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Evolution of Network Access Points (NAPs) and agreements among Internet Service Providers (ISPs) in South America

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PALABRAS CLAVE

Puntos de intercambio de tráfico Internet, acuerdos de interconexión.

RESUMEN Este artículo presenta los aspectos principales del desarrollo histórico y de asuntos actuales en el mercado suramericano de acceso a Internet: los acuerdos de interconexión para el intercambio de tráfico local y regional en Suramérica, los incentivos que tienen los proveedores de acceso a Internet para mantener o modificar la naturaleza de los acuerdos y los métodos de recuperación de costos en los puntos de intercambio de tráfico. El artículo también identifica algunas amenazas a la estabilidad de los puntos de intercambio de tráfico y las ilustra con dos casos.

KEYWORDS

Internet traffic exchange points, Interconnection agreements.

ABSTRACT This paper presents the main aspects of the historical development and the current issues at stake in the South American Internet access market: the interconnection schemes for the exchange of local and regional traffic in the South American region, the incentives Internet access providers have for keeping or modifying the nature of the agreements, and the cost recovery methods at the traffic exchange points. Some threats to the stability of the scheme for domestic traffic exchange adopted throughout the region are also identified and subsequently illustrated with country-cases.

1. INTRODUCTION

Internet is a system of autonomous interconnected networks, known as Autonomous Systems (AS). Routing and a robust system of addresses bind these networks together in spite of their independent pricing policies and service definitions. The dominant feature of Internet has been its hierarchical organization. Nevertheless, its impressive growth and the existence of a myriad of local and regional providers of access to Internet, also known as Internet Service Providers (ISPs), have resulted on a less hierarchical structure. Routing has become less hierarchical as well with the definition of BGP4 (Border Gateway Protocol Version 4), the core routing protocol of the Internet. BGP provides routing table maintenance, which allows reachability between AS.

Secondary peering or the ability of ISPs to exchange their local and regional traffic with other ISPs, multi-homing or the ISPs practice of being a customer to multiple backbones and some examples of non-customer transit contracts are clear instances of disruptions of the hierarchical organization. The result of improved addressing and routing protocols is the decrease in the market power traditionally exerted by core ISPs and the greater flexibility for small ISPs to enter into interconnection agreements with other ISPs therefore bypassing the core ISPs.

Since the late 1990s several ISPs in different South American countries decided to rely on a local traffic exchange point instead of having their traffic routed through the large ISPs routers and gateways in the U.S. The result has been a reduction in costs for all ISPs; such reduction has attracted new ISPs to the market and, therefore, to the exchange. The less developed ISP markets in South America reveal a profound contrast with its North American counterparts and some important characteristics are worthwhile analyzing. To benefit from lower costs and better response times the South American Internet Service Providers have chosen to locally conform Network Access Points (NAPs). The exchange of traffic whose source and destination are located within a country is achieved at national NAPs, of which there is usually one in each country, with the exception of Brazil. The NAPs are cooperative agreements whose financial sustainability depends on a flat-fee tariff structure in some NAPs or a capacity fee in the rest.

The structure of the paper is as follows: in section 2 reviews the main features of interconnection agreements among ISPs; in section 3 a short overview of the historical development of NAPs in South America is presented; in section 4 futures trends and current issues in the access market are identified. Section 5 is an appendix summarising some of the most important facts about NAPs in selected countries.

2. INTERCONNECTION AGREEMENTS AMONG INTERNET SERVICE PROVIDERS

The use of exchange points or NAPs to exchange local traffic, and the existence of agreements - mainly transit agreements - for outgoing international traffic, characterize the agreements among ISPs. The framework of such exchange agreements is the country in which such companies operate; but most of the international regional traffic has to be routed through backbones in the United States, at considerable costs due to the use of bandwidth in intercontinental networks.

The two most significant agreements are peering contracts and customer contracts. Peering agreements are interconnection contracts between ISPs. Under a peering agreement an ISP accepts traffic destined to its customers and does not accept transit

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traffic destined to another ISP´s customers. Peering usually implies no charges between ISPs, therefore ISPs do not charge each other for traffic being delivered into the other's network. A peering contract involves address advertising, settlements and peer monitoring of interconnection features.

In a customer contract, also called transit agreement, an ISP, seeking to get its customers connected to the rest of the Internet, buys access from a usually larger ISP, which in turn accepts and routes all the traffic originated from and destined to the former. This type of agreement requires a payment, set forth when negotiating interconnection [1].

