The Chilean Internet Connection or I Never Promised You a Rose Garden

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Abstract

Chile has had two international 56Kbps links to the Internet since January 1992. This online connection to the world is having a great impact on academic research, extending state-of-the-art communication technology to our country. The impact will be even greater considering the traditional isolation of the country, surrounded by mountains and sea at the end of the world, and a very particular geography: almost 4350 kilometers long from north to south with an average width of 190 kilometers.

However, some problems (technical and political) have also been generated by this connection. For instance, the two links are operated by independent organizations, and there is no local connection between their respective networks. Some of the problems we discuss are unique to Chile, but many may also arise in other countries connecting to the Internet.

This paper presents an analysis and a critique of the solutions implemented in the Chilean networks, focused mainly on the pricing, accounting and billing of the international link. This problem is quite similar to the NSF backbone pricing problem: a shared and expensive resource. We propose some new viewpoints and improved long-term solutions. In particular, we strongly believe that the current situation is not sustainable, and we advise against using a similar solution anywhere else, as we explore better alternatives.

We also discuss the trend towards widespread use of this technology in Chile, and the steps that are being taken to make it compatible with commercial use.

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I. Introduction

The Internet growth in recent years is impressive, and a large part of the planet is now interconnected [3]. This global network presents outstanding opportunities for under-developed countries, which have now access to a wealth of online information, including live discussions on research and application topics [10]. The main problem that countries like Chile face is the distance separating them from the technology, and in particular, from the decision-making process. Traditionally, a researcher in Chile works with papers published last year, written three years ago and discussed five years ago. Now he or she can take part in the discussion, or at least "listen" to it.

However, network access is still a problem because an international link to the US is rather expensive, and also because networks have become tokens of political clout. In Chile, all national universities tried to reach an agreement to share the costs of the link to the USA, as well as costs associated with the national internetwork. Unable to agree on basic issues such as distribution of costs and control of the network, they finally split into two separate and competing networks: REUNA and Unired.

The REUNA network was born as a very ambitious plan to interconnect all Chilean universities via dedicated 64Kbps data links using TCP/IP. The topology of the backbone is very simple (no surprise! see Figure 1) and we believe that it is vital for the research activity of the country that this network operate smoothly and that the project be successful.

However, the costs involved are considerable, and the discussion regarding their allotment has been anything but peaceful. More than a year after the network began operating, the member institutions have finally reached an agreement. The chosen compromise solution may seem reasonable, but we will show that it condemns REUNA to isolation. This solution comes from a mistaken point of view, based upon old experiences with previous networks, and also from mu-

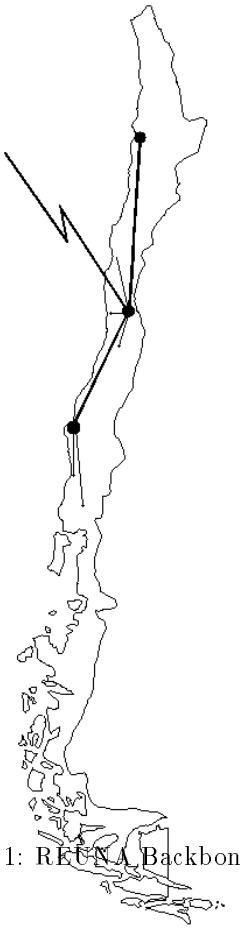

Figure 1: REUNA Backbone (May 1993)

tual mistrust between REUNA members.

We believe that this situation can, and probably will, arise in other countries, and there is a risk that the Chilean solution may be copied elsewhere. In this paper, we will try to show that this is not recommended, and that other solutions should be sought to ensure a globally interconnected Internet.

In section 2 we summarize the history of Chile's international connections and the role played by our university. In section 3 we present the current status of the Chilean networks with their connections and costs. Section 4 is an analysis of the situation, discussing the weaknesses of the current policies. Section 5 explores other themes such as AUPs, the administration of the local domain, and other technical problems. In section 6 we address commercial uses and related projects in Chile. Finally, we reach some conclusions and propose alternative (and obvious) solutions in section 7.

