Responsibly Regulating the Structure of the Internet

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On my honor as a University Student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments

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Introduction

As the internet ages, it continues to undergo changes in structure and organization. A major trend influencing the structure for over a decade is 'flattening', whereby an increasing number of connections are made directly between low level Internet Service Providers (ISPs) and content providers while relying less on the higher-level ISPs that manage longer distance traffic (Gill, Arlitt, Li, & Mahanti, 2008). These connections are known as peering connections, as opposed to more hierarchical transit connections. Peering connections allow two networks to share access to their users without acting as an intermediary for connecting to other networks. In order to reach beyond a single peered network, lower level networks will pay to make a transit connection to a higher-level network. These higher-level networks in turn pay for transit

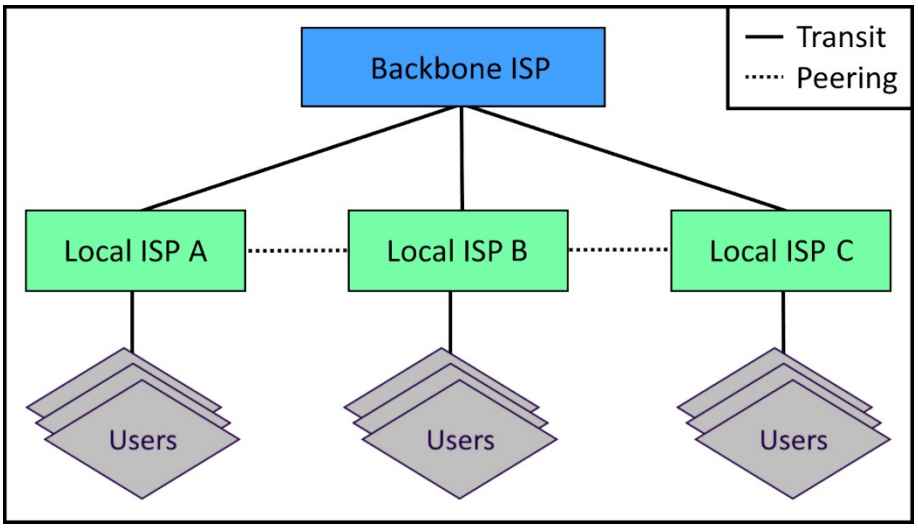

Figure 1: Simplified Internet Networking. This graphic depicts a hypothetical network with three local ISPs with peering connections, separate users, and one backbone ISP.

connections with even higher-level networks, until we reach the internet backbone ISPs, which can be reached by any user. In this manner, a transit connection allows a network access to the entirety of the internet, while peering only makes the peered network accessible. In Figure 1,

users of Local ISP A would be able to reach the users of Local ISP B through the peering connection between the two local ISPs, while they would have to be routed the Backbone ISP in order to reach the users of Local ISP C as there is no direct peering connection between Local ISPs A and C.

A number of motivations for the increase in peering connections have been observed, including avoiding the transit costs incurred by relying on higher-level ISPs and creating more direct and reliable routes from content to customers (Krogfoss, Weldon, & Sofman, 2012). Content providers, most notably large ones such as Netflix, will often seek to peer with ISPs for these reasons.

Like most of the internet's structure, these peering connections have widely remained unregulated. However, high profile allegations of abuse have been raised over peering connections, such as Netflix and Comcast's dispute in 2014 over interconnection bandwidth and payment. Netflix alleged that Comcast's policies were a violation of the principles of net neutrality, and should be restricted as such. Other disputes accuse ISPs of causing market squeezes, where smaller ISPs dependent on the transit provided by the higher-level backbone ISPs have difficulty profiting or are forced out due to the high cost of buying transit connections. Some nations have considered legislation that would more closely control the kinds of connections made by networks, such as the European Commission's (very limited) restrictions on access networks (Krämer & Schnurr, 2018).

In this paper I will examine the current state of internet interconnection as well as arguments for different levels and methods of regulation. I aim to identify barriers to improving how connections are regulated and methods of addressing these barriers. I argue that while current research generally resists further regulation of peering connections, these regulations are

often considered through a primarily economic lens and non-economic values of the internet are often minimized. Further evaluation of the social and cultural aspects of the internet and the impact regulation has on these aspects is needed in order to better evaluate the effectiveness of any considered regulations. Similarly, I urge further surveys to gauge the public's desires for the form and role of the internet. As interconnection markets and technologies continue to evolve, interconnection policies ought to be closely monitored to safeguard against potential abuses from both ISPs and content providers.

