Intended and unintended effects of policy measures aimed at promoting net neutrality: an examination of the value chain for video distribution

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Link to publication

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An examination of the value chain for video distribution

Pieter Nooren[1], Andra Leurdijk[1] and Nico van Eijk[2]

Abstract

Net neutrality has, for a number of years, been a topic of often heated discussion in the Internet and telecom community. Net neutrality, in essence, requires that Internet users have open access to content and applications on the Internet, and, vice versa, that providers of applications can reach their intended end users over the Internet. Video distribution clearly is an area where the Internet opens up opportunities for many new applications for consumers and businesses. At the same time, video distribution is also an area where new applications meet an existing ecosystem with existing business models. Our analysis shows that net neutrality interacts with video distribution at different points along the value chain. We therefore call for a value chain approach, as assets in each part in the chain can develop into a control point for the open access to content and applications. Moreover, a measure aimed at one part of the chain can have an effect in other parts as well. Policy measures that are in force now, or that are expected in 2012, focus at the public Internet lane part of the distribution chain and impose obligations on network providers, and Internet Service Providers (ISPs) in particular: transparency, no blocking/throttling, no ISP tariffing of Over the Top applications. Although each of these measures contribute to a certain extent to their intended effects, our analysis shows that they are likely to lead to more debates in other areas, as players try to compensate the loss of influence or revenue streams by rearranging the ways in which they exploit their assets. Incidents and debates have already occurred or can be expected in the areas of peering and interconnection, distribution of resources between public lane and managed lane and in particular the influencing of people's navigation on the Internet through search, recommendations and app stores linked to devices.
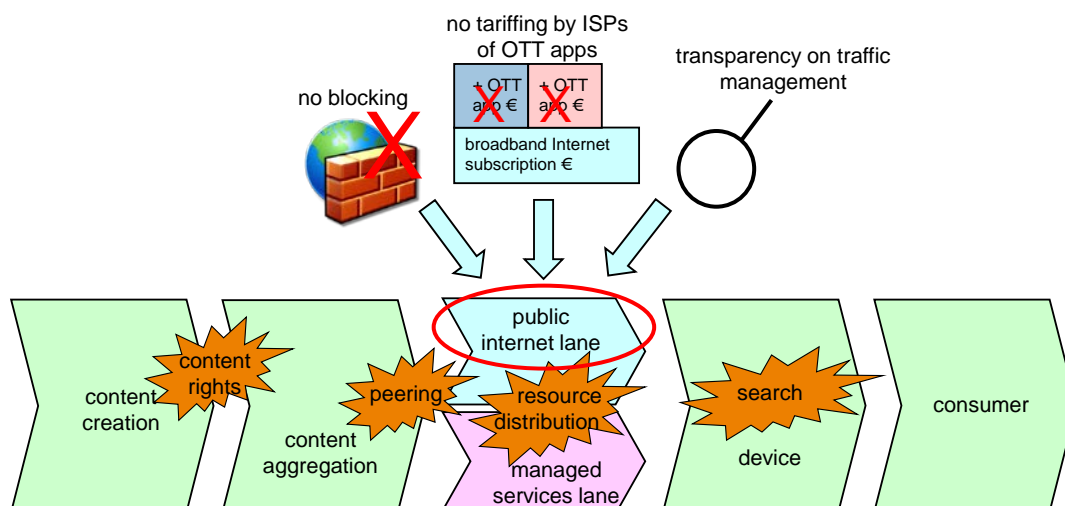
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Contents

1   Net neutrality and video distribution

Net neutrality has, for a number of years, been a topic of often heated discussion in the Internet and telecom community. The issue was put firmly on the agenda by Tim Wu in his famous 2003 paper [1], following the discussion of a number of net neutrality related issues by other authors (*e.g.* [2]). Since then, net neutrality has been analyzed extensively in academia and in regulatory circles. The historical development and background of net neutrality can be found in many excellent papers and texts (*e.g.* [3], [4]). On the regulatory side, important recent positions are contained in the FCC's 2010 Report and Order [5] (that went into force in November 2011), the European Commission's communication on the open Internet and net neutrality in Europe [6] and the European Parliament's resolution on that topic [7].

Looking at the historical development of net neutrality, it is seen that there are two dominant and recurring factors that drive the discussions on this important topic. The first factor is the occurrence of incidents that fuel the discussion by focusing it at specific points in the distribution of services and applications over the Internet. The best-known and widest publicized incident is probably the Comcast case, in which the large US cable operator and ISP was accused of interfering with the ability of its customers to use the BitTorrent peer-to-peer file sharing application (*e.g.* [8]). Other well-known examples are the blocking of VoIP applications (such as Skype) by mobile operators [9]. Incidents like these directly affect the open access that end users have to applications on the Internet. As the incidents are linked to well-known applications, concerns about this open access and net neutrality are readily picked up by a wider public. A recent incident that has led to regulatory intervention is the announcement by a Dutch mobile operator of plans to charge its mobile broadband users for the use of specific Internet services [10]. A combination of media attention and pressure from consumer organizations quickly led to the adoption by the Dutch parliament of a measure with a number of explicit requirements for net neutrality [11].

The second factor driving the net neutrality discussions is the ever-growing importance of the Internet in almost all sectors of business and in society as a whole. The Internet ecosystem continues to provide new applications. There is also an expectation that the Internet will have a key role in the responses that societies worldwide need to formulate to large challenges such as energy sustainability and ageing population (*e.g.*, [12]). This long-term expectation of the contribution of the Internet to societal goals is widely accepted. It is also widely accepted that in order to meet up to these expectations, innovation in the Internet's network technologies and in services and applications is crucial. New innovative applications therefore have a large role to play. They can only play a large role if they can build on the scale of the global internet. A basic requirement is therefore that Internet users have access to new applications, and, vice versa, that providers of new applications can reach their intended end users over the Internet. But, although many new applications offer new functions and features for users, they often also compete with existing services that provide some of these functions and that are supported by existing networks and business models. In many cases, the new applications (*e.g.*, mobile VoIP, streaming video) are delivered over the same network infrastructure as the existing services (*e.g.*, traditional mobile voice, digital television) that they compete with. Not surprisingly, the net neutrality incidents mentioned above occurred in such a situation of co-existence of new applications and existing services on a single network infrastructure.

The focus of this paper is on the value chain for video distribution. Video distribution clearly is an area where the Internet opens up opportunities for many new applications for consumers and businesses. At the same time, video distribution is also an area where new applications meet an existing ecosystem with existing business models. Video distribution over the Internet (often called

Over-the-Top or OTT video), and streaming video in particular, presents a number of challenges which make it interesting to study in the context of net neutrality ([13],[14]). First, large-scale distribution of streaming video requires large amounts of bandwidth (*e.g.*, [15]). Therefore, the growth of streaming video leads to the question which players in the value chain need to contribute to the investments in additional capacity. Secondly, in order to provide streaming video with an adequate quality of experience for the end user, the delays and packet losses in the network should be sufficiently small. This means that streaming video introduces higher requirements on the quality of the networks than traditional Internet services such as e-mail and ftp. Thirdly, OTT video services such as Netflix compete with the Video on Demand (VoD) services offered by telcos and cable companies in their triple play packages, while the end users use the Internet component of the same triple play packages to access the OTT content. As described earlier, this type of competition can lead to net neutrality discussions. Fourthly, other areas in the value chain for video distribution are also being contested by new players, in particular by powerful consumer electronics and search parties like Apple and Google. Thus, the value chain for video distribution is characterized by an ongoing struggle by the various business players in the value chain to influence and even control the access that consumers have to content and applications. This struggle is driven by commercial considerations: "owning" the customer by controlling his navigation through and access to content is valuable as opens up advertising opportunities. The result is a "battle for eyeballs" that takes place amidst an increasing technical, economical and also regulatory interconnectedness of the broadcast media and Internet domains.

As a result of the historical development of the net neutrality debate, current policy measures such as transparency are aimed primarily at Internet Service Providers (ISPs) which provide the Internet access service, an important part of the OTT video distribution value chain. However, as explained above, other parts of the value chain are important too in the struggle for control. Net neutrality therefore calls for a value chain approach: each part in the chain can develop into a control point. And, very important when defining policy measures, a measure aimed at one part of the chain can have an effect in other parts as well. The research question addressed in this study is therefore: What are the intended and potentially unintended effects of policy measures in the area of net neutrality, taking into account the entirety of the video distribution value chain?

Of course, net neutrality is about more than just the business and commercial perspectives sketched above. It also has a dimension relating to the content itself, which can move the discussion to another level where basic human rights are at stake, such as freedom of speech and uncensored access to information. From a human rights perspective, these considerations are more important than the business considerations of various players in a value chain and it is therefore appropriate that they receive ample attention in academics (*e.g.* [16],[17]) and in the public/political debate (*e.g.* [18],[19],[7],[20],[21]). In this paper, however, our focus is on the business perspectives of the net neutrality debate. We also exclude topics such as the impact of net neutrality on duties of care on the internet or the applicability of concepts such as common carrier or universal service [22].