II. History

In 1985, we at the Department of Computer Science of the University of Chile established an experimental UUCP network, using slow modems and phone lines, linking together three Unix systems from different universities. Very soon an international connection to the UUCP network was a must. A test period (during 1986) with an X.25 connection to `inria` in France, and to `seismo` in the USA ended when we started using Telebit Trailblazers to call long distance to `uunet`. We were the first node in Latin America to enter the UUCP network (soon followed by Argentina). This first international connection gave us e-mail and news revealing to us the incredible world of USENET[3]. The machine used as a hub for this service was called `uchdcc`, and it was then an NCR Tower 1632. After several different reincarnations, `uchdcc` is now an IBM RS6000. At that time, we registered the Chilean top level domain (`.CL`), and decided since the beginning to use a domain name system. This early decision proved to be invaluable when we finally connected to the Internet. This Chilean UUCP network slowly grew as more universities, companies and private individuals joined it (currently reaching more than 50 nodes), but its growth was always stunted by the high cost of international telephone communications. As of May 1993, the top-level domain included 844 nodes and 32 direct sub-domains (see Figure 2).

In a parallel effort, the Computer Center of our faculty (Engineering) set up a BITNET link in 1987 and began connecting all the Computer Centers of the regional universities (almost all of them with IBM mainframes) to BITNET. This experience was very important because it gave access to e-mail to many scientists from various disciplines, while the UUCP connection was used mainly by people in computer science or people outside the universities. The Chilean BITNET network did not suffer from high communications costs because it had access to the unused capacity of a link originally installed by NASA. Originally advertised as "free", the charging policy had to be reversed later, after the Computer Center discovered that it took a lot more than just a communication line to operate a network.

A few years later, during 1990, an Ethernet backbone was put in place in the Engineering campus at the University of Chile, and the Chilean UUCP and BITNET networks were interconnected using TCP/IP.

Thus, the University of Chile through two sep-

[3] Due to high communications costs, a full feed of news was received on magnetic tapes until 1991.

