The Role of Internet Exchange Points in Broadband Policy and Regulation

Daniel B. Cavalcanti
www.mc.gov.br
danbrc@gmail.com

BIOGRAPHY

Daniel B. Cavalcanti is a career professional with the Brazilian Government. Since 2006 he has been on assignment at the Ministry of Communications. He also teaches in the areas of telecommunications networks and wireless technologies. Mr. Cavalcanti holds a M.Sc. degree in Electrical Engineering and advanced diploma in Telecommunications Regulation.

ABSTRACT

New investments in Internet backbone infrastructure and the need to exchange traffic with existing backbones, on a peering or transit basis, point to the emergence of a key infrastructure element – the Internet Exchange Point (IXP). There are very few IXPs available today, considering the huge increase in the number of autonomous systems advertised. IXPs deployed by research networks demonstrate that a substantial increase in their number would improve the Internet topology, increase connectivity, reduce latency and the cost of traffic exchange. Additionally, IXPs can be efficient locations from which to offer system services. This paper discusses possibilities of regulatory action to stimulate the implementation of IXPs and to ensure that their benefits are widely shared.

Keywords

Broadband policy, regulation, Internet, exchange points.

INTRODUCTION

Over the last two years several countries have put forth national broadband plans, including the rollout of extensive fiber optic backbone networks, in order to reach unserved and underserved areas. In some countries, this new backbone is also seen as a vehicle to stimulate competition in the wholesale Internet Protocol (IP) transport market. These networks must, however, be able to exchange traffic with existing backbones on a peering basis, as well as providing convenient points where local Internet Service Providers (ISPs) and network operators can interconnect in order to buy transit capacity. All these conditions point to the emergence of a key infrastructure element – the Internet Exchange Point (IXP).

THE CONCEPT OF THE IXP

An IXP is a physical location at which service providers and service-based network operators exchange traffic between their networks, identified as autonomous systems. The first open and neutral IXPs date back to the early 1990's. A typical IXP consists of one or more network switches/routers, to which each of the participants connects. By directly exchanging via peering part of their traffic, networks reduce the portion of the total traffic which must be delivered via transit providers, thus reducing the cost of their service and increasing network performance.

As described by (Kende, 2000), transit and peering are differentiated in two main ways: in a transit arrangement one network pays another network for interconnection, and therefore becomes a wholesale customer of the other network, and, unlike in a peering relationship, the network selling the transit services will route traffic from the transit customer to its peering partners.

The structure of the IXP provides the added benefits of enhanced routing efficiency and fault-tolerance, reduced latency and bandwidth requirements. Traffic directly exchanged via peering at an IXP typically is not billed, unlike upstream transit traffic. Figure 1 illustrates the role of IXPs in providing peering arrangements for direct traffic exchange between participants (Cisco, 2005), as well as transit capacity on network backbones.

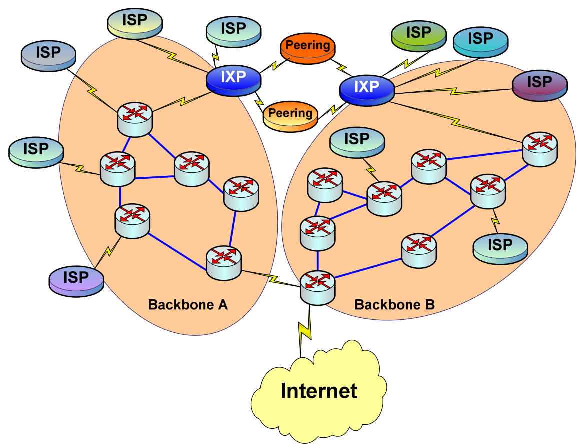

Figure 1. The concept of the Internet Exchange Point (IXP)

Currently IXPs tend to be implemented as cooperative efforts by businesses, academic communities or governments. However, considering the current topology of the Internet and the increase in the number of autonomous systems advertised - which have recently been upgraded to 32 bit addresses, there are very few IXPs available today.

The deployment of IXPs by research networks has demonstrated that a substantial increase in the number of these exchange points would have the effect of improving the Internet topology, increasing connectivity, reducing latency and the cost of traffic exchange. Additionally, IXPs can be efficient locations from which to offer system services. Figure 2 illustrates how Internet topology has been evolving in recent years from a traditional hierarchical structure to a more complex structure.

