ctp

Cuba Transition Project

CUBA: FUNDAMENTAL TELECOMMUNICATIONS PLAN

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Cuba Transition Project – CTP

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Prepared for the Cuba Transition Project (CTP)
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Executive Summary

The purpose of this study is to evaluate the existing telephone network in Cuba, to recommend an interim plan for Cuba's essential communications with the rest of the world (after a transition from the current government), and to provide an order-of-magnitude analysis of the cost of modernizing Cuba's current network to meet short- and long-term demands.

The Republic of Cuba has approximately 610,000 telephone access lines, of which 210,000 are in the Havana metropolitan area. The telephone switching equipment is a combination of crossbar and step-by-step systems, with only a small digital switch (1,200 access lines) serving the international airport in Havana, plus a few more digital switching systems and a fiber ring installed in Havana by the Empresa de Telecomunicaciones de Cuba Sociedad Anonima (ETECSA)[1] since 1998. The fiber ring is used to supplement the data-carrying capabilities of the existing network.

Long-distance service is provided by a combination of crossbar switching systems and cord-boards. Cuba has access to the International Direct Dial Plan for most countries. Direct distance dialing within Cuba is made possible by a crossbar toll tandem network. The local network consists of a copper-and-lead feeder plus distribution cables whose average age is approximately 25 years.

In the Havana metropolitan area, some cables are placed in conduits or buried underground, but the majority of cables are pole mounted. These pole-mounted cables require high maintenance due to their age and exposure to the elements. Interoffice facilities in the local networks are served by copper-based digital carrier systems conforming to CCITT (European) standards (32 channels per system). (CCITT is the Comité Consultatif International Téléphonique et Télégraphique or International Telephone and Telegraph Consultative Committee, which is now part of the International Telecommunication Union or ITT, an agency of the United Nations.)

The toll network is served by a combination of a microwave backbone and a coaxial carrier system. Assignment and maintenance practices resemble the techniques employed in the United States prior to the mid-

1970s. These methods require at least three times the labor force needed by the mechanized methods currently used in the United States and require close coordination among various departments. Details about the present communications infrastructure can be found in the Present Environment section of this paper. Recent updates are included in the sections below on ETECSA (Empresa de Telecomunicaciones de Cuba S.A.) and Cubacel (Teléfonos Celulares de Cuba S.A.), which provide a status report on recent improvements and financial results of current operations.

The primary short-term need in Cuba is improvement of communications with the United States, now being provided by outmoded and limited-capacity systems. The additional capacity can be provided by satellite-based systems similar to those established in Saudi Arabia during the Gulf War and more recently in Pakistan in Operation Enduring Freedom by Coalition Forces.

These systems can be deployed very quickly (within days) and integrated with the current telephone network, which has sufficient capacity to handle the marginal demand. The high profitability of international long-distance service will make it attractive for international long-distance carriers to deploy this technology within weeks after the fall of Castro's government.

Demand for these services will be inelastic due the immediate need for communications with the United States. The various long-distance carriers eventually will provide access to the international long distance network via fiber-based cables linking the United States to Cuba. Competition in the international long-distance arena ultimately will ensure lower costs for the consumer.

The long-term plan for Cuba devised by the author with the assistance of several telecommunication engineers and managers is to have a privately owned telephone network similar to the networks being established in most Latin American countries. The franchise will be awarded based on a bidding process to be established by the new Cuban government.

This telecommunications franchise should cover all services in Cuba, including domestic long distance, wireless services, and Internet access. The provider company should be a regulated monopoly in order to provide safeguards for the consumer. To optimize the benefits of

competition, various competing carriers should provide international long-distance service and the actual Internet service. Eventually, the telecommunications server could also provide cable TV access. Most telecommunications companies in the United States are converting to provide all services.

This document provides a macroanalysis of the potential demand in Cuba, the basis for determining the value of the current network, and a detailed description of the current telephone network, including recent steps toward modernization. The following information will be presented:

- Value of the existing telephone network
- Capital requirements for modernization
- Capital deployment strategies
- Average cost per access line required for providing telephone service
- Profitability data for each submarket

The results of the macroanalysis are depicted in table form. The method used for the analysis, described in detail in the Study Details section of this document, consisted of developing an expected market price (or average revenue per line) for the product, based on profitability requirements for telephone companies investing in foreign markets and on demand parameters experienced in countries whose markets resemble the expected market in Cuba.

Implementation costs and maintenance costs were based on macro study models used by telephone companies in the United States. Demand estimates were based on population distribution in Cuba and expected telephone service penetration. Projected cost includes Internet access and other data services, both of which will increase the demand for telecommunication services.

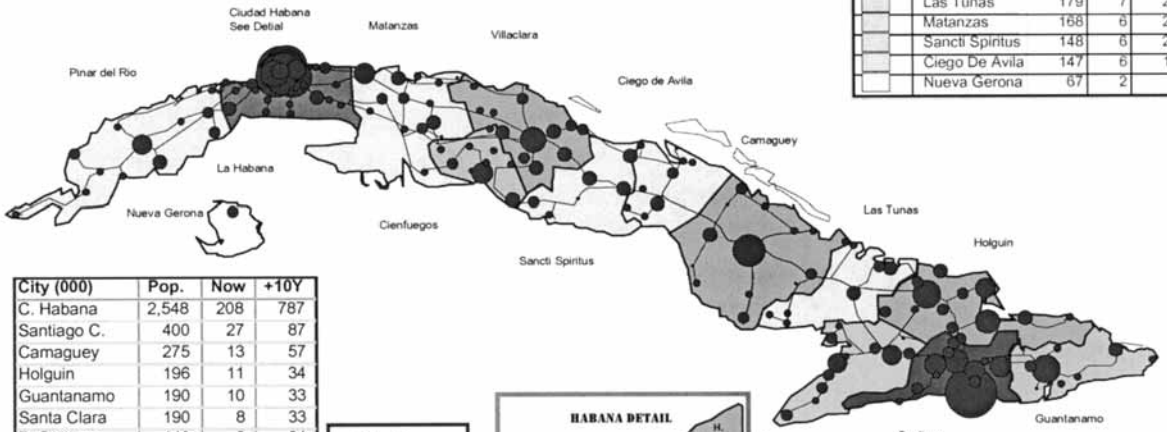
The average revenue per line ($427 per year is approximately 55 percent of the average revenue in the United States) was combined with the existing demand (609,000 access lines) to determine the current value of existing equipment. Estimated capital requirements for implementation of the network are in the amount of $2.5 billion over the next 10 years. The value of current equipment is estimated at $210 million.