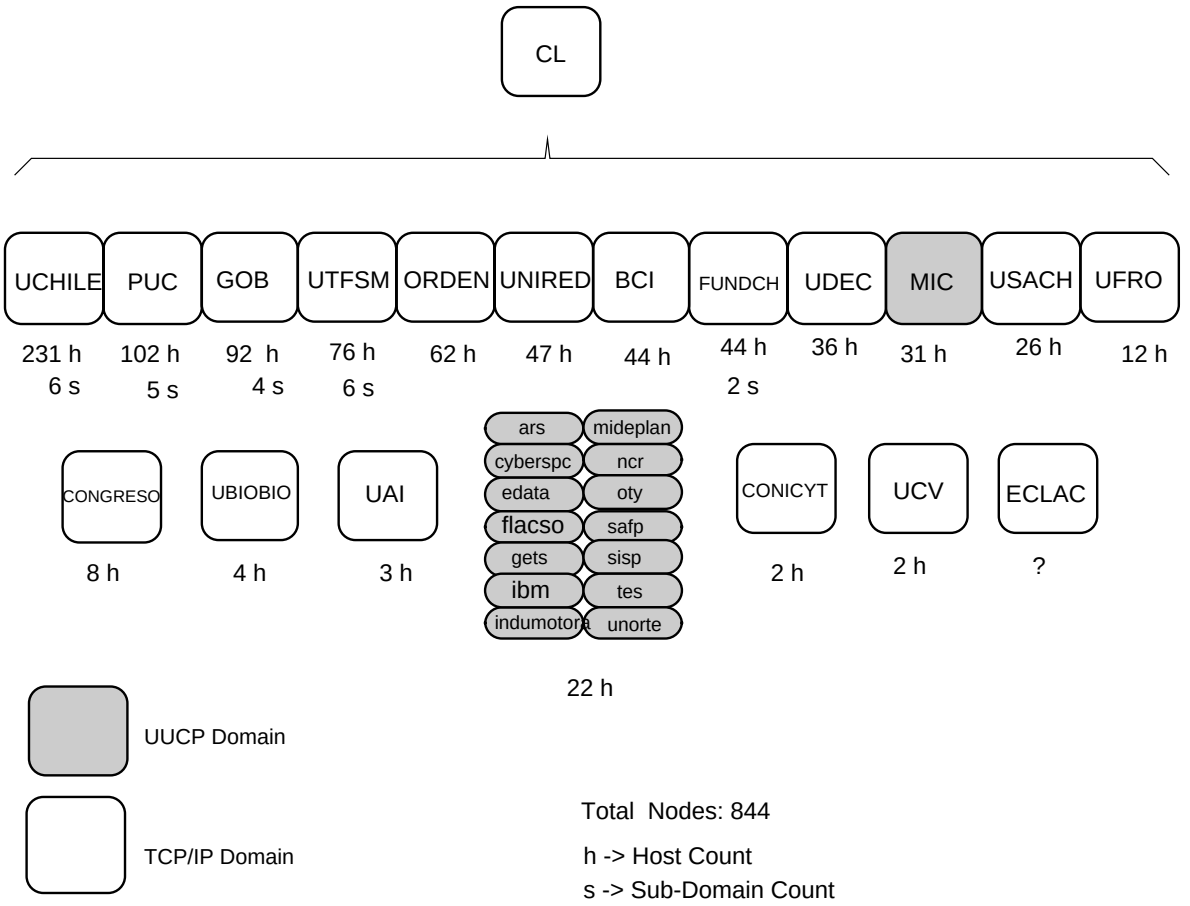

Figure 2: The .CL domain as of May 1993

arate initiatives was a leader in bringing Chile in contact with the world of international networking. This early dominance of the University of Chile, plus the highly competitive nature of the relationship among the largest Chilean universities, played an important role in the disagreements that some years later led to the creation of two separate academic TCP/IP networks.

During 1991, REUNA was proposed as a very large project, to be financed by a special governmental fund for applied research, to create a national TCP/IP backbone linking all national universities, with an international link to the Internet. The project was discussed at length, not only its funding but also its operational policies. Many political problems arose, and this ended up with a group of universities leaving REUNA and establishing a link of their own to the Internet.

Throughout this process, which involved top officials of the member universities and of CONICYT (the Chilean science and technology research commission), it became clear that the network operation had to be financed totally by the member institutions, and by any revenue from potential external customers. The funding provided by the government (if available) would pay only for the initial investment. Therefore, it was essential that the members agree on how to share the cost of the network operation. This included the cost of the international link (about $7000 US per month) [4].

On the other hand, at that stage only a few universities were really heavy users of networks, and for most of the others this would be their first connection to an international network. Therefore, with little experience or understanding of networking, this group had to design basic network policies. Many feared that they could end up paying for somebody else's use of the network, but they also knew that they could not afford to stay out!

As mentioned above, during this process some universities decided to set up their own link to the USA and form an independent consortium named "Internet-Chile," and later renamed "Unired."

[4] When a less-developed country connects to the Internet, it must pay for the connection, presumably because it is in its interest to be connected. Awkwardly enough, in most cases when a developed country connects to the NSFnet in the USA, the cost of the link is shared by both countries.

The early days of 1992 witnessed a frantic race, as both REUNA and Unired hurried to be the first network in Chile to connect to the Internet. After some delay caused by the NSFNET policy of "one-country-one-link", both networks were added to the MERIT routing tables in February 1992.

The emergence of this splinter group (i.e. Unired) was facilitated by the perception that many commercial enterprises would be interested in connecting to the Internet, thus providing a potential source of income to help pay for the network operation.

Some people may wonder why an international link to the US is needed at all instead of a link connected to a regional South American network. Such a regional network does not exist at the moment, and there are several reasons (not all of them good) that explain why this has not been pursued. First, Chile is geographically isolated, and international communications, with very few exceptions, are via satellite. It would not be less expensive (and it would add significantly to the delays) to connect to another South American country instead of the US[5]. Second, telecommunications in Chile are more advanced that in neighboring countries[6]. Third, there are geo-political reasons that prevent having connections to regional countries: many people do not want their Internet connection to depend technically or politically on another country in this region. Opinions among our regional neighbors are probably mutual, so perhaps the only "reasonable way" to set up a regional network is to have a router in the satellite itself!

Similar situations may develop in other countries that are planning to connect to the Internet, particularly in developing countries, and we believe that they may benefit from the Chilean experience.

III. Current Situation

During 1992, only a reduced part of the REUNA network was in operation. Three universities, one research institute and CONICYT were connected, each paying for its own local links, and CONICYT paying for the international link. With major funding already approved to finance the deployment of the rest of the network, 1993 is the year of the real birth of REUNA as a national TCP/IP network. Currently ten universities are already connected (May 1993), but many are slowly entering the net because their internal networks are still being developed.

