Intra regional Internet Connectivity

Still a pending assignment

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Abstract

A review of market trends impacting the development of the applications architecture of the Internet in general is presented, followed by a historical review in the subject and an analysis of regulatory aspects to finalize with a review of the state of backbone interconnection in Latin America.

Introduction

A lot of effort has been devoted in bringing the benefits of the Internet accessible to the majority of Latin Americans. Complete programs including subsidized / free connectivity in public access centers or mobile facilities are sometimes part of more comprehensive programs aiming to use the Net as a transport for better services as health or education.

Given the considerably low ratio of Internet users as a percentage of the total population, no other policies regarding the Internet should be given more short term priority in Latin America. However, while many countries take pride on the deployment of national NAP's as the definitive answer to promote the development of an efficient Internet transport, new technological and market developments are setting the stage for what could be major architectural changes for the networks that integrate those NAP's. Additionally, most of the current literature on the subject focuses exclusively on the perspective of the US market and previous international studies have not been updated to reflect new market and technological perspectives.

Keeping an eye on the development of the US market and its regulatory framework it's vital due to its obvious influence on the development of the Internet word-wide. Two particular issues, whose development is currently uncertain, will be possibly defined in the following years due to changes in market conditions:

- Whether if the Internet will consolidate as a network of services whose intelligence reside on the edge according to the "end-to-end" principle.

- Whether if pricing of basic access/transport will move from a flat structure to a metered, one probably making possible settlement based interconnection agreements.

The developments on those areas will certainly provide new arguments for the debates on critical issues for Latin America.

- The current compensation structure for Internet transit services, which are required by any Network Service operator in the region to connect to the global Internet.
- The mechanisms used to route domestic traffic without any dependence on foreign infrastructure to reduce transmission costs.

It is the intention of this working paper to open the debate on those subjects for further discussion by regulators and market participants. The analysis of the economics of retail ISP services and equal-access to required telecomm services are out of the scope of this work.

The first section gives a market perspective of market trends affecting the foreseeable future of the architecture of the global Internet. The second section reviews traditional regulatory issues of Internet interconnection and the status of the efforts of Latin American countries on the issue.

The terms "Internet backbone" or "Internet transport" will be used to refer in both cases to the optical and packet-switching infrastructure deployed by "network service providers" (NSP's) or "backbone operators" in order to provide wholesale connectivity to the Internet; "backbone services" or "transit services" will be used equally to refer to the services provisioned through the aforementioned networks and, in particular, when referring to the case of Latin America, it is implied that those services specifically involve international connectivity.

Trends

An image like this could describe what was commonly accepted as a "sure" scenario for the future of telecommunications industry at the beginning of the 90's decade: A totally connected world (through wires, mostly fiber) based in a common universal transport for voice, data and video (ATM) and a single communication protocol stack available on every device (the OSI protocols).

The technologies that were envisioned as vital for such scenario do not necessarily are the ones that ended being deployed to make it happen. Today the world is very connected (with wireless communication growing faster and replacing an important portion of the wire line sector), and a single protocol (IP) has two leading roles as the lingua franca for large variety of devices and potentially the universal transport for all telecommunications services.

In order to analyze the changes that will produce profound structural change on the Internet, one should focus on what trends will persist independent of the outcome of competing technologies, standards and market practices.

The current common wisdom on Internet backbone services states that the IP protocol will be the center of all enterprise and consumer telecom services. In order to meet this challenge, it is expected that the market of IP infrastructure will go through the following transformations:

- The greatest revenue opportunity for Internet Services will be in distribution of digitized **content** for entertainment and access will follow the path of all critical infrastructures: while augmenting its overall value to society, it will continuously reduce its cost structure and pricing.
- In order to accommodate for lucrative multimedia services, IP networks should support **differentiated Quality of Service (QoS).**
- IP services will move to a **metered pricing structure**, mandatory for a sustainable business model in an environment of continuously increasing traffic. Differentiated QoS will be the leading benefit for users to accept this change.

The value of content

The Internet has proved to be the most efficient method for the distribution of all kinds of content. St Arnaud[1] recognizes that all Internet traffic could be categorized in three basic areas:

a) ***Human to human data*** for telephony, instant-messaging and videoconferencing.
b) ***Human to computer data*** for web browsing and audio/video streaming or downloading.
c) ***Computer to computer data*** used in e-mail[i], web caching, routing updates, news feeds, database synchronization, etc.

Through a simple comparison of the revenues of the telecommunications industry compared with those of entertainment and other empirical evidences, Odlyzko[3] suggests that end-users perceive more value in communications rather than content and so are willing to pay more for the former.

Odlyzko argues that increasing the number of passive recipients of content broadcasting on the Internet, does not create as much value as a similar increase of active users on peer-to-peer communications as in telephony. Also, according to Metcalfe's Law and consistent with the Katz-Shapiro[4] model on network

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[i] E-mail is considered computer to computer since transmission of e-mail is made from server to server without real-time interaction among humans.

externalities, the more users connect to the phone network, the network itself becomes more valuable. Similar phenomena can not be found on broadcasting.

So, the conclusion is that peer-to-peer services will have a more significant role in the future of Internet services, leaving all forms of content broadcasting (text, audio, video) a secondary role, and, even Odlyzko uses only examples of telephony applications, we could easily assume that his conclusions are valid for "computer to computer" applications.

Current trends on architectures for IP telephony confirm that even the technology itself it's favoring a peer-to-peer model. While several IP telephony protocols like the MGCP or MEGACO imitate the traditional phone network of dumb terminals (phones) that require central intelligence (switches in central offices) to provide services, the industry is moving fast for increased support of protocols that assume service logic distributed on intelligent devices with minimal intervention of central elements. This can be seen in the growing adoption of peer-to-peer protocols as H.323 and particularly the Session Initiation Protocol (SIP) for new Internet services as telephony, messaging videoconferencing and new radio-like cellular services like "push-to-talk".

The need for differentiated Quality of Service

ATM (Asynchronous Transfer Mode) was the first serious attempt to deploy unified networks that could transport any kind of telecom services. From the beginning ATM was conceived as a technology that provided differentiated treatment to several applications over the same physical media: CBR (Constant Bit Rate) provided low-latency for video and voice applications, VBR (Variable Bit Rate) accommodated "bursty" traffic to interconnect LAN's and ABR (Available Bit Rate) offered no guarantee at all in order to transport non-critical data as e-mail.

Apart from the fact that ATM never made it as the universal transport of telecom, it's relevant to remark that its QoS capabilities were rarely, if at all, deployed. ATM was confined to the core of service providers' data networks, mainly because it was the only option available for high-speed transport at the time. Raw speed was the main driver in the limited adoption of the technology, not its inherent QoS capabilities.

[iv] A parallel example could be found in the evolution of the Ethernet Standard. As new transmission speeds were available on traditional media like twisted pair copper or fiber, the "chaotic" CSMA/CD (Carrier Sense Multiple Access with Collision Detection). Since the network is a shared media available for any device that detects it unused at the time, collisions occur when multiple transmissions start at the same time on several devices thus degrading network performance through retransmissions. More elegant schemes were proposed that offered intelligent scheduling mechanisms inherent to the network design: Token Rings networks competed with the original 10Mbps Ethernet standard (IEEE 802.3) with limited commercial success. When 100Mbps where possible over copper, two competing Ethernet standards appeared: Fast Ethernet that maintained the original CSMA/CD access method and 100-Base-VG that arbitrated network access requests through round-robin polling. Again the "cheap and dirty" model of CSMA/CD was favored by the market.

Support for QoS and metered pricing involves adding intelligence to the network. The Internet's generally accepted notion of and "end-to-end" architecture, claims for a network that will always have a "dumb" core and all service intelligence is implemented on the edges by end-users (i.e. in the form of servers and personal computers running applications like e-mail, web surfing, instant-messaging, etc.).

In that architecture, no centralized entity imposes operational controls over the services transported by the network, which remains also completely open for innovative users to provide new services and applications. Odlyzko argues that the industry has repeatedly tried to reverse this current state of affairs, looking for more control over the infrastructure (e.g. the push towards ATM and QoS) to eventually exert price discrimination.