These two types of agreements help to consolidate the hierarchical structure observed in the Internet. Less complex routing tables, a limitation on routing arbitrage, the reduction in connection costs and an improvement in the accountability of providers quality of service are usually listed as the benefits of the hierarchical structure.

Under a peering agreement two similar ISPs exchange traffic originated in one but destined to the other. To be eligible for this type of agreement, ISPs must share similar characteristics, so the volume to be exchanged must be fairly equal in terms of volume and type. Therefore, costs derived from packet transportation from one ISP to the other are compensated by traffic costs flowing in the other direction [1]. Under peering agreements ISPs are connected at several geographical locations. In order to route traffic between two ISPs engaged in this type of agreement, a technique known as Hot Potato Routing is used, whereby traffic goes to the other network as soon as possible. That means that if ISP1 and ISP2 have a peering agreement a packet travelling from ISP1 to ISP2 will leave ISP1 in the geographical location closer to its original location [2]. By means of this type of agreement, and in order to be able to communicate with all network users, there should be a connection with every ISP in the market.

3. THE ORIGIN OF EXCHANGE POINTS

The origin of Internet traffic exchange points may be traced back to the points built up in the United States at the beginning of the 90s. As regional Internet traffic increased everywhere, similar schemes were adopted. In fact, the exchange system among few Internet Service Provider (ISPs) was ineffective, as in many cases - before local exchange points were set up - traffic would travel thousand miles, although its recipient was a few kilometres away. The use of international channels was then an effective exchange method at global level, but proved to be inefficient [3]. More regional Network Access Points (NAP) were therefore created, as well as exchange policies, like peering and transit agreements.

South American countries have adopted the English denomination NAP, although Internet Exchange Points are also called IXP. To optimize Internet traffic exchange, ISPs have chosen cooperative NAP as a strategy in South America. Unlike North American practice, these NAPs are connected to ISPs under a cooperative frame, i.e., participating ISPs jointly designate NAP administrative bodies, and are entitled to the same decision-making rights in board meetings. In North America NAP are usually owned by one company which renders the interconnection service to ISPs and other telecommunication companies.

NAPs were born without government intervention and both its operation and functioning have not been controlled by regulatory bodies. In two South American countries NAPs have been created somehow differently: in Chile, for example, regulation played an important role constraining large ISPs to make local interconnections for Chilean Internet traffic exchange [10], [11]; and in Venezuela, the government itself has promoted the constitution of a NAP [4].

Thanks to those exchange points, ISPs have lowered their operational costs and improve network functioning, thus offering better services to their clients. Such points have been used to exchange only domestic traffic because none has been used to

route international traffic, which may be explained because other ISPs are in the business of providing international transport [5].

As of today, there has been no regulatory intervention in the Internet access market with the exception of the Chilean market where the Chilean Department of Transportation and Telecommunications, through its Telecommunications Sub Secretariat, has regulated the interconnection between ISPs. The Secretariat must guarantee, among other things, the efficient use of resources, and the users' non-discriminatory access to contents, independently from network access providers. In turn, every content provider must be free to choose its hosting provider. The regulatory norms constrain ISPs to establish and accept connections among themselves to send domestic traffic. Established connections should guarantee quality access to users, equivalent not only to their own ISP, but also to the ISP from which interconnection was requested. Regulation allows also the establishment of traffic exchange points for domestic traffic. The Secretariat controls also network functioning by keeping quality indicators for each ISP. These indicators include: number of users, number of content providers, rate of packets lost, delay levels in data delivery (latency), and levels of link occupation, published in a common web page. Another case involving government intervention is Venezuela. In Venezuela, NAP set up was promoted by Casetel (Chamber of Telecommunications), Conatel (National Telecommunications Regulatory Commission) and the Venezuelan Chamber of Electronic Commerce. The NAP is a result of Conatel´s institutional mission to promote Internet deployment in the country.

The peering agreements at NAPs exhibit contradictory features that may render the exchanges unstable; currently, many peering agreements are being held between ISPs that exhibit disproportionate differences, a fact that is the opposite to the set of conditions peering agreements are based on. On the other hand, the flat-fee pricing structure and even capacity-based prices for cost recovery at NAPs seem to give wrong incentives to the participants; it is possible that NAP development is being slowed down because ISPs aggregate traffic before reaching the exchange in spite of the fact that a NAP has spare capacity to get new ISPs connected. More ISPs connected means more benefits to the existing multilateral agreement as long as equipment and facility capacity is timely updated.

The appendix (section 5) is a historical summary of the evolution of NAPs in some South American countries. Appendix reviews the origins of NAPs, some relevant figures and, specially, the features of the financial agreement that support the commercial viability of NAPs.