Now that the network is working, a charging policy acceptable to all members of REUNA must be implemented. As expected, it has not been easy to agree on a set of fees to be paid by the use of the network resources. Initially, the heads of the member institutions decided that all the network costs were to be split in proportion to the budgets of the institutions, with only one exception: there would be a per-megabyte charge for international traffic (both incoming and outgoing).

This decision generated loud opposition from many users when they discovered how much their e-mail, ftp, etc. was going to cost. After the issue was brought to several mailing lists, an international write-in campaign ensued. As seasoned users of the net can guess (but much to the surprise of REUNA authorities), this quickly snowballed, with the real issue soon getting lost among confusion, distortion and misunderstanding.

However, this did have the beneficial effect that the policy, formerly thought to be "natural" and "fair" was rethought, as REUNA itself discovered some of the anomalies it would generate. For example, how many public ftp sites would exist if they had to pay for the traffic of people copying files *from* them? It was also discovered that the routing equipment was nowhere near being capable of performing the detailed accounting that was necessary for implementation of the policy.

The current compromise solution still considers international traffic apart from the rest of the network costs. Instead of a detailed per-megabyte charge, there are several brackets, with subscribers being moved to a different bracket if their international traffic falls outside their previously agreed bounds. The bounds are different during daytime and nighttime.

REUNA has also decided to relax some of its policies regarding the control of the network. Originally, REUNA did not view itself as just a backbone to which subscribers would connect. Instead, each subscriber would become *part* of REUNA, with REUNA acquiring control over the subscriber's networking policies. On the basis of this, for instance, it was decided halfway through 1992 that no subscriber of REUNA would be allowed to connect to Unired.

Under the new REUNA policies, subscribers can now connect to third parties, and these third parties can indirectly gain access to the REUNA network. However, in addition to billing for the

[5] This can change dramatically if the atlantic fiber optic cable finally arrives at the end of 1994, as projected.

[6] For example, it is planned that Chile will have an all-digitally switched telephone network in 1993.

