the only way for the ISPs to survive. For instance, the network operators in India have warned the regulatory bodies that the data prices can rise up to six times as compared to the existing cost, if they are not allowed to handle OTT applications such as Skype, Whatsapp, etc [14]. Hence, the regulatory bodies should make sure that the cost of Internet access should not rise as a result of other regulatory policies that might be enforced on the ISPs.

As discussed in [4], the all or nothing approaches are not suitable for creating a neutral network, hence, a middle ground should be chosen based on the net neutrality regulations and the public opinion. Different levels of network neutrality violations or the different level of discrimination that can be

implemented by the ISPs have been described in Figure 2., starting from the lowest (best effort) to the highest level (blocking). From the network neutrality point of view, the best case is when all the traffic is treated in a best effort manner, irrespective of its source or origin, similar to the functioning of the Internet when it originated.

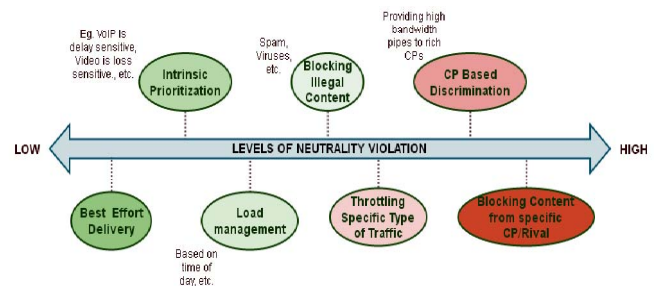


Figure 2. Levels of Neutrality Violation

In contrast, the worst case is when an ISP blocks the content from a CP that might be a competition or threat for the similar in house content or applications that are supported by the ISP.

Hence, the regulatory bodies can choose the level of traffic discrimination that should be allowed, by considering the above defined factors, while making sure that all the traffic management should be completely transparent to the end user.

III. DISRUPTIVE NETWORK APPLICATIONS

In this section, we discuss some of the disruptive network applications that have been in limelight recently, and discuss their impact on the principle of network neutrality.

A. Zero-rating Applications/ Toll Free Data

Zero-rated or zero-ranked network applications are those that are provisioned free of charge by the network operators or the service providers over their wireless networks, and the user is not billed for the data consumed by such applications, under some restrictions. Such applications, also known as the toll free applications are becoming popular in a number of countries. According to statistics presented in [15], nearly 45 percent of the network operators in the world are providing at least one zero ranked application to their subscribers, at present. Such applications are either the core apps including text-based apps or social media, or the data intensive apps involving streaming media. Facebook, Twitter, and Wikipedia, etc., are some of the examples of such applications.

The main benefits of Zero Rating include 1) subsidized prices for the customers, especially those who might not be able to afford mobile data plans otherwise; and 2) expanding Internet adoption worldwide, which can lead to substantial economic and social growth. However, the main motive behind adoption of such zero-rated applications by the network operators or the service providers is to earn more revenue by attracting more users. In some cases, the content

provider, whose app is being zero-rated, pays the cost to the operator. In such cases, the data consumed by the zero-rated apps is commonly known as the sponsored data [16]. In this way, the operator earns revenue from the payment provided by the content or the application provider and the content provider in turn earns indirectly from other means such as advertisements, due to an overall increase in the usage of the application. In other cases, the service provider might offer zero rated apps to attract more users and compete against other service providers who would charge the users for the data usage associated with such apps.

An important issue related to zero-rating is the violation of network neutrality [20]. To support such apps, discrimination among the online content and application providers is required, which indirectly creates benefit for subscribers to access such services provided by famous application providers, than those provided by competing startups. This form of preferential treatment is against the fundamental principle of the network neutrality as the big players such as Facebook, Google, Wikipedia, etc. get preference over the newer applications. It can therefore be considered as a way by which the ISPs can provide preferential treatment to their over the top partners, and is a form of anti-competitive price discrimination.

Two famous examples of such zero-rated apps include the internet.org by Facebook [2] and the Airtel-zero [3]. According to [17], internet.org is collaboration between Facebook and seven mobile operators, including Samsung, Ericsson, MediaTek, Microsoft, Opera Software, Reliance and Qualcomm, to provide an affordable access to Internet in the less developed countries. Although it is claimed to be a non-profit organization, it has been opposed for violating the network neutrality, as the services of the Facebook are favored over its competing rivals. The people, who join the internet.org thinking they have free access to Internet, actually have the access to Facebook, and a couple of other sites/applications that have been chosen. For instance it chose Bing as the search engine instead of the famous Goggle. The reason behind this could be to decrease the market for the rivals. In this way they again violate another principle of openness of net neutrality, as the user cannot freely choose what he wants to access over the Internet. Similarly, Airtel tried to project its offer Airtel-zero as a marketing platform for applications. In India, the non neutral characteristics of both the Zero services: Airtel and Facebook came into picture with the release of the consultation paper released by the Telecom Regulatory Authority of India in March 2015, and was condemned by the public [18][19]. This resulted in Flipkart leaving the Airtel zero and a line of Indian Internet firms: Cleartrip, NewsHunt, NDTV and Times Group leaving the Internet.org.

