Annex IV

The Internet

Annex 4 – The Internet

4.1 – Introduction

The Internet, as we know it today, is a direct result of the widespread dissemination of technology generated by several American university research groups, at the end of the 60's decade, for the purpose of implementing a computer network, at the request of the U.S. Department of Defense.

Like a typical product of the Cold War era, the technology generated incorporates some interesting characteristics from the military point of view, such as:

- Absence of a central node;
- Architectural flexibility;
- Redundancy of connections and functions;
- Capacity for dynamic reconfiguration;
- etc.

But on the other hand, as befits a new model of strategic and multi-institutional research in information and communication technologies (which the Department of Defense itself was experimenting with), the technology generated spread in a generous manner and with very little control by the academic world, first in the United States and then overseas.

By the end of the 80s decade, the effort to encourage the use of the Internet and to advance the technology associated to it in the USA were led by the National Science Foundation (NSF), and no longer by the Department of Defense. Beginning in 1989, the NSF began to actively pursue connections between the United States and other countries, for education and research purposes.

The Academic Sector and the Internet

Following and/or reacting to the model of evolution of the Internet in the USA, the tendency in nations more attentive to the emerging phenomenon was the initial involvement of academic institutions in setting up national networks, either directly employing the Internet line or evolving the older technologies, such as Bitnet, UUCP etc. Then came the involvement of governments, interested in the implementation of infrastructure for networks to support educational and research activities. Finally, already into the 90s decade, the area of services, restricted to education and research up to that point, opened up and expanded in the direction of the Internet open to any purpose.

Certainly, there were and are several variants in this basic evolution. For example:

- The role of Non-Governmental Organizations (NGO) was important in some nations, essential in others, and absolutely detrimental in others. In some countries, the NGOs took on the role of the academic sector and performed the task of being the main agent of dissemination of the Internet.

- The role of government was and has been quite heterogeneous in respect to their own awareness of the potential of the Internet. In terms of concrete support, governments of developing nations have had, in general, delayed reactions and, in some cases, insufficient as well.

The Evolution of the Internet in Brazil

The history of the evolution of the Internet in Brazil followed the basic model described above, beginning with the pioneering efforts of some academic institutions and NGOs, but only taking off when the Federal Government got actively involved, through the Ministry of Science and Technology (MST), and several state governments, such as those of São Paulo, Rio Grande do Sul, Rio de Janeiro and others. Strong and determined government support for the Internet in the country, since the initial stages, clearly distinguishes Brazil from most of the other developing nations.

A first version of Internet services - with points in 21 states of the country - was implemented by the National Research Network (*Rede Nacional de Pesquisa - RNP*) from 1991 to 1993, at a slow rate of speed. Between 1995 and 1996, these services were updated for faster speeds.

Concurrently, beginning in June of 1995, a Federal Government decision defined general rules to expand the availability of Internet services in Brazil to anyone interested.

4.2 – Architecture and Operation of Internet

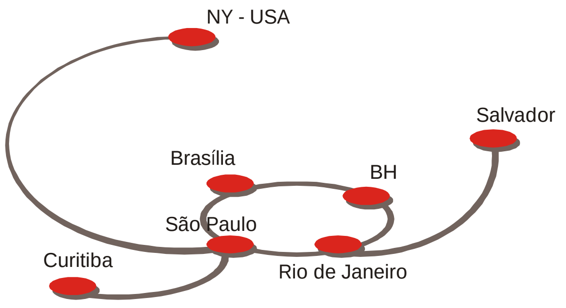
In concrete terms, the Internet has translated into a series of services (such as *e-mail*, ICQ, etc.), based upon a basic functionality - the connection of networks, which is embodied in the so-called IP protocol. In a simpler form, a user uses his or her computer and connects to a service provider by making a simple phone call. The service provider is the closest point the Internet "reaches", and from where e-mails, for example, are sent to a distant recipient, maybe in another country, who will, in all likelihood, access the Internet with a phone call to his or her local service provider. How the electronic message is transmitted between the two service providers, from the point of origin to the final destination, remains a mystery to most people.

Backbone and Access

Internet services are implemented upon the physical telecommunications infrastructure of a region or country. Before the explosion of the Internet, this infrastructure had served a distinct basic purpose, which was voice communication. Gradually, in the measure that Internet services expand, this infrastructure is being modified and expanded and operational problems are being resolved.

