“The Development of Information and Communications Technologies (ICTs) in Latin America: A Comparative Case Study of Mexico, Brazil, Chile, and Guatemala”

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Chapter 1: Introduction

Internet Technology and the New Economy

The advent of modern information and communications technologies (ICTs) followed on the heels of the initial shift to computer technology. ICTs, like the internet, permeated global society at all levels, and have revolutionized the global economy in fundamental ways. While these technologies have been incorporated into traditional, or pre-computer, industries of all sorts, they have, perhaps more significantly, been used to create an artificial world known as the virtual sphere, where, in addition to many other revolutionary developments, an entirely new type of production and consumption, as well as a myriad of previously unimaginable industries, are thriving and changing the face of the global economy in profound ways. This is the main topic explored in Thomas L. Friedman's book, The World Is Flat, which was published in 2005. Thomas L. Friedman says in his introduction that this book is meant to be the next part of his ongoing investigation of globalization, which he began with The Lexus and the Olive Tree.

Economically, this revolution facilitated the instantaneous trade of goods and capital across a global market. Every major corporation in all traditional industries developed online resources and used computers in the production and marketing of their products. Such technologies have become a critical aspect of competitiveness in most industries. As a result, nations have benefited from these changes depending on their degree of technological development. Virtual economic activity has been greatly expanded through a new type of industry, the knowledge-based industry. While it exists in the virtual sphere, it contributes to most production in the physical world as well.

On the surface, the importance of these new knowledge-based industries can be deduced from the fact that they have quickly come to dominate the post industrial economies, like that of the United States. When partitioning the world into economically developed, developing, and undeveloped nations, it is possible to discriminate between the classes of states using a variety of criteria from size of the consumer economy, to total value of exports, to the diversity of industry and the degree of contribution to the international supply chains of the largest multinational corporations. In every case, there exists a corresponding discrepancy in the level of technological infrastructure and the size of knowledge-based industry in the nations' economies. Post industrial economies are, by definition, largely comprised of computerized, knowledge-based industries, and the term "postindustrial nation" has become synonymous with the term "developed nation". Underdeveloped nations that do not have large postindustrial sectors have become well aware of their deficiencies and the incentives to correct them. In Latin America, numerous technological development projects, at the national and international levels, are ultimately geared toward creating and sustaining knowledge-based industry.

Knowledge-based industry is explored in depth in The World Is Flat. Friedman conceptualizes it as any industry in which trained individuals use high tech resources to create an idea-based product that can be digitized and moved around in the virtual sphere.[1] In many cases, the products of such industry are designs which are then fabricated and become a physical product that a consumer purchases. Virtually all traditional industries that predated the computer age, such as automobiles and pharmaceuticals, have had their R&D component, and virtually every graphic application transformed into this type of high tech, knowledge-based work.

[1] Friedman 2005

Furthermore, the software tools now used to do this kind of work are themselves idea-based products. In other cases, the product may be a system or service which is used to market or sell traditional products. The EBay online exchange service is a well-known example of this. Finally, many idea-based products are now often produced and sold without ever taking a physical form. Music, videogames, computer-animated films, and software can now all be bought without ever purchasing a physical object, the digital form of the product is simply downloaded and consumed using a computer or similar device. These products' entire existence (from design, to production, and finally consumption) is never anything more than information stored in light and electricity.

The entire physical infrastructure of computers (as well as internet lines, cables, and satellites), from which this knowledge-based work is created, are often the least complicated and least expensive part of the production of idea-based products. Technology and the virtual sphere cannot produce anything without the "knowledge worker," a person with the training and creative ability to use these resources to invent, design, and program. These workers are well paid, and have creative jobs that take advantage of individuals' unique talents, abilities, and, of course, knowledge. For this reason, most knowledge workers are well-educated, having completed a tertiary level of education.

Part of the reason that knowledge-based industry and idea-based products have fueled so much expansion of the global economy is that such products are often cheaper to produce, transport, and sell than physical products of traditional industries. The rapid permeation of the technological infrastructure in some societies has enabled individuals in many high tech markets to compete with corporations on a roughly even playing field.

This is the “flat world” that Friedman says has been rendered by the creation and expansion of the virtual sphere. In this flat world, most knowledge-based work is no longer done in one place, confined by geography, but is moved through cyberspace to workstations around the world, where international teams collaborate on the same digital project, be it writing computer codes or analyzing x-rays. This collaboration links workers from around the world in global production and supply chains unlike anything that is possible with physical objects. In this new sector of the global economy, products that never existed before are created everyday, and often consumed without ever being materialized or fabricated. Through this evolution of a parallel world of production and consumption, there has been significant expansion in the global economy and the number of markets it contains.

Perhaps the most fascinating aspect of the virtual sphere, and the one that best illustrates some of the advantages of virtual production over traditional manufacturing, is the fact that one finds fewer limitations than one finds in the solid world. With the internet came the spawning of a revolutionary economic activity previously unimaginable. A good example of the extent of virtual sphere opportunity is the phenomenon called “free source software”, which is produced and updated by teams of programmers who agree to make the product, and any improvements or “patches”, freely available to all. Such software includes the Linux operating system and competes directly with the software designed and produced by multinational corporations like Microsoft.

The production of free products rarely occurs in the physical world, where an individual item must be manufactured for each consumer. Software, like music, videogames, movies, and even literature, can now be produced with no resources besides

a trained mind, a computer, and some software, and then simultaneously sold, or given, to all consumers at once. Essentially, there is a marginal cost of zero. When profit rather than charity or hobby is the objective, one can produce a product only once, and then sell it billions of times. As a result, the potential of knowledge-based industry to create new wealth by mere expansion is far superior to traditional industry. It is theoretically limitless,[2] which has potential for a region striving to achieve sustainable development.

As knowledge workers in Latin America increase their use of ICTs to produce these types of products, each new creation greatly increases profit compared to input cost, which creates wealth for a given country when those products are purchased by consumers in other nations. One important characteristic of knowledge labor in general is that differences between individual worker's imaginations, skills, education etc. are much more significant than the potential differences between physical laborers that produce a manufactured product. Educated individuals in Latin America are just as capable as those in any other region or country to invent a new idea-based product, but their potential to do so and thus benefit their respective economy through "virtual exports" can only be realized when the necessary resources are available to them for that purpose. This is why technology development has become a priority for most LAC governments.

In this paper, I will explore the development of the internet and related technology in Latin America and the Caribbean (LAC). In particular I will address the nature of ICT resources and their use in the region, the national and international governmental strategies designed to improve them, and the principal obstacles to their further development. I will begin by summarizing the theoretical and historical framework surrounding ICT development in the region.

[2] Friedman 2005

Background and Observations:

Economic and Technological development in Latin America

Dependency theory, first postulated in Latin America in the sixties, is sometimes evoked in debates over the costs and benefits of globalization and ICTs for developing nations. The increasing role of high technology and knowledge-based industry in the global economy is one of the main concerns of Latin American economists and political leaders with regard to the perpetuation of their region's economic subservience.[3] These scholars and political leaders believe that not focusing on technology development will cause Latin American countries to become dependent upon wealthy economies with knowledge-based industries. This developmental concept is now referred to as the "digital divide" by the International Telecommunications Union (ITU), the World Bank, and other developmental organizations.

Furthermore, there exists a general consensus in the international community that economic development must involve enhancing technological infrastructures and building stronger knowledge-based industries in order to improve economic performance. Since virtually all these new technologies depend on the internet, this one technology in particular can be considered the foundation of a nation's technological infrastructure, and the most important resource to develop for the expansion of knowledge-based industry in the LAC region. To understand this Latin American context, I will provide some information regarding LAC's economic situation, and how it has been impacted by the rise of this new technology.

[3]For dependency perspectives on this topic, see Irogby 2005, Munck 2003, Smith & Smythe 2003, Oppenheimer 1998, Noriega 2004, Lula 2005, Chavez 2004.

Latin America emerged from the cold war as a mostly democratized region, with the obvious exception of Cuba. This has had positive consequences for international cooperation and organizational efforts that have advanced numerous regional development initiatives. However, the end of the twentieth century also left the region weakened by the Latin American debt crisis in the eighties, and many governments continue to operate on austere budgets and policies. The region has remained relatively peaceful and stable compared to the last half century, yet it has remained poor.

The history of Latin America's sub-optimal development of technology can be traced back to the 1980s. The 1980's have been called the lost decade by scholars of Latin America. Economically, inflation, the debt crisis, and exhaustion of Import Substitution Industrialization policies, forced most countries to adopt neoliberal IMF regulations, which crippled many existing industries, and slowed social spending to a trickle[4]. As a result, economic development was slow and focused on macro level improvement with existing industries which have not globally competitive, and social services like education went under-funded. During this time, investment in research and development of science and technology also began to fall and continued to decline until the twenty first century.[5]

This decade was the time in which Latin American technology fell behind that of Asia. In the 1950's, Latin America was considered to be the most advanced developing region the world. Yet by the 1980s-1990, large parts of Asia were developing much faster than Latin America, and performing better economically. This was a recent development

[4] Sheinin, David, "The New Dollar Diplomacy in Latin America", American Studies International; Oct99, Vol. 37 Issue 3, p81, 19p

[5] . Inter-American Development Bank Conference report: Latin American, Caribbean, and Asian Strategies for Science, Technology, and Competitiveness, "Latin American and Asian science and Technology Development Experiences Compared" March 2005

that did not pick up until after Latin America began its slide in the 1980's, and it was due in part to the fact that successful Asian economies were adapting to new technology, and had a good developmental context for integrating those resources.[6] This has led to the economic expansion analyzed by Friedman, as many knowledge-based jobs, including customer service call centers for major corporations and medical research and diagnostic work, have been outsourced from the U.S. and Europe to Asia in great numbers. Latin America, however, has not benefited in this way.

An economic policy perspective sometimes called the "Washington Consensus," has dominated policy making in most nations since the eighties. This theory holds that democracy, combined with neoliberal, free market policies, will allow all nations to find their competitive niches in the global economy and benefit from the open trade and capital markets of the developed nations. This has not only been the U.S. position on economic development, but also driven the policies of the international lending and development organizations like the IMF and the World Bank. These institutions have placed pressure on LAC governments to privatize state industries (including telecommunications providers), reduce spending on social programs (including education), and remove protections and subsidies for domestic industries.

Nevertheless, there is now a general consensus in the region that alternatives to neoliberalism, or at least adaptations of it, are necessary for Latin America to regain economic stability and prosper from globalization. Most LAC leaders view ICT

[6] A. Velho, Léa, "S&T institutions in Latin America and the Caribbean: an overview.", Science & Public Policy (SPP); Apr2005, Vol. 32 Issue 2, p95-108
B. Garrett, Geoffrey, "Globalization's Missing Middle", Foreign Affairs; Nov/Dec2004, Vol. 83 Issue 6, p84-96

development as an essential part of these new strategies.[7] Even the United States has modified its official position regarding development in the region; the State Department has acknowledged that developmental policies inherited from the twentieth century are inadequate to current needs, and also emphasized the importance of ICT resources to economic growth.[8]

In the 1990's, the technological component of their ongoing challenges became apparent to many Latin American leaders, and the necessity of supporting technological development throughout the developing world became a topic of international discourse through the U.N. By the year 2000, several international development programs were in place in Latin America, orchestrated through the OAS, the UN, the World Bank, Inter-American Development Bank, and other organizations, that helped develop a technological infrastructure for the region. This work continues today, and my analysis of internet technology development in LAC focuses on the impact of these initiatives.

One way of conceptualizing the phases of internet technology development, is to simplify growth in user-ship, or penetration, as a bell curve along a horizontal time axis beginning with the first internet user, and ending when there is no more marginal increase in internet penetration and the country is fully developed in that dimension. Throughout this process, the technology becomes more main-stream and the penetration rate rises. This has been typical of the integration of the internet in countries like the U.S. where enough time has passed under a favorable developmental context to reach the downward

[7] A. Smith, Peter J.1 & Smythe, Elizabeth2, "This is What Democracy Looks Like: Globalization, New Information Technology and the Trade Policy Process: Some Comparative Observations", Perspectives on Global Development & Technology; 2003, Vol. 2 Issue 2, p179-214,

B. Roberto Patricio Korzeniewicz; William C. Smith, "Poverty, Inequality, and Growth in Latin America: Searching for the High Road to Globalization**",** *Latin AmericanResearch Review*, Vol. 35, No. 3. (2000), pp. 7-54.

[8] Noriega, Roger, "Transitional Leadership in the Western Hemisphere", DISAM Journal of International Security Assistance Management; Fall2004, Vol. 27 Issue 1, p103-107

slope of gradually decreasing rates of penetration growth. The global context for this development can be illustrated using data from Internet World Statistics. This information is presented in table A.[9]

Table A: Global Internet Statistics

Internet World Statistics			
Region	**Internet Users in millions**	**Internet Penetration**	**Penetration growth 2000-2005**
World	1,023	15.70%	183.40%
North America	226	68.10%	108.90%
LAC	79	14.30%	337.40%
Asia	364	9.90%	218.70%

Latin America is on the upward sloping, or first, half of this process, and the differences in technological achievement between North and South America are clear-cut. In 2006, the U.S. and Canada account for 74.1% of users, meaning that all of Latin America combined only contains 25.9%, or just over 79 million of the more than 300 million users in the Western Hemisphere. Latin America is home to more than 62% of the hemisphere's population, yet in real terms there are more than twice as many internet users in North America. The most recent penetration growth rate measured for each region is for the period 2000-2005. While North America, minus Mexico, has seen its internet use grow by 108.9% in the last five years, Central American use has grown 522.3%, South America's has grown 282.8%, and the Caribbean's internet usage increased by 668.4%. The higher rate of penetration and slower rate of growth over the last period in North America confirm its status as more developed, and "over the hill" of the penetration curve.

[9] www.internetworldstats.com

Since the early 1990s, progress has been made in closing the technological gap that formed between LAC and parts of Asia. This occurred as several developmental programs, which I will analyze later, were established in the region. One can compare LAC and Asian technological development using a resource created by the International Telecommunications Union, a United Nations department concerned with telecommunications development and regulation, and Orbicrom, the U.N.'s network administrator. These organizations collaborated to create a new database called the ICT Opportunity Index. This resource was created at the request of the World Summit on Information Technology in 2003, because increased focus on the value of ICT resources had created demand for accurate systems for analysis of technological growth and development. This index is "an inclusive tool to measure economies' ICT networks, skills, and use."[10] It is the only resource to date that allows a cross sectioning of countries by technological development over time. The period of time covered in this resource is 1995-2003, and there are numerous, detail-oriented technological indicators used to compare nations.

The data show progress in LAC internet technology development vis-à-vis Asia, but also show room for improvement. The basic indicator of internet penetration is useful for evaluating the level of technological development achieved, since the internet is the key resource involved. According to this database, in 1990 Latin America and the Caribbean had 0.6 PCs per 100 people, and 0.0% internet use in the population. By 2003, there were 6.8 PCs per 100 (PC penetration) and 9.0% internet use per capita (internet penetration). In East Asia there was an increase from 0.6 computers/100 people to 9.5 in

[10] Measuring Infostates for Development, foreword, ITU-Orbicom 2005, retrieved online March 15 2006 at http://www.orbicrom.uqam.ca

2003, and the percentage of internet users increased from 0.0% to 8.9%. On this scale and timeline, it appears that Latin America has been roughly on par with East Asian developmental rates since the region joined the technological revolution. My research focuses on recent developmental progress since 2000.

Beyond an understanding of how the hemisphere is stratified technologically, a comparison of Latin America with Asia will further relate its degree of development. The following data comes from the Internet World Statistics website.[11] Compared to all of Asia, which had a growth rate of 218.7% and a penetration of 9.9%, Latin America's internet use seems to be leading in development with its aggregate growth of 337.4%, and an average penetration of 14.3% in 2005. This requires elaboration on claims that Asia is more developed than LAC. When scholars make this assertion, they are really referring only to the highly advanced nations such as Hong Kong, South Korea, Taiwan, Japan, Singapore, and Malaysia which have higher penetration and lower growth rates than most of LAC, as well as some less developed, but rapidly progressing, countries like China, India, and Indonesia. When one considers the entire region of Asia, collective technological performance is not as high as in LAC.

However, because of Asia's superior population resources, even at this relative rate of underdevelopment, the region already has 35.7% of the world's internet users. This is far more than the 7.8% in Latin America. Eight and a half percent of the world's population lives in Latin America, while more than half of it lives in Asia, so regardless of the relative changes in developmental status, Asia's internet users will remain larger in real terms over the long run. However, internet development is more complicated than just increasing PCs and internet users, and parts of Asia were more successful in making

[11] www.internetworldstats.com

productive use of their developing infrastructures than Latin America, and made more progress in integrating internet technology into primary and secondary schools.[12]

To be competitive with Asia in knowledge based industry, and increase its rate of internet penetration significantly beyond that of Asia, Latin America needs to develop its technological infrastructures more rapidly. This is why timely answers to the region's technological development problems are needed. To this end, I will now explain how my research and analytical framework illustrates the LAC context for internet development and can explain the progress therein.

[12] Friedman 2005

Data and Methodology:

Indicators of the LAC technology development context and progress

The primary question addressed in this paper is: how has the Latin American policy context for internet technology development influenced the expansion and integration of ICTs in the region? My hypothesis is that, first, the governments of Latin America, in part through collective programs within the OAS, were successful in identifying the importance of ICTs and in introducing them to the region. Second, there has been significant progress since the internet's inception in the development of this resource and its use. And third, that the general level of technological achievement in Latin America remains below expectations of the region's potential, requiring continued progress to achieve a desirable level of technological development and integration.

In order to test these hypotheses, I first selected specific Latin American countries to examine in detail. Brazil and Mexico are both large, powerful, and technologically developed nations in Latin America. I include these two in my analysis not only because of their economic significance, but also because they have been involved in the majority of OAS development programs. In addition, I include Guatemala, a nation at the lower end of the internet development scale, and average for the region in terms of the size of its population and size of its economy. Like Brazil and Mexico, Guatemala has been involved in development workshops and programs on technology development by the OAS, IDB, and other organizations. I will also consider the small but highly developed nation of Chile, which has higher quality ICT services and infrastructure than most nations. Each country is presented in a separate chapter, and is evaluated based on its developmental context and indicators of ICT development.

