Walled Gardens: the New Shape of the Public Internet

Nancy Paterson, Ph.D, AOCA
Associate Professor, OCAD University
Postdoctoral Fellow, Faculty of Information, University of Toronto
Toronto, Ontario
01-416-977-6000

npaterson@faculty.ocadu.ca

ABSTRACT
This paper argues that the global public internet is undergoing a long-term transformation from a uniform transmission platform to one in which data reachability will be increasingly compromised by emerging technical, political and commercial choices. This phenomenon is not new. It reflects changes away from the original end-to-end principle as a guiding design concept in internet engineering, as well as in the various forms of IP (internet protocol) filtering exercised by governments and other institutions around the world. The emphasis in this paper, however, is on less controversial developments, especially the growth in managed IP services and deployments of MPLS (multiprotocol label switching). The browser-centric public Web has been giving way to 'apps' and 'walled gardens'.

General Terms
Management, Measurement, Documentation, Performance.

Keywords
Transborder data flows, internet, commercialization.

1. INTRODUCTION
In the mid-1990s, the internet underwent a dramatic shift away from research-oriented uses by a small professional community, to a mainstream platform whose technical underpinnings (such as interconnection points) were privatized, and whose resources (especially on the Web) became dominated by commercial interests. This change prompted the development of walled gardens (closed or exclusive information services, content or media on platforms) typified by AOL, whose early objective was to steer subscribers away from the open internet to the company's proprietary services. In a second stage, after privatization and as part of the spread of broadband (the focus here is on the US and Canada), a different kind of internet gatekeeping developed, based on the control of residential access by the incumbent telcos (former telephone monopolies) and cable MSOs (cable multiple system operators), and their corresponding ability to control content and services offered to their subscribers at the application layer. This paper describes developments that cast a new light on issues traditionally associated with network neutrality. Some of these developments already form a well established part of the public and regulatory discourse on broadband.

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This paper argues that policymakers, activists and scholars should now be looking beyond the local access network and the actions of retail ISPs (internet service providers) for clues about the emerging shape of the public internet evolving into a commercial model of managed walled gardens, indeed, noting the not-dissimilar effects of traffic management and IP filtering by governments for political reasons. It points to five significant developments that have taken place in the online environment.

1) the vertical integration of content and carriage resources among incumbent telcos and cable MSOs (such as Bell Canada Enterprises and Rogers in Canada), with the accompanying opportunity and motive for engaging in anti-competitive and anti-consumer behavior;

2) the advancing consolidation among the ten or so Tier 1 networks, which appear to be losing business to large content/cacheing providers like Google, Akamai, Netflix and Facebook, companies that are building their own global private networks, thereby changing the traditional structure of internet transmission patterns;

3) the continued absence of any meaningful net neutrality regulations in either the US or Canada (notwithstanding the attempts of FCC - Federal Communications Commission order of December 21, 2010: "Report and Order, Preserving the Free and Open Internet FCC 10-201"; and in Canada, CRTC - Canadian Radio-television and Telecommunications Commission "Telecom Regulatory Policy 2009-657", "Review of the Internet traffic management practices of Internet service providers") [FCC, 2010; CRTC, 2009].

Two other trends are identified here that, while less familiar, are helping foster the deployment of new types of walled gardens:

4) the traffic management technologies that came to prominence after 2007 (and the Comcast traffic-shaping case) are no longer confined to the local access network. An increased reliance on MPLS (multiprotocol label switching) and related solutions to network engineering problems with the accompanying need for the use of DPI (deep packet inspection) technologies and other intrusive traffic control mechanisms, are growing in both wireline and advanced wireless networks such as LTE (long-term evolution); and

5) the growth in closed (IP) services, usage based billing and bandwidth caps such as in relation to online video combined with the shift of online activities away from the Web to those based on tethered apps eg. mobile devices, smartphones (iPhone) and membership in tightly controlled communities (such as Facebook and Google Plus).

2. CONVERGENCE, CONSOLIDATION & NET NEUTRALITY

2.1 Incumbents versus New Entrants in the Video Space

Over the past decade, a series of events have taken place in North America, in which a small number of wealthy companies have reduced competition and linked various media platforms through a continuous concentration of ownership. As a result of several mergers, many of these mega-corporations have become vertically integrated companies, which own a variety of assets in telecommunications, broadcast distribution and content production for television, publishing, radio and the Web. This has created a battle over internet resources. Upon illustrating the current situation in Canada, with the identification of the traditional and dominant industry players, acknowledgment of services (such as Netflix) and the ongoing issue of net neutrality, one is able to observe the myriad ways in which the environment is in a constant, evolutionary state.