To be precise, and according to its authors[7], the end-to-end argument establishes that it is redundant and not cost-effective to implement on the underlying technology (low-level functions) something that "can completely and correctly be implemented only with the knowledge and help of the application standing at the end points of the communication system",

However (and defendants of the end-to-end principle applied to the Internet typically ignore this), the principle also considers that such implementations could be made, but *only when justified by performance gains*. It can be easily deduced that adding network intelligence to accommodate QoS and improve applications' performance, in no way should be considered a violation of the end-to-end principle.

Again, the slow adoption of QoS intelligence on networks in general has been dramatically delayed by improvements on transmission technology and the subsequent increased availability of bandwidth. Before QoS could solve congestion problems on a particular network, new, cheaper technology has been available that will significantly increase transmission capacity and eliminate such congestion.[iv]

Still, we should expect continuous and stronger attempts of equipment manufacturers to include QoS capabilities on their gear and of service providers to develop QoS aware network services. This, combined with the explosive growth of traffic for existing services and the inclusion of new services (voice and, prevalent or not, some form of multimedia broadcasting) will provide a new scenario for the old QoS vs. more bandwidth dilemma.

Moving from flat-fees to metered billing

Demand for telecommunications services in the world remains solid, but that has not served as a guarantee for the viability of telecom companies. Traditional profit generators services as local lines are being cannibalized by services like DSL or mobile phones. Price for profitable services like Internet access, long distance and bulk fiber capacity have been continuously on decline and the trend seems to continue in the foreseeable future.

In this scenario, the idea of breaking with the trend towards simpler pricing of "all-you-can-eat" flat-fee services seems reasonable as an option to reinvigorate the industry.

Odlyzko[8] also suggests that there are enough incentives in telecommunications for increased price discrimination and more complex pricing, which has been normally the case for the transportation industry. Through an interesting compendium of historical examples, he shows that the norm in transportation has been and continues to be "charging according to the nature of the goods being transported". Still, in another paper[9], Odlyzko recognizes that price discrimination is the final option for goods and services that are expensive and bought infrequently, which seems not to be the case of a ubiquitous and increasingly cheaper Internet.

While Odlyzko's arguments make an interesting point they have also two critical limitations. First, when he compares the relative sizes of the entertainment and the telecom industries he analyzes a static picture, not the trend of those very dynamic markets and, second and more important, when analyzing long-term tendencies for pricing in industries that provide critical infrastructure (both transportation and telecommunications) the conclusion will be in the long run that infrastructure becomes "widely accessible … (and) broadly affordable as the rush to invest leads to more competition, greater capacity, further technological advances, and rapid price declines". This last argument from Carr[10] (2004) is based on analysis during the adoption of telegraph in the 19th century and electricity from 1897 to 1909. In this sense, it is hard to imagine that any relative success at pricing discrimination could eventually be greater than the long term trend of cheaper prices for infrastructures.

For retail Internet access surely there are no current significant attempts from the supply side to move towards usage-based pricing. For wholesale access services however, one should notice that for years NSP's have practiced some kind of per usage charges, not precisely by unit of traffic sent, but in terms of average daily usage (that in practice could make it more similar to a flat-fee than to a traditional telephony per-usage pricing structure).

Odlyzko argues that the Internet pricing model is opposed to the cable industry, where content owners (TV channels) get a small portion of the revenues and cable operators make the most to cover the cost of deploying and maintaining the infrastructure. That's the basis to the perspective that metered billing will occur at the application level, not for basic transport services. In that sense, several attempts and proposals have been made for the following services:

a) **E-Mail**: Usage sensitive pricing has also been continuously proposed[11,12] as a solution for the problem of unsolicited commercial e-mail ("spam"). The more serious and detailed proposal to charge the use of "e-mail" as the only "viable" is a study by Nail[13] that suggests a pricing system that discriminates the volume of e-mails produced by a typical end-user from that of a bulk e-mailer. Through this differentiation, only end-users are entitled to "free" e-mail as today (by "free" meaning having to pay only for standard Internet access) and bulk e-mailers would have to pay according to the number of mails sent. This would help to eliminate the need for users (especially in the business sector) and ISP's to incur in costs related to filtering software, extra storage capacity for mailboxes, additional bandwidth, etc., effectively moving the costs of bulk e-mails from recipients to the marketers that benefit from it.

Content: Meaning human-to-computer access for content where: i) text content (i.e. newspapers and magazines sites) is doing a slow but successful transition from free to paid services, ii) demand for legitimate music services has been halved by peer-to-peer piracy, iii) working business models for video do not exist yet. In any of these cases, content service providers don't pay for the whole portion of Internet infrastructure needed to make their content accessible, while traditional newspapers have to share revenues with newsstands, and music and cinema studios do the same with record stores and theaters.

b) IP Telephony: the first deployments of retail IP telephony offerings, particularly those of the company Net2Phone, considered metered billing as an essential component of their business model. However, newer entrants like Vonage and 8x8 are pushing the market towards flat tariffs following the trends of others services as traditional long-distance or wireless.

Still, Lucas[14] has made the case of the "definitive" push towards metered IP billing coming not from natural market forces but for an eventual need to comply with traditional telephony regulations in the US. Even if the FCC has denied any intentions to regulate VoIP, Lucas argues that state regulators and law-enforcement agencies will eventually make mandatory such obligations as functionalities to determine the location of user terminals as well as taxes. Lucas goes a step forward and establishes that in order to comply with those obligations, IP telephony operators will need to connect with incumbent phone companies at the Local Area level, killing the current "non-facilities" business model. The timing for those probable but complex and radical changes will clearly depend on the rate of adoption of IP telephony (VoIP is still very small compared to PSTN traffic) and the technology representing a relevant proportion of the total telephony market.

Possible outcome

Several forces affecting the market make hard to discern a clear scenario of what the future architecture of the Internet will look like in the following years. What can be certain, however, is that the renewed attempts towards metered billing and the regulatory push from several agencies in the US, will justify additional efforts from equipment manufacturers, as well as software makers of mediation and billing systems, to collect more information about the nature of IP traffic flows.

Currently, basic statistics as average volume of incoming/outgoing traffic traversing circuits can be easily obtained on every network. Whether if carriers could charge more for 1Mb of packets containing a voice conversation (that needs to be transported in real-time) than for 1Mb of greeting cards (that could be delivered anytime within a 24 hour window) remains to be seen. But the capabilities for carriers and applications providers to understand the behavior of traffic flows sure will be increasing. This is particularly relevant for developing countries, since one of the strongest arguments defending the current state of economic models for Internet interconnection (both domestically and internationally) is that there are no certain ways to analyze IP traffic flows.

The push towards metered billing could definitively bring an opportunity to review old assumptions and fine tune the regulatory approach (or lack of it) as well as the accepted trade practices in the Internet backbone markets. A timely analysis and discussion on the issue may also help Latin American countries to reach consensus toward constructive proposals for the good of Internet infrastructure in the region.

The General Issue of Backbone Interconnection

The need for a user on the Internet[v] to establish communication with any other user makes mandatory for every network operator to interconnect to others. As a more or less general rule, there are no national or international legislation[vi] that force either the interconnection or the conditions in which it occurs among Network Service Operators (NSP's) or Internet Service Providers (ISPs)[vii].

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[v] For a general historic review of the economic and regulatory issues of Internet Interconnection, see: Cave, Martin; Mason, Robin, *"The economics and regulation of the Internet", A paper prepared for the OXREP issue on Economics and the Internet*.

[vi] The famous case of Australia does not represent an example of a regulated market. When the ACCC made a recommendation or "competition notice" to incumbent telco Telstra in 1998 regarding its policy of denying peering to other players, as soon as Telstra engaged in peering agreements with three networks selected by the operator itself, the recommendation was retired and no further genera mandatory requirement exists for backbones to interconnect to each other. Source: Australian Competition and Consumer Commission. Submission to the Productivity Commission. Review of Telecommunications Specific Competition Regulation. August 2000. Available at: http://www.pc.gov.au/inquiry/telecommunications/subs/sub016.pdf

[vii] Cuba and Chile are the exceptions in the region.

Antecedents of interconnection of NSP's [15]

When the Clinton administration decided it was time for the Internet to be opened up for commercial use, the US government was still funding the NSFNet, "The Backbone" that interconnected all participating networks in just one single Internet.

A new market was going to be born, where any operator could invest on Internet infrastructure. Still, a new technical mechanism was needed to replace the NSFNet's integrating role so all networks could remain interconnected with each other, without relying on the infrastructure of a single monopolistic provider.

