Paper 1: The Impact of ISPs on the Architecture of the Internet

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The Internet was started over three decades ago as a US government sponsored project. The Internet originally connected several universities and the government; it eventually grew to include some private companies/research labs. As such, the initial users of the Internet were scientists/technologists who were well versed in the workings of the network (and who did not have the malicious intents of modern hackers). The motivation of the Internet at this time was to provide a robust nationwide communication network and to allow for the sharing of scientific research/resources around the nation. The original architecture of the Internet is often described as an end-to-end architecture. The end-to-end architecture is a decentralized one in which a “mechanism should not be placed in the network if it can be placed at the end node.” This type of design keeps the core of the network simple and generic.

Since that time, however, the scale of the Internet has grown exponentially. It became increasingly difficult for a government-sponsored network to scale to such sizes, so the government gradually turned the network over to the private sector. Since the government is no longer responsible for access to the Internet, private companies – Internet Service Providers (ISPs) – have emerged to provide access to this vast network. These ISPs, of course, are private companies whose principal goal is to make a profit – a radical contrast to the goal of the original ISP, the US government. The rise of ISPs as dominant players in today’s Internet has been a catalyst for a more centralized network that is shifting away from the original end to end design; this change has been a negative one for it has hurt the most important group associated with the Internet – the end users.

One of the most fundamental changes from the early days of the Internet to today has been the shift to privatization. It is the profit-making end of ISPs that drives their actions and it is in this interest that ISPs are attempting to move the Internet away from its end-to-end beginnings. In order to make a profit, ISPs must first attract a sizeable number of customers to buy their service and then obtain a significant profit for the services they provide. In the free market economy, ISPs must compete with one another for customers; to be competitive in this market, ISPs must have some attractive feature to offer customers: low prices, unlimited connection hours, high speed access, or some other attractive service that is unique to that particular ISP. One could contend that some of these duties do not necessarily have to fall upon the ISP, but today’s ISPs take the view that they do. As Marjory Blumenthal and David Clark explain, ISPs currently take the stance that such features are “something to be provided within the bounds of the ISP as a competitive differentiator.”

It is in this need to compete for customers that ISPs are driven to centralize the network, to move away
from the simple end-to-end design. One of the most successful ISPs, AOL, for example advertises several unique features: AOL instant messaging, parental control features, exclusive AOL content like streaming audio/video clips and the AOL keyword search. Many of these features urge the ISP to add infrastructure within the network – not at the ends. The streaming audio/video content, for example, may require that AOL add a web cache type device near users so that the streaming content is smooth and continuous. The parental controls feature may necessitate that AOL add something resembling a firewall to block certain content for certain users. The need for the ISP to provide such features pressures it to move away from the end-to-end design. The ISPs could attempt to implement all of these features at the ends but the ISP would then have to trust end users (often novice computer users) to install, maintain and update some sort of software system. As Blumenthal and Clark put it: “The ISP implements the core of the network….So the ISP is most likely to add services and restraints by modifying the part of the network it controls” 5. Hence, the necessity of ISPs to compete for customers coupled with their easy access to the core of the network results in the ISPs pushing the Internet away from the original end-to-end principles.

In addition to the innate need to compete, there are several external groups, such as hackers, the government, and other businesses, that influence ISPs. One serious concern today is network security. Since the early days of the Internet, the threat of attacks by hackers as well as users who maliciously hoard resources has increased dramatically. As such, ISPs have a serious stake in maintaining a secure network not only to maintain customer satisfaction but also to minimize financial losses from repairs and downtime. ISPs today also face pressure from the government. Agencies like the FCC pass regulations that the ISPs must follow. Also, the government has been conducting wiretaps on phone lines for years; the government can similarly tap the Internet to determine the content of emails or other data. Since ISP’s are responsible for providing access, the government can pressure the ISP to reveal information about its customers or to track their activities and communications. In order to respond to such demands by the government, ISPs may have to add additional components to the network to allow for the tracking of emails. In addition to malicious individuals and the government, ISPs face pressure from other companies that have a stake in the growing cyber-market. An individual company may approach an ISP and provide financial incentives for the ISP to integrate its services. As an example, a content provider, such as CNBC or CNN, could approach an ISP and urge them to provide exclusive news content, including streaming news clips, from their site; this again, would mean that the ISP would implement features – possibly a web cache or mirrored server – for that content provider. E-commerce is perhaps a more compelling example. An online merchant could
similarly approach an ISP and form a partnership with them to sell their products online directly through the ISP. To reuse the familiar example, AOL already integrates online shopping into the software that it provides to its customers. As these cases demonstrate, several external groups put pressure on ISPs.

The problem with these external pressures is that they push the ISPs further away from the end-to-end model. Certainly, many of these functions could be implemented either at the end or within the network. However, in many cases, it is advantageous (or even necessary) for the ISP to implement the features in the network. Adding functionality at the end requires that the ISP give the customer some sort of application or interface that integrates these features, such as a modified browser interface. This, however, adds development costs for the ISP and can be a burden on consumers – especially the novice Internet user who is not experienced with computers. The user is forced to use that particular interface for all web activities and the user has to deal with updating software.

Furthermore, as the quotation from Blumenthal and Clark indicates, ISPs will quite simply be tempted to alter the core of the network since they have direct access to it. Thus, it is advantageous for the ISP to merely accommodate the external pressures within the core of the network – it is cheaper and easier. In other words, the various players in the Internet today are pushing ISPs to move away from the original end-to-end design.