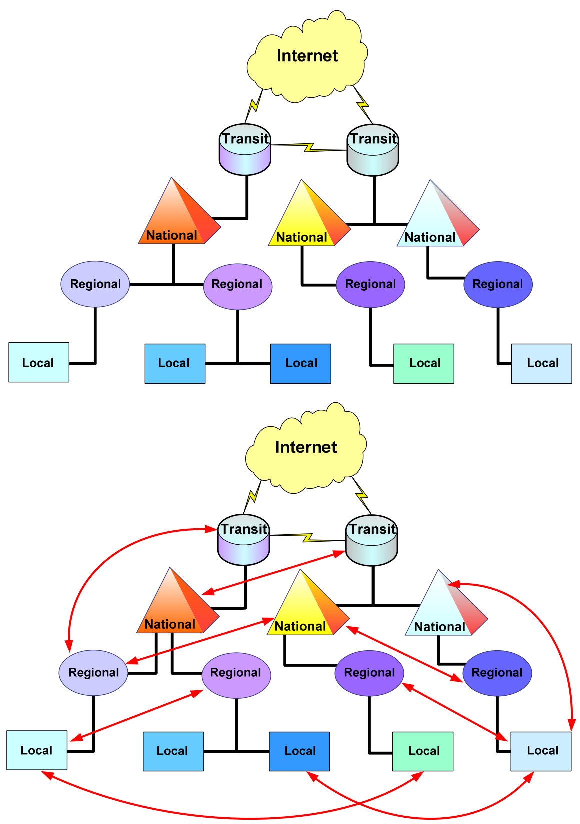

Figure 2. Internet Topology: evolving from traditional hierarchical structure (above) to complex structure (below)

The utility of an IXP is directly related to the number of networks that are present at that particular exchange point. However, the large backbone network providers typically tend to interconnect at a very small number of IXPs. Given the clear benefits of IXPs, this appears to indicate that there is room for regulatory action to stimulate the implementation of IXPs.

In Brazil, the Internet Steering Committee (Comitê Gestor da Internet - CGI.br), created in 1995, is a multi-stakeholder organization comprising representatives of government ministries and agencies, businesses, society and the scientific community. Today CGI operates the largest public IXP deployment initiative in Brazil, called PTT Metro, with points of presence in major cities across the country (Getschko and Moreiras, 2008).

In early 2010 Brazil had a total of 20 public IXPs (also known as PTTs – *Pontos de Troca de Tráfego*) located in 12 cities. Eight of these IXPs were in the city of São Paulo alone. The number of participants in each IXP varies greatly, from 4 participants in the smallest IXP to 94 in the largest. As a measure of comparison, according to the European Internet Exchange Association (Euro-IX, 2009), in October 2009 Europe had 389 IXP sites distributed in 115 cities across 33 countries.

CURRENT TRENDS

The use of IXPs as part of a strategy to stimulate broadband penetration, reduce costs and provide a level playing field for IP interconnection, has been a focus of a number of projects over the last decade. One such example is Project Atlas (Accessing Telecoms Links Across Scotland), which was implemented in 2003 with an aim to improve Scotland's access to the global Internet and substantially cut high bandwidth telecoms costs (Atlas, 2002). This innovative project set up a Telecoms Trading Exchange (TTE) with switches at three neutrally-owned hubs in Glasgow, Edinburgh and Aberdeen, as well as providing backhaul capacity to London. The TTE was devised as a point where transit capacity and broadband connectivity could be negotiated on a competitive basis, and open to any telecoms company or ISP.

A number of researchers have more recently studied the issue of IP interconnection in the context of Next Generation Networks (NGN). The European Regulators Group (ERG, 2007) points out that, as a result of a migration to a NGN environment, incumbents will be less interested to reach neutral interconnection points and will tend to preserve a system that maintains and enhances the asymmetrical condition in their favor.

As also pointed out in a study prepared for the European Commission (Marcus and Elixmann, 2008), with NGN migration incumbents have an opportunity to reduce the points of IP interconnection. Although both access and interconnection will be implemented using IP, they will not necessarily be implemented using the same points of interconnection. The contentious issue is that incumbents that provide IP-based backbone transport service to the end user will not want the operator that provides the physical last-mile IP access to be visible in the IP-level routing. The incumbent has no incentive to provide a neutral interconnection point.

On the topic of broadband investment and regulation, a recent literature review (Cambini and Jiang, 2009) points to the emerging conflict between regulation, competition and investment. Incumbent operators tend to view regulatory intervention as excessively intrusive. Nonetheless, both at the retail and wholesale level, regulatory incentives can help induce infrastructure investments by other players.

In studies relating to the United States National Broadband Plan (Berkman, 2009) a review of broadband Internet policy in several countries was conducted. It is pointed out that regulation can be an important tool in promoting broadband adoption and that ensuring easier interconnection with the incumbent can increase penetration and investment. All providers of telecommunications networks and services are under obligation to provide interconnection, and special requirements should be set for providers with significant market power (SMP) or who control a special competitive bottleneck resource. Rate regulation should be included among these requirements. Further remedies that are found to be essential for a competitive market should also be implemented, such as the "simultaneity rule" in Germany, which bars SMP providers from offering new services unless their competitors also have the opportunity to offer a similar service.

REGULATORY ISSUES AND REMEDIES

A very recent study on regulation, public policy and investment in communications infrastructure (Bauer, 2010), concludes that effective policies do influence investments by affecting the structure and competitive intensity of network platform markets. By establishing rules for transactions between different facilities and service-based network operators, these policies attempt to level the competitive playing field by standardizing important transactions between players and reducing transaction costs. Telecoms infrastructure regulation tends to fall within two large categories: horizontal regulation and vertical regulation.