The US government favored a model of telecommunications hubs. Operators made bids to build and operate one of the four NAP's (Network Access Points) that were established on making possible for all networks to remain interconnected:

- A NAP in New Jersey operated by Sprint, to which the NSFNet backbone interconnected in September 13, 1994[16]
- A NAP in San Francisco operated by Pacific Bell[viii], to which the NSFNet backbone interconnected in mid-October 1994.
- A NAP in Chicago operated by Ameritech[ix], to which the NSFNet backbone interconnected in January 1995.
- A NAP in Washington (MAE East) operated by MFS[x], to which the NSFNet backbone interconnected in March 22, 1995.

These NAP's were established partially financed by the NFS, and almost immediately new for-profit, privately funded NAP's appeared: MFS deployed the MAE West complementary to the Washington NAP and later the MAE Center, the MAE Los Angeles, the MAE Frankfurt and the MAE Paris[17]. Even before the NFS promoted the creation of the four "original" NAP's, in 1990 UUNET, PSINET and CERFNET had created the Commercial Internet Exchange (CIX) for commercial applications then prohibited by the "Acceptable Use Policy" [xi] established by the NSFNet.

By 1997, it was obvious that just four points were not enough to cope with the increasing complexity of interconnecting more and bigger networks. Complains about NAP congestion were a common place and new business perspectives questioned the "interconnect to everyone" proposition; in particular, some large companies (MCI the most notorious example) considered that treating significantly smaller networks as "peers" was equivalent to actually subsidizing competitors.

[viii] Now integrated to SBC Communications.
[ix] Now integrated to SBC Communications.
[x] Now integrated to MCI.
[xi] The policy considered "Unacceptable uses": the use in for-profit activities and extensive use for private or personal business. The Policy is available online at http://www.creighton.edu/nsfnet-aup.html .

In a competitive and unregulated market, the US government neither endorsed nor blocked the development of new NAP's and some companies were created with the sole purpose of profiting by solving the Internet's interconnection issues. Some of those companies provided simultaneous connection to multiple networks ("bandwidth aggregation services"), others focused on the creation of "private" NAP's (by 1997 were around 80 NAP's in the world, created either by private companies or by governments and at least 32 were outside the US[18]) and some other created overlaid networks for fast distribution of content.

But, more relevant, major US carriers decided to interconnect their networks in mutually agreed private interconnection points that used their own facilities and avoided relying on third parties. These private agreements have severely diminished the real importance of the four original public NAP's and of the aforementioned companies that had to survive from other revenue sources like access, collocation or managed services. Most articles dedicated to the history of the Internet, however, ignore these facts and stop at the deployment of the four original NAP's, contributing in some way to the common misconception of NAP's being a mandatory prerequisite for an optimal Internet architecture.

The Debate on Peering Agreements

The need for all operators to interconnect to each other on a single Internet is obvious. Since the IP protocol lacked an intrinsic mechanism for traffic measurement and accounting, interconnection occurring in public (NAP's) or private peering points was based on a "settlement-free", "multilateral peering" (i.e. connect to everyone else) approach established as the basis of the "commercial" Internet architecture during the first years of its operation.

In 1997[19] several NSP's, with UUNet being the most notorious case, announced their intention to deny "peering" to smaller providers alleging that these enjoyed an unfair advantage when interconnecting for free to larger networks. Since then, a continuous debate on the issue of peering exists basically focused on two fundamental questions:

- Whether incumbents have or not incentive to degrade the quality of peering.
- Whether granting small providers peering with larger ones creates unfair benefits to the former.

These questions are responsible for opening the general debate on whether Internet services should be or not subject to some form of regulations.

The general issue of regulating Internet services

Once the multilateral approach ceased to exist, bilateral agreement became the norm as described on the studies of Laffont, Marcus, Rey and Tirole[20] as well as those of Constantiou and Coucoubetis[21] which establish that all modern peering agreements:

1. Are bilateral.
2. Provide transport only for the traffic that terminates on the network of the other provider. No transit services are provided for traffic destined for 3rd party networks.
3. Are governed by "Bill-and-keep", settlement-free agreements.
4. Relay on each NSP to continuously monitor the cost and quality of the connection with the other party, being quality defined in function of:
   a. Quantity of interconnection points, assuring that traffic is always exchanged in the nearest geographical point.
   b. Traffic flows that are more or less equivalent in both ways (balanced traffic).
   c. Both parties having International connections with significant bandwidth.
5. Rely on the best effort that each NSP will provide to handle traffic without any guarantee.

a) The pro-regulation current

Establishes that the Internet is en essence a telecommunications service and whose provision in a non-discriminatory manner should be guaranteed for the common interest. Based on this, there is no reason to not to apply regulatory schemes similar to those of telephony.

The basis for this proposition is a study by Speta[23] that uses as evidence an analysis on the historical definitions of a "common carrier" as well as the definition found on the Telecommunications Act of 1934.

According to Speta, the fact that the FCC continuously has to impose exceptional conditions to the big mega mergers of the industry (i.e. MCI-Worldcom, AOL-Time Warner, AT&T / TCI, AT&T/Media One), is first, a contradiction to the supposedly "free of regulations" Internet, and second, the clearest evidence of the need to define new rules that apply equally to everyone.

b) The "laissez-faire" current

This is the position of most of the telecommunications industry and of the US government. In 2000, Michael Kende (2000)[24] of the Office of Plans and Policy of the FCC published the most comprehensive defense to keep the Internet unregulated given that:

1. A competitive market of NSP's exists since the "privatization" of the Internet, and that's a great difference from traditional telecommunications that were born as regulated monopolies.

2. According to section 230 of the Telecommunications Act of 1996, the existence of a competitive market makes regulation unnecessary.

3. Even if the potential risk of one operator concentrating too much power is big, the enforcement of antitrust laws is more than enough to prevent such scenario.

4. There is no abuse when a NSP denies peering to a smaller NSP forcing the latter to buy transit services since Peering and Transit are not equivalent services.

Incumbents and the quality of peering

Regarding peering, Speta refers in particular to studies by Crémer, Rey and Tirole (2000)[25] that demonstrate (through an extension of the Katz-Shapiro model[26]) that in a non-regulated environment, the dominant operator will always choose to degrade interconnection quality with any other competitor through:

- Installing less bandwidth capacity than needed from the beginning.
- Delaying any capacity increase needed due to the natural increases on interconnection traffic over time.

Subsequent studies, however questioned these conclusions. In 2001, Rosson compared them to those of Foros and Hansen, which declared that two different sized providers have no conflict of interests regarding the quality of interconnection. He concludes that both models are somewhat valid but reach dissimilar conclusions due to the different set of assumptions each one uses: Crémer, Rey and Tirole[27] define a market whose size varies over time while Foros and Hansen use a fixed-size market.

Beyond that particular detail, however, two facts are significantly more relevant:

1) The observation of Rosson regarding the fact that Internet backbones compete in the market through several characteristics that go beyond the quality of interconnection.

2) A subsequent study by Rey, Tirole[28] and other researchers recognized that traditional telecommunications regulation is not viable for the Internet

The impact of peering on infrastructure

Larger NSP's refuse to peer with smaller networks based on the claim that the latter would unfairly benefit from such agreements. The claim is generally based on the so-called "hot-potato" routing algorithm that is the basis of Internet traffic routing.

When a packet travels from one network to another, it will look for the closest interconnection point to reach the other network as soon as possible. A network with significantly smaller geographical scope will frequently use more resources of a larger network given the smaller operator a cost advantage and an incentive to not to increase the reach of its infrastructure.

In Exhibit A, two NSP's interconnect at two cities and traffic is transported using equivalent resources at both networks. In Exhibit B, given the smaller network of NSP C, resources of network B are used more frequently since it's the only network of the two that reaches City 1.