The remainder of this paper is structured as follows. In Chapter 2, we sketch the technological and market trends in video delivery, such as rise of Over the Top (OTT) video providers and Content Delivery Networks (CDNs). Both the unmanaged and managed lanes in the two-lane model for service delivery are considered. In Chapter 3, the main part of the paper, we study the background and goals of a number policy measures and regulatory interventions aimed at the promotion of net neutrality, such as transparency and no blocking. We also analyze the intended and potential unintended effects of these measures by investigating their impact on other parts of the value chain, where they may interact with actual and potential bottlenecks. Chapter 4 presents the conclusions of our analysis, emphasizing the need to include the entire value chain for video distribution in discussions on net neutrality. The findings of this study are of relevance to policy makers who have

the task to promote net neutrality and at the same time stimulate competition and innovation throughout the value chain.

2 The value chain for video distribution

2.1 The traditional TV value chain

The starting point for our analysis is an examination of the different market positions and power relations between the various players involved in video distribution. Figure 1 sketches a basic value chain for video distribution. Traditionally, TV producers created content in the form of TV programs, which were bundled in broadcast schedules by broadcasters and distributed through terrestrial networks. At the end of the value chain were the consumers who watched TV on classical TV sets, the only devices that were relevant at that time. Thus, all of the roles sketched in Figure 1 were present, although sometimes in a rather rudimentary form. With the emergence of satellite and cable networks offering basic and premium TV packages in combination with a subscription to their networks, the role of aggregator became more pronounced, but the model remained the same. It was later also adopted by telecom providers offering TV packages over digital terrestrial, DSL and fiber networks.
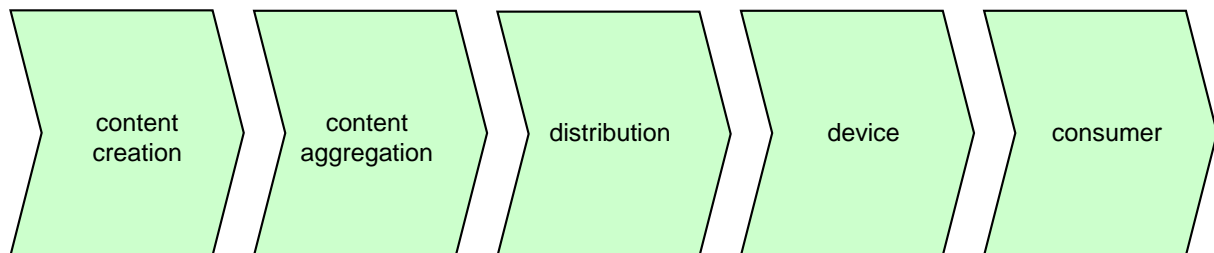

| content creation | content aggregation | distribution | device | consumer |

Figure 1. The value chain for video distribution.

2.2 From broadcast TV to video distribution

Since the 1980s the value chain for video has undergone several changes, in varying speeds and with different outcomes in different countries, but with some similar underlying patterns. In essence, the changes have added players that are active in the basic roles in Figure 1. With the emergence of satellite, cable and later DSL, digital terrestrial and fiber networks, competition between distribution networks has increased. This, in combination with digitization, has dramatically increased network capacity and has enabled networks to carry more and more TV channels as well as video-on-demand and other services. Lately, the growing availability and consumption of online video has started to have an impact on the video value chain. No longer is the TV the only screen on which consumers watch video, they now also use their computer, tablet or smart phone. These developments have led to more players and more competition in different parts of the video value chain. Many players have started to diversify their service offer and attempt to move upward in the value chain and offer value-added services, thereby strengthening their revenue generating potential. Consequently, most communication network providers now offer consumers so called triple-play services, combining fixed telephony, Internet and TV services, or, by adding mobile telephony, even quadruple play. In the Dutch market for instance, more than half of all households (52% in 2011, [23]) already subscribe to two or more services from the same provider. On top of those basic TV, telephony and Internet services, the network providers also attempt to sell additional services such as video-on-demand, games or premium digital TV packages in order to collect as much revenue as possible.

A major development affecting the market is the shift from linear TV consumption to on demand TV consumption. Although most people still prefer to watch linear TV, this situation is starting to change,

especially among young people. Firstly, many people watch video clips through YouTube, Vimeo and other user generated content sites acting as aggregators. Secondly, the offer of professional on-demand services is growing as well, both on the public Internet through OTT services as well as through managed TV services. Public service broadcasters' catch-up TV services such as the Dutch NPO's Uitzending Gemist, BBC's iPlayer and the German ZDF Videothek are among the most popular on-demand services. According to the European Audiovisual Observatory there were approximately 700 on-demand services in the European market in 2008 [24]. Until now, hardly any of the national services introduced in European countries have been profitable on their own. Their popularity and market success depends to a large extent on the size and quality of their catalogue. The online video market in the US has already developed further than its European counterpart, with Hulu and Netflix as two of the main online video providers. Customers of these services either pay per program or movie, or pay a standard subscription fee in exchange for access to a standard number of movies or programs per month. The potential impact of net neutrality regulation in this market becomes clear when realizing that Netflix' streaming video service alone accounts for 21% of all Internet traffic during peak times in the US, while YouTube accounts for 10% and BitTorrent for 8% [15]. Those large US players, which benefit from economies of scale, are now also entering the European markets.

2.3 Control points in the value chain

There are a number of important assets or control points in the video value chain. As explained earlier, a proper understanding of these control points is crucial to come to a useful value-chain based analysis of net neutrality.

- A first asset, and also a firm control point, is the possession of content or content rights, which is ultimately what consumers will want to watch and pay for, either in money or in exchange for 'eyeballs', *i.e.* attention to commercials.
- A second important asset is the possession of a direct relationship with customers, enabling payment and billing transactions and, especially in combination with valuable information on consumer profiles, sophisticated marketing and consumer loyalty campaigns.
- Thirdly, the ability to guide people's attention and thereby their preferences and consumption patterns through search engines, electronic program guides, opening screens, and other navigation tools is also becoming an increasingly important asset in the online world, difficult as it is for consumers to find their way in an abundance of content and information.
- Last but not least, access to networks and bandwidth of course remain crucial.

The distribution of these assets over the different players determines their position and negotiation power. A detailed discussion of how these assets are employed is beyond the scope of this paper. We will for instance not delve into the complicated discussions and negotiations on ownership and exploitation of content rights or windowing strategies for films and TV series. It is important, however, to keep in mind that all these assets might come into play when content providers and (vertically integrated) network and service providers negotiate agreements on transport and delivery of video content.

2.4 Developments in the value chain

In the next subsections, we briefly address four important developments in the value chain that are relevant for the net neutrality debate. In each development, different players in the chain try to exploit the assets described above to extend or consolidate their position.

2.4.1 The rise of OTT video distribution

The possibility to offer video directly to consumers through the open Internet has enabled creators of video content and TV channels to distribute their content independently from the traditional broadcasters, TV packagers and network operators. Some Hollywood studios, TV channels and TV producers have entered partnerships with OTT video providers like Hulu and Netflix. There are also numerous smaller, independent video providers, which offer their content directly online. This option, in combination with increased competition between distribution networks, has somewhat strengthened the position of video content providers and TV channels vis-à-vis network providers in the value chain. They no long need to rely exclusively on network providers for distribution deals, but can also offer their content independently on the open Internet, or choose to refrain from distributing their programs over a particular network and switch to another network. Distribution of video over the public Internet has thus widened the options for content producers. Especially the large, international TV and video producers, whose brand is sufficiently strong to be recognized by consumers, might be able to launch their own services. Generally speaking, content producers, benefit from wide, cheap and unrestricted availability of broadband Internet. This is even more true for the smaller (or niche) video providers.
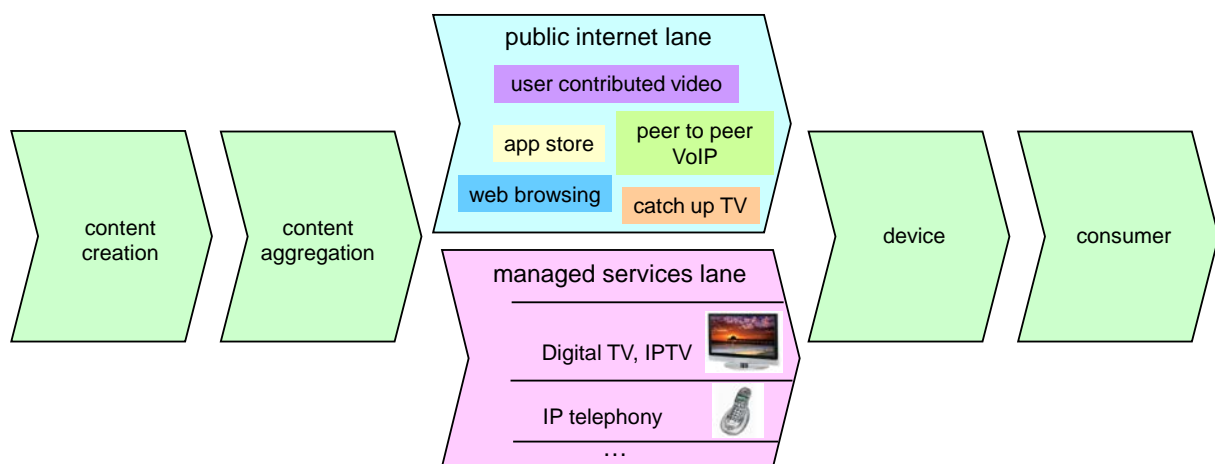

Figure 2.Two-lane model with complementing (and partly competing) OTT and managed video services.