One possible strategy to be followed by the new telephone company could be initially to modernize the major markets, where the density of demand and profitability will be higher, and to continue modernization elsewhere over a 10-year deployment horizon. The current equipment, although incapable of proving enhanced services, can continue in use during the transition period. The current population and demand profile is depicted in chart 1. Most of Cuba's current equipment can be used as a bridge to updated replacement equipment.

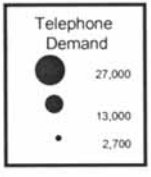
A second strategy could be to provide a parallel cellular network by replacing some existing equipment, thus providing a supply of reused equipment for interoffice facilities connecting the cellular network with fixed-wire networks to enhance system capacity, while serving the marginal demand with wireless services.

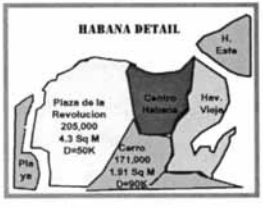
Cuba Current Telephone Demand

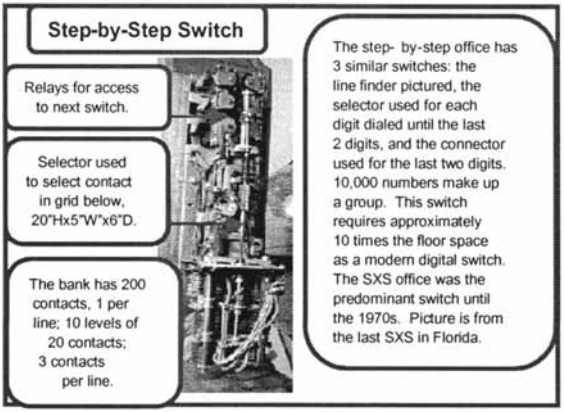
Color	Province	Density /sq. Mile Popu-lation	Tel. Now	Tel +10Y
	Ciudad Habana	10,152	827	3,136
	Santiago	393	22	71
	La Habana	360	14	47
	Holguin	275	11	43
	Camaguey	275	12	41
	Villaclara	277	11	38
	Cienfuegos	239	10	34
	Granma	234	10	33
	Guantanamo	207	9	30
	Pinar Del Rio	171	7	24
	Las Tunas	179	7	23
	Matanzas	168	6	22
	Sancti Spiritus	148	6	21
	Ciego De Avila	147	6	19
	Nueva Gerona	67	2	8

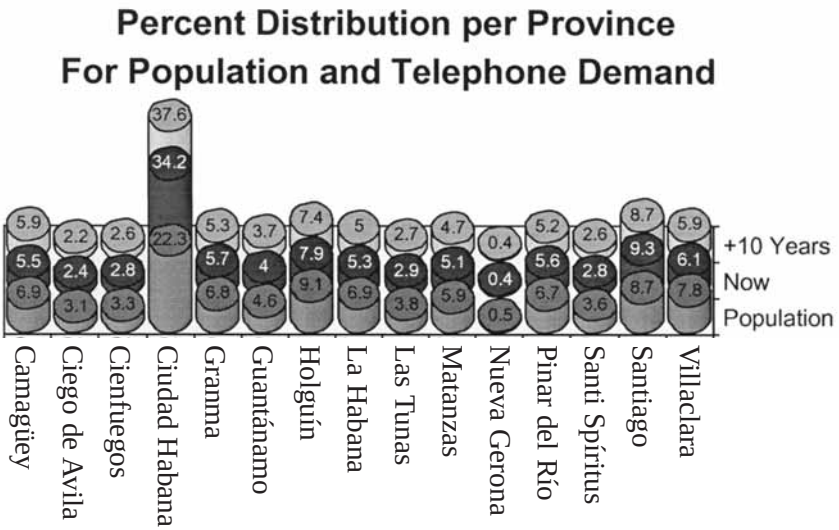


City (000)	Pop.	Now	+10Y
C. Habana	2,548	208	787
Santiago C.	400	27	87
Camaguey	275	13	57
Holguin	196	11	34
Guantanamo	190	10	33
Santa Clara	190	8	33
P. Soriano	140	8	24
Mayari	139	8	24
Matanzas	121	7	21
Contramaestre	117	6	20
la Maya	115	6	20
Cienfuegos	115	6	20
Pinar Del Rio	110	6	19
San Luis	110	6	19
Bayamo	110	6	19






Step-by-Step Switch
Relays for access to next switch.
Selector used to select contact in grid below, 20"Hx5"W"x6"D.
The bank has 200 contacts, 1 per line; 10 levels of 20 contacts; 3 contacts per line.
The step- by-step office has 3 similar switches: the line finder pictured, the selector used for each digit dialed until the last 2 digits, and the connector used for the last two digits. 10,000 numbers make up a group. This switch requires approximately 10 times the floor space as a modern digital switch. The SXS office was the predominant switch until the 1970s. Picture is from the last SXS in Florida.


Percent Distribution per Province
For Population and Telephone Demand
+10 Years
Now
Population
Camagüey 5.9 5.5 6.9
Ciego de Avila 2.2 2.4 3.1
Cienfuegos 2.6 2.8 3.3
Ciudad Habana 37.6 34.2 22.3
Granma 5.3 5.7 6.8
Guantánamo 3.7 4 4.6
Holguín 7.4 7.9 9.1
La Habana 5 5.3 6.9
Las Tunas 2.7 2.9 3.8
Matanzas 4.7 5.1 5.9
Nueva Gerona 0.4 0.4 0.5
Pinar del Río 5.2 5.6 6.7
Santi Spíritus 2.6 2.8 3.6
Santiago 8.7 9.3 8.7
Villaclara 5.9 6.1 7.8

Present Environment (up to 1996, before ETECSA)

Local Telephone Service

Havana

The city of Havana has 17 central offices with a capacity of approximately 210,000 access lines. About half of these central offices are equipped with step-by-step[2] (SXS) and half with crossbar[3] (XB) switching equipment. Some central office locations are as follows:

Principe	Step-by-step, about 40,000 lines (Groups 7, 70, 71, 72)
Vedado	Step-by-step and crossbar, about 30,000 lines (Groups 30, 31, 32)
Guanabacoa	Step-by-step
Monte	Step-by-step
Buenavista	Step-by-step and crossbar (Hungarian)
Alamar	Crossbar (ATZ65, German)

The cord-board[4] operators are located in the International Communications Complex at the intersection of Aguila and Dragones streets.