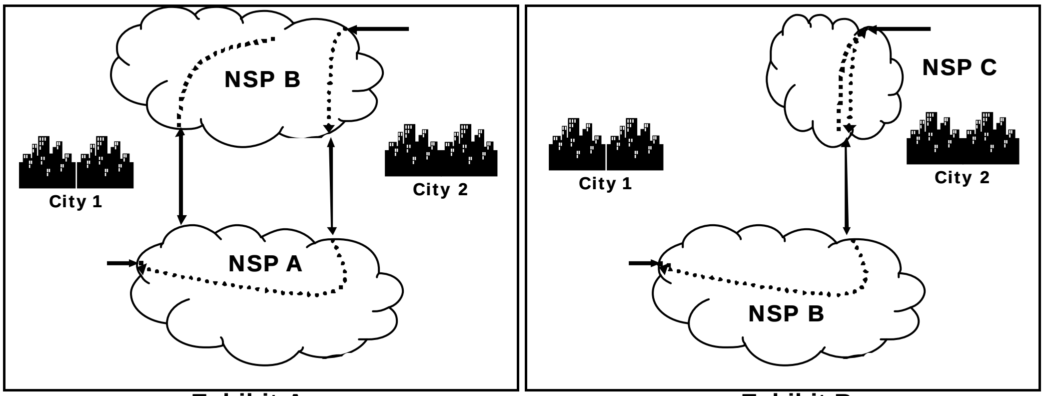

Exhibit A Exhibit B

In spite of this, there is a legitimate concern regarding the power of larger NSP's that control both an essential resource for competitors and eventually market prices when competing for the same customers with their smaller counterparts.

However, a formal exploration of the consequences of regulation that enforces settlement-free peering was made by Little and Wright[29] that concluded that not only smaller NSP's but also the larger ones lose all incentives to increase their infrastructure under such scheme. Since "each firm uses the other's capacity for free and thus receives maximal profits when the other firm provides all capital" leading to firms entering a game to try to avoid being the one to provide the majority of the capacity needed.

Little and Wrigh found also that under regulated peering, the consumers would benefit from reduced prices in the short term but would eventually suffer from poor, congested infrastructure due to low levels of investment.

The Future of Peering Agreements

Assuming no significance changes to the Internet architecture in the foreseeable future (i.e. routing protocols and measurement tools for IP traffic), the arguments that De Laffont, Marcus, Rey and Tirole (2001) [30] proposed explain why all the accumulated experience of regulating telecommunications services is useless for the Internet:

1. Internet traffic flows are different from a traditional telecommunications network.

2. In the history of telecommunications, the flow of traffic has been always subject to regulation; there are no precedents of unregulated telecommunications markets that could be comparable to the Internet.

3. Pricing to the end user (based on flat fees) necessarily has an impact on interconnection agreements.

When making their case against enforcing settlement-free peering Little and Wrigh conclude that the two options left are:

- Allowing NSP's to refuse interconnection to "net users", being those, the ones that use more capacity than what they have installed.
- Allowing NSP's to charge settlements based at the incremental cost of capital provided. A solution that could be established only if the proper measurement tools for traffic are in place.

In order to make possible settlement based interconnection schemes and doing an analogy to the telephone system, it is easy to conceive as mandatory information to collect from IP traffic flows:

- Clearly identified origination and termination points of sessions (not single packets).

Nature of the traffic transported.

- Volume of traffic.
- Adherence to SLA's in terms of actual delay, jitter and packet loss occurred during sessions.

The Current State of International Transit Services

Traditional "correspondent" services among international telephony carriers rely on each carrier paying "half" of the circuits needed to make interconnection physically possible. In the case of the Internet, most NSP's outside the US always buy transit from US carriers and have to pay for both halves of their circuits. Exceptions for this rule are few being the most notorious:

- Cogent: A carrier famous for its policy of peering to “almost anyone”[31] has granted peering to some NSP’s in Mexico. NSP’s have to provide their own fiber links to one of 16 public peering points in the US, making it a not viable option for other Latin American NSP’s further south of Mexico.
- Yahoo: While not being a NSP, Yahoo has looked for ways to reduce bandwidth costs offering “peering” at their US data centers to foreign operators and thus eliminating the intermediation of US carriers. While again, this fact should be considered an isolated one, it could be an argument for the effect of effective market competition in reducing transit cost for Latin American NSP’s.
- Global Crossing[32]: During NAPla 2003 announced adjustments to its peering policy for Latin America making it more accessible while still recognizing as “peers” only those NSP’s with significant bandwidth. As of August 2003, Global Crossing participated on NAP’s in Argentina (CABASE) and Brazil (FEPASP - NAP do Brazil) and was looking for agreements in Mexico City, Panama City and Santiago de Chile.

When analyzing the compensation schemes among International NSP’s, Kende defends markets as providers of efficient mechanisms since international institutions either:

- openly oppose government regulation:
  - The Working Party on Telecommunications and Information Service Providers of the OECD stated in the article “Internet Traffic Exchange and the Development of End-To-End International Traffic Telecommunication Competition”[33] that “As long as there is sufficient competition and markets remain open to new entry, commercially based arrangements for the carriage and exchange of traffic will continue to develop”.
  - The APEC Ministerial Meeting on Telecommunications in Cancun, Mexico from May 24-26, 2000 reaffirmed “the importance of mutually beneficial arrangements on [ICAIS], to allow a continued expansion of the Asia Pacific Information Infrastructure.”[34] The Cancun Ministerial Declaration stated that “Governments need not intervene in private business agreements on International Charging Agreements for Internet Services achieved in a competitive environment”[35].
- or finding the current compensation scheme unfair, haven’t reached an agreement for a new one:
  - In the case of the International Telecommunications Union (ITU) Telecommunications in the Sector Study Group 3 (ITU-

T/SG3) a report was issued arguing that "the PSTN costing model is inappropriate for the Internet," but the group was otherwise "unable to develop an agreed set of principles on the equitable cost compensation between circuit providers."[36]

- The Program of Action resulting from the Ministerial notes in the APEC Ministerial Meeting in Cancun stated that APEC Telecommunications Working Group (TEL) should continue to discuss charging arrangements[37].

Following the same line of reasoning of Kende, the OECD highlights the benefit of the market options for NSP's that are "rapidly developing and thriving" like:

- The ability to interconnect at local IXP's (Inter eXchange Points, i.e. NAP's)
- Prices for transit services decreasing worldwide
- The increasing choices for transit providers in the US due to new entrants (besides traditional Telcos)
- The possibility of partnering with carriers in another regions through:
  - Dark fiber purchases
  - Capacity swaps
- The possibility to purchase an operator in other region

While the claims are generally valid, it is certain that no economies of scale exist in Latin America compared to those of the US and European markets to make feasible the last two options.

The Current State of Domestic Traffic Routing in Latin America

Inter-country routing of traffic is very limited in the region due to:

- The US still being the single most popular destination for web visitors.
  - This not only due to the vast amount of content, goods and services available in the US, but also since that country has enormous economies of scale for web hosting facilities[xii].

- Most carriers preferring to buy transit in the US through direct high capacity links for low-latency and higher performance. Fiber capacity is already deployed for telephony, so it is cost effective to use that capacity instead of interconnecting to intermediate backbones of countries in the middle of routes to the US.

[xii] The US is also a preferred destination for site mirroring. A traceroute command from any PC in Mexico to the portal Terra Perú www.terra.pe initially shows a route from Mexico to Peru that uses Miami as intermediate point. After a few seconds, the traffic is redirected to a mirror copy in Miami for faster access.

- In 2000, 39 of the Top 50 routes for Internet traffic in Latin America terminated in the US[39]. Curiously, the second destination was Canada with 5 routes. Only 5 routes had both ends located in Latin American cities and an additional one terminated in Italy.

In general, NAP's are perceived in Latin America as prerequisites to the development of a "true national" Internet infrastructure necessary for the development of local, and regionalized content as well as the development of regional e-commerce. NAP's are considered also as "signs of the maturity of the markets"[40].

Considering the eight hubs that claim NAP status in Brazil, there are at least 17 NAP's or Internet Exchanges in Latin America: Argentina, Colombia, Cuba, Chile, Peru, Panama and Paraguay have one each and Ecuador has two.

The number of private interconnection agreements complementing those NAP's it is unknown due to their confidential nature, still, the case of Mexico is worth mentioning as a country where all national Internet connectivity relies exclusively on private peering.

NAPla

The Communications Ministry and the Informatics and Telecommunications Chamber of Colombia organized NAPla2001 as the first event congregating the entities responsible to plan, deploy and operate NAP's in the region. A second event occurred during 2003 in Buenos Aires Argentina and in 2004, Brazil will be host of the third version of the event.

These events aim to:

- Uniform NAP-related knowledge among participants.
- Define models to deploy additional NAP's.
- Exchange ideas to improve the performance of traffic routing in the region.

Common concerns voiced on the events have been:

- The difficulty to integrate similar initiatives at the regional level while major NSP's are prioritizing the need for direct links to the US.
- The cost of NAP operation as a barrier to entry for new members to existing NAP's.