In addition to ownership of similar portfolios of assets, conglomerates such as Canada's Bell Canada Enterprises (Bell) and Rogers Communications are also dominant internet service providers (ISPs). Bell and Rogers are in direct competition, while at the same time exist as a duopoly in major urban markets, especially in central Canada, where they offer customers wireless, television and telephone service packages. While Bell has been Canada's dominant wired telephone network for almost a century and Rogers has Canada's largest wireless cellular network, both companies offer similar home phone services as well as cell phone plans. In broadcasting, both companies also offer digital TV subscriptions to customers. In terms of TV content, both companies own an array of local and national networks and specialty channels – which are available as packages. For example, Bell owns CTV, one of Canada's national TV networks, and several regional stations under the A Channel system, while Rogers owns the regional channel systems Citytv and OMNI. Bell owns several specialty channels, including TSN, Muchmusic and CP24, while Rogers owns Sportsnet, OLN and Comedy Network. In addition, both companies also offer on-demand services as part of their digital TV packages. All of these programming networks air content produced by their parent companies [Rogers Communications 2011; Bell Media 2011; and Bell Canada 2011].

As Bell and Rogers are internet service providers, they remain as dominant ISPs in the broadband residential internet market [Winseck, 2011]. Rogers offers broadband to the last mile via digital over cable (or data over cable service interface specification - DOCSIS) infrastructure. Rogers' service is second only by subscriber count to Bell, which employs broadband services via digital subscriber line (DSL) over its wide-reaching telephone network. Throughout Canada, Bell, Rogers, a handful of other ISP competitors (like Shaw, Telus and Videotron) tend to offer similarly-priced bundled service packages for residential internet, and often impose monthly data caps and usage-based billing on customers. Practices such as these not only build larger barriers for entry in the market for newer and/or smaller ISP's, but make it problematic for customers to find alternative providers who may offer ideal, affordable internet rates [Geist, 2011a].

Given that the market is dominated by ISP's whose parent company assets also include substantial ownership in broadcast infrastructure, offering subscriber packages and original programming content, there is much invested in maintaining strangleholds in these traditional media markets. There has been a great deal of resistance from many dominant ISP's, telcos, cablecos, and members of broadcast industries, against the proliferation of new IPTV (internet protocol television) and over-the-top (OTT) services such as Netflix [van Beijnum, 2010]. Even though according to Philip Hunter at Broadcast Engineering magazine, the walled garden will optimistically become history (and he disagrees with the main thrust of this paper's argument) his distinction between OTT and IPTV is useful:

> [T]he distinction between IPTV and OTT will fade quickly and all but disappear in many countries within five years. Both are often delivered over the DSL or fiber-to-the-home (FTTH) access infrastructure already, with the difference being in the backhaul and core networks. At present IPTV is delivered over a service provider's own infrastructure, while OTT comes over the public Internet [Hunter, 2011].

Over-the-top content has become a controversial issue in Canada. The controversy rests on the degree of control exercised by the incumbent ISPs, especially the vertically integrated majors: Bell, Rogers, Shaw and Quebecor. Industry, consumer and regulatory reactions have been focused on the arrival in Canada of the American OTT service Netflix, which launched in September 2010.

Over the last year, the CRTC has announced and/or conducted proceedings on 1) usage-based billing (UBB); 2) vertical integration; and 3) OTT (the latter has been characterized by the CRTC as a fact-finding exercise). All of these proceedings can be seen as a follow-up to the CRTC's creation of a net neutrality framework in its October 2009 decision Telecom Regulatory Policy CRTC 2009-657 entitled "Review of the Internet traffic management practices of Internet service providers". In the intervening period, evidence has grown that neither the economic ITMPs (internet traffic management practices) nor the technical ITMPs sanctioned by the CRTC in its decision have helped discipline ISP behavior in ways that discourage unjust discrimination and undue preference. On the economic side, the use of data caps by Canada's broadband incumbents was met with a widespread consumer backlash beginning in early 2011. The immediate catalyst was the CRTC's wholesale pricing decision - usage-based billing for Gateway Access Services and third-party Internet access services, issued January 25, 2011, regarding the use of UBB by Bell and Bell Aliant, and in particular the downstream effect of Bell's GAS pricing on competitive ISPs [CRTC, 2011a].