A Tandem office equipped with a Hungarian-made crossbar switch is located in the Ministry of Communications.

Interoffice facilities are copper for the most part. Japanese or German (GDR) digital carrier[5] conforming to CCITT standards, PCM (pulse code modulation) with 32 channels/system, is used to connect faraway locations. A Japanese NEC system is used to provide interoffice (trunk) facilities between Marianao and the International Communications Complex.

Equipment

The crossbar switching equipment is mostly of German (GDR) manufacture, ATZ63, ATZ64, or ATZ65. The step-by-step switches still are the pre-Castro American-made types manufactured by Western Electric. The airport complex has the only digital switch,[6] which serves 1,200 lines.

A typical central office switch has a capacity of 10,000 access lines in the larger metropolitan areas. Community Dial (step-by-step) Offices with low subscriber penetration serve the smaller towns. As an example, an 80-line ATZ63 switch providing 15 public telephone lines and 65 private lines serves the town of Fomento.

Billing

The billing of service to private homes is computerized.

Public Communications

Phones of German and Japanese manufacture provide public communications. A local call costs 5 cents, and long-distance calls are sent paid-only. Although directories are available, they are not found at each pay phone location. Dialing 113 gives access to directory assistance. Telephone operators use microfiche with auto-search to locate requested numbers.

National Long-distance Service

Toll offices, called Centros de Mantenimiento de Telecomunicaciones (CMT), are located in each municipal entity (municipio), according to the political structure of pre-Castro Cuba. These offices are mostly Number 5 crossbar of German (GDR) manufacture.

The toll interoffice facilities are either microwave[7] or coaxial cable.[8] The military uses mostly the coaxial facility due to its "privacy."

Numbering Plan

A numbering plan is in place, which allows Direct Distance Dialing (DDD) to any point in the nation. Long-distance lines are accessed by dialing "5" followed by the city code, the 1- or 2-digit exchange code, and the 4-digit station number. A call from Havana to Matanzas would be dialed: 5 + 52 + NN-XXXX.

Microwave Network

The microwave facility network has Thompson (French-made) equipment with a capacity of 960 channels (16 supergroups of 60 channels) linking Havana with the other old province capitals: Pinar del Rio, Villa Clara, Camaguey, and Santiago (but not Matanzas). The terminal equipment located in Villa Clara, Camaguey, and Santiago is the French-made LTT. Pinar del Rio and other secondary points have the German (GDR)-made VKM.

Coaxial Cable

This system has a capacity of 1920 channels out of Havana. The facilities terminal equipment is German-made VLV or Telemecanica VKD. The repeaters are Soviet-made, and all conform to CCITT standards. The cable runs by the new "autopista" (superhighway) all the way to Cabaiguan and then follows the old "carretera central" (central highway) to Santiago de Cuba. Repeaters are located every 6.3 kilometers in huts above ground.

The repeater facility has the following drops: S1 Sancti Spiritus, S2 Cienfuegos, S3 Villa Clara, S4 Villa Clara, S5 Camaguey, S6 Ciego de Avila, S7 Victoria de Las Tunas, S8 Villa Clara, S9 Camaguey, S10 Camaguey, S11 Bayamo, S12 Santiago de Cuba, S13 Guantanamo, S14 Holguin, S15 Santiago de Cuba, and S16 Cerro Pelado, plus 24 channels to Jamaica.

The drop in Cerro Pelado links to a microwave system and is used for aerial corridor communications (AICC). The equipment located at the old province capitals is terminal equipment. At other points, it links with the CW20 microwave facilities.

International Long Distance Service

Satellite

Two systems are in service: IntelSat, an automatic Japanese system with 24 channels; and Intel-Sputnik, a Russian manual system with 60 channels.

Coaxial Cable

A submarine cable was installed in 1950 between Key West and Havana using an analog carrier system.[9] It is composed of two coaxial cables, one for each direction of transmission, and it was originally designed to carry 24 voice channels. The terminal equipment for this system is located on the third floor of the former Cuban Telephone Company on Aguila and Dragones streets. This equipment was damaged by fire several years ago. A new cable was installed by ITT (International Telephone & Telegraph Company) from Key West to Caviar. From Caviar, it terminates in the International Communications Complex in Havana with a capacity for 138 channels (PCM). The terminal equipment has not been installed due to the U.S. trade embargo with Cuba.

Microwave

An over-the-horizon troposcattering system was placed in service in September 1957 for the transmission of one B&W video channel and 36 audio channels of 4 MHz. This system is composed of three radio spans. The first operates at 3 GHz from Havana to Guanabo; the second operates in the UHF range between Guanabo and Florida City; and the third operates at 3 GHz between Florida City and Miami, with a repeater located in Goulds. In Havana, the system terminates on the first floor of the Edificio Masonico, located at Carlos III No. 508. The TD-2 transmitters/receivers reside there along with the L-1 carrier equipment, both of Western Electric manufacture. In Guanabo, in addition to the microwave transmitters, two government systems operate at 10 kilowatts at frequencies of 692 MHz and 740 MHz, along with two receivers tuned to 840 MHz and 880 MHz. Both are connected by waveguide to 60-foot parabolic antennae.

Data Communications

Data communications facilities are utilized only for government-related business, transmitting government and military information. The government-owned sugar industry also is a user.

The data network is composed of three hubs: Havana, Matanzas, and Villa Clara. Packet-switched data interconnects mainframe computers in

these locations. The transmission speed is 9600 bits per second.[10]

Three local area networks (LAN) are located in Havana, and one each is found in Matanzas and Villa Clara. Token ring architecture is used in these LANs. Modems are used for data transmission through voice-grade circuits at 300, 1200, and 9600 bits per second. These circuits are used mostly by the military and Prensa Latina.

Maintenance

Most problems occur in the central offices that provide local service. These problems usually result from the lack of spare parts. Long-distance service fares better since parts are more readily available.

Personnel

About 1,500 graduate engineers work in communications at the Ministry of Communications and for ETECSA in Havana. About 50 of these who belong to the Communist Party hold the more responsible positions.

Recent Upgrades: ETECSA (Empresa de Telecomunicaciones de Cuba S. A.)