Part 1: Interconnection, Regulation, and Economic Arguments

There are generally few regulations governing interconnection between networks, leaving ISPs, content providers, and content distribution networks to determine the details of interconnections, including pricing, location, and bandwidth. This has allowed for the growth of a number of interconnection models including private content distribution networks and paid peering. When connections form between internet entities, smaller ISPs and content providers tend to benefit more than their larger partners, as they gain access to a much larger set of customers and content. As such, larger ISPs tend to impose a cost for creating new connections, either in the form of paid peering or selling transit, to the annoyance of smaller ISPs and content providers. Numerous calls for increased regulation have been made, often advocated for by content providers or smaller ISPs, which would enforce a narrower range of interconnection policies. I will broadly group these regulation initiatives into two categories: net neutrality and market squeeze regulations.

Net Neutrality

Net neutrality is somewhat notorious for its lack of consistency in definition among different regulators and researchers, but most generally, "[net] neutrality concerns throttling,

degrading or blocking a user's access to Internet content" (Read, 2012). It has typically been applied to how ISPs treat traffic of different types within a given network, such as attempts to interfere with BitTorrent file transfers. However, net neutrality principles have been argued to apply to the realm of internet interconnection as well, as interconnection policies can impact the quality of service provided to users. Perhaps most notably, Netflix accused Comcast of violating net neutrality throughout 2013 and 2014 while undergoing disputes over access to Comcast's network. Netflix had recently begun shifting from using 3rd party content distribution networks to a mixture of transit providers and its own content distribution network, Open Connect. Comcast saw a large spike in incoming traffic from these transit providers and decided to attempt to negotiate new deals that accounted for the new imbalance in traffic, while the transit providers hoped that Comcast would simply accept the new traffic without increasing their costs. The dispute was settled in early 2014 when Netflix agreed to pay for a direct connection to Comcast, allowing Comcast users to view Netflix without issue.

Throughout this conflict, Netflix argued that Comcast was seeking to extract extra payment from Netflix. Their argument stems from the fact that Netflix is not simply another site that Comcast customers would like to connect to but a potential competitor, as Comcast produces rival content through NBC, SyFy, and more. Comcast contested that they were not concerned with the source or content of the data, but its quantity. Some worry that Comcast and other large ISPs may use their positions to impose unreasonable prices on rival content producers or refuse to support connections for their content entirely. It is notable that an ISP cannot easily prevent all traffic from a given content provider by refusing to connect directly with them, but even slowing traffic from a content provider can have a significant impact on the quality of service that content provider can provide to internet users (Krishnan & Sitaraman, 2013).

Netflix's argument galvanized public support for an expansion of the ideas of net neutrality into the realm of internet interconnection. This was bolstered by an ongoing debate over net neutrality after the Federal Communications Commission (FCC) was forced to rewrite its net neutrality rules. But Netflix's request, if implemented fully and consistently across all interconnection agreements, would mean a dramatic reshaping of the internet and the profit model for ISPs.

Netflix wanted Comcast to act more like a retailer that distributes Netflix's goods to its consumers at a profit. But the internet is not structured with content providers at the top, distributing to ISPs, which then distribute to their customers. Instead, Netflix is simply another customer of ISPs. They happen to be a very large one that requires a much larger variety and number of services from ISPs, but their relationship is in many ways equivalent to that of Comcast and any individual customer. If Netflix is able to peer with ISPs for free, there is no reason that other ISPs or even individuals should not be able to do the same, eliminating any need to purchase Comcast's services. There likely exists a system that could provide global connectivity much like the internet without ISPs or where ISPs play a very different role, but it is not the goal of net neutrality to create such a system.

While Netflix's request for free interconnection with Comcast's network reached far beyond any sensible definition of net neutrality, there does exist potential for net neutrality violations at points of interconnection. If Comcast was charging Netflix more than other companies to transfer the same amount of data, this could be viewed as an attempt to limit the flow of data and customer access to Netflix. At present, interconnection policies are done in private between two companies and covered by non-disclosure agreements, making it impossible to scrutinize if ISPs are treating all content providers fairly.