Argentina[43]

Argentina was one of the first countries in the region to connect to the Internet and one of the first ones that deployed a national NAP (Panama and Chile claim also "first-mover" status).

In 1998 the member companies of Argentina's Database and Online Services Chamber, known as CABASE, decided to form a Network Access Point or NAP to route Argentinean traffic without having to go through the United States.

The CABASE NAP started operations on April 1, 1998 and has worked efficiently for six years. It also has gained a reputation for being a model worthy of adoption in other countries since all ISPs in Argentina (AOL being the notorious exception) participate on the NAP. CABASE was the host of the NAPla2003.

No specific law has been established to mandate interconnection at the NAP and participation is completely voluntary. All ISP's participate on multilateral peering, similar to that of the first years of NAP operations in the US, and are responsible to cover the operations and maintenance costs of the NAP and individual fees are calculated on the basis of physical space use and energy consumption. According to CABASE[44], 95% of all Argentinean users access the Internet through a CABASE member.

At the beginning of 2004, the CABASE NAP became the center of a controversy that threatened the very performance of the Internet in Argentina. The four main ISPs – Impsat, Ciudad Internet (Prima), Advance (Telefonica of Spain) and Telecom – decided unilaterally to reduce the bandwidth they were providing into the NAP. Together the four companies concentrate about 50% of all Argentinean traffic[45]. According to a statement from CABASE[46], their decision was "purely based on business criteria, since they felt harmed by the free exchange of traffic at the NAP."

The measure of the so-called "G4," as the group has been called in the Argentine press, caused severe delays in the response times for many Argentine web sites and required some ISPs to make hasty changes to their networks to "run around" the congested NAP and avoid a degradation of their services.

In response, CABASE has established monitoring and capacity provisioning Service Level Agreements that ISPs needed to comply with in order to avoid penalties and maintain their membership. The Undersecretary of Consumer Rights demanded that the G4 reestablish their previous bandwidth levels into the NAP, decision that has been appealed by the G4 and, since Internet services are not subject to regulation, no enforcement of the recommendation is seen in the near future.

Responses from the other 30 CABASE members have been so far:

- UOL (a prominent ISP in Argentina and Brazil's number 1) has agreed to pay the "G4" for transit services instead of peering at the NAP[48].

- FiberTel, iPlan and Netizen are backing an initiative to formalize intervention from the Argentinean State through a projected resolution by Congress.

It is very likely, if no new regulations are made, that the members of the "G4" will definitively abandon the NAP, enter into private agreements and charge smaller firms for all traffic coursed into their networks. The departure from the centralized model of a single NAP in Buenos Aires, far from being a tragedy, may result in a more organic development of Argentinean infrastructure, where the NAP in Buenos Aires can coexist with new facilities in other cities (from CABASE and/or other entities) a nd of course with private peering links. In this scenario telecom operators will have incentives to extend interconnection beyond Buenos Aires and into other cities (having a NAP or not) whe never it makes technical en economical sense.

Brazil[51]

No regulations exist in the country for backbone interconnection. An effort by Embratel to establish several NAP's across the country was stopped by the privatization process of the whole Brazilian sector.

Being Brazil the largest ITC market in the region, it is not surprise that is the one with a larger number of NAP's and the one with the most diverse schemes of cooperation among NAP participants: some NAP's were built with the academic community in mind[xv], other by non-profit associations of competing operators and others by private companies that see their NAP's as a source for profit.

The relative size of the market and the number of market participants has made possible the deployment of NAP's into cities additional to the economic capital of the country (Sao Paolo).

The Brazilian State, while not intervening with formal regulation, through the creation of the Management Committee for the Internet in Brazil additionally to administer the ".br" domain and IP addresses in the country, has also published technical recommendations for al Internet Traffic Exchange in the country[60]. Recognizing that operators should be the sole responsible to determine who to interconnect with, the aforementioned recommendations establishes as a condition to enter the NAP the NSP's should enter into peering agreements with other NSP's. If for any reason a NSP is unable to establish at least one agreement, it will automatically lose membership to the NAP. Also, the re commendation defines that

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[xv] While strictly, a site like FIX is mostly a hub for a purpose-specific network (more than a point open for any group of NSP's to interconnect their networks), it is still included in the list for its relevance as a complementary effort to route Brazilian traffic domestically.

interconnection could be either bilateral or multilateral, meaning that NSP's do not necessarily have to interconnect with every other NSP.

While Brazil's shares borders with ten countries in the region, its largest Internet network (Embratel's which claims to transport 85% of total Brazilian traffic) has connections only with two MercoSur partners. Uruguay (1Mbps) and Argentina (47.5Mbps)[61] that combined represent less than 1% of the networks' total international bandwidth. Being Brazil the largest market in the region, these numbers show evidence of the actual few traffic flows that exit among countries in the region.

FAPESP - NAP do Brazil[62]

The Academic Network at São Paulo, or ANSP was established on 1989. In June 2001 announced an agreement to interconnect at the Chicago NAP to have access to other research institutions. ANSP is managed by the Fundação de Amparo à Pesquisa do Estado de São Paulo (FAPESP). While ANSP has focused its effort to provide transit services for all participant academic institutions, the NAP function has been reinvigorated through a partnership with regional NAP operator Terremark that is now responsible for its operation.

Even the NAP do Brazil is considered the largest NAP in the region it is worth mentioning that the largest carrier in the country, Embratel, does not participate in it. Reportedly FAPESP, 70% of Brazilian domains are reachable through the NAP. Still that figure does not necessarily mean that the NAP concentrates the same proportion for total intra-Brazil traffic.

Abranet

The Associação Brasileira dos Provedores de Acesso, Serviços e Informações da Rede Internet, was founded on December 1996. Large carriers as Embratel and Telesp/Telefónica are members of Abranet and the Abranet NAP was launched on December 18, 2001 as a voluntary effort from its members.

Telcomp[63]

The Association for Competitive Telecommunications Providers reunites more than 40 operators that offer telecommunications in Brazil, mostly to the business market, and that were not originated from the break-up of former state monopoly Embratel.

PRIX - Parana Internet Exchange

Located in the premises of the Federal University of Parana, the PRIX started operations in June 2002. There are at least 16 networks connecting in both bi-lateral and multilateral agreements.

FIX - Federal Internet Exchange[64]

Established in 2002, this NAP is mostly dedicated to traffic among federal government institutions at the country's political capital: Brazilia. All federal entities can connect at the NAP free of charge with the only technical requirement of previously having a dedicated international transit connection.

RSIX – Rio Grande do Soul Internet Exchange

Based on the premises of the Federal University of Rio Grande do Soul and started operations in 2000. Most of the traffic exchanged at the NAP takes place among academic institutions. While some private NSP's participate (most notoriously Impsat), most private players involved act just as infrastructure providers.

For profit NAP's

Optiglobe launched in 2001 the OptIX LA NAP that currently has 17 members. Diveo launched the DIVEO NAP the same year and has 8 members.

These two NAP's have both "executed a commercial strategy of turning their Internet data centers (IDCs) into NAP's" given the "critical mass of traffic and low barriers to peering at the NAP do Brasil"

Colombia[65]

During 1997 Telecom ("Colombia Telecomunicaciones, SA - the largest Colombian operator and former state-owned monopoly) announced intentions to launch a regional initiative: the NAP from the Andes or "NAP Andino" with the idea to serve as a hub for connectivity with Bolivia, Ecuador, Peru and Venezuela. The initiative, cosponsored with the former Digital Equipment Corporation was targeted for January, 1998 but never materialized.

The local Chamber for IT and Telecom CCIT ("Cámara Colombiana de Informática y Telecomunicaciones") is responsible for the operation of the NAP Colombia, established in 1999 by 12 members. For years, Telecom hesitated to join and finally connected at the beginning of 2004. As of May 2004, 15 operators participate at the NAP.

Apart from the inherent objectives related to connectivity, CCIIT has established as an additional objective of the NAP the provisioning, on non-discriminatory basis, to all members of the NAP to relevant information about traffic volumes, in/out ratios and other performance metrics.

The only technical requirements to participate in the NAP[66] are having an Autonomous System Number and 4 blocks of Class C IP addresses.

All ISP's are responsible to cover admission and monthly fees, which are the same for all participants without regard of traffic volumes or physical space used. According to Carlos Neira of CCIT[67], the current fees make difficult for smaller players to join the NAP and since these fees were referenced to previous higher prices of international connectivity a new pricing scheme is needed. It is expected that CCIT will publish new tariff for NAP fees on July 2004 and that these will include also algorithms to calculate fees based on actual bandwidth cursed on NAP links.