The Cuban government decided to privatize a portion of the telecommunications system to provide service based on market pricing. The sections on ETECSA, Cellular Telephony, and Cubacel (Teléfonos Celulares de Cuba S.A.) provide additional information. The main improvements of ETECSA include:

- Increment in the number of public telephones
- Fiber ring installed in Havana
- Two digital electronic switches installed in Havana
- Installation of a National Data Transmission Network (NDTN), with the six main nodes in Havana, Pinar del Rio, Santiago de Cuba, Camaguey, Holguin, and Santa Clara
- Secondary nodes branches to the adjacent provinces
- Links operating at 35Mb/s[11] and using Alcatel equipment capable of operating at 155Mb/s
- Provision of Internet infrastructure

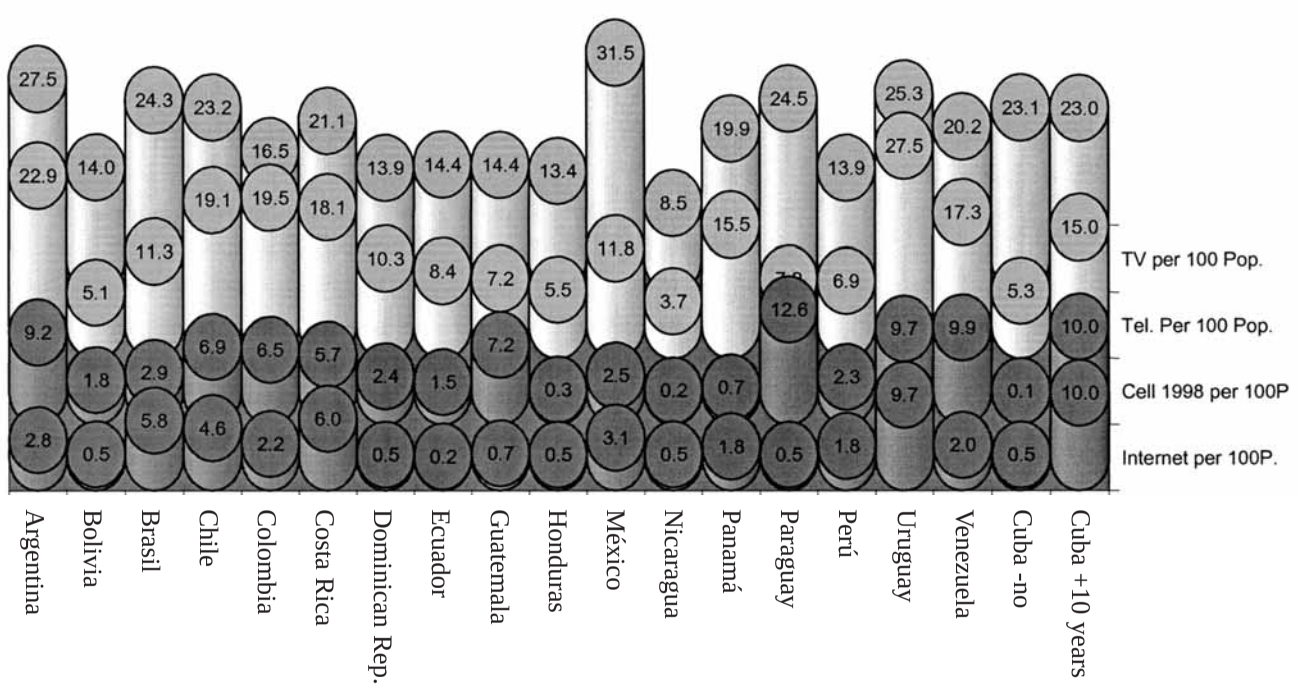
Cellular infrastructure is currently provided by Cubacel, which started operations in 1993 and currently has a network serving several major population centers, including Havana, Varadero, Santiago de Cuba, Moa, and others. Mexican investors own all of these private companies.

Long-term Plan (Market Analysis)

The projected telephone demand in Cuba is based on an analysis of telephone demand in countries in a similar stage of development. The expected post-Castro rate of economic development and the logistic constraints of implementing the new telephone network are depicted in the figure that presents access lines as a percentage of population for various countries in the world.

Based on this information, the demand for Cuba was estimated to be 15 percent within 10 years. This demand was used to estimate the average revenue requirements per line for telephone service based on a complete replacement of all plants. Plant replacement is necessary in order to gain operational efficiencies to provide for a three-fold increase in market penetration. Following are descriptions of methodology, specific assumptions and data sources, and study details.

Comparison of Telecommunications Demand in Cuba to Rest of Latin America



All demand is lines per 100 pop, Data for cell phones is from 1998 , Other data from Year End 2000. Source: CIA WorldFact database.

Methodology

The market price for an average access line was inferred from market conditions expected by a telephone company wishing to invest in Cuba and similar costs in the United States. The specific algorithms used to derive the annual revenue requirements (average cost per line) are shown in figure 3.1. The specific costs used in the study are consistent with assumptions 1 to 7 listed in this section.

In order to determine capital requirements, population data for each population center was obtained from census files. The demand profile generated was based on the ratio of telephones to population for various countries with similar demographics. The data was further refined based on population size for each submarket. Capital replacement costs were based on fixed costs plus variable costs (see assumption 3). The equivalent uniform annual cost was derived based on economic parameters described in detail in assumption 4. The annual cost of initial capital investment (A) was calculated based on a 20 percent rate of return as detailed in figure 3.1. Maintenance costs were calculated as described in assumption 2. The sum of these two numbers is labeled "revenue requirements new equipment, annual" and is presented in Table 2 of the appendix (Demand, Cost, Revenue, and Rate of Return: Study Details for 169 Population Centers). The sum of the individual revenue requirements is labeled "totals" and is included in Table 2. The "annual revenue requirements per line new equipment" is the total annual revenue requirements divided by the telephone demand.

The annual revenue requirements per line for existing equipment were set equal to the cost of new equipment ($427) to derive the current value of equipment as listed in the tables. The same derivation described in the previous paragraph was used to infer the value of existing equipment.

The rate of return (ROR) on new equipment was based on the perpetual annuity assumption captioned in figure 3.1.