However, some have argued against public disclosure of peering policies in light of the severe damage such a policy could potentially cause, such as a reduction in the flexibility of interconnection policies, implicit price collusion between ISPs, and the high costs of enforcing and defending public disclosure. Citing several case studies, Lysons notes that, "even absent collusion, disclosure is likely to adversely affect prices by reducing companies' incentives to discount. Numerous well-documented examples illustrate the negative effect that disclosure regimes can have on prices and competition" (2018). Instead, Lysons recommends the use of antitrust legislation as a method for dealing with unfair interconnection policies, with additional oversight from a regulating body such as the FCC in order to compel negotiation between networks where one party perceives itself to be at a disadvantage.

Market Squeeze

While relevant to content providers, net neutrality arguments are less applicable to connections between fellow ISPs. Instead, emphasis is often placed on the economics of interconnection, particularly market squeezes. A market squeeze can occur when a vertically integrated company both competes with and supplies services to dependent companies. A vertically integrated company, if lacking in competition, may be able to raise the prices of the services that its competitors depend on, harming their ability to turn a profit, driving them out of business, and further cementing its control of the market.

These conditions are met in the internet interconnection market when lower level ISPs are forced to both compete with and buy transit from a single higher-level ISP. Choi, Libaque-Saenz, Lee, and Park conducted a case study on the South Korean market, which they believed shared many of the features of the global internet interconnection market. However, they note that South Korea is one of few countries to have already imposed regulations on the

interconnection of ISPs as a response to frequent conflicts over interconnection and the legal battles that resulted. They found that in the South Korean market, KT, the largest backbone ISP, had engaged in margin squeezing behavior. They noted both that KT had refused to renegotiate the indirect traffic rates imposed on the nation's other two backbone ISPs since 2005, and that KT does not use any other ISPs for indirect traffic. Effectively, KT has sought to maintain the interconnection fees paid to it by other backbone ISPs while minimizing any interconnection fees that it would have to pay to its competitors. They note that this behavior also harms the robustness of the internet in South Korea by limiting the number of possible routes for data to be sent.

Choi et.al's proposals regarding the market squeeze among South Korean ISPs focused on addressing flaws in existing regulations and policies instead of proposing new, more typical market squeeze regulations like forcing KT to offer lower prices. They point to the outdated method for estimating traffic volume and determining interconnection pricing, based on the condition of the market in 2005, as a regulation that may have been valuable in the past, but currently only obfuscates and hinders fair competition. They conclude that "the Korean government should more actively monitor the market to ensure these potential margin squeeze problems do not harm competition, and the current charging system should be reorganized to achieve market efficiency" (Choi et.al, 2018).

They also acknowledge the numerous historical advantages KT has enjoyed that have contributed to the current state of the South Korean ISP market. During the boom of the internet in South Korea, KT had been government-owned, and received significant investment during and after its transition into a privately owned company. The actions of and guidelines set by the South Korean government have, at least in some areas, secured KT's position.

More generally, the effectiveness of attempting to directly regulate against market squeezes is hotly contested. Krämera and Schnurrb modeled the effects of market squeeze regulation where there are two vertically integrated companies, with one dependent company. They found that while market squeeze regulations had the potential to benefit the dependent company, these regulations often harm consumers, even if they manage to keep dependent company in business. While their research was not specifically aimed at the market of internet interconnection, Krämera and Schnurrb note that the parameters chosen for their model, such as the existence of two or more potential suppliers, closely models the situation faced by many telecommunications companies and can be extended to many internet service markets as well. While this does not hold for aspects of the South Korean market, enforcing interconnection prices or policies through regulation seems likely to have a negative impact on the internet market. If margin squeeze regulations are considered, they should be done so carefully and in exceptional circumstances.

Economic arguments posited by a variety of researchers examining different issues facing interconnection point in the direction of limited direct governmental control and market solutions. Still, this is hardly a full picture of the internet. An economically efficient internet certainly has benefits, such as enabling future developments and investments in its growth, but lacks any concern for users beyond what they must pay to access the internet.

Part 2: Enabling Better Informed Regulations

In order to address any shortcomings in the available research and implementation of internet interconnection regulations, it is important to outline the purpose of regulating such a system. Regulations should not be viewed as only a last resort for repairing systems where economics fails, but also as a tool for laying a framework of the rights, processes, and social