Neira recognizes that the biggest threat to the NAP today is increased affordability of international transit services. While in 1999 the capital and operational expenditure of the NAP was more than compensated with cost savings in international bandwidth, today those benefits are minimal and some NAP participants may choose to simply abandon the project. Even in terms of performance, Neira acknowledges, the gap is also becoming narrower with transit services doing better and approaching the NAP performance.

Cuba

On January 11, 2000 the Law-decree number 204[68] changed the denomination of the Ministry of Communications to Ministry of IT and Communications, making it responsible for all regulations related to Internet Access. Previously, the regulatory duties related to IT were responsibility of the Ministry of Iron and Steel, Mechanics and Electronics Industries.

The Project for Adoption of IT in the Cuban Society[69] considers the Infrastructure, Technology and Tools Program, INFRATECH, as the basis for all of its programs. One of the fundamental objectives of the program is to develop connectivity among "sector-specific networks" and ISP's through a NAP.

The aforementioned "sector-specific" networks are operated by the Cuban State and provide connectivity to the State's central administration and other institutions. Examples are INFOMED for health services, TRANSNET for transportation and TINORED for higher education. The four wireline ISP's operating in the country: CENIAI, INFOCOM, TELEDATOS, COLOMBUS and mobile operator CUBACEL are connected to the NAP as required by Resolution 90/2000.

The Cuban NAP does not only accommodate peering traffic but also serves as an intermediary transit node for all Cuban ISP's. Decree 90/194 establishes that only incumbent telco ETECSA can provide international transit services in Cuba. These two conditions determine the topology of the Cuban Internet as follows:

- ETECSA buys transit services from international NSP's and is responsible for the operation of the NAP.

– All ISP's buy Frame Relay circuits from ETECSA to connect to the NAP and obtain both transit and peering. Prices are established on resolutions by the Ministry (Resolution 160 / 2001, established differentiated pricing for *international* –transit- and *national* –peering- traffic).
– All ISP's buy local access loops from ETECSA to connect Cuban entities to the Internet.
– According to the Rules of Value-Added Public Telecommunication Services, ISP's should inform ETECSA during the second quarter of the year of all their infrastructure requirements for the following twelve months.

Chile

NAP Chile SA was established on 1997[70] as an initiative of independent ISP's. The rules of the NAP require all participants to have international connections and provide access services to end-users.

On October 22, 1999, the Undersecretary of Telecommunications of the Ministry of Telecommunications and Transport issued resolution number 1,483[71], establishing that

- Prior to offering services, ISPs should establish interconnections among themselves with the intention to transport national Internet traffic (no specific requirement is made for interconnection to necessarily occur at the NAP, and actually one ISP's do no participate in it)
- ISPs could establish other interconnection (apart from the NAP) topologies as long as authorized transmission media is used to transport national communications.

While assuring that most NSP's interconnect to each other for efficient routing national traffic, the Chilean State has refused to monopolize the architecture[xvi] of the Internet giving room to market participants to develop private peering points or 3rd party NAP's. Transparent performance metrics of the NAP were possible later when Technical Norm number 698[72] appeared of June 30th, 2000, requiring the NAP operators to publish detailed and specific performance metrics of their links (usage, latency and packet loss) on a website.

As reported on a presentation of the technical manager of NAP Chile, of the 26 participants of NAP Chile, 6 are NSP's (AT&T, Equant, Telefónica, IMPSAT, Entel and Chilesat) and the other 20 are pure ISP's.

Ecuador

The Asociación Ecuatoriana de Proveedores de Valor Agregado de Internet (AEPROVI) is responsable for the operation of the NAP Ecuador. The agreement for the establishment of the NAP was made on June 4, 2001[73]. The regulator, CONATEL, doesn't have jurisdiction regarding the rules nor the operation of the NAP but signed the agreement as guest of honor.

Ecuador[74] is may be the only example in the region where geographic diversity was considered from the beginning of the NAP operation. Seven operators interconnect in the capital city Quito and six of them also participate in the Guayaquil node.

NAP participants pay a fixed entry fee of $1,000USD and monthly fees according to NAP bandwidth used: from $100USD for 512Kbps to $400USD for an E1.

Mexico[75]

Several geographical and economical factors make the US-Mexico one of the busiest telephony routes in the world and this has provided large economies of scale that, combined with the opening of the telecom sector in 1996, have made economically viable the deployment of high-speed fiber optics in Mexico. Even with those natural advantages that made possible for the country to be the first one in the region that connected to the Internet[76], Mexico has a lower penetration of Internet services when compared to other countries in the region as Argentina, Brazil or Chile.

In 2001 the Secretary of Communications and Transport of Mexico published its Sector Plan[77] for the 2001-2006 period with an emphasis on extending the reach and quality of government services by providing Internet access in rural areas. The e-México project also considered "the construction of a NAP that will allow the exchange of data traffic among operators, making access to the contents of the e-Mexico System more efficient".

While the first phase of the e-Mexico project was launched on June 5, 2003, no follow-up announcement has been made on the NAP and no attempts for establishing formal regulations on the subject on Internet backbone interconnection have been made. Given the narrow scope of the NAP announcement, the industry has not shown much interest in the project (except for small data center operators aspiring to bid for the contract).

More relevant to the attempt of the e-Mexico NAP is the fact that the three largest backbone operators (Alestra, Avantel, Telmex) and one of the largest ISP's (Terra) already have private peering arrangements in place since the year 2000, typically these agreements consider high-seed links (STM-1 - 155Mbps) and geographic diversity through interconnection in the two biggest cities: Mexico City and Monterrey.

During NAPla2003, the President of the Internet's Mexican Association suggested that 50% of the traffic was intra-Mexico. While the three largest operators have an aggregated international bandwidth of about 4Gbps, peering links do not exceed 1Gbps. Considering that private peering links among carriers are deployed using existing fiber infrastructure, so their deployment does not represent any incremental cost, their installed capacity is typically far more than required. It is fari to assume that the real proportion of intra Mexico traffic is far below the proposed 50% figure.

Panama[78]

With funding of the OAS, the Panamanian Ministry of Science, Technology and Innovation (SENACYT – Secretaría Nacional de Ciencia Tecnología e Innovación) initiated work to interconnect five local ISP's through INTERRED. No regulatory requirement exists for other ISP's to interconnect to INTERRED and some NSP's/ISP's have proffered not to do so.

Paraguay[79]

Paraguay was first connected to the Internet in 1996 and since then connectivity has been mostly based on expensive satellite links.

As of March 2004[80], 44 companies had a license from the local regulator, CONATEL, to offer Internet services through their own infrastructure or by leasing capacity from other operators. The Internet Paraguayan Chamber (CAPADI – Cámara Paraguaya de Internet) was formed in 1997 by 14 of 44 the aforementioned companies with the aim to balance the power of ANTELCO, the state-owned operator and effectively blocking the company to enter the Internet access market. As a natural market response to the economic conditions for operators, private interconnections appeared since 1998 precluding the formal integration of operational and technical norms for the NAP in 2001.

CAPADI claims that by 2002, 90% of all active Paraguayan ISP's were members of the NAP. The long term goal of CAPADI is to integrate a fiber optics ring between the MercoSur countries (Argentina, Brasil, Uruguay and Paraguay) and, in general, avoid reliance on satellite for international connectivity. Connections to the NAP vary from 1 to 45 Mbps, with plans to move all participants' links to 100 Mbps speeds. Half of the companies connect through fiber and the other half through microwave links.

In parallel to CAPADI's efforts, Project Arandu focuses on an academic network to interconnect to other peers as the Internet 2 project.

Peru [81] [82] [83]

On February 2000 during the event "Internet: Agenda Pendiente", it was announced that telecom operators in Peru started talks toward the establishment of a NAP. On August 2000 the Acta de Constitución of NAP Peru was signed and operations started on May 10, 2001. The NAP is located at the premises of the American Chamber of Commerce[84] and it is administered by the Institute of Research and Training on Telecommunications (INICTEL – Instituto de Investigación y Capacitación en Telecomunicaciones).

A Board of Directors of the NAP is integrated by founding members AT&T, BellSouth, Comsat, Telefonica Data and Infoductos. A technical and a legal committee are also responsible to oversee operations.