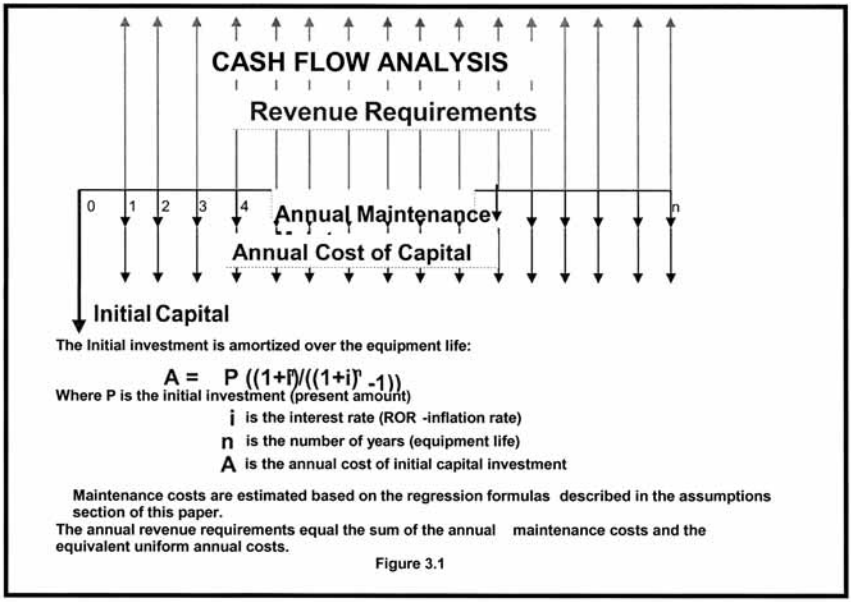


Figure 3.1

It should be noted that the average user cost per line is approximately 60 percent of the average current cost in the United States. This cost to the user per line is expected to be comparable to current costs charged in comparable countries. Although the costs were derived based on complete equipment replacement, the existing plant can continue in use to provide service to smaller areas where sufficient return is not obtained on the marginal investment. Although the combined rate of return on investment is 20 percent, many of the smaller markets provide a rate of return below 20 percent, and the seven smallest markets are unprofitable.

Assumptions and Data Sources

1. Telephone demand was estimated based on the ratio of telephones to population in various countries with similar demographics. The primary source for this data was the *Statistical Office of the United Nations Statistical Yearbook*. Data was obtained for various years. The demand for Cuba assumes that within 10 years the Cuban economy will have developed to a level comparable to the level that would have been attained if Communism had not existed for the last

43 years. On this basis, it is expected that the telephone demand will be 15 percent for the population on the aggregate. The demand was further refined using the following criteria:

Havana metropolitan area	25%
Regions with population over 250,000	18%
Regions with population between 100,000 and 250,000	14%
Regions with population under 100,000	11%

2. Maintenance costs are based on current costs in the United States. Although labor costs, which account for the majority of the maintenance costs, will be lower in Cuba, it is expected that more employees will be required than in the United States. This assumption is based on the fact that productivity is much higher in the United States because of the high level of mechanization.

3. As a comparison, the labor force per 10,000 main stations for the United States is 43, but it is 100 in Germany and 127 in Australia. In Cuba, some 1,200 engineers (20 engineers per 10,000 main stations) are performing tasks that would be accomplished by 300 engineers (5 per 10,000 main stations) in the United States. It is evident that although wages will be much lower, productivity also will be lower; therefore, it is assumed that these impacts will offset each other. The maintenance cost model given below and in figure 3.1 was assumed to be as follows:

Description	Fixed Cost	Variable Cost
Switches with less than 10,000 lines	$ 500,000	$200 per line
Switches with more than 10,000 access lines	$1,000,000	$155 per line

4. Capital costs for telephone equipment also are assumed to be similar to the costs in the United States. The reason for this assumption is that most telephone equipment is purchased from very few international vendors. Among those vendors are AT&T (United States), Northern Telecom (Canada), Siemens (Germany), CIT Alcatel (France and Spain), Fujitsu (Japan), and NEC (Japan).

5. The international vendors set worldwide prices based on volume. The vendors install telephone equipment. The U.S. market has a slightly higher cost due to the cost for operational support systems required to gain labor efficiencies, but installation costs will be higher in Cuba due to the need to have the workforce imported. The capital costs model, also illustrated in figure 3.1, is depicted below:

Description	Fixed Costs	Variable Costs
Switches with fewer than 10,000 access lines	$ 400,000	$1,400 per line
Switches with more than 10,000 access lines	$1,000,000	$1,000 per line

The capital costs are total costs for the equipment. The typical breakdown of costs is as follows:

Description	Percent
Central office equipment[12]	30%
Outside plant feeder	30%
Outside plant distribution	10%
Local inter-office facilities	15%
Toll network (switch/facilities)	15%

The typical network price is based on the components listed above. The central office network assumes digital switches similar to DMS-100 (or No. 5 ESS for the large switching systems and DMS-10 for the small switching systems).

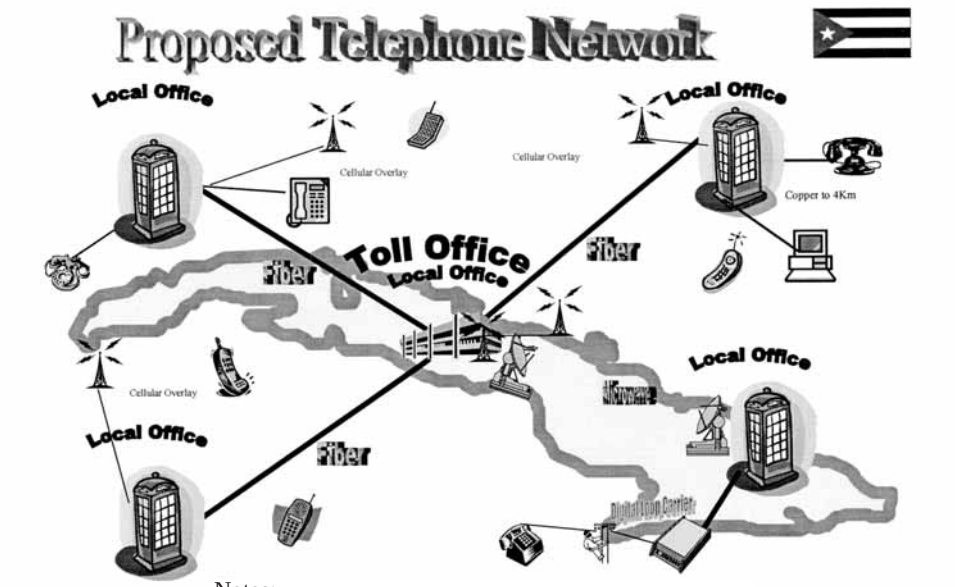
The outside plant feeder network assumes 26-gauge copper cables up to a distance of 12 kilo-feet (3.8 kilometers), and multiplexed single-mode fiber cables equipped with digital pair gain systems similar to AT&T Subscriber Loop Carrier SLC 96 for distances greater than 12 kilo-feet.