The availability of broadband Internet has thus paved the way for new OTT video services like Hulu and Netflix. Conversely, OTT video services stimulate the use of broadband, to the benefit of broadband network providers. The relationship between OTT video providers and network providers is not unproblematic though, as the OTT video services also compete with the TV packages and on-demand services offered by the very same, vertically integrated network and service providers. Typically, these vertically integrated providers offer these services as managed services with certain explicit or implicit quality guarantees. The co-existence of (services and applications over) the public Internet and managed services leads to the so-called two-lane model ([9],[25],[26]). As illustrated in Figure 2, in the two-lane model OTT services and managed services are delivered to the end user over a single broadband connection (*e.g.* cable, DSL or fiber). The managed services are also referred to as "specialized services" [5] and "additional, differentiated online services" [27]. As an example, the catch-up TV service offered by the Dutch public broadcaster is available both as a best-effort OTT service and as a guaranteed, higher-quality service within managed digital TV packages offered by network operators. As another example, the VoD service offered by Netflix competes with the VoD services offered by network providers. From this perspective, network providers have an interest in slowing down the use of OTT video services. In the managed services lane, network operators typically employ hard bandwidth reservations to guarantee the quality of their managed services. Similar mechanisms to guarantee service quality are not available in the public Internet lane.

Moreover, bandwidth reservations in the managed services lane decrease the bandwidth available for the public Internet lane, as both lanes are typically delivered over a single consumer broadband connection and therefore share the available resources. The assignment of bandwidth to either the public Internet lane or the managed services lane is therefore clearly related to net neutrality. An alternative approach for network providers to discourage the use of OTT services would be to charge the OTT video providers or consumers extra for the use of bandwidth. Obviously, this approach would also affect net neutrality.

2.4.2   New powerful players from the consumer electronics and search markets

New powerful players from other markets have entered the market for video distribution. Two well-known examples are Apple and Google. Apple has proved very successful in combining its devices (laptops, desktops, iPads and iPhones) with easy access to its iTunes online shop, which started as a music shop, but now also offers many movies and TV shows. Google started its expansion into video with the acquisition of YouTube in 2006, complementing its own Google Video services. Both Apple and Google have introduced devices linked to their own OTT TV services (Apple TV [28] and Google TV [29]). Neither Apple nor Google produces original video content and thus rely on partnerships or deals with content producers for the services which they can offer.

Apple TV and Google TV thus come to function as new platforms (and potentially also gatekeepers) for online streaming video content. These devices and services will again contribute to the growth in OTT video distribution. Their selection of video content as well as their navigation menus, presentation and ranking of video content will affect what users will find most easily. In this domain they compete with network providers, especially with those offering sophisticated EPGs and other navigation tools, either as separate services or included in proprietary set-top boxes.

2.4.3   Bundling strategies to extend or preserve relation with customer

In the "battle for eyeballs" mentioned earlier, players across the value chain try to build a strong relationship with the end users. Such a strong relation offers the best starting point to open up advertising revenue streams linked to video consumption or search. To extend this relationship and to protect it from competition, many players employ service bundling strategies. The triple play packages offered by network providers are good examples of service bundles. Service bundles are often convenient for consumers as it removes the need to subscribe to each service separately. Consumers can also benefit from cost efficiencies that bundling can create for the network providers. However, bundling also comes with the risk of lock-in effects, making it difficult for consumers to switch from one provider to another in case they are dissatisfied with one of the services. This problem is aggravated by a lack of transparency in the exact contents and conditions of the various service offers. Note that other players than network providers also use bundling, for example by bundling their devices with services: Apple's iPhones and iPads with the iTunes store, Apple's TV device with its video service, Google's TV device with its service.

2.4.4   CDN architectures bring new players and discussions

Global Internet traffic is growing rapidly and this growth is expected to continue in the years to come with overall year-on-year growth rates between 35 and 60% [30]. The growth rates indicated for Internet over mobile access are even higher (*e.g.* [31]). Streaming video is the main driver for the overall growth. The need to handle the large amounts of video traffic has led to the development of specialized architectures for video distribution, commonly referred to as Contend Delivery Networks (CDNs, [32]). Without CDNs, each individual video stream needs to be transported from the video provider's media server through the Internet core and the network of the end user's ISP (Figure 3(a)).

Even if many end users of an ISP choose to view the same popular video, they all receive their own video stream originating at the video provider's media server. Situation b) shows the CDN approach preferred and used by many video providers today. Popular videos are played out from media servers that are located closer to the end user, typically at Internet Exchange Points where the "eyeball" ISPs connect to the global Internet core. This drastically reduces the media server capacity and bandwidth required by the video provider. It also reduces the traffic load on the Internet core and potentially increases the video quality experienced by the end user as the IP transport path is shortened. This CDN approach is offered by specialized CDN providers such as Akamai and Limelight that have come to play an important role in today's value chain for video distribution. Figure 3(c) shows a further step in which the media server moves into the eyeball ISP's network. The arrangements for this step are currently discussed between CDN providers and ISPs. In essence, the introduction of CDNs leads to a "flatter" Internet, in which content is inserted close to the destination rather than being carried through large parts of the global Internet.
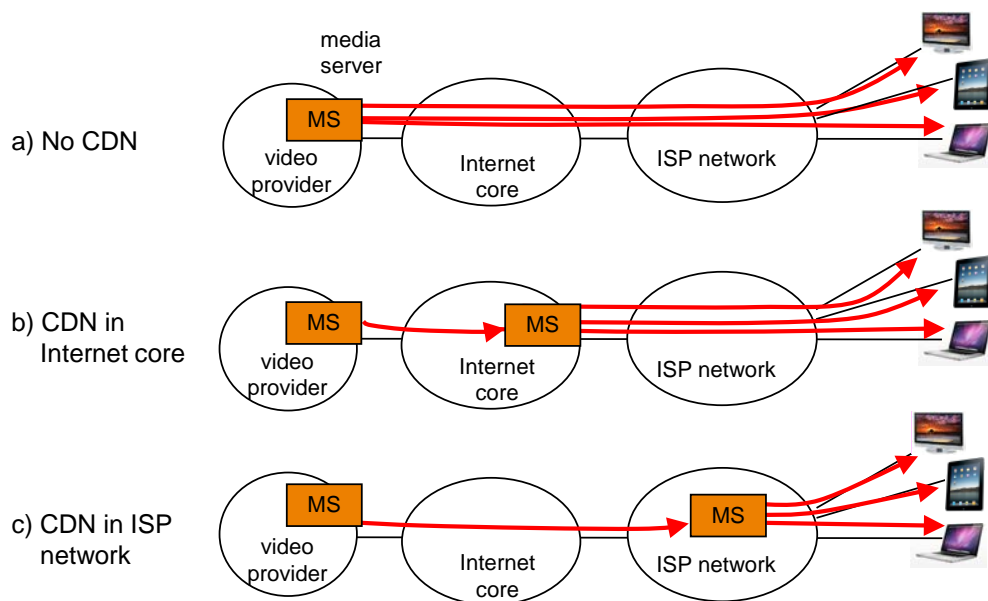

Figure 3. CDNs reduce the traffic volume associated with streaming video and potentially increase the quality experienced by the end user: a) situation without CDN, b) CDN in Internet core and c) CDN in ISP network.

Apart from contributing to the strong overall growth of the Internet traffic, the rise of streaming video also changes the characteristics of the traffic flows across the Internet. Years ago, the Internet traffic used to be dominated by IP flows from e-mail, ftp and web browsing. The distribution of the providers offering these services over various ISPs in many cases led to roughly symmetric traffic flows between ISPs. One ISP's customer would, on average, send and receive roughly the same amount of traffic as another ISP's customer. Streaming video changes this situation. A large portion of the traffic now increasingly originates from fewer, very large sources, such as video content providers with popular content and large CDN providers, to the eyeball ISPs. This introduces asymmetries in the traffic exchanged between CDN providers and ISPs: typically, the amount of traffic from the CDN provider to the ISP is much larger than the traffic flow in the opposite direction. Although asymmetric traffic profiles are not new in the Internet, large-scale distribution of streaming video clearly increases the relevance of this phenomenon. As will be discussed in section 3.5.1, asymmetric traffic profiles have led to discussions that relate to net neutrality and the "battle for eyeballs".

3 Intended and potentially unintended effects of policy measures

The analysis in the previous chapter clearly shows that the value chain for video distribution is growing more and more complex as a result of the interconnectedness between the media and Internet markets. Players in each part of the chain try to build on their assets to protect or extend their influence. In the end, the competing players try to build a strong relation with the end user in the "battle for eyeballs". The policy measures and regulatory interventions aimed at promoting net neutrality have an effect on the struggles for influence and eyeballs in the value chain. In this chapter, we analyze a number of policy measures and evaluate their intended and potentially unintended effects in the value chain.