Figure A4.1 essentially illustrates the underlying model of communication used in the Internet, for a hypothetical provider.

Figure A4.1
A Backbone with Six Points in the Country



Source: SocInfo

In the centers where there is a great flow of information, there is a web of communication, formed by the various high-speed data links, called the "*backbone*".

The *backbone* illustrated above interconnects points in the cities of Curitiba, São Paulo, Rio de Janeiro, Belo Horizonte, Brasilia and Salvador, in Brazil. Moreover, there is also a connection with New York, in the USA, presumably to an American Internet point. These points are denominated the Points-of-Presence (PoP) of this provider.

The stretch that is missing between the user's residence and the provider's nearest Point-of-Presence is the so-called access, or last mile. Usually, this access is made possible, in Brazil, through a simple phone call from one's home through the traditional phone line.

Other options that began to appear include connections through paid television services, wireless telephone, etc.

Speed and Service

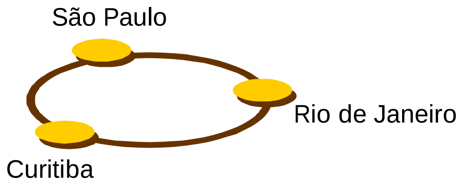
A critical variable in order to have quality Internet service is obviously speed, both of access (in the last mile), as well as in the *backbone*. As a general rule, the main limiting speed is that of the phone line between the user and the provider, which is measured, for example, in 28.8Kbps (or kilobytes per second). The lowest speed of a *backbone* (that is, of the slowest link of a *backbone*) should be at least two orders of magnitude greater, in order to allow for the free flow of the information that is being generated concurrently by a great number of users at the links of collective usage.

Traffic between Different Backbones

Let's consider, hypothetically, the existence of a *backbone* B in Brazil, competing with the one illustrated in Figure A4.1, and interconnecting its own PoPs in Curitiba, Rio de Janeiro and São Paulo, as Figure A4.2 shows.

It should be observed that these PoPs, though in the same cities, are distinct from the PoPs of the previously described *backbone*, because they belong to competing companies, each servicing their own clients (companies and individual subscribers).

Figure A4.2
Another Backbone with its own Three Points



Source: SocInfo

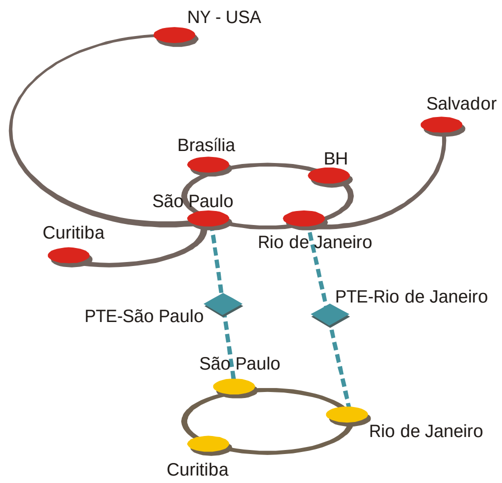
Thus, the following question should be asked: how does a message coming from a user of *backbone* A reach a recipient who is a subscriber of *backbone* B?

The answer is technically obvious: somehow, but preferably in a direct manner, the two *backbones* should be interconnected for an exchange of traffic. Where and how this interconnection is done should not be (in theory, at least) a matter of interest to the normal Internet user. It should be enough for he or she to know the electronic address of a user or know about an Internet service they may use in order to obtain it.

From the point of view of the global architecture of Internet services in a country, however, the matter is totally relevant. In order to assure the efficient transfer of communication from one *backbone* to another, Points of Traffic Exchange (PTE) should set up in critical "crossroads". Figure A4.3 illustrates a possible configuration of two PTEs. In the measure that the number of users of each backbone expands and the speed of the links increases, the implementation of multiple *high performance* PTEs become increasingly more important to optimize the global performance of networks.

Ideally, the PTEs should be set up to include all the national *backbones*. This is a task that will require some negotiation between the various providers, with a possible intervention of regulatory agencies, in order to protect the interests of users and of the providers themselves, since the amount of international traffic between the *backbones* would diminish, given that communication between them would be carried out via the PTEs, and no longer through the highly disputed international *links*.