I must note here that, whenever I reference Latin America and the Caribbean (LAC) in the aggregate or provide data for the region, all of the Caribbean nations are included. Consequently, some readers may question my choice not to include a Caribbean nation in the comparative case study. I chose the nations which appear here because they represent the basic scale of ICT development in the entire LAC region and because there was sufficient literature available on their policy contexts to compare them, whereas the literature on Caribbean ICT development is relatively thin. In the Caribbean, the scale of ICT development is comparable to North and South America, ranging from Jamaica, which is slightly more developed than Chile, to Haiti, which is slightly less developed than Guatemala based on penetration and growth rate, as well as level of technological advancement. Thus, my four countries to represent the general scale of development in the whole region, and enable me to examine the policy context for development more closely than if I had to include a Caribbean nation.

In order to put these nations' relative technological development in perspective, I will compare them to the United States and sometimes to Canada, which are both high-income and highly developed nations. They are also participants in many of the international programs designed to enhance internet technology in LAC. In addition, I selected two Asian nations for comparison with my four LAC countries. First, I chose Malaysia, an upper-middle-income nation, like Chile and Mexico, which represents the highly developed Asian countries in this income group. As such, Chile and Mexico will be compared to Malaysia. Indonesia is a lower-middle-income nation, like Brazil and Guatemala, and is one of the more developed Asian nations in this category. Therefore, data on Brazil and Guatemala will be compared to Indonesia. At times, I will also

compare different indicators to the LAC average, as well as to the average for a specific country's income class.

To examine the hypothesized relationship between the "developmental context" of Latin American countries and the "expansion of ICTs" in the region, I will use two sets of indicators. The first set of indicators I selected to measure the "developmental context and progress" of each country were chosen on two criteria. First of all, sufficient data had to be available for all the countries examined. (At times, when useful information is available for only one or two countries, I will include it in order to provide more detail about the developmental experience in those countries.) A second criteria for the indicators I chose was that they had to be relevant to explaining the relationship between the developmental context and the progress made therein.

This first set of indicators pertains to the context for development in which the internet and related technologies have advanced in Latin America and is measured by way of a number of indicators.

First, education is an important aspect of the context for internet development because of the role of academic institutions in establishing the internet and contributing to its enhancement, as well as its role in producing skilled internet users through incorporating the technology into the curriculum. The first education indicator comes from the ITU's *infostates* report, and consists of each nation's ranking on an 85 point scale for tertiary (university) enrollment per capita in 2003. This indicator reveals the relative portion a population that receives the education and training necessary to be skilled knowledge workers. A second indicator related to education comes from the World Bank's ICT indicators project, and consists of the percent of primary and

secondary schools that connected to the internet in 2000 and 2004, which shows how many of these institutions are becoming a resource for internet access and training. ICTs develop most rapidly in an environment where there are many skilled internet users.

Second, the role of government programs and initiatives to promote internet technology development needs to be examined. While I will present the history of internet development in the region and the strategies employed on the national and international levels to increase internet use, capacity, stability, security, and productive potential. The individual programs and policies are explained within the individual country chapters. This information is vital to explaining the relationship between policy decisions and subsequent development in each country. I also include assessments of government regulation of ICT and ISP markets, as this too has greatly influenced development. I also include one indicator that quantifies this aspect of the developmental context, which is the World Bank's ranking of countries for "government prioritization of ICTs" on a scale of 1-7 in 2004. Ultimately, policies and government programs are the most easily adapted part of the development context that I consider, and this is why my research specifically addresses their role. I hope this work will be a small but meaningful contribution to evaluating contemporary technology development.

The third type of indicator of the developmental context is the nations' consumption of ICTs as a percentage of GDP in 2000 and 2004. This illustrates the amount of technological resources being acquired by citizens and businesses, which encourages the improvement of services and technology in the private sector. It also represents the significance of internet related technology to the economy as a whole. Generally, ICT expenditure is proportionally greater in wealthier and more developed

nations. Likewise, ICT expenditure is lower in less developed and poorer nations. In Latin America, socioeconomic constraints are a significant obstacle to optimizing private sector development and maximizing government initiatives.

These three types of indicators will be used to asses the context for development that I incorporate into each country chapter. Through the educational, governmental, and economic context of development, as indicated by the data, one can understand a substantial part of the forces that have operated in favor of ICT expansion, as well as those that have inhibited progress. The information related to these indicators is summarized in Table 1.

Table 1: Indicators of Development Context

Indicator	Measurement	Source of Data
Tertiary Education Enrollment Ranking	Rank on 85 point scale by % population	International Telecommunications Union (ITU)
Primary and Secondary School Connectivity	% of primary and secondary schools with internet access	World Bank
Government Prioritization of ICTs	Rank on 7 point scale of importance	World Bank
National Development Programs	Policies and programs to promote ICTs, variety and effect	(Chen 2003) (ITU 2005) (Gallegos 2001) (Shaw 2002) (Thomasson 2001)
International Development Programs	Initiatives to promote ICTs and their relative effect on the country	(Garrett 2004) (Financial Times 2002) (Velho 2005) (IADB 2005) (ITU 2005) (OAS 2003, 2004, 2005)
Regulation of ICTs/ISPs	Regulatory Policies of Government	World Bank (Coppock 2002) (Shaw 2002) (Thomasson 2001)
ICT Expenditure	Consumption of ICTs as % GDP	World Bank

The indicators I use to evaluate the progress in developing technological infrastructure and the internet in each country are more numerous. The first indicator used is internet user penetration in 2005 and growth in penetration over the 2000-2005 period. “Internet penetration” is the percentage of a given population that uses the

internet on a regular basis. All data for this indicator come from the Internet World Statistics website, which in turn gets its data from the International Telecommunications Union (ITU) and subscription market report services. The significance of this indicator to the phases of technology development was explained earlier in the Background and Observations section.

The next indicator used is for evaluating the size of the computer networks available to the growing population of internet users in each country. This is accomplished by examining two measurements: the growth in hosts (or computers with direct connections to the internet) per capita (host penetration) and per internet user. The former information is provided in the ITU's World Technology Indicators project, while the latter is an indicator I calculated from the ITU's data. To do this, I multiply the internet penetration (% population) by one hundred to get user per 10,000 inhabitants. I then divide hosts per 10,000 inhabitants by the product. The reason for expressing this information in both ways is that, while growth in hosts is important, the change in hosts per internet user over time reflects how network development is or is not keeping up with internet penetration. This influences the stability and reliability of the internet in each country. I compare the change over time from 2001-2004.

The next indicator for developmental progress is the increase in PCs, the primary piece of hardware for accessing the internet. This is measured first through PCs/1000 inhabitants in 2000 and 2004, using data from the World Bank. I also include the percent of PCs connected to the internet in 2002, midway through the period, for the four Latin American countries. This data comes from the Center for International Development at Harvard.

Next, PCs per internet user is measured in order to represent how the acquisition of hardware is developing relative to growth in internet penetration. This is an important indicator because it allows one to deduce how many people have their own means to connect to the internet versus how many rely on public access points of various kinds. In the more developed countries, PC penetration and PCs/internet user are higher values than they are for less developed nations, and represent a nation's resources relative to need for them (represented by internet penetration). The information included for this indicator comes from the ITU's World Technology Indicators project.

The next indicator of technological progress pertains to the quality and sophistication of internet technology, measured by the broadband subscriptions per 1000 inhabitants for each of the countries in 2000 and 2004. This information comes from the World Bank's ICT indicators project, and shows how this new technology, which is vital to many applications of the internet for productive use, has been integrated into the region. The values for each country are compared to the relevant income class and LAC averages.

The quality of the networks in each country is then evaluated by measuring total national bandwidth in 2000 and 2004. The capacity of a nation's networks is an important aspect of development because, the greater it is, the higher the volume and sophistication of use it can handle. The information for this indicator also comes from the World Bank, and is compared to income class and LAC averages.

The security of networks is a vital area of development for enhancing their usefulness to productive applications, e-commerce, e-government, and other uses that require protecting valuable information. To evaluate this aspect of development, I

examine growth in servers that use secure encryption technology from 2000-2004, and compare this information to each country's income class and the LAC average. This information comes from the World Bank's ICT indicators project.

Finally, I evaluate the progress of the competitive ISP markets in lowering prices to make internet access affordable for greater numbers of citizens. The average price of a month of internet service in 2004 is compared to the income and class averages for each country. This indicator helps show the extent to which socioeconomic restraints affect growth in internet penetration, and the information comes from the World Bank. The information related to these indicators is summarized in Table 2.

Table 2: Indicators of ICT Expansion

Indicator	Measurement	Source of Data
Internet Penetration	% Population that uses internet regularly in 2006	Internet World Statistics
Growth Penetration	% Growth in penetration from 2000-2005	Internet World Statistics
Total users	Internet Users in millions 2006	Internet World Statistics
Hosts per 10,000	# of hosts per 10,000 residents 2004	International Telecommunications Union (ITU)
Hosts per Internet User	# of hosts per internet user 2004	International Telecommunications Union (ITU)
Change in host per internet user	change in hosts per user 2001-2004	International Telecommunications Union (ITU)
PCs per 1000	# of PCs per 1000 residents 2004	World Bank
PCs per internet user	# of PCs per internet user 2004	International Telecommunications Union (ITU)
Change in PCs per user	change in PCs per user 2001-2004	International Telecommunications Union (ITU)
Broadband	# of broadband subscriptions per 1000 residents 2004	World Bank
Bandwidth	bits per person 2004	World Bank
Change in Bandwidth	change in bits per person 2000-2004	World Bank
Secure Servers	# of servers with secure encryption technology per one million residents 2004	World Bank
Cost of Internet Access	average cost of one month of internet service in USD 2004	World Bank

In each case mentioned above, the indicator value for each LAC country is compared to that of the others, in order to illustrate the differences in development between the nations in different dimensions. In addition, I continually elaborate the links between the developmental context indicators, and those that measure development over the 2000-2005 period. Whenever possible, I point out relationships between the two, in order to illustrate which developmental aspects are contributing to current progress, and which ones are a part of persisting obstacles to development.

Before ending each main chapter by drawing conclusions about the success and failures of internet technology development for each country, I will discuss some of the primary challenges facing contemporary development in each country. This helps to identify which indicators are the most relevant to problems in each country. In this way, I can explain how current strategies approach each obstacle, as well as what would be good strategies for future development, based on the contextual and progress oriented indicators I discuss. To help keep track of all these comparisons throughout the paper, I have created two running tables to summarize the indicators for development context and progress, at the end of the corresponding section of each chapter. This completes the summary of my analytical framework and the data I consider. Now I'll proceed to the first individual country chapter on Mexico.

Chapter 2: Mexico

In this chapter, I will examine Mexico's national context for development, and explain how this context influences the ongoing development and expansion of internet technology in the country. The first part of this analysis, describing and evaluating the context for development, will focus on Mexico's participation in various regional developmental projects related to the internet, its connection to and support of regional networks, government regulation of ISPs, the population's total expenditures on ICTs, the government prioritization of ICT development, as well as tertiary enrollment, and the integration of the internet into primary and secondary schools. This information provides a basis for determining some of the primary political, economic, and social forces that influence the expansion of ICTs.

The second part, an analysis of recent progress in internet development, will examine the various indicators of ICT growth outlined in the previous chapter: internet penetration by population, PC penetration per capita and per internet user, percent PCs connected to the internet, host penetration per capita and internet user, broadband technology growth, national internet bandwidth, the number of secure encryption servers per capita, and the average price of internet connections. I will note the changes in these figures over time where information permits. This information provides the basis for an explanation of Mexico's relative level of technological integration and resources, and will be supplemented by additional information regarding types of connection, location of access, and a demographic breakdown of use by education. These supplemental indicators are drawn from data available for Mexico, but not the other countries covered in this paper.

Throughout both sections of this chapter, I will compare Mexico's progress and achievement to that of the LAC region and North America, as well as to Malaysia, which is a highly developed Asian nation in Mexico's upper-middle-income bracket. I will conclude the chapter by explaining some of the principal obstacles to continued development, and summarize the relationship between Mexico's developmental context and its actual progress in expanding and enhancing internet technology since 2000.

Section I: Mexico's Development Context

Mexico is one of the most important nations in terms of its contributions to internet technology development in Latin America. It is the most populous Spanish speaking nation in the world, and the second largest internet market in Latin America behind Brazil, with more than 14 million internet users in early 2005.[13] By 2001, the majority of the population (Between 85-90%) had the "basic knowledge necessary to use computer technology."[14] There is, however, an obvious difference between ability and capability to use the internet. This is reflected in an internet penetration rate of 7.47% for that year, according to the International Telecommunications Union.[15] The penetration level surpassed 16% in 2005, suggesting that progress has been made in reducing the gap between potential and actual users.

Part of the challenge to increasing use is the distribution of technology throughout the education system. While most of the population is literate and completes some elementary education (thus being capable of following directions and operating a

[13] Internet World Statistics, Usage and Population Statistics, Mexico, retrieved online March 10, 2006 from http://www.internetworldstats.com/am/mx.htm
[14] Gallegos et al, Access in Mexico p4, TILAN May 2001, retrieved online March 12, 2006 from http://lanic.utexas.edu/project/tilan/reports
[15] World Telecommunications Indicators, ITU March 2006, retrieved online March 15, 2006 from http://www.itu.int/ITU-D/ict/statistics/

computer), many have not acquired training or familiarity with computer and internet technology because it was not taught at their schools. Though individuals can and do learn to use the internet outside of school, there is, unfortunately, no reliable data on how many families could afford a computer or have one in the home, and there is no standard of internet related knowledge for what is learned outside the education system.

Most of the academic exposure and access to computers and the internet has traditionally occurred at the University level, a level of education not achieved by a large portion of the population. When Mexico first connected to the internet in 1989, internet use was an exclusively academic activity, limited to the Monterrey Tech University, and until the government became involved in developing a national network in 1994, there was no trickle-down of internet use in primary or secondary schools. A major barrier to lower education uptake of the technology that has persisted since then is access to hardware,[16] a socio-economic issue discussed later in this chapter.

Fortunately, it appears that Mexico's internet penetration in primary and secondary schools is becoming less of a problem than it was in the first phases of internet development in Mexico. Achieving a high level of internet penetration in primary and secondary schools is essential to expansion of internet technology and growth, because it exposes individuals to the technology who may not use it in the home or at their job as adults. According to the World Bank, in 2004, 60% of these academic institutions were connected to the internet, equal to the average for all upper-middle-income nations.[17] No data was available to compute this figure for 2000, so how much of this growth has been

[16] Thomasson et all, The Diffusion of the Internet in Mexico, LANIC, University of Texas at Austin, 2001, retrieved online March 14, 2006 from http://mosaic.unomaha.edu/gdi.html

[17] ICT At a Glance Tables, from Information and Communications for Development 2006: Global Trends and Policies, World Bank 2006, retrieved online, March 20, 2006 from http://devdata.worldbank.org/ict/mex_ict.pdf

in the most recent years is uncertain. However, the absence of sufficient data for that year means the percentage was probably still very low at that point.

The International Telecommunications Union and Orbicom, the international network of UNESCO, created a report called "Measuring *Infostates* for Development" in 2005. This report relies on education statistics from all countries to compute the probable "skills" level for each population in internet use. The raw data for enrollment of each nation is not included in the report, instead as they do for all indicators, the researchers created an index, ranking all nations relative to each other. Mexico's relative ranking in tertiary enrollment by population, was 20.5 on a scale of 85 in 2003, behind the U.S. and Canada (71 and 60). It also ranked behind Malaysia (26), which is one of the technologically developed Asian nations that, like Mexico, is in the World Bank's upper-middle-income class.[18] This demonstrates the importance of university enrollment to a nation's potential for expanding its internet-user population. Additionally, it is important to remember that various international development agencies use tertiary enrollment as a technology development indicator because university students are expected to be more highly skilled internet users, and more likely to become knowledge workers that use the internet productively.

In addition to the slower uptake of internet technologies in primary and secondary institutions in Mexico, lower tertiary enrollment in Mexico has contributed to a lower internet penetration than that of its North American neighbors and the advanced middle-income Asian nations. This continues to be the case, according to Mexico's national internet association (AMIPCI) in 2005. Their annual report shows that university

[18] Measuring Infostates for Development, table 3.4, ITU-Orbicom 2005, retrieved online March 15 2006 at http://www.orbicrom.uqam.ca

graduates are only 9% of the population, but at 20% of the nation's internet users, they are the largest group, greater than each of the other less and more educated (masters, PhD) groups. Those who complete only primary education, nearly 15% of the population, represent only 2% of internet users.[19] One would expect a growing tertiary enrollment to lead to an increase in Mexico's total internet penetration, so the persistence of a low rate of university attendance should be considered an obstacle to increasing internet use. Unfortunately, this information, like most of the useful figures in the AMIPCI, is not available for the other countries in my report. It is probable, given the trend of university involvement in internet development throughout the region, that these figures would be similar in other LAC countries.

In addition to the importance of integrating internet technology into education and the prominent role played by universities in establishing the internet in Mexico, the national policies and international development programs in the country are important aspects of Mexico's developmental context as well. The World Bank ranks all governments' prioritization of ICT development, including spending, number and variety of special programs, incorporation of e-government services and other factors, on a seven point scale. No data is available for 200l, but in 2004, Mexico ranked 4.2, 0.1 increments above the average for upper-middle-income countries, and 0.7 above the regional average for Latin America and the Caribbean. Malaysia's ranking is a full point above Mexico's at 5.2, reflective of the observations of Thomas L. Friedman, who wrote about the success of progressive government programs and policies in "teching-up" the advanced Asian nations, allowing them to surpass Latin America. Nevertheless, government

[19] Habitos de Usuarios de Internet en Mexico 2005, AMIPCI, retrieved online March 15, 2006 from http://www.amipci.com.mx/docs/Presentacion_Estudio_AMIPCI_2005_Presentada.pdf

initiatives and policies, both national and international, have been extensive and valuable to Mexico's internet development. One example of this was the decision to build *RedEscolar*, Mexico's educational network for primary and secondary institutions, on the open-source Linux operating system. The standardization of Linux in Mexico's schools saved the government a lot of money over commercial software, conserving resources for other developmental initiatives.[20]

Mexico was one of the promoters of *RedHUCYT*, the first program of the OAS, developed in 1991, to provide internet connections for academic institutions throughout Latin America. This network also received funding and technical support from the U.S. government, through USAID, the National Science Foundation, and other institutions.[21] In addition, Mexico plays an important role in promoting technology training and education throughout Latin America via its *Edusat* satellite programming which it has offered free of charge since 2002.[22] The university system has continued to remain at the forefront of internet development in the region, including establishing a connection to Internet2 in 2000, which is the U.S. Special University and Research Network that has a high bandwidth capacity for data transfers related to academic endeavors, but excludes "extraneous" sites available on the standard World Wide Web.[23] This is significant to the development of Mexico's internet technology for two reasons. First, it provides the

[20] Coppock et all, ".mx", Center for International Development at Harvard 2002, retrieved online March 14, 2006 from http://lanic.utexas.edu/project/tilan/countries/mx/
[21] "Contribution of the RedHUCYT-OAS in the Area of Connectivity", OAS Jan 24, 2003, retrieved online March 20, 2006 from http://www.redhucyt.oas.org/presentationsSH/Outlook%20of%20Connectivity%20at%20the%20OST.pdf
[22]"MEXICO RENEWS EDUCATIONAL SATELLITE OFFER TO LATIN AMERICA, CARIBBEAN", London Financial Times, November 16, 2002
[23] Thomasson et all, The Diffusion of the Internet in Mexico, LANIC, University of Texas at Austin, 2001, retrieved online March 14, 2006 from http://mosaic.unomaha.edu/gdi.html

nation's universities with the same internet based resources available to the U.S. and other partner nations, enhancing the technological aspect of education for future knowledge workers, which will make them more competitive. Second, it allows Mexican university staff and students to be active in and aware of the continuing development of internet technology by the academic community, ensuring the country's ability to contribute to and benefit from this area of development in the future.