3.1 *Transparency as a first, non-intrusive measure*

Transparency is typically the first measure considered by regulators to promote net neutrality and open access to services and applications on the Internet. The main reason for this is that transparency is the least intrusive measure available. Transparency does not explicitly promote or prohibit specific traffic management methods that network operators can use, such as prioritizing, throttling or even blocking Internet traffic related to selected applications. Instead, transparency measures introduce an obligation for network operators to provide information on the traffic management measures they employ. The purpose of this transparency is to give end users a meaningful insight into the traffic management methods which are employed by network operators (typically the ISPs) and what consequences they have for them. Based on the information on traffic management that is provided to them, end users can make an informed choice between different ISPs offering Internet access services. Users can also decide to move to another ISP if they feel that the traffic management methods of their current ISP do not meet their needs. In this way, the transparency obligation can influence the ways in which the ISPs apply traffic management in their networks, without explicitly specifying which types of traffic management are allowed or not.

In the EU, a transparency obligation has been introduced in the universal service directive [33]. Its implementation is analyzed in a number of BEREC studies ([34], [35]) and national studies (*e.g.* [36],[25]). In the US, the FCC has also included a transparency obligation in its rules [5]. Transparency measures primarily focus at the public Internet lane in the distribution part of the value chain (Figure 4). They may touch upon the distribution of the total bandwidth available on a broadband connection over the public Internet lane and the managed services lane, but they do not directly address it. As described in the previous chapter, this distribution issue is of direct relevance to the net neutrality debate. Indirectly, the issue is addressed by other efforts by regulators that aim to provide end users with better insights in the Internet speed they can realistically expect (*e.g.*, [37]).
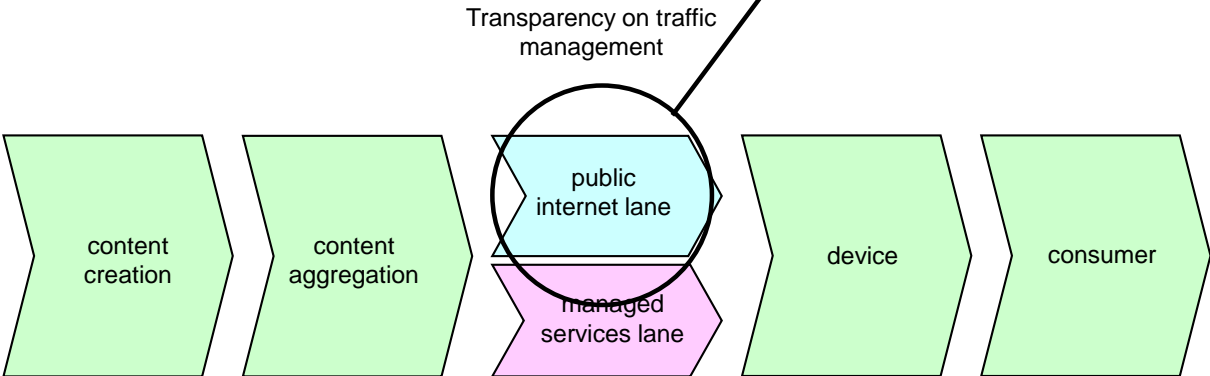

Figure 4. Transparency obligations focus at the public Internet lane part of the value chain.

Whether the transparency measure in itself is sufficient to promote and protect the open access of end users to services and applications on the Internet remains to be seen. Open access to the Internet is a topic that has the potential to draw substantial attention from a wide public, as has been demonstrated in the net neutrality incidents described in the introduction of this paper. Moreover, there is evidence that suggests that transparency can also work if the information provided to the end users is not complete, or when the information does not reach all the end users [38]. The key question, however, is whether consumers will indeed choose to change ISPs in the current value chain environment. A significant obstacle here is introduced by the bundling strategies that are widely employed by network operators. A consumer that has a triple play subscription would not only need to change his broadband Internet subscription, but also his telephony subscription and his digital TV subscription, potentially including a change of set-top box. Thus, even if he is dissatisfied with his current ISP's traffic management practices, it could involve a considerable effort from his side to actually move to another provider. If barriers introduced by bundling and investments in CPE keep end users from switching, then transparency could be false solution that only legitimizes the traffic management practices by ISPs. Indeed, an ISP could claim that, as he is complying with the relevant regulatory stipulations by being transparent about his traffic management practices, there is no need for further concerns.

Independent of whether a transparency obligation will achieve its desired effect, *i.e.* influencing the ways in which the ISPs apply traffic management in their networks, it does provide useful information for other purposes. For example, regulators, consumer organizations and content providers have guaranteed access to information on the technical measures that network providers employ. They can use this information in their own regulatory and business considerations. The transparency obligation also provides the information basis needed for further policy measures, such as the no-blocking measure discussed next.

3.2   No blocking/throttling as a next step

The FCC explicitly prohibits blocking and throttling for Internet access services [5]. A similar measure is included in the amendment adopted by the Dutch parliament in 2011. The amended law has not yet entered into force, awaiting approval by the Dutch Senate (expected in March 2012). The main motivation for the introduction of no blocking/throttling rules is that the transparency measure is expected to be insufficient to safeguard open access to services and applications on the Internet for end users. There are a number of differences between the FCC and Dutch measures, such as the somewhat lighter measures for mobile in the FCCs rules, but rationale is similar. In contrast to the transparency obligations described above, the no blocking/no throttling measures work directly to support the objective of open access to all content and information on the Internet. It does so at the cost of being much more prescriptive and intrusive vis-à-vis network operators. A no blocking/throttling measure clearly removes potential technical obstacles for this open access. However, the no blocking/throttling measures primarily aim at the public Internet lane part of the distribution part of the video distribution chain (Figure 5). It does not directly address potential obstacles in other parts of the value chain.

In general, the no blocking/throttling measures can interfere with useful network management practices employed by ISPs. The FCC rules therefore allow for "reasonable network management", where reasonable should be interpreted as "appropriate and tailored to achieving a legitimate network management purpose, taking into account the particular network architecture and technology". The Dutch amendment also leaves room for network management required for proper delivery and access to services. The challenge here is to judge whether a specific network management practice is reasonable or required when it involves blocking or throttling. In cases where ISPs block specific IP traffic flows to prevent botnets or protect network integrity, this judgment can be, but will not necessarily always be, relatively straightforward. But there is also a

wider issue at stake in network management, one that has already been identified by Tim Wu in his 2003 paper [1] :

> "… IP was only neutral among *data* applications. Internet networks tend to favor, as a class, applications insensitive to latency (delay) or jitter (signal distortion)… . In a universe of applications, that includes both latency-sensitive and insensitive applications, it is difficult to regard the IP suite as truly neutral as among all applications."

The Internet supports an extensive and still-growing set of applications, with strongly varying network requirements in terms of delay, delay variation (jitter), packet loss and other parameters. By treating the IP traffic flows of applications in a way that best matches the application requirements, the user experience can be improved and networks can be operated more efficiently. This is particularly relevant in situations where a network is congested, but also during normal network loads. A strict interpretation of the no blocking/throttling measure would thus remove useful instruments available in network management. This issue directly affects distribution of streaming video, as it bandwidth intensive and sensitive (though not very sensitive) to delay and packet loss. At first sight, the no-throttling measure leaves room to prioritize flows from specific applications and thus promote the quality of their delivery. However, prioritizing one portion of the IP flows inherently means that the remainder of the IP traffic is handled with a relatively lower priority. It is still an open question at what point such a lower priority would be considered to effectively lead to throttling of the applications that are not selected for priorization.

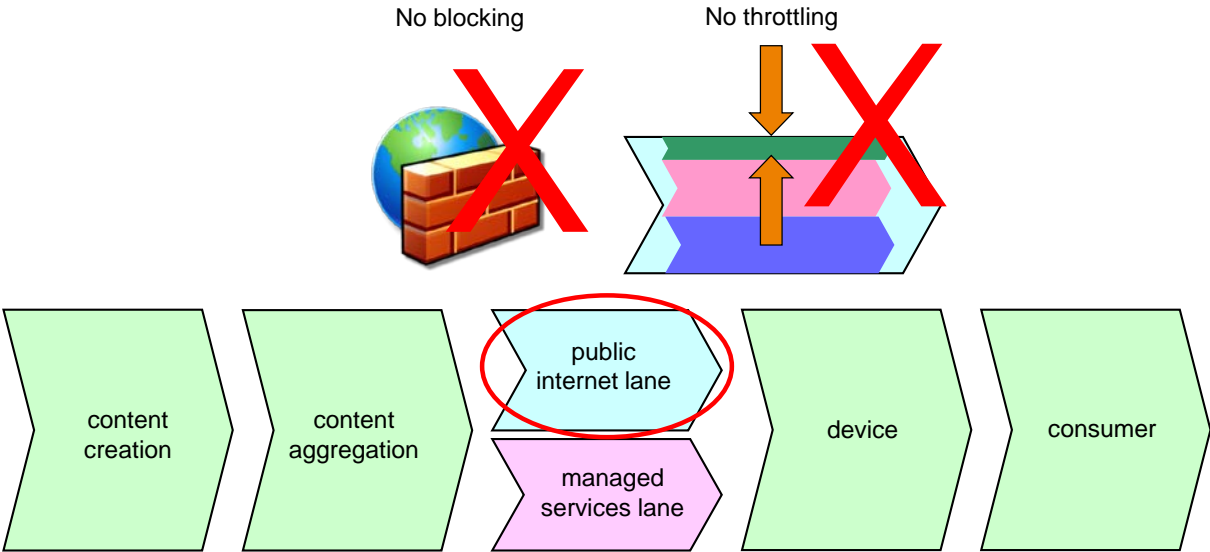Figure 5. The no blocking and no throttling measures are imposed on ISPs that provide Internet access services.