All interesting participants should have international connections, their own Autonomous System Number, an IP addresses and should pay entry and monthly fees. All members pay the same fees without regard of traffic volumes or physical space used.

An additional bandwidth requirement has reportedly blocked smaller ISP's to participate in the NAP. Since the NAP has also reported congestions [85], the continuous need for additional investments is raising the bar higher for potential new entrants.

Venezuela

In 2001, and inspired by its participation at NAPla 2001 the Chamber of Telecommunications Services (CASETEL - Cámara de Empresas de Servicios de Telecomunicaciones) and the Chamber of e-Commerce (Cavecom-e - Cámara Venezolana de Comercio Electrónico) proposed the project to create a NAP in Venezuela [86] in coordination with Venezuelan regulator CONATEL.

The Telecommunications Law of 2000 [87] considers the creation of the Universal Service Fund as well as the Telecommunications Research and Development Fund. Funding from the latter has been approved to integrate a NAP in Venezuela.

In August 5, 2003 Hernando Soto [88], Director of the Chamber of the IT Industry (CAVEDATOS - Cámara Venezolana de Empresas de Tecnologías de Información) and 8 other industry chambers determined to reject the initial NAP Venezuela project arguing that applications and content providers should be included in it. The project was postponed and negotiations among chambers are in progress toward a unified project.

It will be of great interest to analyze the development of those negotiations and the actual deployment and development of the NAP. This would be the first case of a NAP in the region where all content providers are potentially going to be treated as “peers” of NSP’s. While the risks of forcing interconnection of smaller NSP’s to larger networks has been exposed on the second section of this article, the risks of granting peer status to parties with no network at all could be harmful for the competitive environment of the country.

Conclusions

As Latin American Internet markets grew at the end of the 1990’s, exchanging traffic among local providers without using US infrastructure was a top priority for improved cost structures and technical efficiencies for all involved providers.

Fearing monopolization of critical infrastructure by incumbent Telcos, competitive providers in most countries were quick to build consensus and, within the institutional framework of industry chambers, established public peering facilities or NAP’s. On the other hand, some authors[89] say that Telco-operated NAP’s “fail to achieve its goals of providing neutral interconnection facilities while unilaterally imposing conditions and prices”. This last claim can be totally dismissed as based on pure fiction. The original NAP’s in the US are operated by either former Bell companies or established long distance carriers and none of these companies could exert unfair practices on other participants.

Several countries have been able to involve almost all players in multilateral agreements that resemble the operating scheme of US NAP’s during the first years of the commercial Internet, some did from the beginning as Argentina, Chile and Peru and others did gradually as Colombia.

The literature on the subject is not conclusive in the outcomes of keeping interconnection agreements unregulated, especially on how this condition would create incentives for larger players to degrade interconnection quality with smaller peers. Still, empirical evidence clearly shows that while most operators accept multilateral peering agreements when the market is being born, they eventually develop selection criteria to limit their number of peering partners as the cases of MCI and UUNet around 1997 and recently the “G4” in Argentina show. It is expected for this trend to continue as Internet services represent an even larger share of total operator revenue, related trade practices are more carefully drafted and their impact on the business are more thoroughly assessed.

As these events become more common in Latin America, regulators could take two courses for action:

1. Maintaining the current state of affairs, allowing operators to decide which networks to interconnect with, either on NAP's or private peering points, based purely on technical and economical criteria and thus developing an organic and flexible Internet architecture.
2. Forcing large players to interconnect with smaller peers on a settlement-free scheme, creating a long-term unviable market where operators actually subsidize smaller competitors due to the technical intricacies of Internet interconnection (the "hot potato" routing algorithm).

The recommended option of allowing operators to choose their peers may eventually lead to a diminished relevancy of NAP's. In an unregulated environment with increasing bandwidth capacity and decreasing prices, it will become less important (from both the speed and the price angles) where Internet traffic is physically exchanged. Regulators should stay away of giving NAP's artificial life if they stop making economic and technical sense. Of course they did at the moment of their creation and it's possible that most of them still do, but in the long term, NAP's won't certainly be the only option available for peering.

A third course of action would consider establishing a settlement model where smaller players pay only for the difference on mutual use of each other's providers networks. While potentially the most beneficial option, the model does not seem viable as long as no trusted and standardized mechanisms to measure IP traffic flows exist and, moreover, there are little economic incentives for their development since flat fees are the norm for retail prices of Internet services.

Still, the pursuit towards settlement models for backbone interconnection may get a boost from the industry's renewed attempt to establish differentiated pricing based on the quality of service provided to different kinds of traffic. The final outcome on pricing for IP services is still uncertain and subject to a complex set of variables analyzed on this working paper: if communications will be more valued by the user than broadcasted content, if in general the trend to differentiated prices will be overshadowed by the general decline on telecommunications prices or if metered billing will be eventually mandatory due to regulatory requirements. However the outcome, it is expected that serious development efforts will be devoted to precisely meter IP traffic flows.

The impact of a settlement model being possible, however, it will be greater on the international arena. Developing countries in general would achieve greater cost efficiencies if reaching agreements where NSP's pay only for the net use of other networks and a very important portion of the arguments against this are based precisely on the impossibility to characterize IP traffic flows. While some informal attempts have been made for regional NAPs for the exchange of traffic among countries, the evidence of Brazil shows that actual inter-country traffic is minimal and any attempt to improve the conditions of NSP's in th region and the overall market, should focus on the market for international transit rates mostly to the US.

Some arguments expressed as a defense of the current model at international forums are by themselves valid (buying operators in other regions, fiber swaps on international routes) but most of them have as a prerequisite the existence of large economies of scale that are still not possible to achieve in Latin American markets.

From now on, regulators in Latin America should put special attention on the development of backbone connectivity and consider the requirement for operators to inform about volume of traffic coursed over interconnection links as formal regulation geared towards identifying trends on both national and international traffic. As soon as new developments for IP traffic metering arise, those regulations should be updated in order to obtain more detailed information and eventually develop and promote international policies that could be beneficial for the development of Internet infrastructure in the region.

References

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[1] ST. ARNAUD'S, Bill. Network World, Nov 1997. The future of the Internet is not multimedia. Available at http://www.canarie.ca/~bstarn/future_internet.html

[3] ODLYZKO, Andrew. Content is not king. Revised version: January 3, 2000. Available at http://www.dtc.umn.edui/~odlyzko

[4] KATZ, M.L.; SHAPIRO C. (1985), "Network Externalities, Competition and Compatibility" in *American Economic Review 75;* pp. 424-440.

[7] SALTZER, J.H., REED, D.P., and CLARK, D.D. M.I.T. Laboratory for Computer Science. Available at http://www.reed.com/Papers/EndtoEnd.html

[8] ODLYZKO, Andrew. Pricing and architecture of the Internet: Historical perspectives from Telecommunications and Transportation. Revised version, January 3, 2000. Available at http://www.dtc.umn.edui/~odlyzko

[9] ODLYZKO, Andrew. The history of communications and its implications for the Internet. Revised version. January 3, 2000. Available at http://www.dtc.umn.edui/~odlyzko

[10] CARR, Nicholas G. "Does IT Matter? Information Technology and the Corrosion of Competitive Advantage". Harvard Business School Press; April 2004.

[11] BEST, Jo. Gates reveals his 'magic solution' to spam. January 26, 2004. Declarations attributed to Bill Gates. Available at: http://news.com.com/2100-1028_3-5147491.html

[12] TOMÁS, Joaquín. Cómo combatir el spam; no lo proscriba, cóbrelo. November 7th, 2003. Available at http://infochannel.com.mx/busqueda.asp?id_nota=6467&seccion=buscador

[13] NAIL, Jim; with CHARRON, ANDERSON and BAXTER. The Real Answer to the Spam Problem. Forrester Research. Techstrategy Brief: December 10, 2003. Available at http://www.forrester.com/ER/Research/Brief/Excerpt/0,1317,33324,00.html

[14] LUCAS, Jerry (2004): "Revenue Assurance, IP Services and the Laws of Physics". Billing World and OSS Today. April 2004.
Available at: http://www.billingworld.com/archive-detail.cfm?archiveId=7468&hl=ip%3Aphysics

[15] CERF, Vint, KAHN, Robert (1999) "What Is The Internet (And What Makes It Work)" http://global.mci.com/us/enterprise/insight/cerfs_up/internet_history/whatIs.xml

[16] HALABI, Bassam: Internet Routing Architectures. CISCO Press. 1997. pp 6-13.