Mexico was also one of the first countries to be connected to *RedCLARA*, the first regional research and education network based in LAC, which has facilitated the sharing of data, instruments, software and other resources amongst the region's academic and scientific research institutions. This network began in 2004 and now connects most countries in Latin America. It is still being constructed and expanded and is composed of high capacity, fiber-optic cable.

It receives government protection from economic barriers to entry (and help overcoming physical ones) that could be presented by existing national and regional commercial networks in the member countries. The program also provides funding through member and nongovernmental organizations for augmenting and modernizing the networks and hardware of less developed institutions in order to maximize their ability to utilize the high-tech RedCLARA.[24] In addition, this network is a developmental associate of ALICE, a EuropeAID project designed to create a parallel network to connect Mexico and countries to the Pan-European Geánt research network.[25]

[24] "Report on The First Meeting of Ministers and High Authorities on Science and Technology Nov. 2004", OAS Inter-American Council for Integral Development, Feb 17 2005, retrieved online Feb 2006 from http://www.science.oas.org/Ministerial/ingles/documentos/docfinales/INFORME%20FINAL%20-%20FEBRERO%2017-ENG.pdf

[25] "National Research and Education Networks in the Americas, and the Latin American advanced Networks Cooperation (CLARA)", OAS Inter-American Council for Integral Development, Oct. 25, 2004,

In addition to its contributions to these international internet development programs and corresponding networks, Mexico contributes to the overall functioning of the internet in Latin America, as a major hub for international exchanges online. According to the ITU, in 2002 Mexico City was the fourth, and Monterrey the eighth, biggest hub city in Latin America ,[26] illustrating the significance of Mexico's networks to the functioning and development of internet in the entire LAC region.

Much of the progress Mexico has made in its own development of internet resources is the result of an early start compared to most of the region. This, in turn, was largely the result of cooperation between the government and universities, and the OAS development programs such as the Office of Science and Technology and the Inter-American Development council's initiatives. In addition, successive periods of deregulation and increased competition drove down prices and increased the number of national networks in the country. In Mexico up to 50% foreign ownership in ISPs is allowed by law, and this is typical of most of Mexico's ISPs.[27]

However, these same policies have created complications, the most prevalent of which is the unequal geographic penetration of the internet in Mexico. When Telmex, the original state-owned telecommunications company, started offering commercial service on the first national backbone, it was the only ISP in the country, and had a government mandate to use profits from high density urban centers to fund the expansion of networks into the rural parts of the country. This government network quickly became

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retrieved online Feb 2006 from http://www.science.oas.org/Ministerial/ingles/documentos/REMCYT-I-INF4-ING.pdf

[26] Robert Shaw, "Creating Trust in Critical Network Infrastructures: The Case of Brazil", May 20, 2002, retrieved online March 16, 2006 from http://www.itu.int/osg/spu/casestudies/index.html

[27] Thomasson et all, The Diffusion of the Internet in Mexico, LANIC, University of Texas at Austin, 2001, retrieved online March 14, 2006 from http://mosaic.unomaha.edu/gdi.html

outdated and its capacity has not kept up with the newer private networks that have outpaced it. It is still the only internet provider in many of the rural areas, but it can no longer subsidize further expansion in those regions due to increased competition.[28]

Mexico has established several strategies to deal with this problem, including the E-Mexico project announced by Vicente Fox in 2001, the goal of which was to provide internet access to the entire population by 2006. As the contemporary AMIPCI, ITU and other data clearly indicate, this program has fallen far short of its goal, as penetration is still below 20%. There are some regional projects of interest in Mexico that address this problem, one of the most interesting of which is in the city of Chihuahua, where the municipal government has paid for the installation of 70 miles of high speed fiber optic cable below public streets.

These cables now connect more than 30 government, education, healthcare, and research institutions to the World Wide Web and a local area network, at prices far below those of the national ISPs whose services are exclusively priced in the region.[29] Ultimately, the contributions of international development programs to network expansion, and the role of government regulation of and policies promoting internet technology are greatly responsible for Mexico's developmental progress. These programs and policies have played a key role in ICT growth as sources of funding, equipment, and connectivity, as well as regulation.

In addition to the educational and political aspects of the Mexican technological context, one should consider the relative size and importance of the internet and related

[28] Thomasson et all, The Diffusion of the Internet in Mexico, LANIC, University of Texas at Austin, 2001, retrieved online March 14, 2006 from http://mosaic.unomaha.edu/gdi.html

[29] "Report on scientific and Technological Development in the Americas", April 4, 2004, OAS Office of Science and Technology, retrieved online March 20, 2006 from http://www.science.oas.org/Ministerial/ingles/documentos/REMCYT-I-INF10-ING.pdf

technology (the ICT sector) to the economy as a whole. The World Bank reports that total expenditure on ICTs as a percent of GDP remained stagnant over the period 2000-2004 at 3.1% in Mexico. This is significantly lower than the 5.0 % average for Mexico's economic bracket, as determined by the World Bank. It is lower than Malaysia which spent 6.9% GDP in 2004, and below the 5.3% average for the LAC region.[30] This is a significant aspect of Mexico's developmental context because, in a deregulated market, technological progress will grow as fast as the demand for it. The relatively low level of private ICT consumption in Mexico limits the increase in hardware and services necessary for network expansion, increasing the burden on the government to support it. As a result, the country's relative internet technology resources do not keep up with the increase in their use, as I will show later in the chapter. The data related to these statistics is summarized in Table 3.

Table 3: Development Context (Mexico)

Indicator	MX	MA	LAC	UM	US
Tertiary Enrollment	20.5	26	na	na	71
% Primary & Secondary schools connected	60	na	na	60	99
Govn't ICT priority on 7 point scale	3.1	6.9	5.3	5	8.8
National Development Programs	G	na	na	na	na
International Development Programs	G	na	na	na	na
ICT/ISP regulation	C	C	na	na	VC
% GP of ICT Expenditure	4.2	5.2	3.5	4.1	5.2

P (Poor) F (Fair) G (Good) VG (Very Good)
C (Competitive) VC (Very Competitive) UM (upper-middle income) LM (lower-middle income)

[30] ICT At a Glance Tables, from Information and Communications for Development 2006: Global Trends and Policies, World Bank 2006, retrieved online, March 20, 2006 from http://devdata.worldbank.org/ict/mex_ict.pdf

The overall context for development in Mexico, according to these indicators, is mixed. On the positive side, Mexico has a good policy environment that involves diverse national and international programs designed to enhance multiple aspects of ICTs in the country. Mexico also had an early start compared to most of the region, which allowed time for this policy environment to develop before the 2000-2005 growth period that I examine in detail in the next section. Current policies in the country are helping to bring Mexico up to comparable internet connectivity in primary and secondary education, based on regional and income-class averages, and progress in integrating ICTs into these institutions continues. On the less favorable side, Mexico's tertiary enrollment, a predictor of the size of its knowledge-labor force, remains low. Spending on ICTs, a principal force behind private sector ICT expansion, is significantly lower than the LAC and lower-middle income averages. It must increase in order to maximize the benefits of a deregulated ICT market to the country's technological development. As the World Bank's government prioritization of ICT indicates, Mexico is doing better than the LAC average and on par with its income class in doing its part to promote technology, yet it could do more to prioritize ICTs, as indicated by higher values for Brazil, Chile, and Malaysia.

Section II: ICT expansion in Mexico

Now I will examine the progress that Mexico has made under the basic conditions outlined above, by analyzing several indicators I selected to measure growth in use, networks, PC ownership, and quality of technological resources. I will put this information into regional perspective using LAC averages, and will include U.S. values to show Mexico's developmental progress compared to the economic and technological

leader of the hemisphere. In order to place Mexico's development in a global context, specifically in relation to the Asian Nations that are ahead of Latin America technologically, I will compare Mexico with Malaysia, which is a highly-developed nation of comparable wealth to Mexico. Throughout this section, I will relate Mexico's progress in internet technology development to the developmental context set out above.

To understand how internet technology in Mexico has been developing recently, the penetration rate, or percent users by population, is the first thing to consider. According to Internet World Statistics, penetration grew by 526% from 2000 to 2005, and by the time this paper was written in March 2006, it had exceeded 16%. This is above the regional average of 14.3%, but less than half of Malaysia's penetration, which reached 36.7% after growing 171% from 2000-2005. Mexico's penetration is well below the U.S. rate of 68.1% in 2005, one of the highest in the world. Growth in internet users is a principal indicator of Mexico's development in the regional and global context. The high rate of growth signifies an earlier stage of development than nations like Malaysia and the U.S. where growth in penetration has been less dynamic in recent years. However, despite being less developed than Malaysia in this dimension, Mexico's much larger population means that its total user population of seventeen million is more than 50% greater than Malaysia's ten million.

In order to evaluate the impact of a growing user population on internet technology development, one must examine the changes taking place in the networks that support it. One interesting network indicator that can be derived from research done by the ITU is the number of hosts, or PCs with direct connections to the internet, per *internet user*. This can be computed by multiplying penetration, or percent users in the population

by 100, and then dividing the hosts/10,000 inhabitants by the product. This indicator is more important than host penetration per capita because the relative number of hosts a country needs depends on how many people are going to use them, rather than on the total number of inhabitants.

Mexico's user penetration grew more than the hosts per population between 2001 and 2004. As a result, Mexico fell slightly from 0.12 hosts per internet user in 2001, to 0.11 hosts per user in 2004. Malaysia's networks developed more evenly with user penetration, allowing the country to increase its hosts per user from 0.11 to 0.14. At the end of the period, Canada had 0.18 and the U.S. had 1.05.[31] This is an important indicator because, while Latin American internet penetration has been growing significantly, in many cases faster than in North America or the advanced Asian countries, the networks and hardware acquisition have not grown fast enough to keep up with demand. As a result, the networks of countries like Mexico are relatively underdeveloped in that dimension.

This situation in which there is higher demand for internet use than the supply in the internet service market is accommodated through the slow increase of internet resources within schools and libraries, as well as by the large increase in local cybercafés. Sometimes they are nothing more than a shack with a line of computers hooked up and some candy and soft drinks for sale. Sometimes these cybercafés are high class, Starbucks-like coffee houses with computers and wireless access (which is a new technology to Latin America that has not yet penetrated much of the region). According to AMIPCI in 2005, 30% of Mexico's internet users primarily accessed the internet in a cybercafé, the most affordable option available in many places to the general public. This

[31] Table 4

compares to usage data published in 2002 that showed that users who operate somewhere besides work, home, or school only accounted for 18%.[32] The frequency of computer rental among such a large percent of internet users means that the portion of business PCs being used in cybercafés, besides generating profit for the shop, also provides the primary internet access to more than five million Internet users in Mexico.[33] These same PCs also cause the estimated home, or private, PC use figure to be significantly lower than the actual number of people accessing the internet away from work or school. Ultimately, cybercafés in Mexico and other Latin American countries are an end run around socioeconomic barriers to internet use, and they benefit a large number of people while contributing to the service sector of the economy.

The popularity of cyber cafes also relates to PC penetration, which can be evaluated in multiple ways thanks to the prevalence of information on PC ownership in Mexico. According to the World Bank's ICT data, Mexico's PCs per1000 inhabitants increased from 58 in 2000 to 84 in 2004, greater than the 2004 regional average of 75, but less than the income-class average of 99. Malaysia is far ahead of Mexico in this regard, as its PC penetration grew from 95 to 170 PCs/1000 over the same period.[34] The United States had 760 PCs/1000, representing the high end of the development scale in this dimension.

The significance of the PC as the primary tool of internet access is obvious, and Mexico's relative PC penetration is low compared to highly advanced countries like the

[32] Wenhong Chen and Barry Wellman, "Charting and Bridging digital Divides: Comparing Internet Access and Use in Eight Countries", AMD Global Consumer Advisory Board Oct 27, 2003, retrieved online March 10, 2006 from www.amdgcab.org
[33] Habitos de Usuarios de Internet en Mexico 2005, IAMPCI, retrieved online march 15, 2006 from http://www.amipci.com.mx/docs/Presentacion_Estudio_AMIPCI_2005_Presentada.pdf
[34] ICT At a Glance Tables, from Information and Communications for Development 2006: Global Trends and Policies, World Bank 2006, retrieved online, March 20, 2006 from http://devdata.worldbank.org/ict/mex_ict.pdf

United States, where throughout the four year period, there was more than one PC for every internet user. One could assume that this allows for more frequent and convenient use of the internet by individuals with access to multiple computers connected to the internet, a luxury few Mexican's or Malaysians are likely to have, but one that, by the mere fact of enabling people to spend more time online, increases potential knowledge-based production and e-commerce.

The ITU World Technology Indicators project reported that PC penetration per person increased at least one percent each year from less than 7% in 2001, to more than 10.5% in 2004. In 2001, 11.18% of PCs were connected to the internet,[35]and according to AIMPCI, and now nearly two thirds of Mexican PCs are connected to the internet.[36] To get an idea of how well PC ownership is keeping up with demand, the World Technology Indicators data from ITU can be used to calculate PCs per internet user. By 2004, there were 0.80 PCs per internet user, down from 0.90 in 2001. This compares to Malaysia's increase over the period from 0.4 PCs/internet user to 0.5 in 2004.[37] These figures indicate Mexico's relatively high level of development in the size of its computer networks, which remain larger than Malaysia's growing networks, despite a moderate decline in this value.

Mexico's current superiority over Malaysia in this dimension of development could be lost, however, unless PC ownership can continue to grow at a rate comparable to internet penetration. In Malaysia's case, we see that the country's PC penetration is catching up to internet use, the latter of which obviously grew faster during earlier stages

[35] Coppock et all, ".mx", Center for International Development at Harvard 2002, retrieved online March 14, 2006 from http://lanic.utexas.edu/project/tilan/countries/mx/
[36] Habitos de Usuarios de Internet en Mexico 2005, IAMPCI, retrieved online march 15, 2006 from http://www.amipci.com.mx/docs/Presentacion_Estudio_AMIPCI_2005_Presentada.pdf
[37] Table 4

of development. Since Mexico is still at an earlier level of internet development than Malaysia, it is possible that a period of significant growth in use without comparable growth in PC penetration could occur in the future, thus diminishing Mexico's relative development in this aspect. Hopefully, the continuation of government programs to make PCs more affordable, combined with an increase in public access points like cyber-cafes, will keep the ratio of PCs to internet users from creating a shortage of hardware, and limiting internet activity in the country.

Mexico's network infrastructure is relatively high-tech compared to much of the region. In 2005, 43% of internet users accessed the internet via broadband, and another 20% accessed the internet via cable internet services.[38] According to Internet World Statistics, broadband use in Mexico grew 200% in 2004, and this figure remained high subsequent to that, when the competing telecommunication companies in Mexico starting offering "Triple Play Services" a cable, high-speed internet, and basic telephone service package at a discount.[39] Broadband subscriptions for the period 2000-2004 rose from 0.2 per 1000 people to 3.1 in 2004, slightly below the upper-middle-income average of 3.7, and below the average for the region, which is 5.2, largely because of a much higher rate in the most developed LAC countries like Chile. Compared to Malaysia's broadband subscriptions, which grew from 0.0/1000 in to 10/1000 over the period, Mexico appears even more underdeveloped in this dimension.[40] Because broadband is widespread in the

[38] Habitos de Usuarios de Internet en Mexico 2005, IAMPCI, retrieved online march 15, 2006 from http://www.amipci.com.mx/docs/Presentacion_Estudio_AMIPCI_2005_Presentada.pdf
[39] Internet World Statistics, Mexico Profile, retrieved online March 16, 2006 from http://www.internetworldstats.com/am/mx.htm
[40] ICT At a Glance Tables, from Information and Communications for Development 2006: Global Trends and Policies, World Bank 2006, retrieved online, March 20, 2006 from http://devdata.worldbank.org/ict/mex_ict.pdf

advanced countries and is essential to most highly sophisticated internet applications, it has become an essential part of further development for nations at Mexico's level.

Another way of examining this issue is of bandwidth is by looking at Bits per person. Internet bandwidth in bits per person increased from 9 to 108 over the same 2000-2004 period. This number is more than 50 bits per person lower than the regional, and upper-middle-income averages. Malaysia increased its bandwidth per capita from 23 to 127 bits, a greater increase than that in Mexico, but this must take into account its smaller population. Malaysia still has a clear advantage in this respect for long term development, however, because virtually every citizen is a potential user, and thus a potential strain on the networks. While Mexico's bandwidth has likely increased significantly since 2004, it is not possible to know if this improved the nation's standing, or whether this has been neutralized by bandwidth growth in most other countries.

Bandwidth is a significant indicator of development because it determines the networks' maximum capacity, which in turn can limit the speed and stability of internet connections as the percentage of the population using the internet increases. Despite Mexico's advanced, high-speed networks and international connections, its network capacity is not ready for a significant increase in user penetration in the near the future.

The number of servers by population that use secure encryption technology, an important resources for generating e-commerce, e-government, and other advanced internet use, more than doubled from 2000-2004. In 2004 there were 6.1 per million in the country. This is lower than the regional average of 8.6 and the upper-middle-income average of 10.7 for 2004. Malaysia, which already had 6.1 secure servers/million

inhabitants in 2000, had 11.3 in 2004.[41] Mexico's much larger population makes it difficult to compare the two countries' secure server penetration in isolation, but when one looks at the U.S., which has a larger population than Mexico, the figure of 674.9/million, confirming that, despite a large population, Mexico's secure server penetration is in fact low. This is an important area of development on which the nation should work because, according to the AMIPCI, the majority of citizens who say they have never bought anything online indicated a lack of confidence in the security of the internet, and fear of electronic theft, as their primary deterrent.[42] It is clear that there needs to be significant progress in the growth of secure server technology if Mexico is going to become part of the rapidly growing internet-economy, which includes a vast array of digital economic transactions on the web.