4. CURRENT ISSUES AND FUTURE TRENDS

The competitive access environment characterized by the uneven relative sizes of ISPs, who cooperate for the exchange of domestic traffic, is prone to unilateral actions by individual or associated member ISPs that may threaten the very existence of the NAP [6]. Two cases illustrate the actual and potential menaces pending over the future operation of NAPs.

In 2004 four members[1] decided to unilaterally reduce their input capacity to the link. NAP cooperative spirit led the organization to put aside any regards for Service Level Agreements (SLA). When the four members downgraded their connections the NAP administration could not resort to any punishing action against those ISPs. This situation led to a chaotic state of the Internet traffic interconnection

1 Advance Grupo Telefonica, Impsat, Prima-Grupo Clarin y Telecom Argentina

in Argentina. Other members had the obligation of advertising routes while the four ISPs had reduced their capacity. The latter meant the *de facto* creation of two networks in Argentina. Because of the reduction in capacity the subscribers of the remaining ISPs could not "see" addresses belonging to any of the four ISPs. As a consequence, any connection between these two subnetworks was only possible by using international links.

Cabase did not foresee the consequences of not having any type of SLA [7]. The 4 ISPs sought to be economically compensated by the rest of the ISPs connected to NAP Cabase. Both sides argued about the importance of their own traffic in the Argentinian context. If one side demanded compensation, the other side believed they should also be granted compensation. As a result the four ISPs decided to disconnect themselves from NAP Cabase. In fact what the ISPs were after was a change in the nature of the interconnection agreements, from peering agreements to transit agreements or perhaps paid peering agreements.

Cabase did not back off and kept its old scheme: all agreements must be peering agreements and the operation of the exchange must be based on cooperation. As a consequence it is now less expensive to buy international links to "see" the 4 ISPs´ addresses than buying capacity directly from them in Argentina. Perhaps the action by the 4 ISPs may be motivated by the growth of VoIP services [7]. The 4 ISPs argued, anyway, that they had put in the largest part of the initial investment and they demanded compensation for that.

Argentinian Internet traffic exchange or interconnection is covered by regulatory acts. In spite of being its regulatory obligation, *Secretaría de Comunicaciones* did not respond Cabase´s petition in which intervention was demanded [7].

Traffic imbalance has been observed in other NAPs. An illustration of this is presented in [8], which reports one-to-one total exchanged traffic at NAP Colombia. One ISP exchanges more than 50% of the traffic that goes through the NAP. Traffic imbalance may impact the notion of fairness member ISPs may perceive from the financial contract that binds them to the NAP. The original tariff scheme for each ISP was calculated on monthly operational costs, and equally divided among all ISPs. But it did not fairly reflect traffic variations from one ISP to the others, so NAP administration introduced an alternative scheme. According to this new scheme monthly costs, when 70% is incurred, are equally divided among all ISPs; the remaining 30% is estimated by traffic measurements, and proportionally assigned to each ISP's total traffic. Its application required the design of a new system that measures traffic sent in by each ISP every 10 minutes [9].

At regional meetings of South American administrators, NAP representatives have begun discussions on the future existence of a regional NAP. One of the purposes of such exchange point is to gain bargaining power when establishing traffic exchange or contracting bandwidth with a network like the one managed by US large IBPs. The billing agreements, so far existing between North American backbones and South American ISPs illustrate the foregoing. Most of these providers don't have peering agreements with backbones, and therefore must assume all or almost all the exchange costs. A data center created in South America may act as a hub for regional traffic. This scheme would allow Latin American operators to have greater bargaining power with IBPs. This power could grow to the point of conforming an exchange point that could make a peering agreement with one of the backbones, benefiting South American ISPs. This group negotiation could be one of the goals to be reached by smaller ISPs. So, one hub becomes an attractive alternative to develop new tendencies in the Internet market. Since Internet, as it is well known, tend to develop free of frontiers, regulation, if deemed appropriate, should promote the increase of traffic and users.

One of the factors preventing the execution of

such project is the existence of different levels of Internet development in South America. Countries with a more developed Internet access market acquire international traffic at lower costs than less developed countries. It is the case, for example, of Argentina, Chile and Brazil, where this service may be contracted at amounts between US$350/Mbps and US$700/Mbps.

Therefore, there is not an evident economic benefit from using one common connection point at equal cost for all members, because it could be - in some cases- higher than the current price, with no important improvement in service quality. Consequently, Internet providers prefer to maintain their own international connections, aware that international exchange costs tend to decrease, due to the fact that existing network and infrastructure with international connection capacity towards the United States has not been fully used yet [5].