Figure A4.3
Point of Traffic Exchange between Two Backbones



Source: SocInfo

Network Engineering and Security

The installation of Points of Traffic Exchange (PTE) between Internet *backbones* is only one of the concerns to be addressed for the implementation and upkeep of Internet services in a country.

There are several other aspects that must be considered, such as:

- Technical standards for network services;
- New services;
- Security and emergencies.

This means that an "engine room" is needed to plan and monitor the operation of Internet services and to intervene in strictly emergency situations.

On a global level, the main issues of Internet network engineering are discussed and, eventually, resolved by the IETF, which functions as a forum to establish concrete standards of Internet protocols and services. The IETF is open to everyone and accepts applications from professionals of institutions interested in joining. It has become the forum where individual interests are defended, usually resolved through concrete proposals and based on experience with previous implementations, which are refused, improved or eventually accepted. Brazil, that is, Brazilian institutions and professionals, have participated timidly and sporadically of the IETF. This fact reflects the immaturity of the sector in the country. It would be good if the scientific community and private initiative would become aware of the importance of participating in the highest-level technical forum of the Internet.

IP Addresses and Domain Names

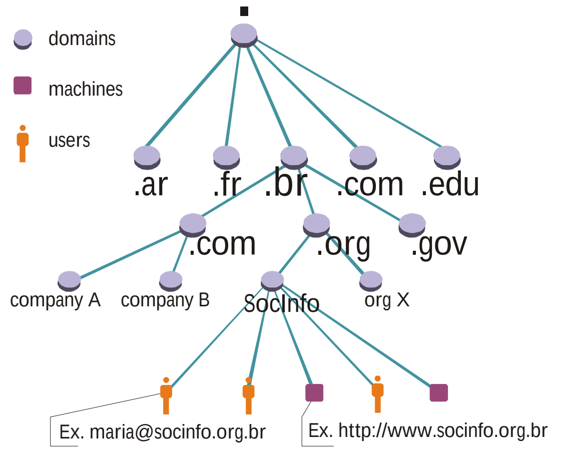
Finally, from the point of view of the users of Internet services, two additional concepts complete this brief introduction: the IP addresses or numbers and the domain names.

An IP address or number is the unique identification of a computer connected to the worldwide Internet, and is equivalent to a telephone number (formed by the <Country Code / Area Code / Customer Number>) in the world of networks. It's through the identification of the recipient's IP number that it's possible to send a message from one computer to another.

How do people identify themselves on the net? Certainly not through their IP numbers! Identification is done by means of electronic addresses such as this one: `maria@socinfo.org.br` referring to "maria", who is at ("@") an entity denominated "socinfo", which is an organization (thus ".org" and not, for example, ".com") registered in the Internet structure of Brazil (thus the ".br" and not, for example, ".fr").
The underlying structure of these addresses and the process of registering and qualifying them, by assigning them an IP address, is the so-called structure of Internet Domain Names. In Brazil, the global domain on the initial level is represented by "br", under which there are specialized sub-domains that are shared, such as ".com", ".org", ".gov", etc. Finally, on the 3rd level, there appear specific names of entities - such as "socinfo", "corinthians", etc. – that identify institutions of the real world. Figure A4.4 illustrates the structure of Internet domains.

The assigning of IP addresses, the registration of Domain Names and the connection between number and name (which is verified whenever an address is referred to) are additional functions carried out at the "engine room" level, which must kept up in order to ensure the proper functioning of the Internet.

Figure A4.4
Structure of Domains



Source: SocInfo

Operation of the Brazilian Internet

The basic functions described above as forming the "engine room" of the Brazilian Internet have been traditionally maintained and operated by a technical and administrative structure linked to FAPESP, initially as the National Research Network (RNP) Operations Coordinator, and, beginning in April of 1995, under the responsibility of the Internet Management Committee in Brazil.

4.3 – Governance of the Internet

Brazil's Internet Management Committee (*Comitê Gestor* - CG) was instituted in April of 1995 - through a joint initiative of the Ministry of Communications and the Ministry of Science and Technology – for the specific purpose of organizing and supervising the basic functions of the infrastructure needed for Internet services in Brazil, as well as planning and steering its evolution in the future, weighing the interests of the public sector, private sector and the country's scientific and technological priorities in a just manner.

The fore mentioned basic functions include:
- Leasing of IP addresses;
- Registration of Domain Names (at ".br");
- Basic protocols and those of services;
- Network engineering.