Finally, progress in the competitiveness of Mexico's ISP market vis-à-vis the regional and income-class averages can be compared by examining the cost of monthly internet service. According to the World Bank, Mexico's average price for monthly internet access in 2004 was U.S. $22.60, much lower than the regional average of $31.50, but slightly higher than the average for all nations in Mexico's economic bracket, and much higher than the $8.40 average in Malaysia, whose ISP market regulation, like that of Mexico, was considered competitive by the World Bank. The $15.00 average in the U.S. was also significantly lower than Mexico when one considers the purchasing power parity. It is important to bear in mind, though, that new ISP bundle services have made

[41] ICT At a Glance Tables, from Information and Communications for Development 2006: Global Trends and Policies, World Bank 2006, retrieved online, March 20, 2006 from http://devdata.worldbank.org/ict/mex_ict.pdf

[42] Habitos de Usuarios de Internet en Mexico 2005, AMIPCI, retrieved online march 15, 2006 from http://www.amipci.com.mx/docs/Presentacion_Estudio_AMIPCI_2005_Presentada.pdf

internet and other ICT services more affordable since these data were collected. This may have reduced the average price so that it is closer to the upper-middle-income average of $20.80. Lowering the price of service is one of the benefits often noted in support of privatization in ISPs, and in Mexico, compared to the rest of LAC, there has apparently been progress in this regard, but not enough to make internet access as affordable as it is in other nations that are more technologically developed in other dimensions, such as Malaysia. It is possible that, in subsequent phases of internet technology development, Mexico will see a significant decrease in connection costs, as long as the government continues to promote competition in the market. The data relevant to these indicators is summarized in Table 4.

Table 4: ICT Expansion (Mexico)

ICT Expansion by comparison															
Country or group	Int. Pen. 2006	Δ Pen. 2000-2005	Int. Users in Millions 2006	Hosts per 10,000 2004	Hosts per Int. User	Δ hosts/ user 2001-2004	PCs per 1000 2004	PCs per user 2004	Δ PC/ user 2001-2004	Broad band/ 1000	Band width Bits/ person	Δ B.W. 2000-2004	Sec. servers per million	Av. price Int. service USD
US	68.1	114	203.0	6645.00	1.06	0.23	760	1.21	-0.04	129.0	3308	2914	675.00	15.00
Malaysia	36.7	171	10.0	52.81	0.14	0.03	170	0.50	-0.10	10.0	127	104	11.30	8.40
Mexico	16.2	526	17.0	145.17	0.11	-0.01	84	0.80	-0.10	3.1	108	99	6.10	22.60
LAC	14.3	337	80.0	na	na	na	75	na	na	5.2	165	na	8.60	31.50
UMI	na	na	na	na	na	na	99	na	na	3.7	176	na	10.70	20.80

There are certain obstacles common to the region that face Mexico in furthering its internet development and integration, and no assessment of the roots and extent of progress is complete without considering them. Two of the most significant are a consequence of the demographic disparities in use, similar to that between persons who attend college and those who do not, as discussed at the beginning of the chapter. One that is considered significant by the authors of “Access in Mexico” (from the Trends in Latin American Networking project of LANIC) is racially based social discrimination in

the media and advertising that reflects the underlying cultural hierarchy of a whiter upper class. The *mestizo*[43] majority in the country is not represented in much of the programming and advertisements that promote the use of the internet.[44] Thus, many of Mexico's citizens may not perceive that this new technology could actually benefit them, a conception reinforced by the greater technological resources available in private schools attended by much of the upper, whiter class. As a result, *mestizo*s are less aware of the material available online that would be of interest to them.

In the United States, where internet penetration is much higher, it is rare to see anything advertised without appealing to a multi-racial consumer-base. Considering the fact that this same type of racial bias persists in the economies and media of other Latin American nations, it is likely that this social phenomena also affects the demographic disparities in internet penetration throughout the region. Other scholars have also expressed concerns that the "racial hierarchy" has created an ethnic divide, despite there not being data on use by ethnicity in Mexico.[45]

A second and more universal factor contributing to Mexico's demographic penetration is economic in nature. Since the implementation of IMF austerity measures, privatization, and liberal market rules in the 1980's, the gap between rich and poor has been widening in Mexico, as it has in much of the region.[46] People living in poverty cannot afford to purchase hardware and pay for internet service. The large lower class in Mexico has meant that much of the population living above the poverty line, and able to

[43] Mix of Amerindian (native) and European.
[44] Gallegos et all, Access in Mexico, TILAN May 2001, retrieved online March 12, 2006 from http://lanic.utexas.edu/project/tilan/reports
[45] Wenhong Chen and Barry Wellman, "Charting and Bridging digital Divides: Comparing Internet Access and Use in Eight Countries", AMD Global Consumer Advisory Board Oct 27, 2003, retrieved online March 10, 2006 from www.amdgcab.org
[46] Poverty, Inequality, and Growth in Latin America: Searching for the High Road to Globalization, by Roberto Patricio Korzeniewicz; William C. Smith

provide basic necessities, does not have the purchasing power to acquire their own computers and internet access. This relates to the slow rate of information technology uptake in primary and secondary schools because, unlike in nations such as the United States, where a large portion of households have PCs, Mexican schools cannot assign work that will require students to utilize internet technology for research and application outside of class.

The fact that most of the upper class students attend private schools, where expectations of students' personal resources are higher and technology is more incorporated in curriculum, creates a digital divide between the classes, which in the future will perpetuate inequality of wealth between the groups as the internet becomes more significant economically. Through private education, the upper class not only has greater access to, but also better training, in computer technology. Throughout Latin America, the problem of class income disparities since the debt crisis of the 1980's has led to a corresponding digital divide that is perpetuated through unequal resources between the public and private institutions.[47]

In conclusion, Mexico has a good context for development with regards to government policies and programs promoting internet technology, regulation of the ISP market, and international connectivity, especially in the academic sector. This can be seen in table 1. However, the nation's ICT expenditures and tertiary enrollment are weak, and internet access in primary and secondary schools is average for the upper-middle-income group (with no figure available for the LAC average). Despite the importance and variety of the good aspects of Mexico's developmental context, recent progress in most

[47] Garrett, Geoffrey, "Globalization's Missing Middle", Foreign Affairs; Nov/Dec2004, Vol. 83 Issue 6, p84-96

dimensions of internet development has been less than average for its income-class, and sometimes not any better than the LAC average.

This disappointing performance in internet development, where it is demonstrated in the indicators I examine, is virtually always connected to lack of economic resources on the part of citizens, which incidentally is the source of the two poor development context indicators: ICT expenditures (which determine the amount of internet related hardware, services, and software being provided and consumed), and tertiary enrollment (which produces a significant number of a nation's skilled internet users and knowledge workers). The latter, in turn, affects the productive use and profits of internet technology.

Ultimately, this signifies the centrality of economic troubles to technological development. It seems that competitive ISP markets develop most quickly where there are economic resources. Those in most need of the educational and employment opportunities available online do not acquire training or proprietary means of internet access, because they cannot afford them. Despite an overall developmental performance that is sub-par in some dimensions, Mexico's past and present contributions to establishing the internet and to networking and interconnectivity in Latin America, make it one of the region's important leaders in developing internet technology in the region. There is also hope that future expansion of government programs to promote and subsidize ICTs could help overcome the cycle of insufficient resources, and pave the way for a greater exploitation of the internet by more citizens, for economic and social benefit.

In recent years, Mexico's ICT development progress has not been as consistent as could be expected based on the country's good policy context. On the positive side, the rate of internet penetration growth continues to be high at 526% for 2000-2005,

indicating that initiatives related to internet expansion have retained momentum. This has brought Mexico up to a 16.2 % penetration level in 2006, nearly 2% greater than the LAC average. The size of Mexico's networks in relation to this growth in internet is good in both the number of hosts per internet user, where Mexico falls slightly behind Malaysia and Brazil, and in the number of PCs per internet user, where Mexico is slightly less developed than Brazil but significantly more developed than Malaysia.

In terms of technological quality, Mexico's progress has not been as great. In both Broadband subscriptions per capita and in total bandwidth, Mexico was behind the LAC and upper-middle income averages in 2004, and was significantly less developed in these dimensions than Brazil, Chile, and Malaysia. When quality is considered in terms of internet security, Mexico has also performed poorly, having less secure encryption servers per capita in 2004 than the LAC and upper-middle income averages, and significantly less than the values for Chile, Brazil, and Malaysia.

Progress in making ICTs more affordable in Mexico has been fair. The average price for monthly access was comparable to that in the more developed nation of Chile, and was slightly higher than the upper-middle income average but significantly lower than the high LAC average. Malaysia, by comparison, has developed farther in this regard and had the cheapest average price of all the countries included here, indicating that the regulatory and economic context in Mexico is inferior to that of its Asian counterpart. Nevertheless, as long as ICT promotion continues and the government pays special attention to the economic inhibitors of ICT expansion, it is possible that Mexico's developmental context will improve and its future progress will be more consistent in the various dimensions presented here.

Chapter 3: Brazil

In this chapter, I will follow the same format used for Mexico. First, I will describe and analyze the developmental context for internet technology in the country by examining related educational statistics, national and international government programs and policies designed to promote the internet, regulation of ISPs, and consumption of ICTs. Next I will examine the progress in internet development within this context using most of the indicators I used before (in some cases, not all the data regarding types of access and use are available for Brazil). By examining change over time, and comparing progress and achievement to the LAC region, North America, and Indonesia (which is among the most technologically developed nations in Brazil's lower-middle-income group, as classified by the World Bank), I will evaluate the progress and achievement of the nation in developing internet technology. I will relate this progress to Brazil's developmental context during this part of the chapter, and conclude with a consideration of significant obstacles to continued development in Brazil.

Section I: Brazil's development context

Brazil is Latin America's largest internet user population. Its 26 million users account for nearly 40% of Latin America's total population online, down from about one half of LAC users in 2002.[48] In Brazil, as in Mexico, the internet's origins are in higher education. In 1988, Latin America's first internet connections were established between three different Brazilian universities, the University of Maryland, Fermilab in Chicago, and UCLA. In 1989, when Mexico got its first internet connection at Monterrey, the Brazilian government's Ministry of Science and Technology established the first national

[48] Korentayer, Countinho, ".br", Center for International Development at Harvard 2002, retrieved online March 14, 2006 from http://lanic.utexas.edu/project/tilan/countries/br/

backbone called RNP, which has linked all the universities in the country as they came online.[49]

The portion of Brazil's population that has benefited from this network, and the training and experience they obtain on it, constitute an estimate of the nation's skilled users. In 2003, when the ITU published its digital divide report, Brazil ranked 17.9 on a scale of 85.3, well behind the U.S. and Canada (71 and 60). It also ranked well as behind Mexico in terms of tertiary enrollment. This ranking was slightly higher than that of Indonesia (15.1).[50] So, as with Mexico, low levels of tertiary enrollment influence the developmental context of Brazil, by limiting growth in skilled internet users (potential knowledge workers).

As with Mexico, there is no 2000 data available on primary and secondary school access to the internet. But in 2004, according to the World Bank, 50% of these institutions were connected to the internet. No average for the lower-middle-income group was calculated, because for many nations like Indonesia there is not sufficient data to calculate their percentages.[51] This figure is significant, though, because it represents a large number of schools connected in Brazil. Secondary education alone accounted for approximately 13,000 schools in 2002.[52] The geographic distribution of schools in the large country makes reaching some of them extremely difficult. For example, there are no local internet connections available to 44% of the populace that live in rural areas. The

[49] Robert Shaw, "Creating Trust in Critical Network Infrastructures: The Case of Brazil", May 20, 2002, retrieved online March 16, 2006 from http://www.itu.int/osg/spu/casestudies/index.html
[50] Measuring Infostates for Development, table 3.4, ITU-Orbicom 2005, retrieved online March 15 2006 at http://www.orbicrom.uqam.ca
[51] ICT At a Glance Tables, from Information and Communications for Development 2006: Global Trends and Policies, World Bank 2006, retrieved online, March 20, 2006 from http://devdata.worldbank.org/ict/bra_ict.pdf
[52] Korentayer, Countinho, ".br", Center for International Development at Harvard 2002, retrieved online March 14, 2006 from http://lanic.utexas.edu/project/tilan/countries/br/

problem of service concentration in affluent areas causes uneven geographic internet penetration, and is due largely to the deregulated, competitive ISP market[53], to which I will return later.

The Center for International Development at Harvard confirms that this uneven geographic penetration is a challenge that Brazil shares with Mexico. This problem affects businesses, schools, and private homes in these un-serviced, remote areas.[54] In terms of geographic disparities in primary and secondary schools' internet resources, and in terms of its low tertiary enrollment, Brazil appears comparable to Mexico in terms of the educational aspect of its developmental context. Unfortunately, no income group average is available for the lower-middle-income class's primary and secondary school connectivity. This information is also lacking for Indonesia, making a complete comparison of Brazil's development in this dimension, within its own economic class, impossible for the time being.

The Brazilian Government's prioritization of ICTs in 2004, according to the World Bank, was 4.4 on the 7 point scale. This is higher than the LAC average, the lower-middle-income average of 3.8, and that of Indonesia which shares the rank of 4.2 with Mexico.[55] The Brazilian government stands out from the rest of the region specifically in its promotion and incorporation of e-government services for its citizens, and in utilizing and developing free source software through its *Softex* program.[56] Since

[53] Robert Shaw, "Creating Trust in Critical Network Infrastructures: The Case of Brazil", May 20, 2002, retrieved online March 16, 2006 from http://www.itu.int/osg/spu/casestudies/index.html
[54] Korentayer, Countinho, ".br", Center for International Development at Harvard 2002, retrieved online March 14, 2006 from http://lanic.utexas.edu/project/tilan/countries/br/
[55] ICT At a Glance Tables, from Information and Communications for Development 2006: Global Trends and Policies, World Bank 2006, retrieved online, March 20, 2006 from http://devdata.worldbank.org/ict/bra_ict.pdf
[56] "Brazil Gives Nod to Open source", Associated Press, Nov 16, 2003, retrieved online March 16, 2006 from http://www.wired.com/news/infostructure/0,1377,61257,00.html

internet hardware (principally PCs) has traditionally been out of the price range of most Brazilians, the government established resources and programs to distribute them in various ways to compensate for the high price of hardware in the country. These initiatives amount to a significant effort by the government to promote internet technology.

Such resources include the Universal Service Fund (FUST), which includes tax incentives for PC purchases, government subsidies for low cost PC packages, lines of credit for hardware purchase, and the installation of public internet kiosks. These constitute the government's primary resource allocations for ICTs. All of these measures, in one way or another, help families and small businesses afford computers for the home or productive purposes, and according to the ITU, from 1995-2003, PC ownership increased five fold.[57] This progress certainly related to these government initiatives.

Brazil, along with Mexico, was one of the first members of both RedHUCYT and RedCLARA, and helped other LAC countries that joined these networks later with funding and technical support. RNP2, a modern, high-capacity research and academic network, is connected to Internet2 in the United States, and reaches every state in Brazil.[58] This has enabled the Brazilian universities to remain active in progressive internet development projects, such as collaborating with national and local governments in designing and launching e-governance applications.[59] In addition, there is the automatic benefit of having access to the same resources available to the universities in

[57] Robert Shaw, "Creating Trust in Critical Network Infrastructures: The Case of Brazil", May 20, 2002, retrieved online March 16, 2006 from http://www.itu.int/osg/spu/casestudies/index.html
[58] Robert Shaw, "Creating Trust in Critical Network Infrastructures: The Case of Brazil", May 20, 2002, retrieved online March 16, 2006 from http://www.itu.int/osg/spu/casestudies/index.html
[59] Measuring Infostates for Development, table 3.4, ITU-Orbicom 2005, retrieved online March 15 2006 at http://www.orbicrom.uqam.ca

more developed nations like the U.S., which is to help the students develop internet skills comparable to those of U.S. graduates.

Prior to the full opening of the market and the end of government participation as an ISP, between 1991 and 1998, the RNP network was continually extended and upgraded with faster connections.[60] This was not the case in Mexico, where the original national backbone, belonging to Telmex, never upgraded its bandwidth significantly, but survived in the market of modern networks by being the sole ISP in many, less profitable rural areas. In Brazil, Telebras was able to remain a major ISP in markets across the country after privatization. This also supports the argument that the combination of national and international development projects in Brazil have created a good developmental context, through expansion of capacity, connectivity, and reliability of the original network, around and upon which private networks were later built.

The regulation of ISPs in Brazil determines the extent to which they are driven by a competitive market. Market forces should lead to lower prices and better services, but can also create pockets where no service is available to remote communities if it is not profitable to extend networks to them. In 1995, the first commercial ISP started up in Brazil, and by 1998, the privatization of the previous state owned monopoly, *Telebras*, and extensive deregulation, including limitless foreign ownership, led to a lot of growth and foreign investment in the ISP market. This generated the laying of new fiber optic networks, submarine cables and other technological advances.

It also created a very competitive market. *Anatel*, Brazil's telecom regulator, is often referred to by industry experts, such as Robert Shaw, "one of the most transparent

[60] Robert Shaw, "Creating Trust in Critical Network Infrastructures: The Case of Brazil", May 20, 2002, retrieved online March 16, 2006 from http://www.itu.int/osg/spu/casestudies/index.html

and independent in the world".[61] Shaw's article reports evidence of the highly competitive nature of the ISP market, documenting more than 1,200 ISPs operating in Brazil in 2002. The large number of ISPs in Brazil would suggest that rural areas are serviced by many small, localized ISPs. So, deregulation has certainly contributed to the growth of internet technology in Brazil, by providing a framework that attracts a lot of foreign direct investment into the ISPs and their networks.

Finally, the consumption of ICTs in Brazil influences its developmental context in precisely the same way as it does in Mexico and every where else that there are competitive ISP and ICT markets. Without increasing consumption of ICTs, at least in nominal terms, there will not be significant developmental progress, as long as a lot of internet development projects are done by ISPs in the private sector. Finally, the significance of ICT expenditure to the whole economy appears to be significant, evident in an increase from 5.6-6.7% of GDP by 2004, greater than the income-based and LAC averages by a little more than 1%.[62] Indonesia's expenditures increased from nearly 2.5-3.0% GDP, more than 2% less than the lower-middle-income average. This suggests that Brazil is on track developmentally in terms of spending on internet related technology for its wealth. The relative importance of ICTs to the Brazilian economy also signifies a stronger consumption-based developmental context than that of Indonesia, and Mexico, which are doing poorly in this regard compared to their economic peers.