Rural areas were priced using a cellular network. The cellular network can also be used to provide alternate service in major metropolitan areas such as the city of Havana. It is expected that 70 percent of the demand will occur at distances less than 12 kilo-feet and that the cable placed in proximity to the central office will be placed on conduit. The outside

plant distribution network will use 26-gauge copper cables (aerial or buried).

Central office facilities will use a single-mode fiber backbone route utilizing multiplexing equipment similar to the DDM100. The toll network assumes a combination of DMS-200 toll switches for the major toll points and DMS-100/200 switches for the smaller locations.

A sketch depicting the existing interoffice network is included in the section on the Present Environment, and the typical network assumptions are stated below.



Notes:

1. Cellular used for rural and urban alternate service
2. Copper 26 gauge for up to 4 kilometers
3. Same network for data and voice

6. Item 5 discusses the cost of a wire-line network. A cellular network uses the same switching components as the wire-line network, but replaces the outside plant "feeder" and "distribution" network with radio transmission systems, as discussed in detail below in the Cubacel section of this paper. The cost of providing individual wires to a fixed customer is much higher than cellular costs.

   Cumulative costs to serve an average cellular line have been

maintained by the U.S. Federal Communications Commission since the introduction of cellular systems and have been approximately constant, with an average cost of $842 per line. This cost has not changed significantly, because technological innovations have offset the inflationary effects. A complete analysis is contained in the appendix.

Cellular costs, unlike those of wire-line counterparts, do not vary significantly as a function of demand density because the cellular tower transmission range can vary from 2 to 20 kilometers, based on demand density.

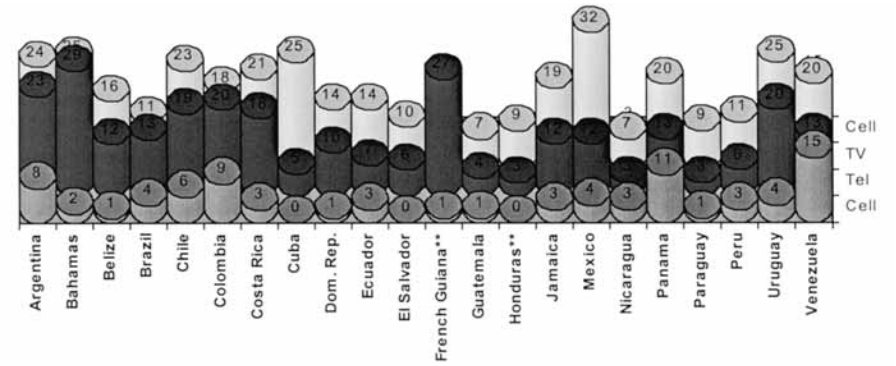
7. The minimum attractive rate of return was assumed to be 18 percent, consistent with the foreign investment threshold currently assumed by U.S. companies. It was further assumed that revenues would increase by 1 percent per year after the switch is replaced. The discount rate used in the discounted cash flow analysis is therefore 17 percent. This takes into consideration the revenue trend and the cost of capital.

8. The average equipment life in the economic analysis was assumed to be 25 years for new equipment and 5 years for current equipment, with a total replacement of equipment in 10 years. This average life results in a capital recovery factor (annual cost factor) of 0.173423 for new equipment and 0.31256 for existing equipment.

9. It is assumed that one company will provide telephone service for the entire country and that the price will be based on market pricing for the aggregate market.

10. The figures below depict telecommunications demand per 100 access lines for comparable countries; additional details are found in the appendix.

Telecommunication Demand per 100 people for Comparable Countries



11. Population distribution for 169 population centers was based on information gathered from census files and forms the basis of the author's analysis. The annual population growth was assumed to be 1 percent, based on historical trends.

Study Details

The table called "Demand, Cost, Revenue, and Rate of Return: Study Details for 169 Population Centers" (table 2 of the appendix) summarizes detailed results of the market analysis. The assumptions used for the analysis are included in the methodology section. A table summarizing the study results by province is included with the analysis in this section.

To conduct the study, each population center was evaluated, along with demographic characteristics. Note that the Havana metropolitan area has 15 population centers (see Ciudad Habana in the table labeled Summary of Provinces and Cities) and 17 wire centers (telephone central offices). Santiago de Cuba also has 2 wire centers within its boundaries. The profitability of telephone equipment is directly related to size and density of the serving market. Locations with a low density of telephones and smaller size are not as profitable as areas with a high density of service. Table 2 in the appendix (with study details for 169 population

centers) includes a ranking of profitability from 1 = most profitable to 169, which is not economically viable.

It is essential to award a bid for service to the entire island so that the selected company can cover the risks of serving lower-density markets. This concept, generally called universal service, is essential to any utility that requires a company to serve unprofitable markets in order to serve highly profitable markets.

The estimated current line demand in Cuba was based on data obtained from interviews with people who have worked in telephone industries in Cuba and on information from sources listed in the appendix. The line demand in 10 years reflects a 15 percent aggregate demand in Cuba, with distribution based on the parameters described in assumption 1. The 15 percent of market is for a wire-line demand profile; wireless will increase the demand beyond the 15 percent. Table 4 of the appendix (Worldwide Telecommunications Demand) provides additional details on market penetration for wireless services worldwide. The current Cubacel service also is described, even though the service is not targeted to the general population. The current Cuban cellular network is designed for foreigners, who supplement the Cuban government infrastructure by providing investment capital, and for high government officials and diplomats.

Economic analysis provides an estimate of the economic value of Cuba's existing equipment (see the table labeled Study Details by Province). This valuation, $210 million, recognizes the economic value of the existing franchise. Note that the investing company will be required to make a capital outlay in the range of $2.5 billion to provide fully adequate service for the anticipated long-term demand of 15 percent.

If the transition in Cuba is made during the next few years, the selected company could possibly reduce capital outlay for Cuba by purchasing used equipment, which currently is available in large supply in the United States due the recent bankruptcy of many small to mid-size common carriers.

Equipment from those carriers costs less than new equipment, in some cases as much as 70 percent less. The available equipment is state of the art since it was deployed during the recent period of phenomenal telecommunications growth, which ended in early 2001.

Details about the other figures included in this study follow.