The most visible consumer protest took the form of a campaign organized by OpenMedia.ca, which over the span of several weeks managed to collect approximately 450,000 signatures on a petition protesting the anti-competitive effects of Bell's pricing scheme on the smaller ISPs dependent on Bell for wholesale bandwidth. At this writing, the CRTC has created a compromise on this issue rejecting Bell's revised proposal that would see a smaller ISP charged for the aggregate total of data used by all its customers instead introducing a pricing model that would see smaller providers pay for the total capacity they need, but not the volume of data downloaded [CRTC, 2011b].

In a blog post dated July 8, 2011 entitled "Canada's Net Neutrality Enforcement Failure," Michael Geist describes the CRTC's highly flawed complaints process, on the basis of 38 complaints released to him by the CRTC under an Access to Information (ATI) request. The CRTC's handling of the complaints in question show a pattern of delay, inconsistency and disregard for the frustrations faced by many of the complainants [Geist, 2011b].

The apparent failure of a net neutrality framework in Canada has taken on heightened importance as the consumption of online video continues to grow, while battle lines have been drawn between vertically integrated incumbents on one hand and independent ISPs and new entrants like Netflix on the other. This conflict has deep roots. These concern the control over application-layer services exercised by the broadband incumbents in both the US and Canada, thanks to their long-standing ownership of last-mile residential facilities. Because the incumbent telcos and cablecos offer many content-based and other services that compete directly with unaffiliated providers, they have both the opportunity and the motive to interfere with such services.

2.2 Bandwith Intensive Video

Bandwidth-intensive video services are the main culprit in what has become a qualitatively different last-mile conflict. The storm is forming around: 1) the explosive growth in online video consumption; 2) the threat new OTT services like Netflix pose to traditional multichannel video distributors; 3) the heightened competition over TV distribution prompted by full-scale telco entry into the video business; and 4) the oft-repeated claim by Bell and other incumbent ISPs that their networks face mounting congestion from bandwidth-intensive applications, as well as other traffic engineering problems that must be managed by intrusive technologies such as DPI.

Netflix saw its subscriber base in Canada reach one million in July 2011, barely ten months after launch of the service. This growth has taken place against the backdrop of the global growth estimated by Cisco in its "Visual Networking Index: Forecast and Methodology" report: Internet video is now 40 percent of consumer Internet traffic, and will reach 62 percent by the end of 2015, not including the amount of video exchanged through P2P file sharing [Cisco, 2011, p.2]. Cisco further estimates (p.4) that the number of Internet video users in Canada will grow almost seven-fold between 2010 and 2015.

In the light of emerging audiences with an increasing appetite for online video, and the establishment of Netflix as a perceived threat to traditional services and network congestion, many ISPs have been forced to devise innovative new services in attempts to maintain market power over several of their assets. In 2010, Bell began delivering IPTV services through fibre to the node (FTTN) to customers in Toronto and Montreal [Bell Canada, 2009, Oct 8]. Bell acquired CTV in the fall of 2010 and despite plans to launch new social media interactivity, is a bit behind Telus which recently launched Optik television service employing a new Facebook TV application. This Facebook program borders the left and bottom sides of the screen during television episodes and is controlled from the user's remote, built expressly for Telus' new IPTV initiative [Sturgeon, 2011].

Rogers also provides broadband cable internet through fibre and has not made any announcement regarding IPTV plans. In western Canada, Shaw provides direct to home satellite TV services, Shaw Direct, and internet through DSL and fibre. In a July 15, 2011 blog post, Michael Geist points out that Shaw Communications has introduced the Shaw Movie Club, which allows subscribers to watch movies on-demand, streamed online, either to their set-top box, or onto their computers. In both cases, the Movie Club's programming is streamed via a Shaw subscriber's broadband internet connection. However, electing to stream the content online to a computer contributes to the subscriber's monthly data cap [Geist, 2011c].