3.3   No retail tariffing by ISPs of OTT as a business complement

In the Dutch amendment, the no blocking/throttling measure is accompanied by a complementary measure that explicitly prohibits ISPs from charging their retail customers for the use of OTT services over their broadband subscriptions, see Figure 6.
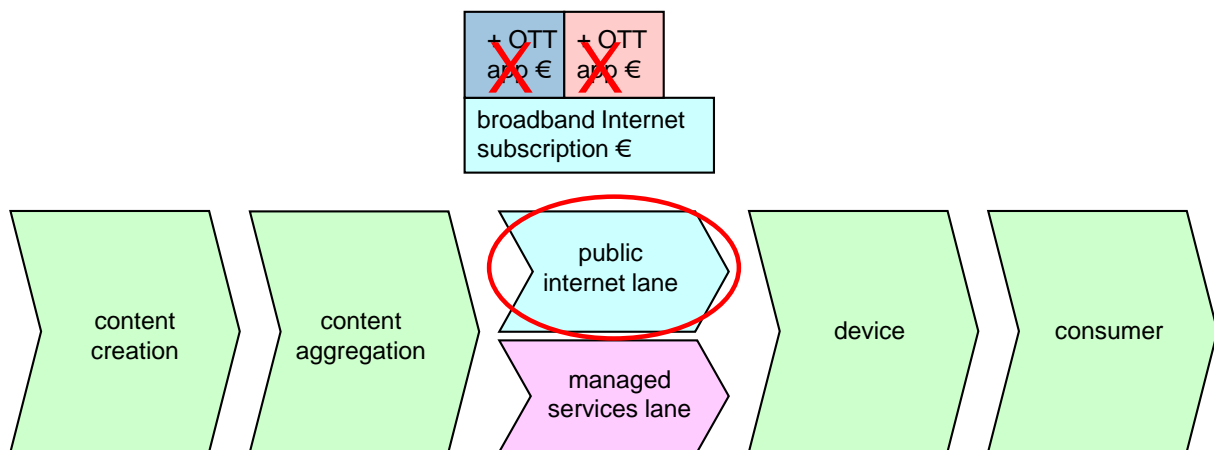
Figure 6. The Dutch measure prohibiting ISPs to charge their retail customers for the use of OTT services and applications.

Similar to the no blocking/throttling measure, this measure is aimed at the public Internet lane part of the distribution part in the chain. Clearly, it removes a potential obstacle to open access to the Internet for end users. This obstacle is not far fetched, as demonstrated in particular in mobile Internet access, where a number of operators have announced plans to charge their retail customers for use of OTT services. At the same time, the measure is rather prescriptive for business models and product development, in at least two areas:

1. At the retail side, the measure - clearly inspired by common carrier/universal service principles[1]- forces ISPs in the direction of subscriptions that only charge for volume and speed in broadband access. This is probably an intended effect for OTT content providers who can keep full control about the retail pricing of their services. It may also be an intended effect for regulators, as it could be a way to make the combined costs for network capacity and traffic management transparent and comparable in the retail pricing of broadband access subscriptions. It is clearly an unintended effect for vertically integrated providers that aim to provide their retail customers with bundled offers of Internet access, managed services and special arrangements for OTT services. If charging for volume and speed in broadband access leads to higher prices for (mobile) broadband, then this could be a negative effect for consumers.

2. At the interconnection/peering side, the measure weakens the position of network providers in their negotiations with content providers. As explained in section 3.5.1, interconnection and peering between network operators and content providers is one of the areas where players in the value chain use their assets to negotiate the conditions for distribution of content, including video. Prohibiting the network operators to charge their retail customers for the use of OTT services weakens the negotiating position of network operators vis-à-vis the content providers, as they lose the option to charge for specific OTT services.

The measures prohibiting network operators to charge their retail customers for the use of OTT services has received less attention than the no blocking/throttling measure. In the discussion following the Dutch amendment, it is often considered an integral part of the no blocking/throttling measure. However, as described above, the "no charging of OTT apps by ISPs" measure is complementary and can have different effects. The two measures should therefore be evaluated on

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[1] Although these principles are often misunderstood, in this context they relate to the aspect of non-discriminatory transport of services/content where speed and volume remain as the only parameters for charging the end user.

their own merits. It can be expected that the "no charging of OTT apps by ISPs" measure has a large effect on the value chain for video distribution, as it directly affects business models.

3.4   Minimum requirements as a measure of last resort

The European Universal Service Directive [33] also introduces the option for national regulators to introduce minimum requirements for the quality of the network services provided by operators. An example of a potential minimum requirement is a no blocking/throttling requirement, as introduced in the Dutch amendment and by the FCC. The requirements can also cover other areas, including the specification of a typical or minimum bandwidth [39]. In principle, the directive allows for minimum requirements in both the public Internet lane and the managed services lane. However, in the managed services lane, end users have a clear expectation of the quality they can expect, *e.g.* a digital TV package consisting of 20 high definition and 30 standard definition channels. This quality is typically contained implicitly or explicitly in the service contract and deviations are readily noticed by the end user. The quality of the Internet access in the public Internet lane is not defined as precisely in most cases. It is therefore expected that if minimum requirements are introduced, their focus will be at the public Internet lane.

The intended and potentially unintended effects of no blocking/throttling requirements have already been discussed in section 3.2. Specifying a minimum bandwidth would be a further step that could be taken if it is felt necessary to safeguard applications from bandwidth shortages in the Internet access services offered by network operators. Although the measure itself and its intended effect are relatively straightforward at first sight, it may prove to be more difficult in practice. The Internet supports a wide variety of applications, making it hard to come to a generic judgment of a bandwidth that should be considered sufficient to support them with sufficient quality. It will be challenging task for regulators to get the actual specifications right and to keep them up to date. But the main drawback of imposing minimum bandwidth is that is a rather prescriptive and intrusive measure that directly affects the opportunities that operators have for product development and differentiation. It is therefore not surprising that the BEREC work on minimum requirements [39] recognizes that they should only be applied when no effective alternatives are available and when their benefits outweigh the drawbacks.

3.5   Policy measures stimulate new net neutrality-related discussions

The policy measures examined in the previous sections are all aimed at the promotion of net neutrality and open access to the applications and services on the Internet for end users. They also have in common that they, explicitly or implicitly, focus at a specific area of the value chain for video distribution: the public Internet lane portion of the distribution part. However, the ongoing struggle by the various business players in the video distribution value chain to influence and even control the access that consumers have to content and applications is not limited to the public Internet lane. Therefore, the policy measures aimed at this admittedly important part can result in a transfer of issues from the public Internet lane to other parts of the value chain. Below, we examine three areas where the debate on net neutrality and open access could be affected and even intensified.

3.5.1   Interconnection and peering: a new battleground?

The relevance of interconnection and peering for the net neutrality debate is readily demonstrated by the Level3-Comcast case [40], illustrated in Figure 7. Level3 uses its CDN (section 2.4.4) to distribute substantial amounts of streaming video for its customer Netflix, a large US provider of OTT VoD services. As a CDN provider, Level3 depends on ISPs such as Comcast for the final part of the delivery of the videos from the peering point to the end users' home. Level3 provides the video