In the table on Study Details by Province, "annual revenues for existing equipment" refers to the sum of capital and maintenance-related costs based on the method described in Figure 3.1. All other categories are consistent with the information described in the methodology section. This table was used to determine annual revenue requirements (cost to serve) as well as the value of existing equipment (minimum bid price for the franchise).

The "revenue requirements" figure depicts the annual revenue requirements (cost to serve) for a portion of the total market. For example, the top 10 percent of the market can be served at a cost of approximately $350 per line, while the cost to serve the bottom 10 percent of the market is between $550 and $700 per line. The results depicted in this graph point to the need to award a single franchise for the entire country.

If competition were allowed in the telephone industry, smaller markets would not be served at all, due to the high cost of serving those markets. In the telephone industry, traditionally, the more profitable markets help subsidize the less profitable areas. Figures provide information on rate of return for the various markets, using a common price for all equipment and services in the country (an average price of $427 per access line, or 60 percent of the average price in the United States).

The table on Study Details by Province depicts selected data summarized by province. This information can be used to provide detailed information summarized by governmental units.

Sensitivity Analysis

Study Details by Province

Province Name	Population (000)	CURRENT LINE DEMAND (000)	ANNUAL MAINT. EXTG EQ. ($000)	ANNUAL COST OF CAPITAL EXTG. EQ. ($000)	ANNUAL REV. REQ. EXTG. EQ. ($000)
Camagüey	788.7	33.7	$12,859	$1,529	$14,388
Ciego De Avila	353.2	14.4	$5,485	$652	$6,137
Cienfuegos	373.6	16.8	$6,397	$760	$7,158
Ciudad Habana	2,548.3	207.6	$79,284	$9,425	$88,709
Granma	780.5	34.7	$13,234	$1,573	$14,807
Guantánamo	526.5	24.3	$9,269	$1,102	$10,371
Holguín	1,040.0	48.2	$18,408	$2,188	$20,596
La Habana	794.6	32.3	$12,340	$1,467	$13,807
Las Tunas	439.0	17.9	$6,818	$810	$7,628
Matanzas	674.3	30.8	$11,748	$1,397	$13,144
Pinar Del Río	689.7	29.5	$11,281	$1,341	$12,622
Sancti Spiritus	489.9	19.9	$7,608	$904	$8,513
Santiago De Cuba	1,050.0	60.1	$22,943	$2,727	$25,670
Villa Clara	890.5	36.9	$14,083	$1,674	$15,757
Nueva Gerona	60.0	2.4	$932	$111	$1,043
Total	11,498.8	609.5	$232,689	$27,660	$260,350

Province Name	LINE DEMAND IN 10 YEARS (000)	ANNUAL MAINT. NEW EQ. ($000)	ANNUAL COST OF CAPITAL NEW EQ. ($000)	ANNUAL REV. REQ. NEW EQ. ($000)	VALUE OF CURRENT EQUIPMENT
Camagüey	127.0	$30,242	$27,002	$57,243	$11,958
Ciego De Avila	46.1	$14,138	$11,176	$25,315	$5,928
Cienfuegos	53.8	$14,709	$12,332	$27,041	$6,664
Ciudad Habana	783.7	$138,471	$138,858	$277,329	$60,013
Granma	111.3	$28,625	$25,535	$54,160	$13,430
Guantánamo	78.0	$19,381	$16,584	$35,965	$8,515
Holguín	154.8	$36,558	$32,367	$68,925	$17,360
La Habana	103.8	$30,563	$25,124	$55,687	$13,111
Las Tunas	57.3	$15,809	$13,207	$29,016	$7,049
Matanzas	98.8	$26,880	$22,296	$49,177	$12,168
Pinar Del Rio	94.9	$26,236	$22,151	$48,387	$954
Sancti Spiritus	64.0	$17,139	$14,232	$31,371	$11,740
Santiago De Cuba	192.9	$39,095	$36,302	$75,397	$7,774
Villa Clara	124.6	$30,298	$26,844	$57,142	$19,618
Nueva Gerona	7.8	$2,117	$1,972	$4,089	$14,109
Total	2,098.8	$470,261	$425,982	$896,244	$210,391

Summary of Provinces and Cities

CAMAGUEY
Camaguey
Carlos Manuel
De Cespedes
Cubitas
Esmeralda
Florida
Guaimaro
Jimaguayu
Najasa
Niñas
Nuevitas
Santa Cruz del Sur
Sibanicu
Vertientes

CIEGO DE AVILA
Baragua
Bolivia

Chambas

Ciego De Avila
Florencia
Majagua
Moron
Primero de Enero
Venezuela

Cienfuegos
Abreus
Auade de Pasajeros
Cienfuegos
Cruces
Cumanayagua
Lajas
Palmira
Rodas

Ciudad Habana
Arroyo Naranjo
Boyeros
Centro Habana
Cerro
Cotorro
Diez De Octubre
Guanabacoa
Habana Del Este
Habana Vieja
La Lisa
Marianao
Playa
Plaza de la Revolucion
Regla

GRANMA
Bartolome Maso

Bayamo
Buey Arriba
Campechuela
Cauto Cristo
Guisa
Jiguani
Manzanillo
Media Luna
Niquero
Pilon
Rio Cauto
Yara

GUANTANAMO
Baracoa
Caimanera

El Salvador

Guantanamo
Imias
Maisi
Nicento Perez
San Antonio Del Sur
Yeteras

HOLGUIN
Antilla
Baguanos
Banes
Cacocum
Calixto Garcia
Cieto
Frank Pais
Gibara
Holguin
Mayari
Moa
Raael Freyre
Sagua de Tanamo
Urbano Noris

LA HABANA
Alquizar

Artemisa
Batabano
Bejucal
Caimito
Guanajay
Guines
Guira de Melena
Jaruco
Madruga
Mariel
Melena Del Sur
Nueva Paz
Quivacan
San Antonio de los Baños
San Jose de Las Lajas
San Nicolas

Santa Cruz Del Norte

LAS TUNAS
Amancio
Colombia
Jababo
Jesus Menendez

Las Tunas
Majibacoa
Manati
Puerto Padre

MATANZAS
Caliente
Cardenas
Colon
Jaguey Grande
Jovellanos
Limonar
Los Arabos
Marti
Matanzas
Pedro Betancourt
Perico
Playa Larga
Union de Reyes
Varadero

NUEVA GERONA
Nueva Gerona
Santa Clara

PINAR DEL RIO
Bahia Honda

Candelaria
Consolacion Del Sur
Guane
La Palma
Los Palcios
Mantua
Niñas De Matahambre
Pinar Del Rio
San Cristobal
San Juan
San Luis
Sandino
Viñales