The Management Committee is Brazil's version of the *International Corporation for Assigned Names and Numbers* (ICANN), a supranational organization created in 1998 to manage and oversee basic operational functions of the worldwide Internet.

4.4 – The Internet in Brazil

The Brazilian Internet, begun in 1989 as an academic network, disposes today of 446,444 hosts, ranking 13th in the world in volume of hosts, as Graph A4.1 indicates.

There are currently 6 domestic *backbones*, according to the Brazilian Internet Management Committee:

- RNP - http://www.rnp.br
- Embratel - http://www.embratel.net.br
- Banco Rural - http://www.homeshopping.com.br
- Unisys - http://www.unisys.com.br
- Global-One - http://www.global-one.net
- IBM - http://www.ibm.com.br

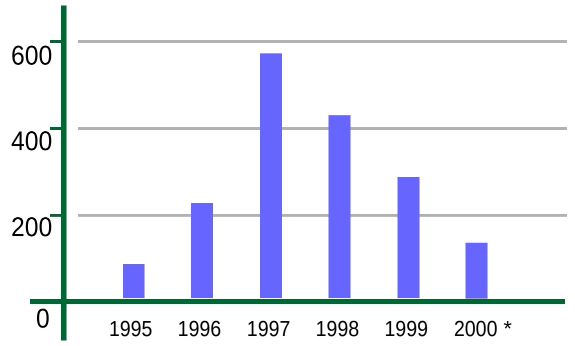
In the area of networks for education and R &D, the RNP can also rely on these additional regional academic networks:

- Red ANSP (Red Académica Paulista)
  http://www.ansp.br
- Red Bahia
  http://www.redebahia.br
- Red Catarinense
  http://www.funcitec.rct-sc.br
- Red Internet Minas
  http://www.redeminas.br
- Red Paraibana de Investigación
  http://www.pop-pb.rnp.br
- Red Rio
  http://www.rederio.br
- Red Rio Grandense de Informática
  http://www.pop-rn.br
- Red Pernambuco de Informática
  http://www.pop-pe.rnp.br/RPI/welcome.html
- Red Tchê
  http://www.tche.br

There are also state government-run networks that are included to the Brazilian Internet web.

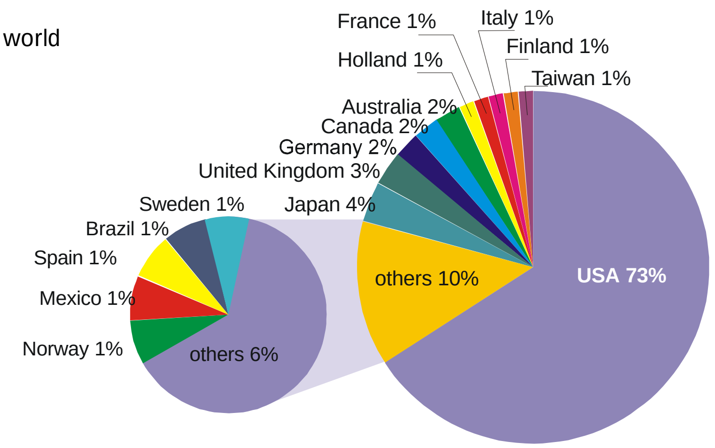
According to Abranet, the country has around 150 Internet providers today, as illustrated in A4.2.

Graph A4.2
Evolution on the Number of Provider in the Country



Source: Abranet - http://www.abranet.org.br

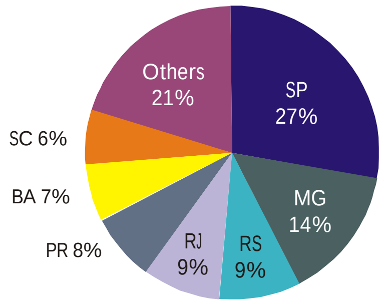
Graph A4.1
Distribution of *Hosts* in the world



Source: Internet Software Consortium, January/2000 - http://www.isc.org

In 1997, there were around 600 providers, which is a clear indication of the strong process of oligopolization that characterizes the sector around the world. A great number of providers are concentrated in the South and Southeast regions of the country, where 72.9% of all Brazilian providers were operating in 1999, as Graph A4.3 reveals.