traffic to Comcast on the basis of peering agreements that Comcast and Level 3 have. A conflict arose in 2010 when Comcast stated that it would no longer accept the growing amount of video traffic from Level3 without payment of an additional fee by Level3. This conflict is partly driven by the strongly asymmetric traffic profiles associated with large-scale distribution of streaming video: for streaming video, the amount of traffic from Level3's CDN into the Comcast network is much larger than the traffic flow in the opposite direction. In the (unregulated) market for Internet peering, a certain degree of asymmetry is accepted in settlement-free peering agreements, but for larger asymmetries typically a fee is paid by the party generating the larger amount of traffic. As such, the request by Comcast for payment of a fee is not unusual. What makes this conflict interesting for the net neutrality debate is that the Netflix OTT VoD service competes with Comcast's own managed VoD service. Therefore, the conditions for peering, traditionally seen as an issue between carriers of IP traffic, also affect the competition at retail level. In the end, Level3 decided to pay the extra fee to ensure delivery of streaming video to Netflix' customers on the Comcast network.
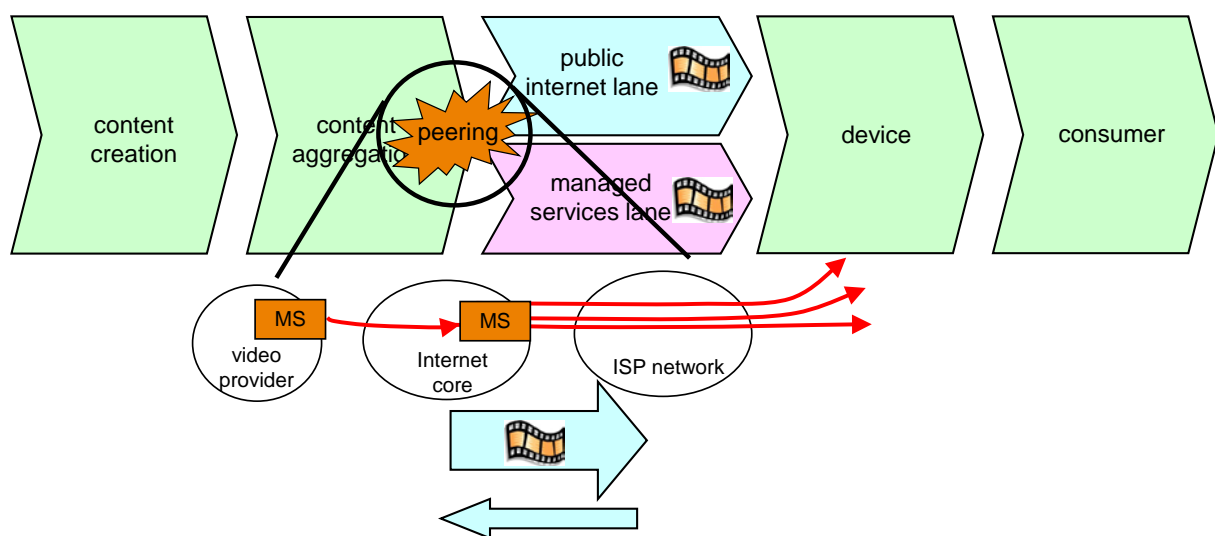

Figure 7. Peering agreements for streaming video exist in an environment of asymmetric traffic profiles and competition between OTT and managed services.

The Level3-Comcast case points at a path that can potentially be followed by network operators that experience competition from OTT VoD providers or that cannot charge their retail customers for the use of OTT services: they can try to gain additional revenues at the peering and interconnection side from the OTT players they are competing with on the retail side. Another option for network operators could be to offer OTT providers an improved delivery path through their network (*e.g.*, with certain bandwidth or quality guarantees achieved through priorization). In the US, this would probably be unfeasible in fixed networks as the FCC has introduced its "No unreasonable discrimination" rule. Although it does not explicitly prohibit paid prioritization, the FCC's expectation is that it will be considered as unreasonable discrimination in practice. At the same time, the FCC states in a footnote [41] "We do not intend our rules to affect existing arrangements for network interconnection, including existing paid peering arrangements." At this time, the European rules for net neutrality do not cover the area of interconnection or peering.

In our view, peering and interconnection deserve more attention. First of all, it needs to be determined whether peering and interconnection are a separate issue. It is without question that both directly affect net neutrality, but if compared with the more traditional concepts of telecommunications policy/regulation, service provisioning has been considered to be part of a different regulatory context than interconnection. Interconnection is a prerequisite for access and interoperability, but is governed by a more specific set of rules and regulations. This is in particular

the case with "traditional" interconnection regulation with rules on negotiations, access to facilities (*i.e.* colocation) and financial aspects (tariffs). In a European context, interconnection in order to secure interoperability is more regulated than interconnection in order to make services accessible. "Significant market power" plays an important role: without it, the possibility to impose remedies via sector specific regulation is lacking. Until now, peering agreements have mainly remained outside the scope of regulators.

It seems that we have to assume that interconnection and peering negotiations not aiming at blocking particular services remain unaffected as such. But, these negotiations will become more complex when video content needs to be delivered closer to the end user, which might require access to facilities and the installation of additional active equipment (Figure 3(c)). It will be necessary to question whether in those circumstances the thin line between service-related and non-service related interconnection/peering has been crossed. And if so, what type of regulatory intervention is appropriate.

3.5.2   The rise of the managed services lane?

In the two-lane model (section 2.4.1), OTT services and managed services are delivered to the end user over a single broadband connection. Among these managed services are typically the TV packages and on-demand services offered by the vertically integrated network and service providers. The assignment of bandwidth to either the public Internet lane or the managed services lane is therefore relevant in a value-chain based net neutrality analysis. In particular, three of the policy measures described earlier, transparency, no blocking/throttling and no ISP tariffing of OTT, all focus mainly on the public Internet lane portion of the distribution part of the chain. One way to look at the measures is that they promote the neutrality and openness of the public Internet lane and as such work towards their intended effects. Another way to look at these measures is that they make the public Internet lane less attractive for network operators as they introduce a number of obligations and restrictions in network management and business models. In comparison, the managed services lane becomes more attractive (Figure 8).
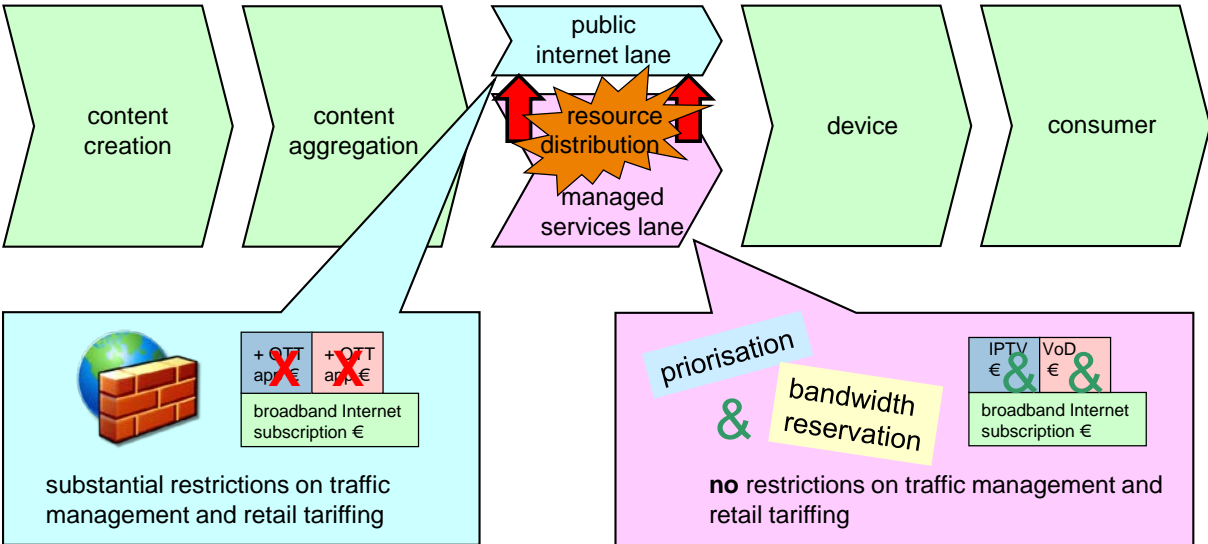

Figure 8. No blocking/throttling and no ISP tariffing of OTT measures may tempt network operators to assign more resources to the managed services lane at the cost of the public Internet lane.

Therefore, as a response to the policy measures, network operators could be tempted to widen the managed services lane by assigning more resources (*e.g.*, bandwidth) to it, at the cost of the resources available to the public Internet lane. Whether the public Internet lane would indeed be in

danger of becoming the metaphorical "dirt road" remains to be seen [42]. The competition between ISPs on the capacity and quality of their Internet access services can work to protect the public Internet lane from becoming such a dirt road, as good-quality Internet access is obviously valued by end users.

Content providers also have an interest and a role here. Large content providers can be in a position to negotiate a path in the managed service lane of network operators. They could then benefit from quality guarantees for the delivery of their content. The European Broadcasting Union (EBU) is of the opinion that network operators should make their managed services available on fair, reasonable and non-discriminatory (FRAND) terms [43]. Given acceptable conditions for access to the managed lane, large content providers and ISPs could even find shared interests in the battle for eyeballs and promote these interests by developing combined packages of digital TV, on-demand and other content in extended triple play packages. For smaller content providers it would be more difficult to come to attractive arrangements with network providers.

The EBU also identifies the risk that the public Internet lane could suffer from the redistribution of resources towards the managed services and concludes that regulatory intervention may be needed to protect the quality of content delivered over the public Internet. Regulators could impose minimum requirements (e.g. in terms of bandwidth and other parameters) on the Internet access services that network operators provide in their ISP role. As described in section 3.4, this would be a very prescriptive and intrusive measure. It would be inappropriate if the introduction of this measure would be required primarily because of the introduction of the other regulatory interventions, such the combination of no blocking/throttling and no ISP tariffing of OTT policy measures.