Another way to strengthen the ties between the South American countries is the possibility of NAP interconnection discussed at the NAP regional meetings. The most important element for this idea to succeed is the will NAP Cabase and NAP Chile may have for initiating a direct connection between the two countries. NAP Chile members have agreed to run some trial period with NAP Cabase. The exchange of traffic will be among networks with a regional prefix, which must be IP addresses in the two countries. Strategic and technical reasons are exhibited to justify such connection despite the traffic level may not yet justify the economics of the interconnection.

5. APPENDIX

5.1 NAP CABASE ARGENTINA

NAP Cabase Argentina began operations on April 1, 1998, with 12 founder members; currently it has 41 [7]. This NAP was created by the Cámara Argentina de Bases de Datos y Servicios en Línea, Cabase (Argentinean Chamber of Data Base and On-line Services), as a non-profit body which gathers Argentinean telecommunication companies, and on-line and Internet service providers. NAP Cabase was created without government intervention, and with a large participation of small ISPs. Cabase contracted with Comsat Argentina the tasks of NAP operation, but its operation and management are still Cabase's responsibility. The existence of this NAP has brought most convenient operational costs for ISPs, and improvement of quality of service for users.

NAP Cabse was created when Argentinean communication authorities opened the country to international traffic. Data access and e-mail companies (whose clients were mainly companies) operated with a X.25 network. From the moment of migration to Internet Protocol (IP) and the arrival of Internet, Argentinean regulations allowed access from these companies to Telintar, the only company that could operate data with international connection; but Telintar did not allow local connection. Three Argentinean ISPs decided then to joint efforts to interconnect themselves, solving the local connection issue. Before that, one ISP had to pay an expensive international access to communicate with other ISPs at local level.

There is no private agreements between two ISPs at the NAP. Routing addresses are publicly advertised for all members. NAP Cabase adheres to an open-policy principle. All business affairs are publicly discussed. The recent break up meant a reduction in the total Internet Argentinean domestic traffic handled by NAP Cabase. Traffic at Cabase is now 40 % of the total Internet traffic. [7].

Cabase's approach to financial sustainability lies on the concept of NAP points. Depending on the capacity needed by each ISP from NAP, the latter determines the amount of NAP points to each ISP. ISP's monthly payments depend on the amount of

NAP points. One NAP point not only includes the connection capacity, but also the kind of installation needed by each ISP. It is worth mentioning that connectivity bandwidth was not considered as a parameter to determine costs, because one ISP connecting with a larger bandwidth is somehow improving NAP operation with other ISPs [7].

5.2 NAP CHILE

NAP Chile aims at interconnecting Internet access providers in Chile. It was created in September 1997 as a stock company, conceived as a syndicate, and originally created by six independent ISPs to prevent international transit of domestic IP traffic. Foundinf ISPs members created the *Asociación de Proveedores de Internet* (API).

Chile has Internet domestic exchange points that gather and exchange traffic from two or more ISPs; they are known as Traffic Exchange Points or TEPs [10]. Such connections are non-discriminatory, and must accept all ISPs' domestic traffic, without restrictions, interchanging also routes with ISPs connected to other TEPs. It should be mentioned, however, that in order to accept such connections the relevant technical aspects must be complied with, and equipment must be managed according to international standards [11].

Such TEPs also manage quality indicators not only of TEP connections with ISPs, but also of connections among TEPs. This quality measuring is made regardless of the amount of international traffic handled [10]. In the case of ISPs not connected to any TEP, the latter must provide information about its indicators. For this measuring the intervention of a third party --that is, somebody alien to such ISP-- is necessary. [11].

It is important to mention that there must be full connection among TEPs, if they are less than five. If they are more than five, each one must be connected, at least, to another three [12]. TEPs existing in Chile are NAP Chile, ENTEL, NAP de Telefónica Mundo, Global One, AT&T, Equant, Impsat, and Chilesat.

NAP Chile's entrance policy has been to allow participation of other ISPs with independent international links. On the other hand, to guarantee non- discrimination, ISPs must accept and establish connections among them to send domestic traffic. Therefore, to comply with the domestic connection requirement, every ISP must be physically connected to and entitled to route exchange, at least with one TEP [11]. In this case, the existing agreement among ISPs connected to a TEP should be a peering agreement. But they may agree on other connection topologies, provided that the domestic traffic be exchanged by authorized providers [10].