A different group of ISPs and media conglomerates are facing a similar challenge regarding IPTV competition in the US. According to Cable and Satellite International magazine as of June 2010, Comcast, which is the largest US cable operator, has rolled out a 100 Mbps data service and is continuing to lose pay TV customers - Comcast is the largest paid television operator in the U.S., with 22.9 million U.S. video subscribers at the end of the third quarter, 21% more than of the second largest U.S. TV-service provider, DirecTV. After losing approximately 275,000 video customers in the third quarter of 2010 [Schechner and Vascellaro, 2010], Comcast proposed a new solution entitled 'Spectrum', in an attempt to maintain market dominance. Within this system, content flows through a set-top box, combining features of the Web with those of a digital-video recorder thus allowing users access to some Web video and the ability to search on-demand and recorded programming through set-top televisions, but with restricted access to freely browse the Web [Schechner and Vascellaro, 2010].

Comcast gave rise to criticism among consumer rights groups when it purchased NBC Universal and all of its properties including its television channels. Combined with its new ownership of television stations and studios, owned by NBU-Universal, this allows Comcast the potential to "choke free video services and gouge cable customers" [Singel, 2009]. The merger would not only continue Comcast's dominance as an ISP with ownership of traditional television networks and broadcast properties, but also the control of the popular, NBC-owned, Hulu.com online service. This is crucial, as not only are traditional film and TV content appearing on free video sites such as Hulu, but traditional TV audiences are also flocking there to view the content, and this would potentially enable Comcast not only market dominance in IPTV, but the potential to decide how customers are able to consume the content [Singel, 2009].

Verizon FiOS and AT&T U-verse are two high profile IPTV offerings in the US. Verizon's FiOS is a bundle package of internet service, telephone, and television that operates over fibre-to-the-premises network. Though FiOS was the first national fibre to the home video provider [Drawbaugh, 2009], unlike AT&T's U-verse product, Verizon's broadcast video service is not internet protocol based. AT&T's IPTV service U-verse provides users access to telephone, internet, and one hundred or more high definition channels from content providers, through a fiber-to node network. Users are able to access U-verse on their television using a set-top box, computer or Total Home DVR. AT&T provides its internet through VDSL and fiber networks.

Current pay TV channels derive revenue from subscribers through the cable or satellite network and are challenged by recent content services offered only over the internet such as Netflix, providing retransmissions of older film and TV programs. DirecTV has begun offering subscribers with a digital-video recorder, limited internet connectivity to websites such as Flickr, and expects that 40% of its subscribers will be internet-connected by late 2013. But many of DirecTV's competitors such as digital cable providers, for example Time Warner, expect to deliver video services over the internet in 2011 [Schechner and Vascellaro, 2010]. This may suggest that broadcast television companies who are slow to adapt and offer customers an adequate internet connection service may lead to the ultimate demise of once-profitable, traditional broadcast platforms.

A significant evolution is occurring in light of the emergence of IPTV, combined with mergers between traditional broadcasters and dominant ISPs, not to mention the various technical overhauls that traditional TV platform services have been forced to go through in order to stay competitive with increasing online competition. Evidently, this continues to affect the neutrality of the internet. Observers, such as Josh Silver, former president of the Free Press media reform organization have labeled this environment as synonymous with the "end of the internet as you know it", as companies continue to blur the lines between traditional and online platforms:

> Since its beginnings, the Net was a level playing field that allowed all content to move at the same speed, whether it's ABC News or your uncle's video blog […] A non-neutral Internet means that companies like AT&T, Comcast, Verizon and Google can turn the Net into cable TV and pick winners and losers online. A problem just for Internet geeks? You wish. All video, radio, phone and other services will soon be delivered through an Internet connection [Silver, 2010].

2.3 Reconsidering "Open" and "Closed" Networks

In "Network Neutrality, Broadband Discrimination," published in 2003, Tim Wu coined the phrase "network neutrality" to denote an internet free of discrimination exercised by broadband providers in favor of certain applications, vendors or end-users over others - with one goal of such neutrality being a robust climate for innovation [Wu, 2003, pp. 145-47]. Since Wu's introduction of the term, and thanks in part to his vigorous advocacy of non-discrimination in the intervening years, the debates concerning the clash between the interests of broadband providers and those of end-users have been framed mainly in terms of network neutrality and almost exclusively in the context of incumbent control of the residential last mile.