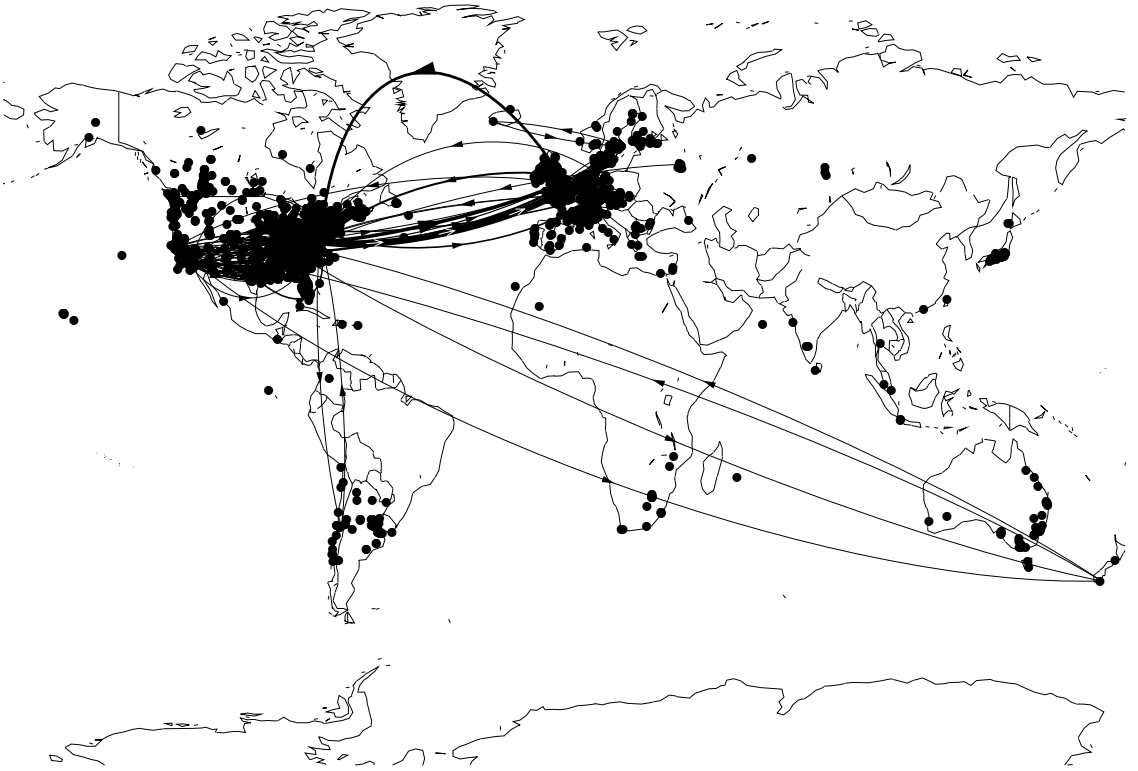

Figure 3: World News Flow

service, REUNA will charge an extra fee for each third party connected in this manner. This system would seem to meet all the requirements: the cost sharing is fair, the national traffic is "free," and every member pays for the fraction of the international link "it really uses." Nevertheless, in the following section we will see why this system is flawed.

Meanwhile, Unired has chosen a different approach. With the two largest of its three founding members in Santiago, it has not concerned itself with deploying a national backbone. Instead, it has began actively marketing its network, trying to sign up as many customers as possible. Currently, there are six TCP/IP clients (besides the three founders) in this network, plus several login clients. Controlled basically by the Catholic University, it has not been saddled by the burden of having to make more than a dozen university presidents agree (as REUNA has), and it has been able to react much more quickly to user demands. For example, Unired's original charging policy was identical to REUNA's (although expressed in different currencies and units of measure). However, after the uproar caused by REUNA users, Unired quietly dropped its charge for international traffic, adopting a flat fee for its academic and non-profit customers. However, it still charges a significant fee for international traffic to its commercial customers.

Currently, our department is by far the heaviest user of the Internet in Chile, and we have great interest in the smooth operation of both networks: we run the main news and name servers in the country, and the news flow is the most important in Latin America (see Figure 3).[7] We have involved ourselves actively in the technical operation of REUNA, from which we obtain our connectivity, and we have supported a large portion part of the initial work. We have also advised Unired whenever we have learned of actual or potential problems in its own network. We do this mainly as a volunteer effort, complementing the work of the staff of the networks, as a way to assure that everybody's connectivity (and ours in particular!) will not be endangered.

IV. Analysis

The current situation in Chile is that we have two networks connected via international links to the Internet, but locally disconnected. This is particularly bad for us in the Department of Computer Science at the University of Chile because of our active academic collaboration with the Catholic University, which is on the other network. This situation is shown in Figure 4.

Although the roots of this "unnatural" situ-

[7] Figure obtained thanks to DECWRL netmap-2.1 by Brian Reid.

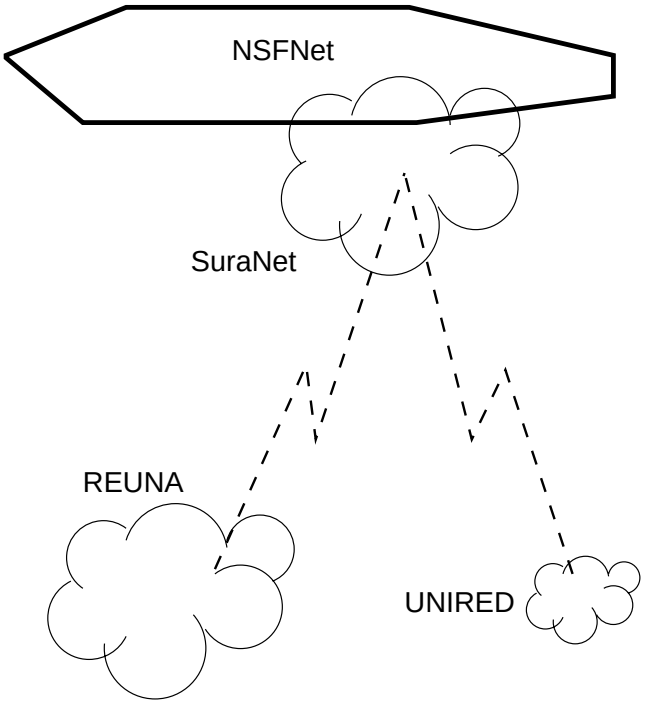

Figure 4: Chilean Internet international links

ation are political in nature, it is also a logical consequence of previous decisions. In its original concept, REUNA was going to hold the monopoly for Internet access in Chile. The only way the rules described in the previous section can make sense is if every international link is controlled by REUNA. Now that REUNA is not a monopoly anymore, the interconnection with another network that also has a route to the Internet requires a complicated agreement about how to charge for international traffic.