[61] Robert Shaw, "Creating Trust in Critical Network Infrastructures: The Case of Brazil", May 20, 2002, retrieved online March 16, 2006 from http://www.itu.int/osg/spu/casestudies/index.html

[62] ICT At a Glance Tables, from Information and Communications for Development 2006: Global Trends and Policies, World Bank 2006, retrieved online, March 20, 2006 from http://devdata.worldbank.org/ict/bra_ict.pdf

Table 5: Development Context (Brazil)

Indicator	BR	MX	MA	IN	LAC	LM	US
Tertiary Enrollment	17.9	20.5	26	15.1	na	na	71
% Primary & Secondary schools connected	50	60	na	na	na	na	99
Govn't ICT priority on 7 point scale	4.4	4.2	5.2	4.2	3.5	3.8	5.2
National Development Programs	VG	G	na	na	na	na	na
International Development Programs	G	G	na	na	na	na	na
ICT/ISP regulation	VC	C	C	C	na	na	VC
% GP of ICT Expenditure	6.7	3.1	6.9	3	5.3	5.1	8.8

P (Poor) F (Fair) G (Good) VG (Very Good)
C (Competitive) VC (Very Competitive) UM (upper-middle income) LM (lower-middle income)

The overall technological development context in Brazil, as indicated by these data is mixed. However, the relative strengths and weaknesses of Brazil's context are different than those in Mexico. In addition to the high rate of ICT consumption, Brazil's governmental and policy context for development is also superior to the LAC and lower-middle income averages, and is largely due to an early start in establishing the internet in the country. These economic and political factors promote a lot of ICT expansion in the country. The particularly underdeveloped part of Brazil's technology development context is educational. Brazil ranked only slightly above Indonesia and below Mexico for tertiary enrollment, which may indicate a contemporary and future problem of insufficient knowledge-labor resources for the nation to maximize the productive potential of its technological infrastructure. Additionally, the percent of primary and secondary schools connected to the internet was a full ten percent less than in Mexico and Chile, and should be increased in order to educate more citizens about the use and value of ICTs.

Section II: ICT expansion in Brazil

To examine ICT growth in Brazil, I will start with user penetration, since this is one of the most valuable tools for estimating a nation's stage of development. Brazil's user penetration grew by 418% per capita from 2000-2005, according to Internet World Statistics' website, and now 14.1% of the country's inhabitants use the internet. This is slightly below the LAC average of 14.3%. By comparison, Indonesia grew 800% during this period. This could be interpreted as indicative of Indonesia being at an earlier stage on the developmental curve, compared to Brazil. This conclusion is supported by examining Indonesia's penetration at the end of the term, which was slightly more than half of Brazil's, at 8.1%. This statistic is a little below the average for the Asian region, which contains several nations of various sizes that surpass 60% penetration. Brazil is slightly less developed in this dimension than Mexico, as one might expect in comparing an upper-middle-income LAC country with a similar developmental context to a lower-middle-income country like Brazil.

The networks' ability to keep up with this rise in internet use can be evaluated based on the growth of hosts per capita, and more importantly, hosts per internet user. From 2001-2004, Brazil's hosts per 10,000 inhabitants increased from 95.7 to 193, according to the ITU.[63] This was a slower growth rate than that for penetration, and produced a change of 0.2 hosts per internet user in 2001 to 0.16 hosts per user in 2004. Due to a relatively slow rate of growth in hosts per capita, the decline of hosts per user over the period was greater than Mexico's. But in 2004, Brazil's network was nevertheless comparably developed in this dimension to that of Canada, which at .18

[63] World telecommunications Indicators, ITU March 2006, retrieved online March 15, 2006 from http://www.itu.int/ITU-D/ict/statistics/

hosts per user, was typical of many high-income nations in Asia.[64] Indonesia's hosts per internet user over this period fell from 0.01 to 0.007 in 2004. From this comparison we can determine that Brazil is highly developed in this dimension, with a much better host/user penetration than a lower and upper-middle-income-nation, and only slightly less than several, highly developed high income nations. This achievement is possible in part due to the strong developmental context for government promotion of ICT consumption and network development, and through effective network regulation.

During the 2000-2004 period, according to the World Bank, personal PCs increased from 50 to 86 per 1000 inhabitants in Brazil.[65] Midway through this same period, in 2002, 11.69% of PCs were connected to the internet.[66] This growth in PCs per capita compares to Indonesia's growth of only 11-19 PCs/1000 inhabitants during the same years. According to my calculations using the ITU's World Telecommunications Indicators data, in 2004, there were 0.88 PCs per internet user in Brazil, down from 1.45 in 2001.[67] Indonesia's change was from 0.55-0.2 in 2004. Brazil is clearly more developed in this dimension, but beating a country with a PC penetration growth of just 0.26% is not much of an accomplishment.

Brazil's high ratio of PCs/internet user in 2000 allowed for a decrease in this value that was greater than Mexico's decline for the period, but left Brazil with a 2004 ratio close to what Mexico started with. The extent of PC penetration in Brazil has most likely been helped by the FUST and other programs designed to subsidize ICT and

[64] Table 6
[65] ICT At a Glance Tables, from Information and Communications for Development 2006: Global Trends and Policies, World Bank 2006, retrieved online, March 20, 2006 from http://devdata.worldbank.org/ict/bra_ict.pdf
[66] Korentayer, Countinho, ".br", Center for International Development at Harvard 2002, retrieved online March 14, 2006 from http://lanic.utexas.edu/project/tilan/countries/br/
[67] Table 6

increase their affordability, as well as by a high ICT expenditure ratio, which is expected to reduce prices for ICT products over time in a competitive market.

The fact that there is a gap between penetration growth and the increase in acquisition of hardware in recent years indicates that there is an increasing use at school, work, and in public access areas like cyber cafes, and libraries. Therefore, due to the decline of Brazilian development in this dimension, like Mexico, Brazil has been challenged by low rates of hardware acquisition. However, it has managed to increase user penetration steadily because of the availability of educational and public internet access points, some of which have been created or supported by government resources. The expansion of cyber-cafes of various types has occurred throughout Latin America, and is an important resource for getting around socioeconomic constraints on ICT consumption, which limit potential internet penetration in every LAC country, to varying degrees.

Broadband technology was slow to pick up in Brazil, but in recent years there has been rapid growth. According to the World Bank, there 0.6 broadband subscribers per 1,000 inhabitants in 2000, and by 2004 there were 12.8.[68] Brazil once again outperforms Mexico and is slightly more than the average for all countries in the lower-middle income group, and more than twice the average for Latin America. Indonesian performance in this indicator was poor, as broadband increased there from 0.0-0.3. In 2002, 93% of

[68] ICT At a Glance Tables, from Information and Communications for Development 2006: Global Trends and Policies, World Bank 2006, retrieved online, March 20, 2006 from http://devdata.worldbank.org/ict/bra_ict.pdf

internet users in Brazil used a basic dial up service, according to the ITU,[69] which signals that most of the growth seen in the World Bank chart occurred in the latter two years.

This is reaffirmed by a report on Brazilian internet technology from Wired.com that said broadband subscription growth in Brazil was near 100% in 2004, with more than 2.3 million broadband subscribers by year end.[70] The relatively high Brazilian values for many indicators, combined with the rapid growth in markets for new technology like broadband, suggests that Brazil is still on the upward slope of its developmental curve, but has been climbing quickly in the last six years, due to a very active ICT market. The successful development of Brazil in the context of many of these indicators is evidence of a well regulated and competitive ISP market, successful efforts to reduce the cost of related technology, and effectively promoting the internet to the population.

The same 2000-2004 period mentioned above saw a growth in the Brazil's total bandwidth/person bandwidth from 5 bits per person to 154, which is almost three times the average for Brazil's income class, but slightly below the 165 bit/person average for LAC.[71] Brazil did outperform Mexico once again, however. Indonesia was no comparison with a growth rate of 1-18bits/person, making it likely that investment in network enhancement and bandwidth there are significantly less than in Brazil. This does not, however, reflect one of Brazil's developmental strong points, because many of the other nations in its income class are quite underdeveloped. Nevertheless, it does represent the success of many developmental efforts at establishing advanced, high capacity

[69] Measuring Infostates for Development, table 3.4, ITU-Orbicom 2005, retrieved online March 15 2006 at http://www.orbicrom.uqam.ca
[70] "Brazilians Hot for Broadband", Reuters News Service, Nov 1, 2004, retrieved online March 18, 2006 from http://www.wired.com/news/business/0,1367,65538,00.html
[71] ICT At a Glance Tables, from Information and Communications for Development 2006: Global Trends and Policies, World Bank 2006, retrieved online, March 20, 2006 from http://devdata.worldbank.org/ict/bra_ict.pdf

internationally-linked networks within the country, and this is clearly one of the positive aspects of Brazil's developmental context for ICTs.

In terms of the network security, the interest on the part of the government to overcome e-commerce trust issues and to ensure the stability of the networks through various initiatives and investments has benefited Brazil in recent years. In 2000, there were 6 secure servers per one million people. By 2004, there were 11.2/million, significantly higher than the 1.6 average for Brazil's income group, and much greater than Latin America's 8.6/million average.[72] Indonesia's less developed networks began adopting this technology much later than Brazil, and growth was only 0.3-0.4 secure encryption servers per million.

Brazil's current average price for internet service is not low. Many scholars report that home internet access is out of reach for the majority of the nations' poor, despite government subsidies and other incentives.[73] In 2004, according to a World Bank report, the average price for a subscription was $28 (U.S.) per month, compared to an average of $25.30 for Brazil's income class.[74] However, it was still lower than the LAC average of $31.50. The relatively high cost of internet access in Brazil is surprising because there is much scholarly work that characterizes the ICT and specifically ISP market as competitive and progressive. It is entirely possible, as in Mexico, that in the past two years the average price in Brazil has fallen significantly due to competition

[72] ICT At a Glance Tables, from Information and Communications for Development 2006: Global Trends and Policies, World Bank 2006, retrieved online, March 20, 2006 from http://devdata.worldbank.org/ict/bra_ict.pdf
[73] Korentayer, Countinho, ".br", Center for International Development at Harvard 2002, retrieved online March 14, 2006 from http://lanic.utexas.edu/project/tilan/countries/br/
[74] ICT At a Glance Tables, from Information and Communications for Development 2006: Global Trends and Policies, World Bank 2006, retrieved online, March 20, 2006 from http://devdata.worldbank.org/ict/bra_ict.pdf

among the many ISPs and/or new regulatory policies that favor multi-service ICT packages.

Table 6: ICT Expansion (Brazil)

ICT Expansion by comparison															
Country or group	Int. Pen. 2006	Δ Pen. 2000-2005	Int. Users in Millions 2006	Hosts per 10,000 2004	Hosts per Int. User	Δ hosts/ user 2001-2004	PCs per 1000 2004	PCs per user 2004	Δ PC/ user 2001-2004	Broad band/ 1000	Band width Bits/ person	Δ B.W. 2000-2004	Sec. servers per million	Av. price Int. service USD
US	68.1	114	203.0	6645.00	1.06	0.23	760	1.21	-0.04	129.0	3308	2914	675.00	15.00
Malaysia	36.7	171	10.0	52.81	0.14	0.03	170	0.50	-0.10	10.0	127	104	11.30	8.40
Brazil	14.1	418	26.0	192.95	0.16	-0.04	86	0.88	-0.57	12.8	154	149	11.20	28.00
Mexico	16.2	526	17.0	145.17	0.11	-0.01	84	0.80	-0.10	3.1	108	99	6.10	22.60
Indonesia	8.1	800	18.0	5.01	0.01	0.00	19	0.20	-0.35	0.3	18	17	0.40	22.30
LAC	14.3	337	80.0	na	na	na	75	na	na	5.2	165	na	8.60	31.50
LMI	na	na	na	na	na	na	38	na	na	na	58	na	1.60	25.30

It seems that Brazil is doing well, on the whole, in ICT and internet development compared to the majority of the region. However, there is one important issue that sets Brazil apart from most of LAC. Because of the language difference from the rest of the region, and perhaps because of lower levels of English literacy per capita, much more of Brazil's internet activity, between 75-85% in 2002, is restricted to internal material and Brazilian websites.[75] This means that many of Brazil's twenty million users would not be considered potential knowledge workers for the global market. Instead, their potential productivity would be largely limited to filling demand only within Brazil, since the internet has not been used heavily to access information and opportunities outside of the country. Unfortunately, this data is not available for Indonesia and Malaysia, which could also have a high rate of internal internet traffic.

This figure has most likely decreased in the last four years, but no current data on the subject is available, and the relative "language isolation" of Portuguese speaking

[75] Robert Shaw, "Creating Trust in Critical Network Infrastructures: The Case of Brazil" p8, May 20, 2002, retrieved online March 16, 2006 from http://www.itu.int/osg/spu/casestudies/index.html

Brazilians probably still results in a higher-than-normal percentage of intra-national internet exchanges. On the other hand, the success of programs like *Softex* in generating so many online resources in Portuguese could also be viewed as great success, even if it correlates into less international exchanges by Brazilians.

In conclusion, Brazil has a good context for development that, like Mexico, has benefited from national and international programs to increase penetration, enhance networking, and overcome some of the socioeconomic obstacles to ICT consumption through subsidies, and special loans. Brazil, however, has had a better context for development with regard to the role of ICTs in the market and the amount of consumption of internet and related technology services, hardware, and software. This would be a logical reason for Brazil's superior technological achievement compared to Mexico in most dimensions, since throughout the region, and clearly in Mexico, the socioeconomic digital divide is a serious challenge to long term progress in expanding internet use and resources.

In recent years, Brazil's growth in internet penetration has been significant. At more than 400%, this figure indicates that Brazil is comparably developed to Mexico, ahead of Indonesia and Guatemala, but behind Chile and Malaysia. In 2006, Brazil's penetration was slightly less than the LAC average, but at 26 million users it had the largest number of all the countries presented here except the United States, and now accounts for more than one quarter of LAC users. The size of Brazil's networks relative to this growth in penetration has remained better than most. There was a decline in the number of hosts and PCs per internet user over the 2001-2004 period, but Brazil still

retained the highest ratio of each for all countries considered here except the U.S., and its values are comparable to those of Mexico.

In terms of quality, Brazil has outperformed Mexico, as well as Guatemala and Indonesia. There were more broadband subscriptions per capita in Brazil in 2004 than in all the other nations presented here except Chile and the U.S., and this value was significantly greater than the LAC average. The same is true in terms of bandwidth in bits per person, with the exception that Brazil had slightly less bandwidth than the LAC average, but was nearly three times the lower-middle income average. In terms of secure servers, Brazil developed much more than Mexico, and is comparable in this dimension to Malaysia, with far more secure servers per capita than the LAC and lower-middle income average.

The one area in which Brazilian development of ICTs has been poor is in the price of internet access. At U.S. $28 per month, Brazil had a higher cost in 2004 than all countries considered except Guatemala. This was still slightly less than the LAC average, but slightly more than the lower-middle income average. Since this seems to be the only dimension of technology development where Brazil has not performed well, overall progress should continue at a good rate in the next five years. If this turn out to be the case, Brazil will be at a significantly higher level of ICT development, both in terms of penetration and quality.

Chapter 4: Chile

This chapter will follow the same format of the previous chapters, utilizing the same indicators for developmental context and developmental progress. Chile's level of technological achievement and developmental experience is different from Mexico and Brazil, and a comparison of Chile's relatively advanced state to these more moderately developed countries will help demonstrate the range of technological development in the region. It may also help illuminate the differences that created the developmental gap between these countries. I will also explain some of the challenges that Chile faces to future development and what is being done about them.

Section I: Chile's development context

Chile's ICT resources are a function of its current phase of development, which is farther along then most of Latin America because the nation was the first to develop an advanced telecommunications infrastructure in the region, according to the Center for International Development at Harvard.[76] As is the case for most countries in the region, internet development began as an academic endeavor within the university system, and this network has remained at the forefront of modernization and advanced usage of the internet in Chile.[77] According to the ITU's infostate report in 2003, Chile ranked 37.1 on a scale of 85.3 for tertiary enrollment, ahead of Mexico and Brazil, as well as Malaysia.[78] This translates into a superior educational context for internet development than in much

[76] Carlos Osario, ".cl", Center for International Development at Harvard 2002, retrieved online March 14, 2006 from http://lanic.utexas.edu/project/tilan/countries/cl/
[77] Measuring Infostates for Development, table 3.4, ITU-Orbicom 2005, retrieved online March 15 2006 at http://www.orbicrom.uqam.ca
[78] Measuring Infostates for Development, table 3.4, ITU-Orbicom 2005, retrieved online March 15 2006 at http://www.orbicrom.uqam.ca

of Latin America, where the percent of citizens who benefit from the universities' internet resources is much lower.

According to the World Bank, by 2004, 62% of primary and secondary schools in the country were connected to the internet, placing the nation slightly above the 60% average of most upper-middle-income nations.[79] This high rate of internet access in schools has been made possible by the government's *Enlaces* program. In addition to providing access to the remaining unconnected rural schools, the program now focuses on training faculty to teach internet use and on creating and augmenting the educational programming on its network.[80] This intensive focus on internet technology advancement in education is an important quality of Chile's developmental context, one that incorporates more advanced applications of the technology into pre-university education, thus enhancing the skills of a larger portion of the populace than would otherwise get such training.

Educational initiatives are one of the more successful examples of the Chilean government's commitment to technology development. The World Bank gave Chile a ranking of 4.8 in 2004 on their 7 point scale for government prioritization of ICTs, above the income-class and regional averages (4.1 and 3.5 respectively). This value is just 0.1 increments less than the high-income-class average, and implies a recognition by the country of internet technology's value and importance for the future.

Chile is one of the original members of RedHUCYT, and has one of the first satellite internet connections to the U.S. through Chile's *Reuna* network, the first

[79]ICT At a Glance Tables, from Information and Communications for Development 2006: Global Trends and Policies, World Bank 2006, retrieved online, March 20, 2006 from http://devdata.worldbank.org/ict/chl_ict.pdf

[80] Carlos Osario, ".cl", Center for International Development at Harvard 2002, retrieved online March 14, 2006 from http://lanic.utexas.edu/project/tilan/countries/cl/

backbone which connected academic and research institutions. By 2004, the government had activated Reuna2, which provides a direct link to the U.S. internet2 research network.[81] Chile is also a member of RedClara and the Alice academic network with Europe. This degree of international connectivity is comparable to Mexico and Brazil, which were also in the vanguard of the initiatives that created these network connections in the region.