In a comparative analysis of the efficiency of measures adopted in horizontal regulation (such as access to rights of way, collocation, interconnection, unbundling and resale, among others) and vertical regulation (including accounting separation, functional separation, structural separation, as well as non-discrimination rules – such as network neutrality), the balance seems in favor of horizontal regulation measures. These clearly are well established and have substantial theoretical backing. Nonetheless, seldom there is a single best way of implementing a measure. On the contrary, the use of a set of instruments allows to adjust to a specific context, as well as to strike a balance between short-term static and long-term dynamic aspects of efficiency. Crucially, it is important that safeguards are in place, allowing access to backhaul and interconnection to backbone networks, in order to take advantage of the modularity of advanced communication technology.

It is pointed out, however, that vertically integrated network operators have incentives to discriminate and to exclude competitors that are not vertically integrated. In this respect, the question is whether and which form of vertical separation is the correct regulatory response. Regarding non-discrimination rules, the perception is that the discussion is at an early stage, although some findings suggest that non-discrimination safeguards have benefits for sector performance.

BRAZIL: A CASE IN POINT

One of the aims of the National Broadband Plan, currently under study, is to increase broadband penetration with the active participation of small and medium sized Internet service providers and service-based network operators. To these players, the single most important issue today is the cost of upstream Internet transit traffic and the lack of means to exchange locally and directly, via peering, part of their total traffic.

In the current wave of migration to an NGN environment, and in the absence of specific regulation, the vertically integrated incumbent network operators have incentives to discriminate against those that are not vertically integrated. They will tend to establish a reduced number of IP interconnection points, and will not be interested in reaching neutral interconnection points. In this scenario, the incumbent backbone network operators will not allow these small operators that provide last mile access to be visible in the transport level IP routing.

Given these constraints, an effective horizontal regulatory measure in the area of IP interconnection would be to increase the number and ensure a wider geographic distribution of IXPs, so as offer to small and medium-sized service providers and network operators the competitive advantages of locally exchanging peering traffic and buying Internet transit capacity.

Besides the economic benefits of stimulating competition in the wholesale IP transport market and ensuring a level playing field, the deployment of IXPs carries the positive externalities of improvement in topology and routing efficiency, increased connectivity and reduction in network latency. Since the utility of an IXP is directly related to the number of networks that are present at that point, clearly this justifies a regulatory requirement of neutral and open interconnection points. It is essential, however, that incumbent backbone network operators are among those present at these IXPs.

As noted by (Kende, 2000), Internet backbone providers face conflicting incentives: an incentive to cooperate with one another in order to provide their customers with access to the full range of Internet users and content, but on the other hand, these same backbones have an incentive to compete with one another for both retail and wholesale customers.

Regulation in the IP interconnection market, particularly the mandatory deployment of neutral IXPs, is all the more relevant since Internet fiber optic backbone networks in Brazil tend to converge on very few locations – mainly in Rio de Janeiro, São Paulo and Fortaleza – where they interconnect with submarine cable networks that provide international Internet transport capacity. Access to this bottleneck resource is a key factor in the price structure of the wholesale IP transit market in the country. Due to the SMP position of incumbent backbone network operators, it is essential that smaller network operators can also access interconnection facilities either directly at these locations, or indirectly through a nationally distributed mesh of interconnected IXPs.

Nonetheless, in order to enjoy the benefits of participating in a more level playing field in the IP market, a substantial number of ISPs and local access network operators has yet to upgrade to the category of autonomous system (AS). This is an essential condition to interconnect at an IXP, although a fairly straightforward step, once regulation ensures the offer of neutral and open exchange points.

As mentioned in a study addressing the complexity of Internet interconnections (Faratin, Clark, Gilmore, Bauer, Berger and Lehr, 2007), the earlier world of settlement-free peering and paid full transit agreements was an appropriate, market-based response to the Internet environment at the time. However, the landscape of interconnection is getting increasingly complex and the emergence of the newer types of contracts yields mutually self-enforcing efficiencies, available to all autonomous systems.

In this new environment, it is noted (Yoo, 2010) that regional service providers and service-based network operators that do not have sufficient volume to peer with backbones find, however, that they do have sufficient volume to peer with other regional providers, known as secondary peering. Exchanging traffic reduces the costs to end users and increases control over quality of service. Secondary peering reduces transit services that need to be purchased, by providing the ability to reach directly those customers served by its secondary peering partners. As a result, these providers have begun to purchase partial transit that covers only a portion of their total Internet traffic.

CONCLUSION

The case for active regulation in the IP interconnection market appears to have significant support, as recent reviews in the literature seem to indicate. Several countries are currently discussing national broadband action plans, some of which include setting up new national fiber optic backbones. These plans must focus as well on regulatory actions that would ensure access to backbone and backhaul infrastructure by small and medium-sized service providers and network operators. One of the tools that could prove to be most effective is the substantial deployment of IXPs, which allow for improvement in topology at the backbone level and a more open environment for local access providers to interconnect with national backbones. Specific regulatory measures could include mandatory presence at these neutral IXPs for all backbone network providers with SMP.

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