Although the REUNA authorities find it hard to believe, the usual Internet policies have avoided charging for traffic, and have used flat fees instead (possibly depending on the bandwidth) [6]. Pricing the Internet is still an open problem[9], in particular when a common expensive backbone is subject to congestion. In our case, the expensive backbone is in fact the international link, and this is the reason that moved REUNA to price it differently. In [9], a theoretical optimum price solution is designed (although probably impossible to implement) trying to find an efficient pricing scheme. In that paper, they establish that:

> *...the important scarce resource is bandwidth, and thus efficient prices need to reflect the current state of the network. Neither a flat price per packet nor even time-of-day prices would become very close to efficient pricing.*

In fact, the solution designed by REUNA is worse than that. Once REUNA begins connecting to other networks, its charge policy may generate subtle anomalies and unexpected consequences. For example, if REUNA connects to another national network that does not charge for international traffic, then every REUNA subscriber will prefer to route packets through that other network. This may be unacceptable for the other network due to the load generated, but strangely enough, it is also unacceptable for REUNA itself because no traffic through their international link means no revenue to pay for it.

In the current situation, with REUNA and Unired having evolved complicated ad-hoc fee schemes for international traffic, the problem of reaching an agreement that would allow both networks to connect directly would seem to be very hard to solve, even assuming that both parties were willing to seek that agreement. In the meantime, traffic between computers that are only a few kilometers away in Santiago has to travel back and forth to the USA, and the delays make interactive communication almost unusable. Actually, the REUNA link is now suffering from heavy congestion, causing enormous delays in our communication with Unired.

Therefore, the separation of national and international traffic that seemed natural at the beginning is condemning REUNA to local isolation, and the same restrictions (a complicated agreement on international fees) also apply to connect to regional networks, if they ever exist.

We believe that this distinction between local and international traffic is fundamentally flawed, that it will create major problems in the near future, and that REUNA will be forced to change it in view of the troubles it will cause. Moreover, charging for international traffic discourages the external use of the network (and also REUNA-Unired traffic!), which is exactly the opposite to the goal of the network itself.

We hope that this policy will not be adopted by other countries faced with circumstances similar to Chile as they plan to connect to the Internet. Furthermore, we hope that our experience serves to alert them to the difficulties they are likely to encounter.

V. Technical Issues

Although the Chilean networks are still far from reaching a state of "peaceful coexistence", there are some areas in which they must cooperate. One of them is the administration of the top level domain (`.CL`). So far, the smooth operation of the domain name system has been possible

because it has stayed in the hands of our department, away from the battles between REUNA and Unired. The current *status quo* (as of May, 1993) consists of a primary name server running at our department (at `dcc.uchile.cl`), with one secondary name server administered by REUNA and another by Unired (in addition to several other secondary servers around the world).

Our department is part of the University of Chile, which is one of the founding members of REUNA and the most influential one in the consortium. In spite of that, and mostly because of our influential work in the field of networking in Chile, we have been able to act with independence from the two existing networks as a neutral third party in the "network wars". The fact that the registration under the `.CL` domain is being handled in this manner has been essential to keep the system running until now, with each network being able to avoid telling its customers that they should register with their competitors. However, it is unclear for how long this can continue as REUNA has declared, in the past, its intention to take over the domain administration, believing that, as the largest academic network in Chile, it has the right to do so.

We have seen that REUNA has decided to isolate itself from other Chilean networks. However, in a TCP/IP network it is almost impossible to guarantee such isolation without compromising the efficiency and the functionality of the net. As subscribers of a network can connect to third parties, which can in turn be connected to other networks, unexpected bridges between networks may unknowingly be created. Interestingly enough, the REUNA network was plagued at the beginning by sporadic routing problems. The source of these problems was traced to a local bank that was connected to Unired. This bank was in turn connected to a clearinghouse for credit card operations, and while this clearinghouse was not actually connected to REUNA nor Unired, it used an IP address (assigned by REUNA) that was a subnet of REUNA's own class B address. From the outside, it appeared to be a subnet of REUNA, and whenever REUNA went offline for some reason, the route to the clearinghouse (via Unired!) became active. When it came back online, REUNA found itself being ignored by all the rest of the world. This misbehaviour was finally corrected by changing the IP address of the clearinghouse.