5.3 NAP COLOMBIA

NAP Colombia was founded in 1998 as a cooperative body, thanks to an agreement signed by 12 ISPs (founders) which, led by the Colombian Chamber of Informatics and Telecommunications, CCIT, acquired infrastructure and contracted an operation that allowed all ISPs involved to benefit from a common exchange point [13].

NAP Colombia is responsible for the concentration and routing of all communications of Internet access provider companies connected to it in order to avoid international connection costs previously derived from the connection to their servers. Communication concentration and routing services are rendered under equal conditions and opportunities for all entitled NAP operators.

It is estimated that the total traffic sent by such operators through NAP represents 90% of all domestic traffic. Measures at NAP reached a peak capacity of 619 Gbps in the first quarter of 2006 and monthly traffic routed reached 77,000 GB. [13]. In its first years of operation, NAP saved about one million dollar a year to member ISPS, as they did not have to spend on international bandwidth to route domestic traffic [9]. The services offered by NAP

Colombia are: physical infrastructure for Internet traffic exchange, web sites, router collectors (a router provided by NAP to which all operators may peer), mailing lists, and router placement for all members.

NAP Administrative Council acts as a decision-making body. If technological changes are implemented by NAP, the technical subcommittee -conformed by technicians in charge of NAP members' infrastructure- issues recommendations to be approved by the Council and carried out by the NAP. Before operations started with ISPs, the founding members set forth an entrance fee to cover infrastructure expenses. NAP operating costs are financed with a monthly payment set forth by NAP members, which purpose is to cover projected expenses.

5.4 NAP BRAZIL AND NAP DE LAS AMERICAS

NAP Brazil is located in Sao Paulo. It is administered and operated by Terremark Latin America (Brazil) Ltd, together with FAPESP (Fundaçáo de Amparo á Pesquisa do Estado de Sáo Paolo). In addition, Terremark owns and operates NAP de las Americas, the world's 5th network access point Tier-1, and the model for data centers, TerreNAP(sm), that the company is developing in San Paulo, Brazil (NAP do Brasil), in Madrid, Spain (NAP de las Americas, Madrid), and in other emerging markets. However, NAP Brazil and NAP de las Americas are wholly independent. [14]

NAP de las Americas is a neutral complex with the latest technology, which furnishes interconnection to Internet and other access service providers (ISPs), and supplies optical fiber network connectivity between Latin America, Europe, Asia and Africa, and the United States. NAP de las Americas operates in Miami, Florida, since July 2001 . Terremark financed the necessary infrastructure to operate this NAP. NAP Brazil uses instead FAPESP facilities and some FAPESP's expenses are covered by Terremark. [14]

Among the services offered by the NAP are information placement, peering, and data services. Another service rendered is the access to peering agreements, when its clients acquire peering ports. Each party privately carries out such agreements, and other similar commercial agreements, among ISPs present at NAP. NAP de las Americas acts simply as a facilitator and operates the peering structure and the meeting points used by its clients during the implementation of such agreements. Another service is the selling of cross connections at different speed for those clients who may interconnect among themselves. Finally, it offers system monitoring, services and other kind of installations used by its clients once connected to NAP. These services are offered to its clients, who are divided in four categories: network service transporters or providers, service providers (hosting companies), and government companies and bodies.

There are other NAPs in Brazil, namely RSIX (Porto Alegre), ANSP (Academic Network at Sao Paulo), and Diveo NAP (Sao Paulo).

5.5 NAP PERU

NAP Peru is a non-profit civil association founded on August 2000, which started operations in 2001. It is an independent non-profit cooperative body [16]. Local traffic exchange does not interfere with international exchange because international bandwidth is not shared with domestic traffic. Another benefit is the reduction of costs derived from time of connection, final destination, and network and infrastructure used for the interconnection.

NAP Peru has 8 members; five founders rotate at the presidency. There are also a technical and an administrative committee, which the American Chamber of Commerce currently administers. NAP Peru is physically located at the American Chamber of Commerce. Entry fee for new members is US $30,000 and every member pays a US $2,000 monthly fee. [16]

The main problem faced by this NAP is the result of its original legal framework (an association instead

of a company), because it does not reflect the existing traffic disparity. Under the original rules all the parties had to connect with the same capacity, and if links were saturated they had to increase their capacity on equal basis. But this restriction to conform to bandwidth harms small traffic operators. Since NAP Peru is usually saturated, it is preferable to route traffic to international links. As a consequence the administration has been decided to increase interconnection links to 30 Mb. But this action has presented small providers with higher interconnection costs, which in turn has led to financial difficulties. [15]

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