3.5.3   Steering the eyeballs with EPGs, app stores and devices?

A very powerful, if not the most powerful, way to guide the end users' attention and thereby their preferences and eyeballs is through a combination of attractive devices, apps and cloud services. This concept has been introduced in the mobile market through Apple's iPhone-iOS-iTunes combination. Apple has extended this concept to other market segments with its iPad and Apple TV. Google has also built a strong position in mobile through its Android OS-Android Market combination and is also extending it with Google TV. Increasingly, search and navigation are or will be linked to devices and apps on devices rather than to traditional search engines on the open Internet. The combination of smart devices and apps, linked to cloud storage and processing provides the OTT providers a wealth of information on end users that can be exploited in the battle for eyeballs and advertising revenues. Apple and Google have gained a strong position in this field, although they face fierce competition from Facebook that uses another mechanism, social networking, to obtain information on end users and guide their attention and choices.

Network operators have also identified the relevance of devices and have started to offer their services and content on popular devices in order to attract the end user's attention. For example, a number of cable and DSL based TV providers in the Netherlands provide the option to view channels from their digital TV packages as streaming video on a tablet. This streaming video option is tightly linked to the digital TV subscription, as it is only available at the address registered for the TV subscription. UPC has announced a further step in its project Horizon [44], which combines digital TV content with Internet content, smart recommendations and an app store. Network operator initiatives like Horizon directly compete with Apple TV and Google TV in the battle for eyeballs, see Figure 9.
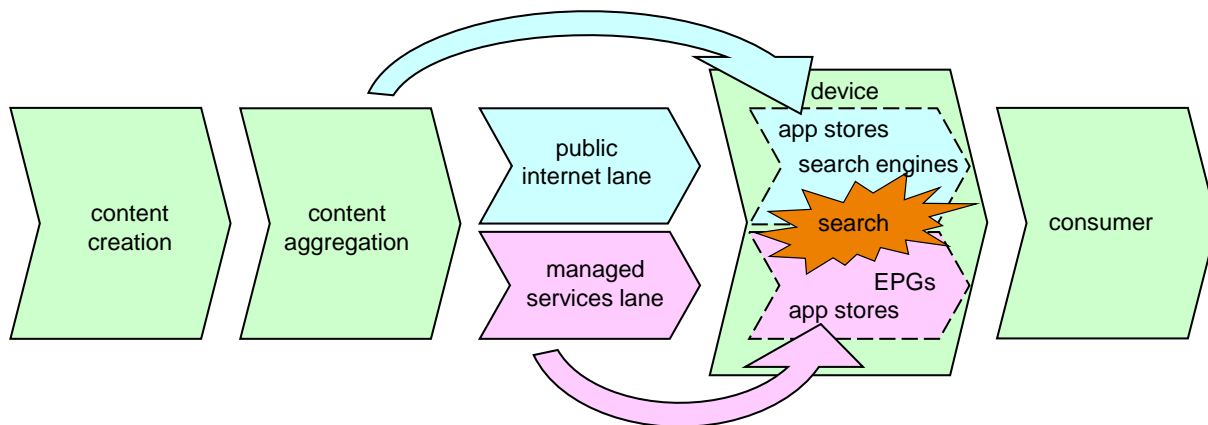
Figure 9. OTT providers and network operators both attempt to guide the attention and preferences of end users through combinations of devices, apps and recommendations.

The role of devices and apps in the battle for eyeballs is directly related to the net neutrality debate and can therefore not be neglected. Search neutrality (*e.g.* [45]) may seem to be a different type of neutrality than net neutrality, but it appears in the same struggle for influence in the value chain.

It is interesting to see that the transparency measure (section 3.1) imposes, to some extent, obligations on the network operators in the areas of devices and apps. The European Universal Service Directive [33] stipulates that operators must inform the end user about "any restrictions imposed by the provider on the use of terminal equipment supplied". Operator-defined preferences in EPGs, search and recommendation engines would in principle be covered by this obligation. How this obligation would be interpreted in practice is unclear at this point. More importantly, the obligation as such does not cover OTT players that provide search and recommendation tools to the end users, as they do not offer "services providing connection to a public communications network and/or publicly available electronic communications services". This again shows that a more consistent value chain approach is needed in order to secure the rights that these types of provisions are aiming at.

4 Conclusions

Net neutrality and video distribution are a combination that leads to complex considerations for regulators and the players in the value chain. It makes net neutrality dilemmas visible and concrete. Net neutrality in itself is already a challenging subject that relates both to fundamental human rights and to strategic business considerations of players in the converging communication-media-applications market. The video distribution chain is developing and changing rapidly, through the rise of OTT video distribution and the growing importance of smart devices. Our analysis shows that net neutrality interacts with video distribution at different points along the value chain. We therefore call for a value chain approach, as assets in each part in the chain can develop into a control point for the open access to content and application.

The policy measures that are in force now, or that are expected in 2012, focus mainly at the public Internet lane part of the distribution chain and impose obligations on network providers, and ISPs in particular: transparency, no blocking/throttling, no ISP tariffing of OTT. Although each of these measures contribute to their intended affects, our analysis shows that they are likely to lead to more debates in other areas, as players try to compensate the loss of influence or revenue streams by rearranging the ways in which they exploit their assets (Figure 10). Thus, a measure aimed at one part of the chain can have an effect in other parts as well. Incidents and debates have already

occurred or can be expected in the areas of peering and interconnection, distribution of resources between public lane and managed lane and in particular the influencing of people's navigation on the Internet through search, recommendations and app stores linked to devices.
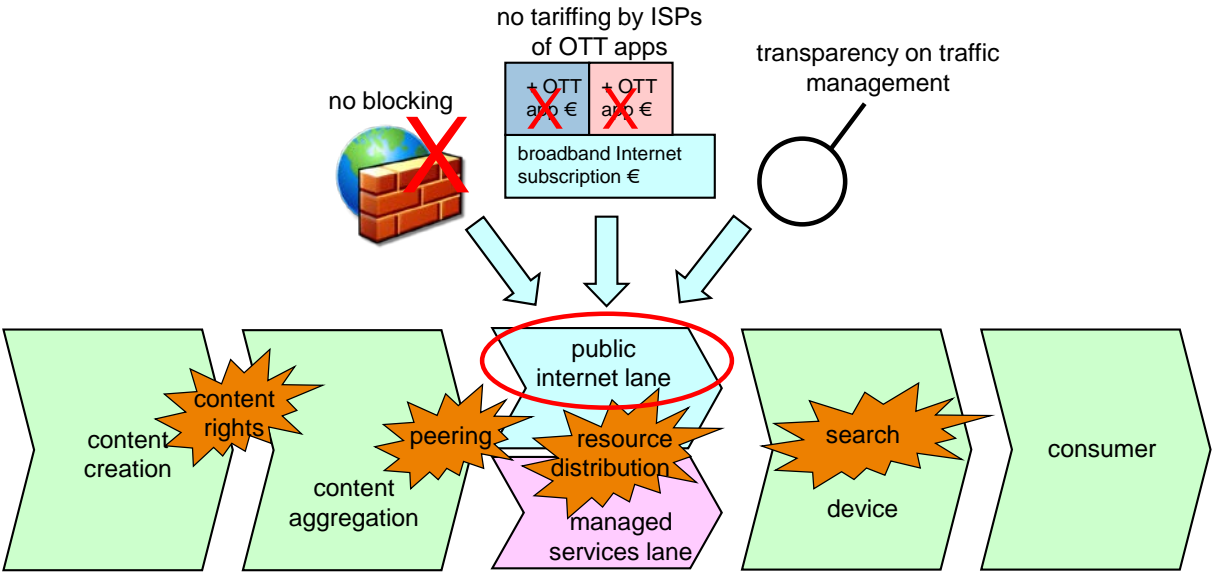
Figure 10. The focus of current policy measures on the public Internet lane can lead to debates in other parts of the value chain.

For the European policy and regulatory environment, these new debates bring a risk of divergence between the considerations and decisions of national law makers and regulators. Although the concerns around net neutrality are shared by most law makers and regulators, this does not necessarily lead to uniform results in the application of rules and guidelines. At the same time, the video distribution market with its CDNs, devices and applications has a European or even global scale that would benefit from uniformity or at least coherence in the policy measures aimed at promoting net neutrality.