Retail broadband is a highly concentrated industry in Canada and the US, while retail services, including rates, are still unregulated. As network neutrality proponents like Wu have argued, and a large body of research has demonstrated, these market attributes have resulted in high prices, slow speeds and service subject to a high degree of interference by incumbent ISPs. This interference has taken the form of traffic-shaping and other intrusive but sanctioned technical ITMPs (internet traffic management practices), considered by the CRTC, and to a lesser degree the FCC, to be "reasonable" measures necessary for the routine management of alleged network congestion - a concept that since 2010 has come under increasing criticism by consumer advocates such as internet legal scholar Michael Geist. ISP interference with customer traffic in the local access network has also taken more contentious forms, such as measures to reduce or prevent customer access to third-party services, as when a broadband provider adds an extra fee to a competing VoIP (voice over internet protocol) service.

The open internet - is not a clear term despite the fact it is often treated that way in policy and other discussions. This paper argues that debates about the future of the internet require an updated descriptive framework to better address how and why certain online services and activities are considered accessible or inaccessible. The semantic tangles regarding open and closed networks owe much to the simple matter of perspective - a point underscored by Jonathan Sallet in his 2003 paper, "Just how open must an open network be for an open network to be labeled 'open'?" Sallet indicated the difficulties involved in trying to capture the perspectives of industry players and governments, in addition to those of end-users. From a user's perspective: the network can include the activities of an end user, competitive network provider, an independent content/software provider, or the network owner itself. Thus a claim of an end user's "right" to access content through a network may shed little light on the claim of a competitive network provider to use that same network [Sallet, 2003].

Most residential markets in North America are a duopoly between incumbent telcos and cablecos; in contrast the global internet core is an oligopoly of between ten to twelve Tier 1 bandwidth and content provider networks owned or controlled by a small number of companies, many of which are based in the US. This list (which includes AT&T, Sprint, Verizon, Level3, Global Crossing, NTT, Cogent, TeliaSonera, Savvis and AboveNet) was fairly stable up until 2009, according to the ATLAS Internet Observatory Annual Report from Arbor Networks, University of Michigan & Merit Network, when for the first time the top tier included the Google, Facebook, and the Comcast networks. Out of the 40,000 routed end sites in the Internet, 30 large companies – "hyper giants" like Limelight, Facebook, Google, Microsoft and YouTube – now generate and consume a disproportionate 30% of all Internet traffic [Labovitz, Iekel-Johnson, Jahanian, Karir, McPherson, and Oberheide, 2009]. While the top tier appears to be consolidating, the widely used services of internet giants such as Google and Facebook seem to necessitate building their own large scale networks. At this time, it is unclear regarding the intent of building such vast, global networks, but one can surmise that the traditional hierarchical structure of data transmitted from end-users, through tier 3s to tier 1s, is going to change. All it might take is a few companies to fracture the internet into a parallel universe of multiple internets. Previously, the internet was commonly and casually understood as one entity. But it is evident that the internet is now breaking up into a number of separate, overlapping partitions. There are differences in the ways various kinds of traffic are being delivered, and this phenomenon is growing rather than shrinking.

3. THE USE OF INTRUSIVE TECHNOLOGIES IN NETWORK TRAFFIC MANAGEMENT

One of the single most contentious issues raised during the CRTC's 2010-11 proceedings on usage based billing was the extent to which the incumbent ISPs (especially Bell through its Gateway Access Service) have been obliged to apply both economic and technical traffic management practices including data caps because of the alleged need to minimize the effects of traffic congestion on their networks. Although many of the claims made by Bell and others about congestion have been debunked, the Cisco VNI report cited above describes two major trends that lend support to the idea that internet traffic management problems will become more challenging in the next four years. One of these trends is the dramatic overall growth projected in global internet

IP traffic in the period from 2010 to 2015. The other is the equally dramatic growth in video traffic. Video is a particularly important factor since, when delivered in streaming formats, it is both bandwidth-intensive and time-sensitive. These technical characteristics put strain on IP delivery networks that, as described below, are often amenable to solutions such as traffic management based on DPI and MPLS.