B. Over The Top (OTT) Voice and Messaging Applications

An over-the-top application/service can be understood as information or communication related service over the Internet that is not dependent on the network of the telecom service provider. These application/services depend only on

Internet access and hence bypass or go “over the top” of telecom network. These services are generally free or are low in cost as compared to traditional messaging/calling services. OTT, though, can use telecom networks’ service as an Internet Service Provider (ISP). These apps are widely used for some time now for messaging, voice and video calling, and exchange of multimedia information. Popular examples are Facebook app, Google Hangouts app, WhatsApp, BBM, Viber, Skype, Kakao Talk, and WeChat etc. These apps have increasingly been developed as desktop and phone versions, and developers support seamless integration between the two versions, e.g. Whatsapp, KakaoTalk etc. Independence from telecom service providers is one of the main reason of growth and popularity of these apps; and the second one being free to very low charges. Another reason is advent and boom of smartphones, which has revolutionized the use and growth of OTT apps. Also increased processing powers of smartphones have enabled developers to provide a rich, customizable and powerful apps and interfaces for the users [21][22].

The popularity of OTT apps, especially VoIP and messaging apps such as Skype, Whatsapp, etc. have put the traditional voice and messaging services provided by the telecom operators at stake. Therefore, the telecom operators have been trying to gain profit by monetizing the data traffic through such applications, which is against the network neutrality. In addition, some of the operators have attempted to restrict or ban the OTT services that are responsible for generating low revenue and high traffic, such as VoIP apps, or streaming media. The reason provided by the operators to ban or throttle such kind of applications is to decrease the load on the networks, as the huge data flow in such apps can create congestion in the network and affect the overall performance. However, the real motive behind this is that such OTT apps are a strong competition for the operator’s voice and SMS services, in most of the cases. For instance, the Indian telecom operators wish to block the Whatsapp OTT VoIP [14], Jamaican operators such as Digicel and Lime have started blocking many VoIP based OTT apps [23], and the restriction of Apple’s Facetime by AT&T [24]. In this way, blocking or throttling the content of certain application or content providers is against the essence of network neutrality, and proper laws and regulations are required to avoid such scenarios.

C. Multi-bitrate Streaming Media Applications

The volume of mobile data traffic that is transferred over the Internet has increased rapidly since past few years, and it is estimated that this exponential growth will continue in the future. The main factor behind this is the rapid advancement in the networking technologies and applications, and a rise in the number of connected devices on the Internet. The increase in the connection speed in fixed and mobile networks has resulted in the proportion of streaming media content in the Internet, due to availability of higher bit rate. According to the statistics from the Cisco visual networking index [6] (2014-

1019), the growth in mobile video traffic will dominate all other forms of traffic with a CAGR of 63% by the end of 2019.

Video applications generally require a high bit rate, and are hence resource intensive. Therefore, a number of techniques such as Variable bit rate and Adaptive bit rate streaming have been deployed for performance management of streaming media over highly variable and congested networks. Adaptive bit rate streaming is based on the estimation of the available bandwidth and adjusting the quality accordingly for a smooth playback. Hence, the encoding rate automatically adapts to the varying network performance. As in the case of above disruptive applications, the ISPs can take advantage of these kinds of encoding schemes, by throttling the network at the beginning of the streaming, which will result in adaptation and hence in lowering of the source bit rate. As the source rate will be equal to the received throughput thereon, the end user will be unable to detect the throttling. In this way, the ISP can violate the network neutrality principle, without being noticed by the end users. Hence the net neutrality regulations and violation detection techniques should take appropriate measures to combat such situations.

IV. CONCLUSIONS

Network Neutrality is an important concept to safeguard the openness of Internet, allowing the end users to connect and exchange the lawful information freely. Hence, the network neutrality rules and regulations will play an important role in the technical and political decisions related to the future Internet. In the current work, we reviewed a number of such regulatory frameworks that have been proposed in the literature. In addition, we provide an insight to some of the recent disruptive network applications that how they can lead to the violation of the net neutrality.

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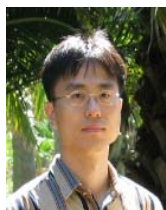
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