relations for a market to operate under (Baldwin, Cave, & Lodge, 2012). Social and human rights are perhaps uniquely pertinent to the internet and its structure. The United Nations has identified the importance of considering human rights with regards to internet access, stressing "the importance of applying a human rights-based approach when providing and expanding access to the Internet and for the Internet to be open, accessible and nurtured by multi-stakeholder participation" (2016). While interconnections may not play a direct role in determining whether an individual is able to use the internet, they play a decisive role in determining the quality of internet access available to both users and websites. As such, the goal of regulating internet interconnection should be to promote a version of the internet that protects the rights and desires of the public. Achieving this requires two significant pieces. Firstly, a clearer outline of the rights and values the internet should uphold. Secondly, a more complete understanding of the impacts of proposed regulations that looks beyond market analyses and takes into account human values and rights. As emphasized by the United Nations, expanding internet access is a crucial component of granting access to all sorts of social and political tools. Any rights-based approach should take into account all humans, not just those of us who currently have access to the internet. Without both a goal for internet interconnection and an understanding of how to achieve it, we cannot responsibly regulate for the benefit of the public. Our current understanding of both of these components is insufficient.

Public Opinion

Some efforts have been made to hear public opinion on matters of internet regulation, such as the FCC's invitation for public comment on issues of net neutrality in 2014, but both the quality of the feedback and the government's response should be scrutinized. A large wave of responses occurred after John Oliver prompted his audience and internet commenters to flood the

FCC with their opinions, bringing down the site less than a day after his satirical segment aired. John Oliver's segment undeniably inflated the volume of pro net neutrality comments that the FCC received, as well as informing and shaping the opinion of the public. (Brewer, Young, Lambe, Hoffman & Collier, 2018).

A key difficulty in understanding the wishes of the public is that the public is not a monolith, can be influenced by current events, and sometimes is un or misinformed. Public opinion is often measured through surveys or soliciting comments, which are inherently subject to a number of biases that need to be carefully controlled for. Without making an effort to gather responses from a representative population, any results gathered come with a number of uncertainties that limit any generalizations that can be made. Despite any actual shifts in public opinion caused by satirical segments like John Oliver's, the flood of comments they triggered was likely not representative of the public at large: rather, it represents the attitudes of late-night show viewers, or those caught up in the movement. When the FCC received overwhelming support for net neutrality in 2014, there was no way to know whether that accurately represented the opinions of the American public as a whole, or was entirely the result of a relatively small but active group of supporters.

However, if conducted more rigorously, surveys can offer meaningful insights into some of the aspects of the internet that are valued by the public, but not easily measured economically. If such policies are desired by a large portion of the public, it may be prudent to implement regulations that are detrimental economically but support the public's vision of the internet. Performing better surveys can give regulating organizations more confidence in their understanding of the public's desires for the internet, and lets them inform more of their goals

through that understanding. The same rigor that has been used to understand the economic systems of the internet needs to be applied to the public discourse that surrounds internet policy.

Understanding Impacts of Regulation

There exists a wealth of research on interconnection policies that are at the disposal of regulators. However, it tends to focus heavily on economic analyses and models applied to either real world or hypothetical scenarios. The effects of regulations are evaluated in terms of cost, and little consideration is made for the services of the internet that are more difficult to quantify economically. An open internet where users can easily and quickly access any site regardless of their location or the ISP that they use is certainly a public good, but it may not be the most profitable model for the internet. Direct margin squeeze regulation, while potentially increasing the cost of internet access, may be a measure that effectively safeguards other aspects of the internet. Increased research to consider and quantify the social goods provided by the internet is required to more fully assess the effects and value of regulations.

This task is, unfortunately, much more difficult to accomplish than better surveying the public. Economic research is often generalizable to a multitude of fields, and possesses a variety of existing modeling techniques. As such, existing research into other markets can often be reasonably applied to the case of internet interconnection. However, understanding the social impacts of the internet requires research exclusive to the internet. Developing methods for weighing social benefits of certain regulations is required in order to achieve a more holistic view of different policies.

Conclusion

Regulating the internet has been approached very tentatively, allowing regulating authorities to assess the state of the internet from afar as it rapidly develops. While most

economic arguments seem to resist further regulating the interconnection of internet peering, this approach may not best match the values or interests of internet users. As balances of power between ISPs and content providers continue to shift, and connection policies are often dictated by the larger party, it is pertinent to consider protecting the connectivity that makes the internet equally accessible to all users.

Economic assessments of interconnection and regulation policies are a vital component in information interconnection regulations, but should not be viewed as the sole arbiter of what constitutes good regulations. Regulating agencies should encourage or conduct surveys to better understand the non-economic values of the internet, and look to promote market systems that protect these values. When considering regulatory policy, both regulators and researchers should recognize that not all systems ought to be perfectly efficient. Economics may be able to reveal which regulations are effective in achieving certain results, but it should be public, not economic, values that determine the results we aim for.

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