The Chilean government is still actively involved in the development of internet technology and use through programs, such as ones that provide special loans for purchasing PCs, that are aimed at closing the digital class divide in the country and have helped increase internet and PC penetration.[82] In addition, like Mexico and Brazil, Chile contributes to the speed and reliability of the internet throughout the region through one of the top ten internet hubs in Latin America, which is located in Santiago.[83]

Chile was one of the first countries in the world to liberalize its telecommunications industry through the national regulator, Subtel, and its competitive market has generated a lot of investment in stability and capacity enhancements to the country's networks, which will be discussed later. There have also been significant technological innovations in Chile's ISP markets. One example is the country's largest power company, Chilectra, which became one of the first such companies in the world to enter the telecommunications market, and offer citizens voice and high-speed data

[81]Dr. Saul Hahn, "OAS and networking in the Americas REDHUCYT: Perspectives in Development of Science and Technology", April 22, 2004, retrieved online March 25, 2006 from http://www.redhucyt.oas.org/presentationsSH/presentations.htm

[82] Measuring Infostates for Development, Chile profile, ITU-Orbicom 2005, retrieved online March 15 2006 at http://www.orbicrom.uqam.ca

[83] Robert Shaw, "Creating Trust in Critical Network Infrastructures: The Case of Brazil", May 20, 2002, retrieved online March 16, 2006 from http://www.itu.int/osg/spu/casestudies/index.html

transfer through their power lines.[84] This service was made possible by deregulations that the government recognized would increase competition and benefit ICT consumers. Chile is comparable in its early phases of development to Mexico and Brazil, through its participation in OAS development projects and the role of the academic sector, to early government support of a commercial ISP market, which has been progressively liberalized.

To conclude this discussion of Chile's developmental context, I consider the size and significance of the ICT market in Chile. The World Bank reports that over the 2000-2004 period, expenditure on ICTs as a percentage of GDP rose from 6.0-6.7% in Chile, more than 1.5% higher than both the income-class and regional averages, and just 0.2 percent less than in Malaysia.[85] This relatively high rate of ICT consumption is responsible for fueling the investments and improvements made in networks and services within the private market. In other LAC countries, the profit oriented nature of the ISP market has sometimes failed to produce desired development due to lack of demand, but Chile's larger ISP markets have been able to integrate new technology and improve networks by attracting investment.

Table 7: Development Context (Chile)

Indicator	CH	BR	MX	MA	IN	LAC	UM	US
Tertiary Enrollment	37.1	17.9	20.5	26	15.1	na	na	71
% Primary & Secondary schools connected	62	50	60	na	na	na	60	99
Govn't ICT priority on 7 point scale	4.8	4.4	4.2	5.2	4.2	3.5	4.1	5.2
National Development Programs	VG	VG	G	na	na	na	na	na
International Development Programs	G	G	G	na	na	na	na	na
ICT/ISP regulation	VC	VC	C	C	C	na	na	VC
% GP of ICT Expenditure	6.7	6.7	3.1	6.9	3	5.3	5	8.8

[84] Carlos Osario, ".cl", Center for International Development at Harvard 2002, retrieved online March 14, 2006 from http://lanic.utexas.edu/project/tilan/countries/cl/

[85] ICT At a Glance Tables, from Information and Communications for Development 2006: Global Trends and Policies, World Bank 2006, retrieved online, March 20, 2006 from http://devdata.worldbank.org/ict/chl_ict.pdf

Overall, Chile's context for internet development is the best of the four Latin American countries examined here. The governmental and policy environment is positive and characterized by early participation in international development projects and a significant effort by the government to overcome socioeconomic obstacles to internet and PC penetration in poorer communities, and Chile shares this good foundation with Mexico and Brazil. According to the World Bank, government prioritization of ICTs in Chile is significantly greater than it is, on average, in Latin America and the upper-middle income nations. In terms of education, Chile is far more developed than the other countries, except the U.S. in terms of tertiary enrollment, and this value is considerably higher for Chile than for the comparably developed nation of Malaysia. It also has a higher percentage of primary and secondary school internet connectivity than all the countries for which data is available, with the exception of the United States, and is significantly. This greater educational context, combined with the high level of ICT expenditure that Chile shares with Brazil, complete a well rounded and above average context for ICT development.

Section II: ICT expansion in Chile

Now we will consider how Chilean internet technology has evolved recently on the foundation laid in earlier years. First, Chile's progress in internet user penetration is representative of its developmental state with respect to this technology. From 2000-2005, Chile's internet user penetration grew 218.7%, reaching 35.7%. This is more than twice the LAC average, and is the second highest penetration rate in LAC behind Jamaica. The higher penetration and slower rate of growth compared to Mexico and Brazil demonstrates Chile's higher position on the development scale. In this aspect of

development, Chile is more comparable to Malaysia, which grew 171.4% over the period, reaching 36.7% penetration. In order to put this growth in context, one should consider its impact on the networks and physical resources that enable internet use in the country.

The development of Chile's networks' in relation to hosts is one of the exceptions to its generally high level of development. According to the ITU World Telecommunications Indicators, hosts per capita nearly doubled from 2001-2004.[86] As a result, hosts per internet user increased from 0.04 in 2001, to 0.05 in 2004.[87] Although Chile saw growth in its hosts relative to internet users for the period, which is unusual, the country has remained behind Mexico and Brazil, as well as the U.S., Canada, and Malaysia, whose networks all boast more than 0.1 hosts per user. Unfortunately, there is no information in my research that would explain why this has been the case. Chile's economic and regulatory context is good, so there should be plenty of impetus to augment networks and improve service and stability with more hosts. This could be a regulatory issue, or perhaps there are fewer hosts per user because the geographic dimension of the networks requires less of them to function effectively. Ultimately, if the low ration of hosts does create strain on the networks, it will most likely result in their increase, since Chile does have a profitable and well financed ISP market.

When one considers PC penetration, Chile's progress in this dimension is superior to most of the region. Between 2001 and 2004, PC penetration per capita increased from 10.65% to 13.87%. During this same period, internet use increased from 20% to 28%, resulting in a change from 0.52 PCs per internet user to 0.50.[88] Hardware acquisition in

[86] World Telecommunications Indicators, ITU March 2006, retrieved online March 15, 2006 from http://www.itu.int/ITU-D/ict/statistics/
[87] Table 8
[88] Table 8

Chile has not fallen as much vis-à-vis the increase in internet users as in Mexico and Brazil, resulting in a higher level of development in this regard. As noted in the Mexico chapter, PCs per internet user in Malaysia grew from 0.4 to 0.5, meaning that the two nations were similarly developed in this regard, and superior to Canada and some of the most of the high-income-nations in Asia.

This raises the question of whether it is common for nations' PC penetration to peak during the-mid-range of development, and fall back to previous levels by the time user penetration passes the 60% mark. This is obviously not the case with the United States, but seems to be a trend linking Canada and the highly developed, wealthy Asian nations, which are more developed than Chile and Malaysia in most dimensions, but do not have nearly as high a ratio of hardware to internet users. Unfortunately, I did not find enough information to graph a detailed change in PC penetration over enough time to support or disqualify this possibility, and it is possible that the data does not exist for enough countries to make such a discovery possible. If this were done, however, PC penetration would be an even more useful developmental indicator, by creating an alternate scale of ICT development with which to compare the change in user penetration and growth curve.

Despite these resources, socioeconomic barriers to hardware and internet service do exist in Chile as they do throughout the region. In 2002, approximately 26% of households represented 50% of the nation's wealth while amounting to about 68% of all internet users in Chile.[89] This means there has been a significant digital divide despite the extent of technological development, reinforcing the evidence from previous chapters

[89] Carlos Osario, ".cl", Center for International Development at Harvard 2002, retrieved online March 14, 2006 from http://lanic.utexas.edu/project/tilan/countries/cl/

that socioeconomic factors may be the greatest persisting obstacles to continued expansion and integration of the internet. Governmental initiatives to subsidize PC purchases and guarantee loans for them should continue to bring the internet into more homes, as long as they affect the areas where PC ownership and internet use are low.

My research did not turn up any literature on geographic penetration of the internet, but there are some clues as to Chile's development in this dimension. Chile is very peculiar in its shape and size, stretching most of the length of South America and averaging about 100 miles wide. I lived and studied in the centrally located capital city of Santiago for six months in 2005. I visited the homes of many university students from both the middle and upper class. The large city, which is a commercial and educational center for the country, has a very big and competitive ISP market, which is not surprising. What was surprising is that, in traveling throughout very remote regions of the country, I found that, out of about twelve hostels in which I stayed, only one did not offer internet access, and about half had high speed connections of one sort or another. Since these locations were more or less evenly distributed in the center two thirds of the country, it would appear that internet service, often of high quality, is available in most places. This may not be true, however, in the extreme desert north and artic south of the country, which are very thinly populated. If there is a more uniform geographic distribution of the internet in Chile, it is certainly the joint product of both developmental initiatives, and the unique shape of the country, which requires little more than one solid north-south backbone to reach the majority of the population.

Broadband was introduced early and is relatively common in Chile. This is part of the reason its ICT infrastructure is considered advanced. According to the World Bank,

from 2000-2004, broadband subscriptions per 1000 people increased from 5 to 30, well above the upper-middle-income average of 3.7 and the LAC average of 5.2.[90] These services were first offered in 2000 and within the first year, broadband subscribers were 8.4% of all internet users.[91] Chile is noteworthy for simply having any broadband connections during the beginning of the period when most LAC and other middle-income nations had none, including Malaysia. At the end of the period, Chile's broadband subscriptions were three times those of Malaysia's per capita. For reasons explained earlier, broadband growth is an important step in internet technology development because it is essential to many important and profitable applications.

In part due to the correspondingly high ratio of broadband to conventional dial-up connections, Chile's bandwidth in bits per person increased from 12 in 2000 to 796 in 2004, more than three times the average for its income class and region.[92] When compared to Malaysia, the significance of his growth becomes clear. At the beginning of the period, Malaysia had twice as much bandwidth per capita, but in just four years, Chile had surpassed it by several hundred bits/person. This shows that, even though Chile has attained a relatively high developmental level, it is still making significant progress in improving aspects of its infrastructure, like increasing capacity, that will make it possible for knowledge workers in Chile to be productive in the virtual economy.

Chile has also made progress in the integration of secure server technology. In 2001 there were 9.2 per one million people, and this figure rose to 17.2 in 2004, well

[90]ICT At a Glance Tables, from Information and Communications for Development 2006: Global Trends and Policies, World Bank 2006, retrieved online, March 20, 2006 from http://devdata.worldbank.org/ict/chl_ict.pdf

[91] Measuring Infostates for Development, Chile profile, ITU-Orbicom 2005, retrieved online March 15 2006 at http://www.orbicrom.uqam.ca

[92] ICT At a Glance Tables, from Information and Communications for Development 2006: Global Trends and Policies, World Bank 2006, retrieved online, March 20, 2006 from http://devdata.worldbank.org/ict/chl_ict.pdf

above the income class and regional averages, and more than 50% greater than Malaysia's percentage.[93] High demand for secure server technology signifies active use of the internet for commercial and other applications that involve sensitive information, and reflects a sophisticated level of use.

The average monthly price of internet access in the country in 2004 was U.S. $21.80, slightly higher than the upper-middle-income nations' average, but significantly lower than the regional LAC average of $31.50. Malaysia, by comparison, had an average price of U.S. $8.40 per month. This is much cheaper, and considering the fact that Malaysia's penetration is equal to Chile's (within 1-2%), and that its PC penetration is similar, the difference in price does not appear to be a significant developmental advantage for the former.

Table 8: ICT expansion (Chile)

ICT Expansion by comparison														
Country or group	Int. Pen. 2006	Δ Pen. 2000-2005	Int. Users in Millions 2006	Hosts per 10,000 2004	Hosts per Int. User	Δ hosts/ user 2001-2004	PCs per 1000 2004	PCs per user 2004	Δ PC/ user 2001-2004	Broad band/ 1000	Band width Bits/ person	Δ B.W. 2000-2004	Sec. servers per million	Av. price Int. service USD
US	68.1	114	203.0	6645.00	1.06	0.23	760	1.21	-0.04	129.0	3308	2914	675.00	15.00
Chile	35.7	219	5.5	142.27	0.05	-0.01	155	0.50	-0.02	30.0	796	784	17.20	21.80
Malaysia	36.7	171	10.0	52.81	0.14	0.03	170	0.50	-0.10	10.0	127	104	11.30	8.40
Brazil	14.1	418	26.0	192.95	0.16	-0.04	86	0.88	-0.57	12.8	154	149	11.20	28.00
Mexico	16.2	526	17.0	145.17	0.11	-0.01	84	0.80	-0.10	3.1	108	99	6.10	22.60
Indonesia	8.1	800	18.0	5.01	0.01	0.00	19	0.20	-0.35	0.3	18	17	0.40	22.30
LAC	14.3	337	80.0	na	na	na	75	na	na	5.2	165	na	8.60	31.50
UMI	na	na	na	na	na	na	99	na	na	3.7	176	na	10.70	20.80

One characteristic of being more developed than other Latin American nations is evident in one of the primary challenges that hinder further progress: Chile was slower in adapting and applying the internet for commercial purposes. By 2002, "Chileans had not

[93] ICT At a Glance Tables, from Information and Communications for Development 2006: Global Trends and Policies, World Bank 2006, retrieved online, March 20, 2006 from http://devdata.worldbank.org/ict/chl_ict.pdf

made as productive use of their networks as many of their peers. The high quality of Chilean infrastructure contrasts with low levels of sophistication of use" (Osario 2002). To address this issue, the World Bank in 2003 began a project called "Chile: Accelerating E-Business for Small Business Innovation and Growth", which reviews e-commerce challenges in Chile and related policy and regulatory issues, with the objective of increasing ICT use by small businesses.

Small businesses in Chile provided 73% percent of all private sector employment in 2003, so effective use of the World Bank project to inform policy and developmental investment could greatly enhance the productive use of the internet and related technology in the future.[94] Chilean business practices should catch up to the nation's technological potential and benefit the economy with more internet based services and sales, as long as the government is focused on this goal.

In conclusion, Chile represents the top end of the scale of internet development in LAC. One factor contributing to this higher developmental state is a better educational context for the internet, in terms of primary and secondary school connections and tertiary enrollment, than is the case in the more average countries like Mexico and Brazil. Another source of Chile's progress is the high ICT consumption, which directly affects the resources available for growth and promotes better-quality, advanced networks. Chile has a comparable context for development in this regard to Malaysia. If Chile continues to develop at its current rate, in another five years it will have surpassed in the 60% penetration mark that distinguishes North America and the high-income Asian "tigers".

[94] World Bank project update, "Chile: Accelerating E-Business for Small Business Innovation and Growth", retrieved online March 18, 2006 from http://wbln0018.worldbank.org/LAC/LAC.nsf/ECADocBYUnid/

Progress in recent years has been mixed and slower than in the less developed nations like Mexico and Brazil. Chile's internet penetration grew 219% from 2000 to 2005, significantly less than Brazil and Mexico, and slightly more than Malaysia, suggesting that, in this dimension, would be somewhere between these nations on the ICT development curve. By 2006, however, Chile had obtained a level of penetration comparable to that of Malaysia, and much higher than the LAC average. The size of its networks have not developed as favorably, as evident a host per internet user ratio in 2004 that was less than half the value for Mexico, Brazil, and Malaysia. In this regard, Chile was more closely developed to Guatemala than to the previous three countries. As for the PCs per internet user in 2004, Chile was once again less developed than Mexico and Brazil, but equally developed in this dimension with Malaysia.

In terms of quality, Chile's broadband subscriptions per capita and bandwidth per capita in 2004 were much greater than the income and LAC averages, and greater than all the other countries examined here, except the United States. As for secure servers per capita, Chile also had a higher ratio than all the other countries with the exception of the U.S. Chile's cost for internet access was lower than the rest of the Latin American countries examined, yet higher than that in the U.S. and Malaysia, indicating that the ICT market in Chile remains less developed, requiring the continued support for improving regulatory policies and investment. All-in-all, if this progress continues, Chile appears poised to be among the first LAC countries to break out of this intermediate stage of development and achieve a technological level comparable to the post-industrial nations.

Chapter 5: Guatemala

Guatemala is not as wealthy or as technologically-developed as the first three countries covered in this paper. After having examined some of the leaders in internet technology for the region, it is necessary to examine a less-developed Latin American nation to illustrate the lower range of internet technology in the region, and the principal challenges facing countries at earlier phases of ICT development. Many of the obstacles to Guatemala's technological development are evident in the following indicators of its development context.

Section I: Guatemala's development context

As in the rest of the region, the origins of the internet in Guatemala are academic. In 1995, the first internet connections in the country were established in seven universities, through an OAS and RedHUYCT program, that coordinated efforts between Guatemala's National Science and Technology council, the National Telecommunications provider, Guatel (now privatized Telgua), the administrators of the government's MAYAnet, national backbone project, and the universities. These first internet access points were connected through the RedHUCYT Pan-American satellite internet link to the U.S., which was provided by the National Science Foundation.[95] The integration of a national network in Guatemala was rapid, and by December of 1995, the national MAYAnet network was up and running.[96]

[95] "Contribution of the RedHUCYT-OAS in the Area of Connectivity", OAS Jan 24, 2003, retrieved online March 20, 2006 from http://www.redhucyt.oas.org/presentationsSH/presentations.htm

[96] Saul Hahn, "Case Studies on the Development of the Internet in Latin America and the Caribbean", OAS 2000, retrieved online March 10, 2006 from http://www.redhucyt.oas.org/presentationsSH/INET2000/paperINET2000.htm

Development of the internet through incorporation in the university system is limited, however. Guatemala's ranking for university enrollment in the ITU infostate index of 2003 was only 8.4 on a scale of 85.3, less than half the rank of Mexico and Brazil, and less than a fifth of Chile's score.[97] Unfortunately, the World Bank was not able to acquire enough information to report the percentage of primary and secondary schools that have internet access. As is the case with other underdeveloped nations, this most likely signifies a relatively low number of institutions with internet resources available to Guatemalan students.