Graph A4.3
Regional Distribution of Providers in the Country (1999)



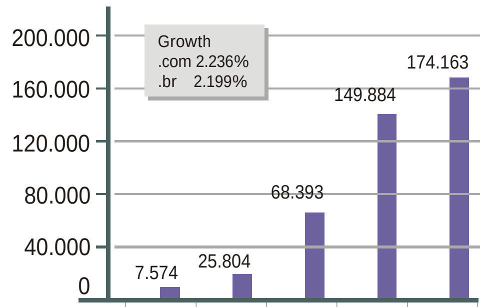
Source: Abranet - http://www.abranet.org.br

There is, on the other hand, a growing tendency towards giving greater value to the providers of content, with the emergence of notable domestic services, such as UOL, Terra, iG, Starmedia, among others.

Number of Domains in Brazil

The number of domains in Brazil rose from 7,574 in 1996 to 174,163 in February of 2000, being that the commercial domain is the one that most expanded among first-level domains (FLD), with growth slightly greater than the expansion of all other domains during this period (according to Graph A4.4).

Graph A4.4
Internet Service in Brasil
Number of Domain (2000)



	1996	1997	1998	1999	2000
others		71	2.993	6.264	8.592
edu.br	297	513	854	1.224	1.278
mil.br + org.br + net.br	313	965	2.265	4.068	4.326
gov.br	134	201	319	402	411
com.br	6.830	24.054	61.962	137.926	159.556

Data from 17/02/2000

Source: Fapesp (registro.br/estatistica.html)

4.5 – Challenges for the Future

Backboning

High-speed communication depends increasingly more on the utilization of fiber optic infrastructure. Only with fiber optics is it possible to achieve speeds (and, especially, interactivity) in the order of Gbps (109 in Graph 9.1 of Chapter 8 – Advanced Infrastructure and New Services). Though the fiber cable usually costs 10-times more than the copper cable, it transports almost 40,000-times more information, or in other words, it offers an enormously superior cost-benefit relationship. Finally, the physical characteristics of transmission through fibers make it much less vulnerable to interference and problems.

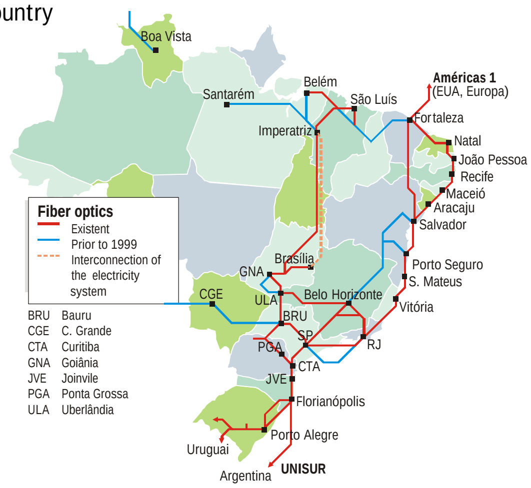
It's not surprising, therefore, that the implementation of fiber optic webs is a booming business today for companies that install any type of physical infrastructure linking points on a map: electrical transmission lines, pipelines, railways, highways, etc. At the end of 1999, ANATEL, ANEEL and ANP published a Joint Regulation that regulates the Sharing of Infrastructure set up by companies of any sector (regulated by a government agency) for data communication.

Figure A4.5 illustrates the fiber optic structure installed or under implementation in 1999.

What is readily apparent is the absence of infrastructure in the North and Northeast regions of Brazil. This vast area will still depend, for some time, on satellite-based means of communication, either geostationary or low orbiting, to meet their communication needs, including voice telephone. Two technologies with very promising potential for the region are those based on DTH (*direct-to-home*) transmission, on the Ku band, and low-orbiting satellite networks, such as *Globalstar*.

Figure A4.5

Fiber Optics Infrastructure under Implementation in the Country



Source: Ministry of Planning

Access

There is a clear tendency for the telecommunication infrastructure existent in the world today (as well as in Brazil) - originally set up to meet the needs of voice telephone and later extended to support communication between computers - to migrate towards a model in which the commutation stations themselves are based on IP support, in such a manner that voice service will become a variant of Internet services. Furthermore, the phone line of today will give way to a multi-service line operating at a medium to high speed. And, most likely, the utilization of the Paid Television infrastructure should become more widespread, creating another alternative to access the Internet at a medium/high velocity. Finally, wireless telephone will certainly occupy an increasingly greater space as a means of access to the Internet, especially with the implementation of the third generation.