References

[1]   Wu, Tim, Network Neutrality, Broadband Discrimination. Journal of Telecommunications and High Technology Law, Vol. 2, p. 141, 2003. Available at SSRN: http://ssrn.com/abstract=388863 or http://dx.doi.org/10.2139/ssrn.388863

[2]   Lemley, Mark A. and Lessig, Lawrence, The End of End-to-End: Preserving the Architecture of the Internet in the Broadband Era (October 1, 2000). UCLA Law Review, Vol. 48, p. 925, 2001; Stanford Law and Economics Olin Working Paper No. 207; UC Berkeley Public Law Research Paper No. 37. Available at SSRN: http://ssrn.com/abstract=247737 or http://dx.doi.org/10.2139/ssrn.247737

[3]   Marsden, Christopher T., Net Neutrality: Towards a Co-Regulatory Solution, Bloomsbury Publishing, 2010, ISBN 978-1849660068. Available at SSRN: http://ssrn.com/abstract=1533428

[4]   Marcus, J. Scott, Wernick, Christian and Carter, Kenneth R., Network Neutrality: Implications for Europe, December 01, 2008, WIK Diskussionsbeitrag No. 314. Available at SSRN: http://ssrn.com/abstract=1522039 or http://dx.doi.org/10.2139/ssrn.1522039

[5]   FCC, Report and Order, In the Matter of Preserving the Open Internet; Broadband Industry Practices; GN Docket No. 09-191, WC Docket No. 07-52, December 23, 2010, Federal Register, Vol. 76, No. 185, p. 59192, 23 September 2011

[6]   The open Internet and net neutrality in Europe, European Commission COM(2011) 222 final, Brussels, 19 April 2011

[7]   The open internet and net neutrality in Europe, European Parliament resolution of 17 November 2011, Strasbourg, B7-0572/2011

[8]   Marcus, J. Scott, New Directions for U.S. Telecommunications Regulation? The Comcast Decision and the 'Third Way', August 10, 2010. Available at SSRN: http://ssrn.com/abstract=1656570 or http://dx.doi.org/10.2139/ssrn.1656570

[9]   BEREC Response to the European Commission's consultation on the open Internet and net neutrality in Europe, BoR (10) 42, 30 September 2010

[10] Dutch Lawmakers Adopt Net Neutrality Law, New York Times, June 22, 2011 http://www.nytimes.com/2011/06/23/technology/23neutral.html?pagewanted=all (retrieved February 14, 2012)

[11] Wijziging van de Telecommunicatiewet ter implementatie van de herziene telecommunicatierichtlijnen, Amendement van het lid Verhoeven c.s., Tweede Kamer der Staten-Generaal, vergaderjaar 2010-2011, 32 549, Nr 29 (in Dutch). An unofficial translation of the Dutch net neutrality provision has been made available by the Dutch NGO Bits for Freedom (BOF) at https://www.bof.nl/2011/06/15/net-neutrality-in-the-netherlands-state-of-play/

[12] A Digital Agenda for Europe, European Commission, 26 August 2010, COM(2010) 245 final/2

[13] Nico van Eijk, Net Neutrality and Audiovisual Services, IRIS Plus, European Audiovisual Observatory, 2011-5, p. 7-19, ISBN 978-92-871-7249-5

[14] Andra Leurdijk et al., Audiovisuele mediadistributie, bottlenecks en beleid, TNO report 35587, 2 December 2011, (in Dutch), available at http://www.rijksoverheid.nl/documenten-en-publicaties/verslagen/2011/12/06/audiovisuele-mediadistributie-bottlenecks-en-beleid.html

[15] Web Video Hogs Up 37 Percent Of Internet Traffic During Peak TV Hours, TechCrunch.com, http://techcrunch.com/2010/11/19/web-video-37-percent-Internet-traffic/ (retrieved February 14, 2012)

[16] Newman, Jennifer L., Keeping the Internet Neutral: Net Neutrality and its Role in Protecting Political Expression on the Internet, 31 Hastings Comm. & Ent. L.J. 153 (2008-2009), p. 153-172

[17] Sluijs, Jasper P., From Competition to Freedom of Expression: Introducing Art. 10 ECHR in the European Network Neutrality Debate (September 15, 2011). TILEC Discussion Paper No. 2011-040. Available at SSRN: http://ssrn.com/abstract=1927814 or http://dx.doi.org/10.2139/ssrn.1927814

[18] The Declaration of the Committee of Ministers on network neutrality, Council of Europe, 29 September 2010, available at https://wcd.coe.int/ViewDoc.jsp?id=1678287

[19] Council conclusions on the open internet and net neutrality in Europe, Council of the European Union, Brussels, 13 December 2011, available at www.consilium.europa.eu/uedocs/cms_data/docs/pressdata/en/trans/126890.pdf

[20] Regulating net neutrality and use of deep packet inspection. Parliamentary questions, European Parliament, E-005259/2011, Questions 26 May 2011, Answer 13 July 2011, available at http://www.europarl.europa.eu

[21] NGO activities reported at http://www.edri.org/, https://www.bof.nl/home/english-bits-of-freedom/ and http://www.laquadrature.net/

[22] N.A.N.M. van Eijk et al., Moving Towards Balance: A study into duties of care on the Internet, WODC/ University of Amsterdam, 2010, available at http://www.ivir.nl/publications/vaneijk/Moving_Towards_Balance.pdf

[23] Dieter Verhue, Rogier van Kalmthout en Ingmar Doeven, Afnemers van televisiediensten productafname, keuze voor infrastructuren en overstapgeneigdheid, March 2011, (in Dutch), available at http://www.opta.nl/nl/download/publicatie/?id=3374

[24] Video on demand and catch-up TV in Europe - A report edited by the European Audiovisual Observatory and the Direction du développement des médias (DDM) with the collaboration of NPA Conseil, Strasbourg, October 2009, ISBN 978-92-871-6737-8

[25] Pieter Nooren and Mark Prins, Transparency about Net Neutrality – a Translation of the New European Rules into a Multi-Stakeholder Model, 22nd European Regional Conference of the International Telecommunications Society (ITS2011), Budapest, 18 - 21 September, 2011, available at http://hdl.handle.net/10419/52189

[26] Scott Marcus et al., Network Neutrality: Challenges and Responses in the EU and in the US, May 2011, European Parliament IP/A/IMCO/ST/2011-02, PE457.369, available at http://www.europarl.europa.eu/document/activities/cont/201108/20110825ATT25266/20110825ATT25266EN.pdf

[27] Verizon-Google Legislative Framework Proposal, August 9, 2010, via http://googlepublicpolicy.blogspot.com/2010/08/joint-policy-proposal-for-open-Internet.html (retrieved February 14, 2012)

[28] Apple TV, http://www.apple.com/appletv/ (retrieved February 14, 2012)

[29] Google TV, http://www.google.com/tv/ (retrieved February 14, 2012)

[30] Current state of the OCEAN market, Deliverable 2.1, FP7 Ocean consortium, October 2010, available at http://www.ict-ocean.eu/

[31] Global Internet Traffic Projected to Quadruple by 2015, Cisco Visual Networking Index, June 1, 2011, available at http://www.cisco.com/

[32] Pathan, M., Buyya, R.,Vakali, A, Content Delivery Networks: State of the Art, Insights, and Imperatives, Lecture Notes in Electrical Engineering, Springer , 2008, Volume 9, Part I, 3-32.

[33] Directive 2002/22/EC of the European Parliament and of the Council of 7 March 2002 on universal service and users' rights relating to electronic communications networks and services (Universal Service Directive) OJ L 108/51 (24 April 2002). Consolidated version available at http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CONSLEG:2002L0022:20091219:EN:PDF

[34] BEREC Guidelines on Transparency in the scope of Net Neutrality: Best practices and recommended approaches, BEREC, BoR (11) 67, December 2011, available at http://berec.europa.eu/

[35] BEREC report on the public consultation on the draft BEREC Guidelines on Transparency in the scope of Net Neutrality, BEREC, BoR (11) 66, December 2011, available at http://berec.europa.eu/

[36] Traffic Management and 'net neutrality', A Discussion Document, OFCOM, June 24, 2010, http://stakeholders.ofcom.org.uk/binaries/consultations/net-neutrality/summary/netneutrality.pdf

[37] 2010 Voluntary Code of Practice: Broadband Speeds, OFCOM, Version 2.0 dated 27 July 2010, http://stakeholders.ofcom.org.uk/binaries/telecoms/cop/bb/cop.pdf

[38] Sluijs, Jasper P., Schuett, Florian and Henze, Bastian, Transparency Regulation as a Remedy for Network Neutrality Concerns: Experimental Results, November 15, 2010, TILEC Discussion Paper No. 2010-039. Available at SSRN: http://ssrn.com/abstract=1709268 or http://dx.doi.org/10.2139/ssrn.1709268

[39] A framework for Quality of Service in the scope of Net Neutrality, BEREC, BoR (11) 53, 8 December 2011, available at http://berec.europa.eu/.

[40] Level 3 Communications Issues Statement Concerning Comcast's Actions, http://level3.mediaroom.com/index.php?s=23600&item=65045 (retrieved February 14, 2012)

[41] Federal Register, Vol. 76, No. 185, p. 59192, 23 September 2011, p. 59205, footnote 79. Also, p. 59213, footnote 121; on VoIP interconnection, see p. 59217.

[42] J. G. Sidak and D. J. Teece, Innovation spillovers and the "dirt road" fallacy: the intellectual bankruptcy of banning optional transactions for enhanced delivery over the Internet. Journal of Competition Law & Economics (2010) 6 (3): 521-594. doi: 10.1093/joclec/nhq003

[43] The EBU response to the questionnaire for the public consultation on the open internet and net neutrality in Europe, European Broadcasting Union, 30 September 2010, available at http://www.ebu.ch/

[44] Liberty Global Unveils Next-Generation TV Platform at IBC - Announces New Software Developers' Kit to Populate App Store, Liberty Global Press Release, September 8, 2011, http://www.lgi.com/PDF/09-08-Horizon-release.pdf

[45] James Grimmelmann, Some Skepticism About Search Neutrality, The Next Digital Decade: Essays on the Future of the Internet. Ed. Berin Szoka & Adam Marcus. TechFreedom, 2010, pp 435-459.