According to the ITU, large areas of Guatemala are not covered by any ISP. This geographic asymmetry of the network corresponds to a demographic one. Seventy percent of Guatemala's population lived in rural areas in 2002, when there were 15 ISPs in the country.[98] By 2003, low incomes in urban areas, combined with a lack of service in many rural areas, left only "about 20% of the population in a position where they could obtain access to the internet" (Lugones, Peirano p123) [99] Based on this information, very few citizens in Guatemala were getting much, if any, experience with the internet in school. There also exists a demographic divide in the educational opportunities available to Guatemala's large *mestizo* and indigenous populations, similar to that in Mexico, which contributes to the wide digital divide in Guatemalan society.

The link between this problem and government regulation is important to consider. Although the ISP market in Guatemala is classified, by the World Bank, as

[97] Measuring Infostates for Development, table 3.4, ITU-Orbicom 2005, retrieved online March 15 2006 at http://www.orbicrom.uqam.ca
[98] Mark Lopez, Lester Escheverria, ".gt", Center for International Development at Harvard 2002, retrieved online March 14, 2006 from http://lanic.utexas.edu/project/tilan/countries/gt/
[99] Gustavo Lugones, Fernando Peirano, Measuring Infostates for Development, Guatemala profile, ITU-Orbicom 2005, retrieved online March 15 2006 at http://www.orbicrom.uqam.ca

competitive, rather than public or mixed, according to the Center for International Development at Harvard, foreign investment in the industry remains restricted due to a "lack of user-friendly foreign investment laws."[100] This situation is probably influenced by restrictions on foreign ownership of ISPs, which could be more or less than Mexico's 50% limit. There may have been significant development in this area in the past few years, but that information did not turn up in my research. *Telgua*, the first and once public ISP in the country, was not privatized until 1998, leaving little time for a competitive market to develop before these conditions were analyzed in 2002-2003. By comparison, Mexico's state ISP, Telmex, was sold off in 1990, allowing more than a decade for the commercial ISP sector to develop and enhance ICTs in the country before the World Bank and Harvard made their evaluations and comparisons.

In 2004, Guatemala's government ranked 3.3 on the World Bank's government ICT prioritization scale, slightly lower than the income-class and regional averages, and point below the Mexican Brazilian, and Indonesian rankings.[101] It is also apparent that Guatemala's government is not as effective as other LAC governments when it does commit to promoting, diffusing, and teaching internet technology. The ITU, in its 2003 infostate report, claimed that Government and other Public initiatives related to the internet "tend to be poor."[102]

One example of such initiatives failing to achieve their objectives was a satellite earth station funded by OAS CIDI in 1998. The National Science and Technology

[100] Mark Lopez, Lester Escheverria, ".gt", Center for International Development at Harvard 2002, retrieved online March 14, 2006 from http://lanic.utexas.edu/project/tilan/countries/gt/
[101] ICT At a Glance Tables, from Information and Communications for Development 2006: Global Trends and Policies, World Bank 2006, retrieved online, March 20, 2006 from http://devdata.worldbank.org/ict/gt_ict.pdf
[102] Gustavo Lugones, Fernando Peirano, Measuring Infostates for Development, Guatemala profile p127, ITU-Orbicom 2005, retrieved online March 15 2006 at http://www.orbicrom.uqam.ca

Council constructed this satellite earth station in Guatemala to improve the stability and speed of connection in metropolitan areas that had satellite links to the U.S., and to provide access to more rural areas that had not been penetrated by commercial ISPs. Additionally, the station is supposed to provide back up to satellite links in surrounding Central American states. Considering the persistence of large areas where no access is available, it would appear that the management of this project got off track, or it was not maintained. There are no recent reports on the progress of this program, but the data on ISP coverage suggests it has not fulfilled its intended purpose.

In addition, Guatemala's international connectivity is very limited. Guatemala was one of the second group of countries to be connected to RedClara, though its network has not been directly integrated into the Internet2 or ALICE international networks.[103] The RedCLARA network is connected to Internet2, so there may be some applications that Guatemalans can access through the regional network, but the lack of direct connections between Guatemala's networks and internet2 represents a failure by the government to provide the nation with necessary resources to take full advantage of the regional developmental projects in which it participates.

Throughout my research, I noticed that information on the Guatemalan government's strategies for promoting internet technologies were thin. There is barely any mention of programs to subsidize PC purchases, establish special loans for technology consumption, promote productive use, or enhance nation-wide internet education for Guatemala in the literature I cited for the other three countries, such as the ITU infostate report. There are a few exceptions, including a government project in

[103] Internet2 partners, from the Internet2 website 2006, retrieved online march 28, 2006 from http://international.internet2.edu/partners/

cooperation with the World Bank and UNDP that developed an integrated financial system which records all federal transactions in a central database to increase transparency and increase efficiency. This could be considered one of the government's successful initiatives, and it won the World Bank "Excellency Award" in 1999. There is also a joint project between the government and the Non Traditional Exporters Association that establishes business centers that provide internet and videoconferencing resources, as well as training in these technologies, to small and medium business in Guatemala.[104]

No data was available to determine the expenditure on ICTs as a percentage of GDP for the 2000-2004 period, and it was probably quite low given the nation's limited access opportunities, high prices, and low incomes. As with internet connectivity in schools, the World Bank data for ICT expenditures is incomplete for other poor, underdeveloped nations as well. This dimension of Guatemala's developmental context is weak, and because of its significance in a country with a competitive ISP market,[105] it represents a significant obstacle to continued growth. One reason for the low consumption of ICTs, in addition to socioeconomic constraints, has traditionally been a lack of services that would benefit the commercial sector. The lower level of technological sophistication in the country is hindering productive use because private companies had not, by 2002, provided affordable e-commerce solutions for small and medium businesses that would make entrepreneurial use of the internet.[106]

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[104] Mark Lopez, Lester Escheverria, ".gt", Center for International Development at Harvard 2002, retrieved online March 14, 2006 from http://lanic.utexas.edu/project/tilan/countries/gt/

[105] ICT At a Glance Tables, from Information and Communications for Development 2006: Global Trends and Policies, World Bank 2006, retrieved online, March 20, 2006 from http://devdata.worldbank.org/ict/gt_ict.pdf

[106] Mark Lopez, Lester Escheverria, ".gt", Center for International Development at Harvard 2002, retrieved online March 14, 2006 from http://lanic.utexas.edu/project/tilan/countries/gt/

Table 9: Development Context (Guatemala)

Indicator	GT	CH	BR	MX	MA	IN	LAC	LM	US
Tertiary Enrollment	8.4	37.1	17.9	20.5	26	15.1	na	na	71
% Primary & Secondary schools connected	na	62	50	60	na	na	na	na	99
Govn't ICT priority on 7 point scale	3.3	4.8	4.4	4.2	5.2	4.2	3.5	3.8	3.8
National Development Programs	P	VG	VG	G	na	na	na	na	na
International Development Programs	F	G	G	G	na	na	na	na	na
ICT/ISP regulation	C	VC	VC	C	C	C	na	na	VC
% GP of ICT Expenditure	na	6.7	6.7	3.1	6.9	3	5.3	5.1	8.8

Guatemala's overall development context is poor compared to all the other countries considered here. In each dimension, Guatemala is significantly underdeveloped. Its tertiary enrollment ranking was barely half that of Indonesia, and its ranking for government prioritization of ICTs was nearly a full point lower than Indonesia's on the seven point scale. It appears the majority of primary and secondary schools are without internet resources, putting future generations of Guatemalan adults behind the average in terms of technological literacy and skills. National development programs are poor in variety and number. A large part of this policy failure is probably due to insufficient funding, considering Guatemala's large debt and struggling economy. As a result of the inadequacy of national programs to keep Guatemalan networks up to date, Guatemala cannot fully benefit from new, advanced network resources developed in the region, thus given Guatemala's relative ranking for the impact of international programs on technology development, which is only fair. Nevertheless, Guatemala has seen some progress in recent years, which is certainly the result of a deregulated ICT/ISP market in

the country, considering the weak economic, educational, and government program dimensions of its development context.

Section II: ICT expansion in Guatemala

Now I will turn to the second set of indicators, to elaborate on the progress of internet technology within this context in recent years. In Guatemala, the growth and level of internet penetration indicates its relative developmental level compared to other nations in the region. According to the Internet World Statistics Website, from 2000-2005, internet penetration in Guatemala grew more than 1,063%, from 0.6% to 6.1%, which is a little more than half the regional average. Indonesia, by comparison, grew 800% and achieved a penetration of 8.1% by the end of the period. The slightly higher penetration level and lower growth rate signify that Indonesia is somewhat more developed than Guatemala in this dimension, but these two nations are closer to each other, developmentally, than to any of the other nations included in this paper.

The networks available to these users can be analyzed through the growth in hosts per capita and per internet user. Guatemala's hosts grew from 5.67 to 18.75 per 10,000 inhabitants from 2001 to 2004, more than tripling host penetration. Hosts per internet user was 0.03 at the beginning of the period, it fell to less than 0.025 in 2002, rose to more than 0.035 in 2003, and by the end of 2004, was back at 0.03, far below Mexico and Brazil, but 0.023 greater than the ratio for Indonesia.[107] Based on these calculations, no real progress was made in improving the networks in this dimension, despite the fact that use of the internet increased every year.

[107] Table 10

Guatemala's hosts/user penetration is close to Chile's (0.05), but this is insignificant when compared the difference in size of the two countries' networks, because Chile's had more than 5.5 million users by 2005, and Guatemala had less than 800,000. Indonesia on the other hand, is significantly less developed in this dimension, with 0.007 hosts/user by the end of the period, but had an impressive 18 million internet users by the next year.[108] If penetration continues to grow 200% annually, then the slow growth in hosts will become a limiting factor in network and internet quality within Guatemala.

Another important aspect of technological resource development is the purchase of hardware, specifically PCs, which enable access to the internet. PCs per 1000 people increased from 19 to 35 over the 2000-2004 period, which was less than a fifth of Mexico or Brazil's PC penetration by that time.[109] Guatemala fell slightly short of the lower-middle-income average of 38, and well below the LAC average of 75 per 1000, but was still more developed in this aspect than Indonesia, whose PCs per 1000 increased from only 11 to 19, just reaching Guatemala's starting point.

In 2002, only 1.61% of Guatemalan PCs were connected to the internet, much lower than in the other LAC countries included in this report.[110] The ratio of PCs to internet users fell from 0.75 in 2001 to 0.3 in 2004, according to my calculations of the data provided in the World Telecommunications Indicators.[111] The PC penetration by internet user was lower in Guatemala than in Mexico, Chile, Brazil, and was closer to the

[108] Guatemala: Internet Usage and Market Report, Internet World Statistics 2006, retrieved online March 22, 2006 from http://www.internetworldstats.com/am/gt.htm
[109] World Telecommunications Indicators, ITU March 2006, retrieved online March 15, 2006 from http://www.itu.int/ITU-D/ict/statistics/
[110] Mark Lopez, Lester Escheverria, ".gt", Center for International Development at Harvard 2002, retrieved online March 14, 2006 from http://lanic.utexas.edu/project/tilan/countries/gt/
[111] Table 10

0.2 value for Indonesia. Hardware acquisition did not grow significantly, and if the trend continues, internet penetration growth will eventually lead to a situation worse than that of the present, where greater numbers of internet users do not have their own personal computer, and must rely on public resources. This could be a problem for a poorer and more rural nation like Guatemala, where not as many people can reach a public access point, and this could, therefore, limit future growth in users.

With the exception of a few innovations like the online financial system discussed above, the quality or sophistication of technology and use of the technological infrastructure is relatively low in Guatemala, compared to the rest of the region. Broadband technology did not arrive in Guatemala when the service became available in Mexico, Chile, and Brazil. According to the World Bank, from 2000-2004, Broadband subscribers per 1000 in habitants remained at 0.0.[112] While Broadband access may have become available from one or more of Guatemala's ISPs in the last two years, given the low average income in the nation and low internet user penetration, it is unlikely that there would be a significant number of users yet.

On the other hand, lack of broadband availability is an example of the kinds of services that could enable small and medium business to conduct e-commerce and enhance production with ICTs. Since the limited services available are partially responsible for low ICT expenditures, it is possible that Broadband could grow rapidly in the commercial sector, thus benefit the economy and improving the context for future technological development. Additionally, the slow or absent growth in Broadband has

[112] Mark Lopez, Lester Escheverria, ".gt", Center for International Development at Harvard 2002, retrieved online March 14, 2006 from http://lanic.utexas.edu/project/tilan/countries/gt/

implications for the stability, speed, and capacity of the nations networks for all applications, and contributes to low overall bandwidth.

The national bandwidth in Bits per person grew from 1 to 56 over the 2000-2004 period, ending just behind the lower-middle-income average of 58, but well below the regional average of 165 in LAC, and Brazil's 154.[113] Guatemala is significantly more developed in this respect than Indonesia, which ended the period at only 18 bits/person. As the quality of Guatemalan networks improves, the national bandwidth should expand, enabling more sophisticated applications and services, and supporting continued growth in user penetration.

The nation's secure internet servers grew from one per one million inhabitants in 2000, to four in 2004. This was well above the income-class average of 1.6, but less than half the LAC average of 8.6, and far less than Brazil's 11.2/million,[114] meaning Guatemala's capability to handle important or vulnerable information transfer, as well as to conduct e-commerce, is not as developed as many of its neighbors. Indonesia's growth in secure servers from only 0.3-0.4 was inferior to Guatemala's progress, but the rapid growth of Indonesia's much larger population must be considered as another reason, besides the respective developmental contexts, for the difference in the two countries' relative internet security resources. In order for government initiatives to expand internet integration into commercial productivity to succeed, the Guatemalan government will need to remain focused on increasing the number of secure encryption servers needed by companies to make transactions safely and protect valuable information.

[113] ICT At a Glance Tables, from Information and Communications for Development 2006: Global Trends and Policies, World Bank 2006, retrieved online, March 20, 2006 from http://devdata.worldbank.org/ict/gt_ict.pdf

The ICT indicators report from the World Bank also provides information on the affordability of ICTs and their contribution to the economy. Average monthly internet access in Guatemala was expensive at $31.20 U.S. in 2004, well above the income class average of $25.3 and slightly below the high LAC regional average of $31.50 per month. This distinguishes Guatemala from Mexico, Chile, and Brazil, all of which were above their income class averages, but much lower than the LAC average. This reinforces Guatemala' classification as a less technologically developed country, since prices are highest in those nations where penetration is lower, and ISP markets are not as lucrative.

This low indicator is also related to minimal foreign investment in the industry, which is attributed to sub-optimal regulations. As mentioned before, recent initiatives to increase the availability and usefulness of services and resources to small and medium businesses may have increased ICT consumption, and consequently lowered the cost of internet service. In a country where poverty and income inequality are greater than most LAC countries, the relatively high price of internet service in nominal terms is more cost-prohibitive for many Guatemalans, and demonstrates how differences in socioeconomic conditions are a key differentiating factor in the nations' developmental context and progress.

Table 10: ICT expansion (Guatemala)

ICT Expansion by comparison														
Country or group	Int. Pen. 2006	Δ Pen. 2000-2005	Int. Users in Millions 2006	Hosts per 10,000 2004	Hosts per Int. User	Δ hosts/ user 2001-2004	PCs per 1000 2004	PCs per user 2004	Δ PC/ user 2001-2004	Broad band/ 1000	Band width Bits/ person	Δ B.W. 2000-2004	Sec. servers per million	Av. price Int. service USD
US	68.1	114	203.0	6645.00	1.06	0.23	760	1.21	-0.04	129.0	3308	2914	675.00	15.00
Chile	35.7	219	5.5	142.27	0.05	-0.01	155	0.50	-0.02	30.0	796	784	17.20	21.80
Malaysia	36.7	171	10.0	52.81	0.14	0.03	170	0.50	-0.10	10.0	127	104	11.30	8.40
Brazil	14.1	418	26.0	192.95	0.16	-0.04	86	0.88	-0.57	12.8	154	149	11.20	28.00
Mexico	16.2	526	17.0	145.17	0.11	-0.01	84	0.80	-0.10	3.1	108	99	6.10	22.60
Guatemala	6.1	1063	0.8	18.75	0.03	0.00	35	0.30	-0.45	0.0	56	55	4.00	31.20
Indonesia	8.1	800	18.0	5.01	0.01	0.00	19	0.20	-0.35	0.3	18	17	0.40	22.30
LAC	14.3	337	80.0	na	na	na	75	na	na	5.2	165	na	8.60	31.50
LMI	na	na	na	na	na	na	38	na	na	na	58	na	1.60	25.30

Finally, I will consider some of the major challenges to further technological development in Guatemala. One major issue mentioned earlier is the uneven geographic distribution of the internet, and the large number of remote communities in the country. This is a persisting obstacle that is clearly significant in Mexico, Brazil, and other LAC countries of reasonable size. A more unique problem facing integration of internet technology is demographic. Some of the literature covered on Mexico mentioned the role of class divides in discouraging penetration growth among certain ethnicities. As in Mexico, Guatemala's indigenous and M*estizo* populations tend to be the majority of the lower class, and are less capable of acquiring internet access and skills. The unique part of Guatemala's situation, in this regard, is the language barrier that also exists for certain indigenous groups which comprise 60% of the population.

In the chapter on Brazil, I discussed other research which shows that the differences between Portuguese and Spanish, not to mention English, are sufficient to

cause the nation's ratio of exclusively internal internet exchanges to be very high, excluding many opportunities to exploit regional network resources and contribute to international idea-based production systems. In Guatemala, the majority of citizens do speak Spanish, but 40% speak one of the 23 officially recognized Amerindian languages of the many different indigenous groups that live in the country.[115]

The inability of much of this 40% of the population to understand the content on the internet seems to be a deterrent to becoming an internet user, compared to indigenous groups in other countries, like the *Zapatistas* in Mexico, which have used the internet extensively. This is why the ethnic and linguistic divide, in addition to inadequate education resources, is considered a significant limitation to internet penetration.[116] In Brazil, this obstacle has been addressed, in part, through the development of Portuguese software initiatives. In Guatemala, the proliferation of different languages, which are more differentiated than Spanish and Portuguese, could make such efforts more difficult.

Based on the indicators used in this paper, Guatemala is certainly on the low end of LAC internet technology development. Hopefully, Guatemalan infrastructure will develop at a better rate over the next five years and keep up with user penetration, while at the same time improving quality and variety of services available to internet users, especially businesses. The rural concentration of the population and the large percentage of people living around the poverty line are big barriers to greater diffusion of the internet, and will require greater effort and resources from the Guatemala government, the OAS, and other international developmental organizations if they are to be overcome.