On the medium run, the main challenge to the more widespread dissemination of the Internet, in terms of access, will be the cost of the service. Recent studies by the OCDE indicate that the main reason for a significant rise in the number of Internet users in some countries, most notably in Great Britain, seems to be the system of phone call charges through which the cost of some calls are exempted.

One, certainly, can't advocate such a system in a generalized manner and, especially, in developing nations, where infrastructure still requires a lot of investment. However, it should be noted how important the idea of creating special fees that encourage the use of the Internet is. Within this context, ANATEL has an interesting proposal of setting up a system for self-access to the Internet that bypasses the traditional telephone infrastructure and allows for the charging of this service in an independent fashion. This proposal, with the codename 0i00, includes another advantage, which is the possibility of effectively encouraging the dissemination of providers throughout a wide area, and not only in a city, with fixed and uniform prices, regardless of the distance between the prospective user and the provider.

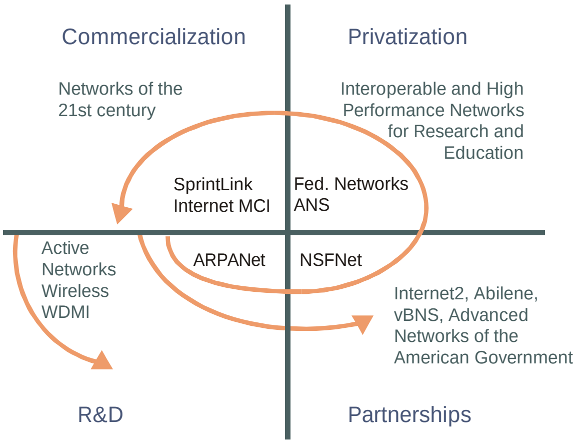
Internet 2 and the New Generation Internet

As is widely known, the Internet evolved throughout more than 20 years (beginning in 1968/69, when its original concept began to take concrete form) in the semi-anonymity of research laboratories and government institutions of the United States and a few other nations, with the cooperation of industrial research groups.

Beginning around 1988, as infrastructure and applications were taking off in the USA, the Internet began to win the world, until the web started to become, around 1993/94, the phenomenon it is today. Throughout this period, the leadership of the NSF and the existence of the so-called NSFnet were crucial. In 1995, with the end of NSFnet operations, the first cycle of Internet evolution was over in the USA, as Figure A4.6 illustrates.

Beginning in 1996/97, a new cycle began, driven by the converging (but not totally harmonious) interests of research institutions on one hand, and the North American government on the other. The intent was to focus on and bolster technologies to allow Internet networks and their applications to take a new leap forward. This new cycle is symbolized by the Internet 2, of UCAID, and by the Next *Generation Internet* (NGI) initiative, of the U.S. government, as Chart A4.1 summarizes.

Figure A4.6
Cycles of the Evolution of the Internet in the USA



Source: Sepin/MCT

The two endeavors, in various aspects, complement each other and are integrated. They use common *backboning* structures (vBNS, Abilene). They involve similar technological levels and goals. In the organizational area, the fundamental difference is that the UCAID is a consortium of universities that work together to sustain the initiative and launch new projects (of which the Internet 2 is the first, but not the only one).

The main difference between the two endeavors rests in their goals. Project Internet 2 focuses on the implementation of new advanced network applications, with an emphasis on the needs of education and research. On the other hand, the NGI is more deep-rooted and all-encompassing, addressing the fundamental problems of the current Internet, such as security, quality of services (QoS), robustness, management, etc. In various aspects, the NGI supports, finances and expands Project Internet 2 in the United States.

Like the American initiatives, there are various similar projects underway in Canada, Australia, Japan and the European Union. From an organizational point of view, each attempts to turn the specific outlook of a country or bloc into reality, in terms of cooperation between government, academia and the private sector for the development of new network services, which, prototyped in R&D environments, can rapidly gain space and applications in commercial networks.

One of the great challenges of the Information Society Program is precisely to conceive, implement and consolidate a model of cooperation in this area in Brazil.

Chart A4.1
American Initiatives for the Evolution of the Internet

	Internet 2	**NGI**
Coordination	UCAID	*White House*
Financing	Consortium members, Corporations	American Congress
Goals	. Development of advanced applications . Development of network tools	. Development of advanced network technologies . Implementation of *testbeds*

Source: SocInfo