VI. Commercial Issues

Immersed in their internal problems and in their sometimes fierce competition, the Chilean networks have had little time to consider establishing a set of acceptable use policies (AUPs). The *de facto* situation is that any kind of traffic is allowed in their internal networks, and traffic that uses their international links has to comply with the NSFNET AUP [5]. It is unclear to what extent this is actually enforced.

Although there are no commercial IP providers in Chile at the moment, there is much interest among commercial companies to connect to the Internet, and a few of them have already signed up with either REUNA or Unired. Inevitably, the issue of communication with the rest of the world for purely commercial purposes will come up, especially considering that Chile bases much of its economic livelihood on exports [7]. This will either prompt other providers to enter the market, possibly connecting to commercial carriers in the US, or cause REUNA or Unired to evolve into commercial networks. Unless the current Chilean networks change their policies for charging for international traffic, it is unlikely that a concept similar to a CIX will be possible in Chile.

In anticipation of this trend towards more commercial use of the net, our department has presented a proposal to a government fund for applied research to study some of the issues surrounding this use [11]. We think that Chile could be a good testbed for commercial TCP/IP, considering the country's geography and the availability of good quality communication services throughout the country. Furthermore, we have much less old technology to contend with, and it is therefore easier to introduce a new one.

Providing commercial services on the network (selling services, support, consulting, etc.) is still to a large extent an open problem, especially in a worldwide network where national laws may be contradictory. The project proposes to do research in the area of distributed information services, generating the platform necessary to develop the sale of services by small and medium-size companies. The project also seeks solutions to the problems posed by worldwide distributed information systems, defining platforms for commercial interchange on the net, navigation systems, information representation, etc. [4, 8]. We will have to address problems such as security, authentication, and electronic funds transfer, as well as the filtering of information [2] using previous research results. Moreover, a single protocol should be provided for commercial information services so that customers can use that single protocol to access all information services. Furthermore, there should be inexpensive ways to connect to the network and to provide services.

This project should encourage the creation of many small companies devoted to selling information in a manner similar to the French Minitel system [1]. The level of services, however, should be significantly higher, taking advantage of technological advances in recent years. In fact, we already have the support of several companies that will collaborate with us.

VII. Conclusions

The Chilean connection to the Internet is working now, and by the end 1993 almost every traditional Chilean university will be connected to the network. In this sense the Chilean networks are a great success, having achieved the long overdue hopes of many researchers throughout the country.

However, previous experiences with simpler store-and-forward networks, and cost sharing problems have led Chilean universities to split into two opposing networks that levy a special tax on international traffic.

We believe the current situation is most unfortunate, and that it is slowing the development of the Internet in Chile. Our main goal in this paper has been to allow other countries to avoid repeating these mistakes.

One of the main objectives of any network is to connect itself with as many networks as possible, thus providing better connectivity to their customers. To do that, we believe that the only solution is to use flat rates to bill for network access. In the case of REUNA, including the cost of the international link in the total operating cost already shared by its members would mean an increase of less than 10% in their fixed fees (and the abolition of any variable fees). The resulting network would be much easier to manage without having to bill for traffic, the customers would know in advance how much their network bill would be, and the network would be able to connect to most other networks that operate on the same principle [6, 9]. Variable fees, even congestion-based, can only be applied by a monopoly or on a global agreement basis. In a globally interconnected Internet, this is simply impossible, and we believe that flat rates are the only way to bill users all around the world.

Even if it is true that the international link (or the national backbone in the NSFnet case) is more expensive than the other ones, it is almost impossible in TCP/IP to distinguish which packets are coming from where, following what route, and bill them differently. From the internetwork point of view there is no such distinction, and a policy that tries to force it creates more problems than what it tries to solve.

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Dr. Patricio V. Poblete is a Professor at the Department of Computer Science at the University of Chile. His research interests include the design of efficient data structures and the mathematical analysis of algorithms. Out of necessity, he has been involved in the development of computer networks in Chile, from the early connections using UUCP, to the current TCP/IP network, and is the administrative contact for the `.CL` domain. Currently, he is spending a sabbatical year at the University of Waterloo, where he obtained his Ph.D. in 1982.