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[115] Guatemala Profile, CIA World Fact Book, retrieved online, April 4, 2006 from http://www.cia.gov/cia/publications/factbook/geos/gt.html#People

[116] Mark Lopez, Lester Escheverria, ".gt", Center for International Development at Harvard 2002, retrieved online March 14, 2006 from http://lanic.utexas.edu/project/tilan/countries/gt/

Guatemala did see some progress in recent years, most notably in its penetration growth rate, which at more than 1,000% for the 2000-2005 period, indicates that Guatemala has arrived at the stage of development where growth in users is very high and will bring Guatemala closer to the LAC average for internet penetration. The relatively poor level of development achieved in all the other dimensions of progress included here has not been the result of a lack of development during this time. Progress has been slower in Guatemala for two main reasons. First, the more severe socioeconomic restrictions on ICT consumption and use complicate all areas of development. Second, Guatemala started developing the internet and related technology much later than Chile, Mexico, and Brazil, so even at a good rate of progress, it would not have reached the same stage of development. In addition, the geographical asymmetry of ICT distribution is more extreme in Guatemala, and this also complicates many areas of development. The primary goal of the Guatemalan government now should be increasing the size and capacity of the computer and internet networks in the country, in order to avoid it currently high rate of penetration growth causing a severe shortage of technological resources.

Conclusions: Closing the Digital Divide

The main question of my research was how the developmental context in Latin American countries affects their progress in expanding and integrating the internet and related technologies. In the course of writing this paper, I have tested a three part hypothesis: 1.) that the governments of Latin America, in part through collective programs within the OAS, were successful in identifying the importance of ICTs and in introducing them to the region; 2.) that there has been significant progress since the internet's inception in the development of this resource and its use; and 3.) that the general level of technological achievement in Latin America remains below expectations of the region's potential, requiring continued progress to achieve a desirable level of technological development and integration.

I have found that the information available suggests that the efficacy of government efforts to introduce the internet and related technology has varied. The initial projects in the region were designed to provide internet access to academic institutions and connect university and research networks within the region. The RedHUCYT and the network developments of individual nations in the early 1990s, when the internet was primarily conceived of as an academic resource in LAC, were successful in providing higher education institutions the resources needed to update and expand the technological opportunities available to students to international standards. This also established the foundation upon which future, commercial networks would be built. This format was used to evaluate all four Latin American countries examined here.

The educational dimension of the developmental context in the four countries covered here is still insufficient, however, as indicated by low levels of tertiary

enrollment and large percentages of primary and secondary schools that remain without internet connections. In order for future growth in internet penetration to translate into productive use and economic benefit, the potential knowledge-worker resources of these countries, through their education systems, must be improved. This is particularly true for Mexico and Brazil (which have advanced technological infrastructures but low level of tertiary enrollment) and less so for Chile (where university enrollment is higher), and Guatemala (where the underdeveloped state of the infrastructure would be of marginal productive use to greater numbers of knowledge workers). In Guatemala's case, increasing ICT resources must precede an increase in the knowledge-labor force for productivity to increase.

After the initial phase, the governments in the region realized the commercial value of the internet, and made technology a priority for the OAS Office of Integral Development. During this time, governments in the technological vanguard like those of Mexico, Chile, and Brazil developed national networks and established ISPs within the regulated monopolistic or duopolistic telecommunications industries to market the new national backbones commercially. Guatemala has remained behind these other countries at every step of development, a result of having started developing internet resources later.

During this time, these governments were partially successful in expanding the internet. They began integrating government services online, programs to wire schools to the internet, and incentives or mandates for telecommunications companies to offer internet service to less profitable, rural areas in order to bridge the digital divide developing between socioeconomic and demographic groups in their populations, as was

done by Telmex in Mexico. To this day, the formerly state run ISP is the only one providing service to many regions of the country, but now has the nation's weakest network backbone, having been surpassed by new ISPs that only focus in profitable areas. Based on the literature available on Brazil, Guatemala, and Chile, such a difference between the quality of the original ISP network and more recent ones does not appear to be an issue.

As one might expect, the privatization and deregulation that followed this period, occurring in the late 1990s for the earlier developing countries, caused a shift in internet development toward a market driven strategy, where the governments' previously public ISPs could no longer afford to prioritize network expansion in geographic and demographic terms, and are forced to compete for the high profit, urban areas. As a counterbalance, the OAS developed RedCLARA which further connected most national networks throughout the region, helped finance the increase in regional bandwidth, and established regional internet hubs and backup networks to increase the speed and stability of the internet in the region.

As a result, cities in countries like Brazil, Mexico, and Chile became some of the primary hubs (or transfer points between networks) for Latin American internet content, decreasing the dependency on US network hubs that originally linked many early academic networks to the internet via satellite. However, the remaining initiatives intended to increase access to rural populations were apparently few, and included the earth station satellite link in Guatemala which was intended, in part to provide access to areas outside existing networks within the nation and surrounding Central American

countries. Despite this effort, Guatemala still contains large territories in which no internet access is available.

Even though the liberalization of telecommunications has hindered network penetration in spatial terms, and thus technologically marginalized some rural populations, LAC governments have had plenty of reasons to stick with this strategy for development. First of all, it increased opportunities for foreign direct investment in fast growing industries, and in many cases these opportunities have been met, easing the burden on the nations' resources for the expansion of networks. Some scholars have pointed to the reduction in internet access costs since deregulation, but the markets are not as competitive as they are in other developing regions like Asia, as signified by much higher average costs in Latin America than in the lower-middle-income and upper-middle-income countries on the whole, as classified by the World Bank. This is particularly true for Brazil and Guatemala, whose prices are close to the very high LAC average. Mexico and Chile's average prices for internet service are somewhat lower, and closer to their income class averages, but still much higher than those in Malaysia.

Nevertheless, the internet use growth and quality enhancement has been strong in most of the LAC region under market conditions, and regulation has become increasingly effective. In Brazil, the national telecom regulator is internationally recognized as an example of effective, progressive regulation. Initially, the greatest growth in internet use and computer ownership was commercial, but the private, or individual, internet service market has been catching back up, and in Mexico household use and ownership has surpassed that of businesses. Deregulation has also paved the way for some important internet technology innovations, including the federal financial system database in

Guatemala, and *Chilectra*, the power company-turned-ISP in Chile, both of which have served as models for similar developments in other countries.

Economic barriers continue to thwart acquisition of hardware and internet service by much of the region's population in lower income brackets. The income and wealth divide throughout LAC widened after the debt crises in the 1980s and were followed by the austere, liberal economic reforms required by the IMF. This economic divide created a "digital divide" when the internet and modern telecommunications technology became available in the region, and were exploited by the small section of the population that had come to acquire the majority of the nations' wealth, but were out of reach for the majority living on tight budgets. This divide continues to persist, but is being narrowed, as indicated by growth in PC penetration per capita in each of the four countries.

The creation of public internet access points (either privately or corporately owned) in public institutions like libraries and free internet labs has enabled many people to access the internet without investing in proprietary hardware or services. The digital divide has been the focus of recent international and regional developmental organizations, and many of the summits and current and programs are dedicated to decreasing inequality in internet and computer use. Providing resources for personal computer and internet service purchases will continue to require governmental activism and coordination in the future. This is especially true for Mexico, Brazil and Guatemala, where ICT expenditures are low. In Chile, where higher ICT consumption indicates that more private resources are being spent on these products, the burden on the government's programs to increase consumption and network resources is not as great.

Overall, the governmental context for development in Chile, Mexico, and Brazil is good. Of these nations, Brazil seems to be the one to benefit the most from this context in recent years, based on certain indicators like hosts/internet user. Chile has achieved a higher level of development, but its technological resources have not been growing as rapidly as those of Brazil and Mexico. Guatemala has some positive characteristics in this regard too, but the country has not initiated as many of its own programs for development, nor has it acquired the resources or connectivity to take full advantage of the region's network resources which have been developed through OAS technology development programs like RedHUCYT and RedCLARA.

The economic context of development is also satisfactory in all the countries except for Guatemala, as indicated by ICT consumption levels comparable to their income groups. This is significant because, in competitive markets, increasing consumption encourages investment in ICTs, which in turn enhances the quality of networks and the variety and sophistication of services offered. It is also apparent that this is a cyclical issue for these countries, since the increase in sophisticated services increases relevant applications for businesses and citizens alike, which subsequently increases spending further.

Based on the indicators that are used to measure progress within the developmental context, one can observe that Latin America has been improving its position relative to its Asian counterparts. The superior growth and penetration rates for LAC in the last six years have begun to close the gap between LAC and North America, and eliminated the gap between the region and Asian nations of comparable wealth that surpassed it technologically during the 1980s. Most of Asia did not experience the same

success as the high-income, highly developed nations, and as a result, the LAC region as a whole has become more technologically developed than the majority of Asia once more.

The networks in Mexico and Brazil, like Malaysia, are more developed in terms of hosts/internet user, while Chile and Guatemala, along with Indonesia, have underdeveloped networks in this regard. The numerous government programs in Mexico and Brazil designed to expand and enhance networks, compared to relatively fewer such initiatives in Chile and Guatemala, have clearly influenced this developmental divide. Most countries experienced negative growth in networks in this regard over the 2001-2004 period, indicating that internet penetration has continued to outpace network development. Ultimately, this aspect of development is not unsatisfactory, bringing Mexico and Brazil very near Canada's level, but could still be improved, considering the much higher ratio of hosts to users in the U.S.

Growth in hardware acquisition also differed between the countries. Mexico and Brazil had at least 0.8 PCs per internet user in 2004, significantly more than Malaysia and Indonesia by comparison. Chile and Guatemala, on the other hand, are similarly developed to the Asian countries from their income class. In all cases, PC resources relative to internet use are significantly less than those of the U.S. and Canada, and over the 2001-2004 period, all four countries experienced negative development in this dimension, revealing the need to continue programs to increase the affordability of hardware.

Broadband technology appears to be developing well in Mexico, Chile, and Brazil, but has not become main-stream in Guatemala. As this technology continues to

grow, it will improve the speed and reliability of networks, as well as the variety and sophistication of applications that they can handle. Compared to North America and Malaysia, however, these resources are still underdeveloped. This should be remedied in the near future, in light of high growth in demand for this technology in Chile, Brazil and Mexico. Guatemala has not reached the phase of ICT development where advanced technology like broadband access is in significant demand.

Bandwidth was significantly increased in Mexico, Chile, and Brazil, and is above the income class averages for these nations, but below that of more highly developed nations. Guatemala, like Indonesia, still has extremely low network capacity, due in part to the slow integration of new resources like Broadband and high capacity networks like those established in the other three countries to facilitate connections to advanced international networks. It is in the interest of each of these governments to continue investing in network expansion and quality, to ensure that a growing population of users can make the most productive use of the internet possible, and to ensure that greater numbers of users do not compromise the reliability of networks in the future.

The growth in secure severs has been decent in all countries but Guatemala, yet remains significantly below the level of countries like the U.S. and Canada. The greater number of secure servers by population in these countries as compared to their income class averages suggests that, while still at a low level of development in this regard, LAC is regaining a lead in technology development in the developing world. As government efforts continue to increase these resources and integrate them into e-commerce and other productive use, they will become more important, and should grow more rapidly, as LAC companies become active in e-commerce and idea-based production.

In an effort to summarize the comparison of these indicators of ICT expansion across the seven countries examined here, I have created a table that illustrates the scale of technological development. I classify each country based on its stage of development, which is indicated by internet penetration levels and growth rates, and also corresponds directly to the developmental context. The data confirms that the most developed nations have the best educational and economic contexts for development, while the least developed nations have the poorest context in this regard. Then I classify each nation by the level of technological development achieved, as indicated by the size of networks and the prevalence of advanced services and resources. The four stages of development are initial, early, late, and final. The levels of technological development are very low, low, moderate, high, and very high, and represent the result of recent progress to enhance ICTs. This technology development scale illustrates these nations' relative position to one another in terms of the integration and the quality of ICTs.

Guatemala and Indonesia both remain at the initial stage of development and have very low levels of development. Mexico and Brazil are both in the early phase, but Brazil's technological level has surpassed Mexico's in many dimensions, and thus warrants the moderate rank assigned to it, as opposed to Mexico, where the level of development remains low. Brazil is closer in development to Malaysia, which has reached the late stage of development, yet retains a moderate level of development, as opposed to Chile's high level of development at the same stage. Finally, the United States is in the late, slow growth stage of development and, correspondingly, has a very high level of technological development. This scale is presented in Table 11.

Table 11: ICT development Scale

Stage of Development	Level of Technological Development				
	Very low	Low	Moderate	High	Very High
Final					United States
Late			Malaysia	Chile	
Early		Mexico	Brazil		
Initial	Guatemala and Indonesia				

The major challenges remaining to internet development include obstacles common to all countries, like the socioeconomic restrictions that impede economic development in general. In Brazil, Mexico, and Guatemala, the asymmetric geographic expansion of the internet remains a problem for future penetration growth and for closing the demographic, digital divide, since many poorer citizens live in rural areas sparse in public access points, internet service, and internet resources in schools. In Chile this is not as significant, largely due to the geographic composition of the country. Brazil and Guatemala share a language barrier issue that has been an obstacle to internet penetration and to international exchanges, which are an important part of internet use for productive purposes. In Chile, which is at a higher stage of development than the other three, one of the major challenges to further development is integrating the technology deeper into the economy for productive use, such as e-commerce, the production of digital products, and the application of ICT to enhance agriculture and traditional industries. As in the other nations, government programs to increase this type of application will remain important to potential economic benefits of the nation's investment in ICTs.

Ultimately, my research has shown that, since 2000, Latin America has been recovering lost ground in technological development vis-à-vis Asian nations of comparable wealth, and is now generally more developed in many dimensions. This challenges the generalization that Friedman and others have made in claiming that "Asia" has become more advanced than Latin America. Clearly, these scholars are only discussing the "tigers", such as Taiwan, South Korea, Japan, and Singapore that have reached technological levels comparable to post-industrial nations like the U.S. When the greater technological disparity in Asia is taken into account, and the comparison is not simply between the most developed nations in each, it becomes clear that recent progress has allowed Latin America to surpass Asia as a whole in technological development, as measured by current, aggregate internet penetration and aggregate penetration growth in recent years.

One exception, already mentioned, is the relatively high price of internet service in the region. This continues to inhibit internet use growth, and is representative of the socioeconomic impediments to development. The socio-economic and educational dimensions of the developmental context in all four Latin American countries remain the most relevant to current challenges, and for this reason have become the focus of contemporary developmental projects in the OAS. If the region manages to make similar progress over the next five to six years, and remains committed to ICT development, by the end of the decade Latin America could become a highly developed region technologically. In turn, this could fundamentally improve the socioeconomic conditions in the region and raise Latin America to a level of global economic competitiveness and participation that the dependency theorists of the 1960's never could have imagined.

So, it appears that Friedman was off the mark to claim that Asia, in the aggregate, has surpassed, or remains ahead of, Latin America in ICT development. The indicators included in this report clearly show comparable levels of development between Asian and LAC nations within the same income class. Chile is most promising of all the countries examined, in terms of potential for significant improvement in the near future. Its higher rate of tertiary enrollment should guarantee Chile enough knowledge workers to effectively increase productive use of the internet and other ICTs. The large proportion of broadband subscriptions and secure internet servers in the country, along with a very high bandwidth for the region, will enable Chile to incorporate its knowledge workers into the virtual economy better than the other developing countries presented here, and will facilitate the integration of new, advanced technologies as they become main-stream. If there is a "tiger" about to be born in Latin America, Chile is going to be it.

This returns us to the question of how Latin America got behind many Asian nations in technology development in the first place, and why no LAC countries have had the kind of developmental success of the most developed Asian nations. The reason was not a lack of potential to integrate these technologies. Theoretically, people are as intelligent and talented in one country as they are in any other, so putting aside socioeconomic and other environmental constraints, Latin America's population should be able to reach the same level of penetration as the United States, once it reaches the final stage of development. Most likely, slow uptake of technology in the 1980s was partly the result of political perspectives that such resources were of primarily academic value, and education was not a priority of LAC governments at the time. Another significant factor that influenced poor developmental decisions and policies during the

"lost decade" were the austere, structural reform measures that most LAC governments implemented under pressure from the "Washington Consensus", as manifested in the conditions imposed by the IMF. The resulting decline in spending on R&D, technology, and education in order to earn debt forgiveness certainly prevented governments from promoting ICTs at the time.

On the other hand, during this early phase of computer technology, there were already links in technology industries between the U.S. and other postindustrial economies and several Asian nations, including those which became known as the "tigers" in the 1990s, after a period of very rapid technological development. Similar links between tech firms in the advanced countries and Latin America are becoming more common now, primarily through foreign investment into the regions growing ICT markets. Hopefully, this trend will continue and lead to the types of productive relationships that formed between postindustrial economies and the "tigers", which have been an important force behind the overall economic development in those nations.[117]

If the success of the "tigers" means anything for Latin America, in light of their comparable levels of development in the 1950s, it is that LAC countries do have the potential to achieve the same high levels of development, under the right conditions. International and national government programs to promote ICTs are good in the LAC region, especially so in Chile and Brazil, and these initiatives have been largely responsible for progress in technology development since the advent of the internet in the region. Pro-competitive regulation of ICT markets, and the resulting influx of foreign

[117] Torres, Carlos A & Schugurensky, Daniel, "The political economy of higher education in the era of neoliberal globalization: Latin America in comparative perspective", Higher Education; Jun2002, Vol. 43 Issue 4, p429-455

investment in the industry, has also been critical to the expansion of ICTs in recent years. If new programs designed to reduce the socioeconomic barriers to ICT consumption are successful, the digital divide with nations and the region should be reduced as well.

As for educational limitations on ICT expansion, the lack of internet resources in primary and secondary schools is becoming less of a problem in most countries at the early and late stages of development, where knowledge workers become a more important part of the developmental process. Progress in increasing tertiary enrollment is likely to be the slowest, but governments in Brazil and Chile's position should focus on increasing funding for scholarships and grants, in order to produce a large enough knowledge labor force to take full advantage of the technological infrastructures' productive capacity.

I hope my research has shed some light on the ICT development situation in Latin America. For one thing, this work has offered strong evidence against a commonly held perception that Asia is generally more technologically developed than Latin America. As we have seen, this is only true if one looks exclusively at the most developed countries. Instead, what we discovered was less technological inequality between LAC countries on the whole than there is in Asia. This is largely due to successful international development programs designed to "tech-up" the whole region. In addition, it is clear that government initiatives, combined with free market forces, have enabled most of the recent progress in the region, while educational and socioeconomic disparities remain the principal forces working against progress. The decision by the region's political leaders, IGOs, and NGOs to focus current and future efforts at eliminating these obstacles should

result in continued progress toward a more technologically advanced and economically stronger Latin America.

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