Cisco's VNI report posited several internet milestones which will occur between the years 2010 to 2015. Chief among these milestones was the prediction that internet video traffic will increase to become the most common type of traffic on the net, and that traffic from wireless devices will exceed traffic from wired devices, such as desktop PCs [Cisco, 2011, p.2]. Milestones such as these will definitely require crucial network innovation and restructuring. For example, in anticipation of an increase in traffic over high-speed wireless broadband networks, the proposed adoption of new technologies, such as LTE (long term evolution), are seen as necessary in order to maintain network efficiency. In a February 2010 Broadband Forum Marketing Report, edited by Bhaskara Chinni (Ericsson) it is demonstrated that MPLS plays a key role in the future of LTE:

> Deployment of MPLS in the access segment is expected to strengthen in the near future. In converged deployments where both mobile and fixed subscribers share the same transport network, MPLS in both access and aggregation segments enables better and more cost-effective control of services end-to-end. The development of additional packet transport capabilities (MPLS-TP) will further strengthen the adoption of MPLS in new market segments [Chinni, 2010].

Due to growth in mobile data traffic and coupled with the fact that spectrum efficiency remains finite, Manish Singh argued in 2009 that, "[E]ffective traffic management in mobile broadband networks is essential, and [deep packet inspection] holds the key" [Singh, 2009, p.3]. DPI technology can allow operators to open IP packets, inspect packets in real time, and route them appropriately, thus ensuring a more efficient performance across complicated networks. In defense of deep packet inspection, he argues that with the forthcoming employment of LTE data environments, DPI will enable operators to convert ordinary "bit pipes" into "smart pipes," as well as offering solutions to ongoing network concerns, such as poor QoS (quality of service) and data security lapses [Singh, 2009, p.3]. It is inevitable that packet inspection technologies will raise a red flag within the arenas of net neutrality and data security. But it can and will be argued that such innovations will be necessary for networks in anticipation of new network devices of the future, and in order for consumers to continue enjoying and benefiting from the internet's full potential.

With MPLS the network has a lot more control of routing as they can select particular data traffic, setting a pre-determined path for that traffic through their network. This MPLS network 'core' is also called an MPLS 'cloud' and consists of routing where directly connected hardware/software (in the form of custom label-switched routers termed 'hierarchical cloud routers') direct internet traffic according to a prescribed policy. Compare packet transmission in the stylized historical TCP/IP network in Figure 1 below, to the MPLS networking illustration in Figure 2. The MPLS clouds are prioritized networks where the network has set up a pre-determined path for data traffic:

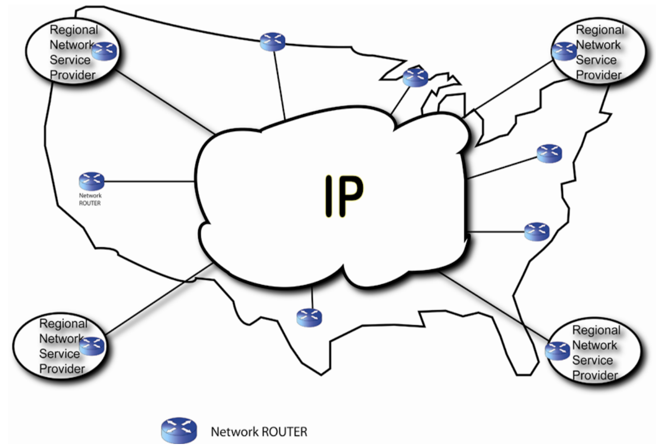

Figure 1. TCP/IP networking.

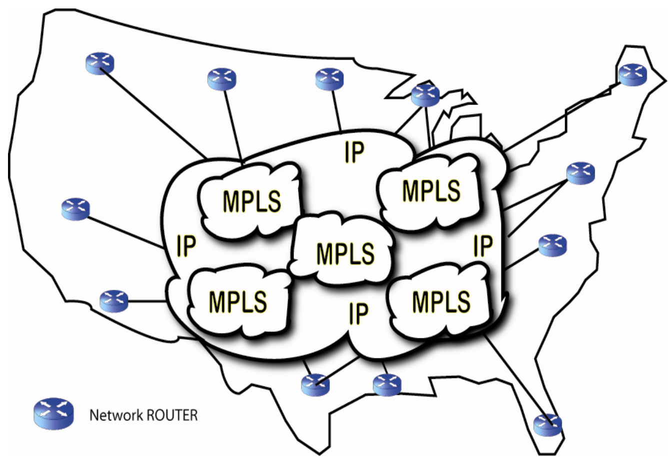

Figure 2. MPLS networking.