[17] MCI: MAE Internet Exchange Facilities. Available at: http://www.mae.net/fac/

[18] INTERMEDIA COMMUNICATIONS (1998). "Peering White Paper". Available at: http://www.intermedia.com/products/businessinternet/whitepapers/bis-peering.html

[19] KENDE, Michael; OXMAN, Jason (1999): "The Information Interchange: Interconnection on the Internet", page 10.
[20] LAFFONT, MARCUS, REY, TIROLE (2001), "Internet Peering" in *American Economic Review 91(2)*, May 2001, "Interconnection and Access in Telecom and the Internet" pp. 287-291.
[21] CONSTANTIOU, Ioanna D; COURCOUBETIS, Costas A. (2001),"Information asymmetry Models in the Internet Connectivity Market"
[23] SPETA, James B. (2002) "A Common Carrier Approach to Internet Interconnection" in *Federal Communications Law Jounal*. Vol 54, pp. 225-280.
[24] KENDE (2000), "The Digital Handshake: Connecting Internet backbones". *Office of Plans and Policy, Federal Communications Commission*. OPP Working Paper No. 32. Washington DC.
[25] CREMER, Jacques; REY, Patrick; TIROLE, Jean. (2000), "Connectivity in the Commercial Internet" in *The Journal of Industrial Economics*. December, Vol. 48; pp. 433-472.
[26] Idem 4.
[27] Idem 25
[28] Idem 20
[29] LITTLE, Ian; WRIGHT, Julian (1999). Pricing and settlement in the Internet: An economic analysis. September 1999.
[30] Idem 27
[31] COGENT: Cogent Peering Strategy. Available at http://www.cogent-sp.com/peering.html
[32] HOLGADO, Gabriel: Global Crossing. Presentation during NAPLA2003. Available at http://www.napla2003.com.ar/presentaciones/NAPLA2003_GlobalCrossing.ppt
[33] OEDC. "Internet Traffic Exchange and the Development of End-To-End International Traffic Telecommunication Competition". Working Party on Telecommunications and Information Service Providers March 13, 2002. Available at www.oecd.org/dataoecd/47/20/2074136.pdf
[34] APEC. The Fourth APEC Ministerial Meeting of the Telecommunications and Information Industry (TELMIN4) *Press Conference.*
[35] APEC, *Cancun Declaration*, May 24-26, 2000 at Annex B.
[36] ITU. Study Group 3. "Final Report for Internet Rapporteurs Group," COM 3-77-E, October 1999, a report adopted by the Study Group in December 1999.
[37] APEC. *Cancun Declaration*, May 24-26, Annex A, APEC Telecommunications Working Group (TEL), *Programme of Action*,
[39] TELEGEOGRAPHY. Global Internet Geography Database & Report 2000.
[40] CAVALLI, CROM, KIJAK. "Desarrollo de NAPs en Sudamérica"Atlantic Consulting. IDCR. ICA. Abril 2003.
[43] Idem 43.
[44] BELLAGAMBA, Sebastián – Remarks during NAPla2003 – August 21, 2003 – http://www.ebizlatam.com/newsletter/2003/letter-3-34.html
[45] LA NACIÓN – Economía – "Internet crece, pero afronta dificultades regulatorias" – May 17, 2004
[46] CABASE – Press Release – Abril 12, 2004 - http://www.cabase.org.ar/cabase.asp?sys=CABASE&xid=root/nappressrelease1&ssn=0YZGHCZ2DSAS3380632118
[48] CASTIGLIONI, David: Director of Business Development and Marketing of UOL Argentina http://www.pergaminovirtual.com.ar/revista/cgi-bin/hoy/archivos/00000546.shtml
[51] GROJSGOLD, Alexandre L. Presentation of RNP at NAPLA2003. August 21th, 2003. Available at http://www.napla2003.com.ar/presentaciones/NAPLA2003_Brasil.ppt
[60] COMITE GESTOR DA INTERNET NO BRASIL. "Operação e Administração de PTTs no Brasil**".** Available at: http://www.cg.org.br/grupo/operacao_ptt_v1.1.htm
[61] EMBRATEL. Topologia Backbone IP. Available at: http://www.embratel.com.br/Embratel02/cda/portal/0,2997,MG_P_951,00.html
[62] SMITH, Grant. THE YANKEE GROUP. The Missing Link: Latin America's Network Access Points REPORT Vol. 2, No. 12—July 2001.
[63] TELCOMP. http://www.telcomp.org.br
[64] PONTO FEDERAL DE INTECONEXAO DE REDES. Available at: http://www.fix.org.br/principios.html
[65] NAP COLOMBIA. http://www.nap.com.co

[66] CÁMARA COLOMBIANA DE INFORMÁTICA Y TELECOMUNICACIONES . Requisitos de Afiliación. Available at: http://www.ccit.org.co/pages/html/nap/nap.asp#requisitos

[67] NEIRA, Carlos. Interviewed specifically for this working paper. May, 2004.

[68] MINISTERIO DE LA INFORMÁTICA Y LAS COMUNICACIONES. Resolución No. 90/2000. Available at: http://www.cubagob.cu/des_eco/mic/docs/r090-00.htm

[69] CUBAN DELEGATION – Situación Actual y Perspectivas del Comercio Electrónico En Cuba ALADI's (Association for the Integration of Latin America), State of e-commerce in LatinAmerica Workshop. Montevideo Uruguay, June 2001. Available at: http://www.aladi.org/nsfaladi/reuniones.nsf/0/4ea21444af6077b103256a790050e7ad/$FILE/cuba.doc

[70] NAP CHILE. "Acerca de NAP Chile". Available at: http://www.nap.cl/acerca.html

[71] REPÚBLICA DE CHILE. Ministerio de Transportes y Telecomunicaciones . Subsecretaría de Telecomunicaciones. REF. FIJA PROCEDIMIENTO Y PLAZO PARA ESTABLECER Y ACEPTAR CONEXIONES ENTRE ISP. RESOLUCIÓN EXENTA N° 1483. Santiago, October 22, 1999.

[72] NAP CHILE. Condiciones Técnicas Para La Conexión. Available at http://pit.nap.cl/ctecnicas.html

[73] AEPROVI. Presentation of NAP Ecuador at NAPLA2003. Available at http://www.napla2003.com.ar/presentaciones/NAPLA2003_Ecuador_Aeprovi.ppt

[74] NAP Ecuador. Monitoreo. Available at: http://216.219.14.8/

[75] SILVA, Carlos. Un NAP Mexicano, ¿indispensable para el cierre de la brecha digital?. CIDE Telecommunications Consortium Working Paper.

[76] CAHAHN, Saúl – OAS – SIGCOMM - Presentation for the Workshop on Data Communications in Latin America and the Caribbean – San José Costa Rica, April 2001 – www.redhucyt.oas.org/presentationsSH/presentationCRMarch01.pdf

[77] SCT - Programa Sectorial 2001-2006. Chapter 7, Section 7.2 "Oportunidades y retos". Available at: http://www.sct.gob.mx/prog_sectorial_01_06/pg_capitulo7.html

[78] BUSH, MEYER. "The First Neutral Exchange in ALyC". Available at: https://rip.psg.com/~randy/970810.intered/sld001.htm

[79] Idem 40.

[80] AMARILLA, Gustavo O – "Reporte del estado actual de la red nacional y académica del Paraguay" March 18, 2004 – http://nsrc.org/STHAM/PY/estado-redes-PY.pdf

[81] NAP PERU. Historia. Available at http://www.nap.pe/histo.html

[82] Idem 40

[83] Idem 62.

[84] Ibid.

[85] NAP PERU. Presentation of NAP Peru at NAPLA2003. Available at http://www.napla2003.com.ar/presentaciones/NAPLA2003_Peru.ppt

[86] CAVECOM NAP. Available at: http://www.cavecom-e.org.ve/bin_cavecome/main/templates/seccion.asp?seccID=78

[87] RODRIGUEZ, Rolando. Presentation of CASETEL's NAP Comission. Available at: http://www.napla2003.com.ar/presentaciones/NAPLA2003_Venezuela_Casetel.ppt

[88] As quoted by the newsletter: "Hoy en Telecomunicaciones" August 6, 2003. Published by La decisión acertada, Mexico City.

[89] Ibid.