Once it has been established that competition and external groups are causing ISPs to move away from the end-to-end principle, the issue becomes whether this development has been positive or negative. In evaluating the value of this change, some sort of rubric or standard needs to be defined. That is, what is best for the Internet? Is it business interests, competition, technical development, or user interests? The position taken here is that the interests of the end users should be held paramount. The justification for this position is that the Internet was created, not as a product to be sold, but as a tool for users to communicate. The ostensible purpose of ISPs and other groups associated with the Internet is to serve users in some way. So, the primary consideration with the development of the Internet should be the interests of users. In order to evaluate how positive or negative the move away from end-to-end has been, the motivations of ISPs and the matter of to whom ISPs should respond must first be considered.

Ideally, ISPs could respond to all the groups that pressure them. Certainly, the ISP should be sensitive to the customer who is, after all, the lifeblood of the ISP. Another principle, network security, is certainly of central importance to all who use the network so ISPs should make strides to secure their networks. When it comes to the government, ISPs may have little choice. Regardless of whether the governmental policies are positive or not, the ISP must adhere to them to maintain a lawful business. ISPs should also accommodate other commercial entities for
doing so often makes “good business sense”. Other businesses can bring large amounts of revenue to the ISP, which should increase profit margins, provide resources to improve the network, research new technologies, and possibly even lower the cost to the consumer. Thus, it follows that ISPs should try to accommodate all the interests that pressure them, for doing so is in the best interest of the ISP. The thorn arises from the fact that these interests require different responses from the ISP. The government, other businesses and security concerns would likely have the ISP add elements in the network and move away from the end-to-end philosophy. It is in the best interest of the consumer, however, to maintain the end-to-end architecture.

This tension between maintaining the end-to-end design for the sake of consumers and moving away from it for business reasons typically harms the consumer. In general, the government and business sector has more clout, authority, money and organization than the individuals. Individuals usually do not have a strong institution representing them. Moreover, if all the ISPs follow the same practices, individuals lose their leverage to select from competing sources that do look out for their interests. So, from a business perspective, ISPs face strong incentives to adopt the interests of government and commercial groups – that is to move the Internet away from the end-to-end ideals. However, maintaining the end-to-end architecture would limit the control that other groups could place on the Internet. Limiting control by other groups leads to freedom for the user and limits the ability of ISPs or other businesses to monopolize the Internet. At its foundation the Internet was to be an open communication network that allowed anyone to share thoughts and communicate with other users end-to-end. The weakening of the end-to-end structure has shifted the balance of power towards ISPs and business interests limiting the freedom that modern users have. As Lawrence Lessig argues in his book Code: “The invisible hand, through commerce, is constructing an architecture that perfects control – an architecture that makes possible highly efficient regulation” 6. This type of control is not in the best interests of users. As David Clark et. al. suggest, “making sure that the users are not constrained in what they can do is doing nothing more than preserving the core design tenet of the Internet….user empowerment is a basic building block” 7. As such, ISPs have weakened the original architecture of the Internet, which has been a negative development for the users of the Internet. In short, ISPs to date have not given high priority to “user empowerment”.

Though the Internet still has not become victim to an “architecture that perfects control” the development of ISPs has the potential to lead down this path of control in the future. The new policies of ISPs, the rising competition over broadband service and government decisions have provided a glimpse of how ISPs will shape the
Internet in the future. The September-October 2002 issue of Dollars & Sense paints a very bleak image of what the Internet could become at the hands of ISPs: “today’s Internet could soon come to resemble something much more like cable TV, with rising prices, limited access, and a monotonous diet of mostly corporate content” 8. The article goes on to explain that ISPs could give privileges to certain web sites with which they have partnerships so that those sites load much faster (according to the article, cable companies already have the technology to do this and AOL already prioritizes certain sites). The article also describes how ISPs could have different packages that would allow users to only visit certain sites; to visit all the sites on the web, users would have to pay extra, much like current cable television packages. As the article astutely observes, these measures are a hair short of censorship since the small, individually run websites of today would not be included in the cheaper packages9. The picture becomes even more austere when vertical integration is considered. As with other industries, ISPs will certainly make attempts at vertical integration to increase revenue. According to Clark et. al., “Vertical integration…requires the removal of certain forms of openness. The user may be constrained to use only certain providers of content, or to pay to run certain protocols, and so on”10. Under vertical integration, ISPs could be driven to prevent users from using competing ISPs with broadband services, for example. As ISPs merge with major phone and cable companies for vertical integration, the situation could worsen. A potential FCC ruling could stop forcing major line carriers to share their lines, which would cause skyrocketing prices for small broadband companies and substantially limit competition in the broadband market11. With such striking possibilities in mind, it can be concluded that the rise of ISPs has limited and will continue to limit the freedom that users of the Internet possess.

Overall, it appears that the rise of ISPs to provide access to the rapidly growing Internet was essential after the US government stepped aside. However, the rise of ISPs has led to the deterioration of the original end-to-end architecture of the Internet. This compromise in the original design of the Internet has led to a more complex network that has more elements of control and regulation. This development has hurt the individual user of the Internet and holds the potential to completely transform the Internet from an open communication network into a controlled network with little user freedom. These developments could be counteracted if ISPs become committed to protecting individuals and reestablishing the end-to-end design as the central tenet of the Internet. However, the prospect of ISPs making such a move – in the absence of a strong consumer lobby – remains bleak.
Works Cited


3 Blumenthal, Marjory; Clark, David C., "Rethinking the Design of the Internet: The End-to-End Arguments vs. the Brave New World". ACM Transactions on Internet Technology. Vol. 1, No. 1, August 2001, pp.70-109.


5 See 3.


7 See 2.


9 See 7.

10 See 2.