One of the key goals of network bandwidth control is the assurance of various levels of quality of service (QOS) for end-users. QoS mechanisms are based on packet classification and queuing within routers, thus making some packets go slower, either by delaying them or deleting them so that they have to be retransmitted. QoS has been a crucial part of data traffic engineering technologies with 'IP precedence' graduating to 'differential service' (diffserv) between 1996 to 2002, followed by MPLS diffserv in 2003 [Evans and Filsfils, 2007. p.142].

In 2001, Zheng Wang of Bell Labs, noted that internet architectures for QoS had already been around for more than a decade [Wang, 2001, p.2-3]. At that time, Wang also indicated MPLS was by then considered on its way to becoming the "standard signalling protocol for the internet" [Wang, 2001, p.11]. The evidence indicates that over the past decade, MPLS has been gaining favour with network engineers and part of the reason for this growth is that MPLS is especially effective in handling popular services such as video. According to Epitiro - a global leader in QoS service testing and measurement - MPLS is growing in use from network core to the edge, closer to the end user: MPLS is now being liberally deployed in areas such as [local] access, [intermediate] aggregation and backhaul to support fixed and wireless broadband services by adding MPLS capability to edge-devices, such as MSANs, DSLAMs and cellular base station gateways [Epitiro, 2010].

MPLS is a logical core technology for traffic engineering and control and the essential feature of MPLS functionality is the use of labelling [De Ghein, 2007, p. 25]. MPLS is not strictly speaking, a layer 2 protocol, because it straddles OSI layers 2 and 3. MPLS is often referred to as Layer 2.5 [De Ghein, 2007, p. 28]. Packet inspection occurs in order to route data traffic according to a specified MPLS class of service [Bryant, McPherson and Swallow, 2004]. The classes of service are the prioritizing mechanism by which packets are delivered through an MPLS network. MPLS can set up data paths by tunnelling across a domain (network), offering capabilities for traffic shaping and QoS.

MPLS was used originally to create virtual private networks or tunnels through the internet. A "wrapper" or "label" was added to each data packet in order to make it transportable. In an MPLS network, packets are assigned a "label" and are forwarded along a label switch path (LSP) where each label switch router (LSR) makes forwarding decisions based solely on the contents of the label. At each hop, the LSR strips off the existing label and applies a new label which tells the next routing hop how to forward the packet [DeGeest, 2001]. The initial justification for this virtual network tunnel technology has become replaced by its traffic engineering capabilities and it has become employed widely in internet backbone networks [King-Guillaume, 2003]. Traffic engineering and prioritization are easily configured in MPLS networks. An MPLS network does not necessarily employ packet inspection but has coincided with this technology as packet inspection tools from companies such as Fluke Instruments (Visual Uptime Select probes) use DPI to examine each packet in real time and identify what is being carried [so that] from a high level, the network can see everything from Layer-1 fault management […] to visibility into Layer 7 into the applications that are running across the network, how much bandwidth […] performance of applications, what class of service [etc] [Wilson, 2009].

In order for an edge router to communicate with the carrier MPLS-enabled backbone, the access router must mark its outgoing packets for prioritization accordingly. While MPLS offers significant advantages over the 'dumb pipe' approach, it is not able to differentiate between traffic flows intelligently and to determine which applications are to be prioritized or demoted in routing. MPLS lacks the ability to adequately map applications into the MPLS service levels.

> MPLS cannot offer the same granularity as a dedicated traffic management […] device. MPLS QoS also requires the enterprise to know exactly which of its applications need to be prioritized or demoted, when in many instances the company may not know what traffic it is carrying. If you can't monitor traffic, you can't monitor performance. To see this it is necessary to have a deep packet inspection (DPI) engine […] [Guy, 2006, p.20]

The use of DPI by Canadian and American ISPs has become controversial since it was discovered in 2007 that Comcast was traffic shaping without notification or specification to its customers. In Canada, DPI has been debated almost exclusively as a network management tool with many critics arguing that the rationale of managing traffic congestion has masked other issues that appear to interfere with the free flow of packets to and from subscriber homes. It turns out, however, that DPI and similar

technologies have been widely deployed in higher level networks, including internet backbones, in conjunction with MPLS. Many technologists argue that the deployment of MPLS networks is impractical without the associated use of DPI technologies, particularly given the rapidly expanding IP traffic devoted to bandwidth intensive applications such as video. Antoine Guy, marketing director, Allot Communications states:

> For this reason, a dedicated traffic management device capable of performing deep packet inspection (DPI) at the layer seven network level is virtually a prerequisite. Located at the access point to the MPLS network, it can identify the application and map it not only to the classes of traffic already prescribed by the operator but even shape and prioritize it into sub-classes specified by the IT manager […] It's only by combining an MPLS service with a DPI enabled traffic management device that service providers will be able to offer enterprises the spectrum required for managing their converged networks. Lumping VoIP into a high class of service, for instance, will not ensure its priority over other high bandwidth services nor can its delivery be monitored without the granularity of a traffic management system [Guy, n.d.]

Herein lies one of the most controversial aspects of MPLS networks, namely, they do not keep the transmissions they support private as classification of packets requires examination and prioritization. Additionally a significant evolution is occurring in light of the emergence of IPTV, continuing to affect net neutrality discourse in North America. Traditional broadcasters, telcos and incumbent ISPs have been forced to engineer various technical overhauls in order to stay relevant with increasing online competition. And while the net neutrality debate is framed involving incumbents, regulators, and consumer interest advocates, it has become evident that consumers and audiences are now developing connections to uniquely innovative applications on the internet. In addition to IPTV, profoundly novel and sophisticated virtual network services (eg. Facebook and Google), and wireless devices (i.e.: smart phones and tablets), games and applications (apps) are continuously becoming tailored to suit wider consumer adoption and demand. It appears that new forces are emerging that indicate that the battle is going to be contested in new places on the internet.

4. CONCLUSION: WALLED GARDENS – THE NEW SHAPE OF THE PUBLIC INTERNET

Something important has changed in the way mainstream consumers use the internet, as well electronic and computing devices, especially since the introduction of the first iPhone in 2007 - changes that speak directly to the extent of freedom of choice and access enjoyed by internet users. Two notable analyses have looked at the implications of the shift in recent years from what are typically referred to as "open" platforms, in connection with both computing and networking. The first of these is Jonathan Zittrain's 2008 book, "The Future of the Internet-- And How to Stop It"; the second is the Wired magazine article co-authored by Chris Anderson and Michael Wolff, entitled "The Web Is Dead; Long Live the Internet," published in August 2010

[Anderson and Wolff, 2010]. Zittrain argues for a sharp distinction between what he terms "generative" and "tethered" technologies, and laments the rise of computing appliances that greatly restrict the end-users range of options. He further argues that the "stall of the generative net" - and the "appliancization" of computing devices - is becoming both endemic and a serious risk to end-user welfare. Zittrain see these trends as a throwback to the early days of AOL and Compuserve [Zittrain, 2008, pp. 101-02].

In their 2010 perspective on these issues, Chris Anderson and Michael Wolff make the role of consumer demand in app culture both more explicit and more determinative:

> Today the content you see in your browser — largely HTML data delivered via the http protocol on port 80 — accounts for less than a quarter of the traffic on the Internet … and it's shrinking. The applications that account for more of the Internet's traffic include peer-to-peer file transfers, email, company VPNs, the machine-to-machine communications of APIs, Skype calls, World of Warcraft and other online games, Xbox Live, iTunes, voice-over-IP phones, iChat, and Netflix movie streaming. Many of the newer Net applications are closed, often proprietary, networks [Anderson and Wolfe, 2010].

Managed services are indeed a response to consumer demand - and the major issue to be addressed is who will be allowed to offer such services and how much freedom of choice will end-users retain in unregulated broadband markets. The public internet offers many of the aspects of "open" services; however, the successful ones which consumers are flocking towards can be characterized as "walled gardens." In light of large consumer demand, as well as the appeal and scope of the services offered, several of the more successful services present on the public internet are rapidly becoming major players in the industry. Wider consumer adoption and an increase in traffic allow them to become economically empowered and privileged. Nevertheless, it is arguable that, for consumers, the notion of "closed" networks may not necessarily be cause for extreme concern, as suggested by the rise of the Facebook community, commercial services like Amazon and Netflix, and the introduction of new, easy-to-use wireless devices and "apps" (applications) in the marketplace. It would appear that these new services and devices provide a walled garden in which short sighted contented consumers have enough toys to play with, thus lessening the desire to vacate the comfortable confines of such gardens.

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