SANCTI SPIRITUS
Cabaiguan

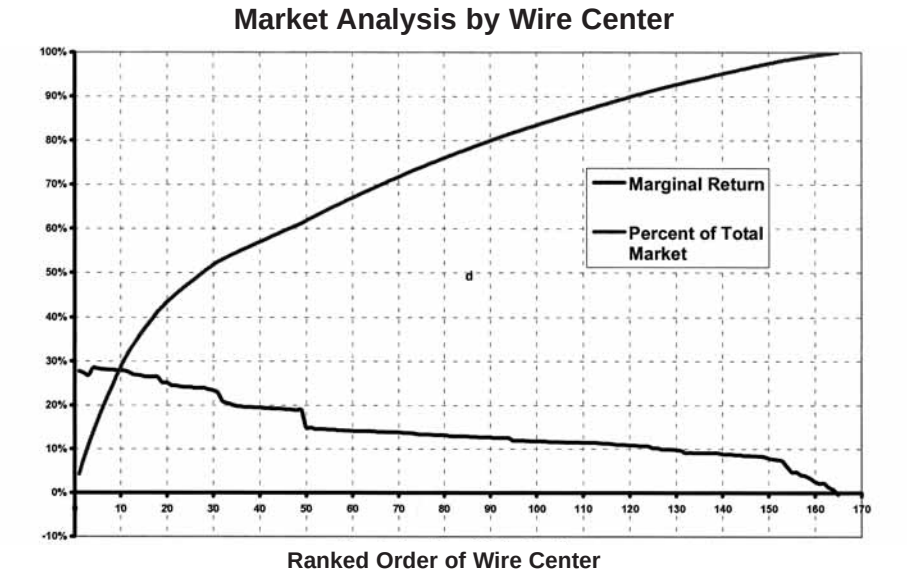
Fomento

La Sierpe
Mella
Sancti Spiritus
Trinidad
Yaguajay
Jatibonico

SANTIAGO de CUBA
Contramaestre
Guama
La Maya
Palma Soriano
San Luis
Santiago de Cuba
Segundo Frente
Taguasco
Tercer Frente

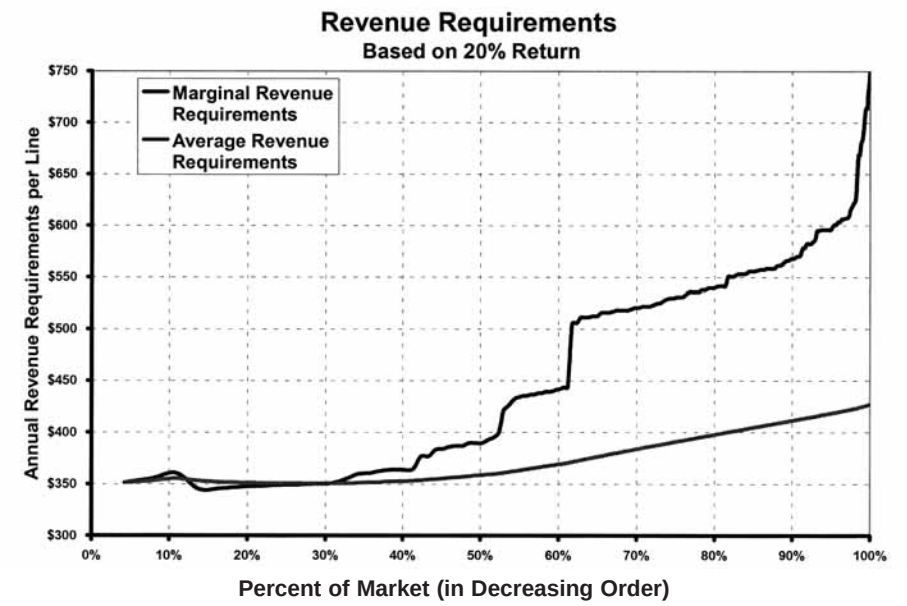
VILLA CLARA
Caibarien
Camajuani
Corralillo
Encrucijada
Manicaragua
Placetas
Quemado de Guines
Ranchuelo
Remedios
Sagua la Grande

Santo Domingo



The figure above (Market Analysis by Wire Center) depicts the cost required to serve a portion of the market. The market is arranged in order of profitability. The figure below (Revenue Requirements) analyzes annual costs assuming that the telephone company will earn 20 percent return on investment.

Figure 3.2



This section will evaluate the impact of changes in conditions that vary from the situation described in the preceding study details section. Although capital and maintenance costs could vary from the predicted range, the most volatile parameter is the demand for telephone service. The study assumed 15 access lines per 100 people within a 10-year deployment horizon. This section will evaluate the possible impact of different demand parameters. Demand can be further enhanced by a significant wireless market demand since wireless provides higher margins than traditional wire-line business.

The Republic of Cuba currently has 5.3 access lines per 100 people, and it is highly unlikely that the demand for telephone service within the planning horizon will exceed 20 access lines per 100 people. Therefore, profitability and cost parameters were based on the variation of demand between 5.3 and 20 access lines per 100 people.

The graph labeled Sensitivity Analysis depicts the return expected if the price set is based on earning 20 percent for various demand levels (assuming that the demand could vary over the range of 5.3 to 20). Table 3.1 depicts each of the points on the graph.

As an example, if the average revenue per access line is $427 (based on 20 percent return at 15 access lines per 100 people), and the actual demand is 10 access lines per 100, the actual return will be 16.9 percent, assuming that maintenance costs and capital deployment costs are as expected and that sufficient equipment is purchased to meet the demand of 10 access lines per 100 people.

The graph generated was based on computation of the internal rate of return (using Lotus algorithms) for a variable demand profile using the same distribution of demand described in the assumptions listed earlier in this study. The total demand for Cuba and the total capital costs, maintenance costs, and unit capital and maintenance costs are depicted in table 3.2.

Table 3.2 also depicts various other parameters for variable demand. Note that the provisioning (equipment and maintenance) costs increase as demand decreases. Profitability, therefore, is significantly influenced by demand.

The revenue requirements (cost to consumers) are significantly impacted by demand. For example, if the demand did not increase from 5.3 access lines per 100 population (other than growth due to population growth of 2 percent per year), the market price to the consumer would be approximately 30 percent higher ($555 vs. $427). The Sensitivity

Analysis graph depicts price variability.

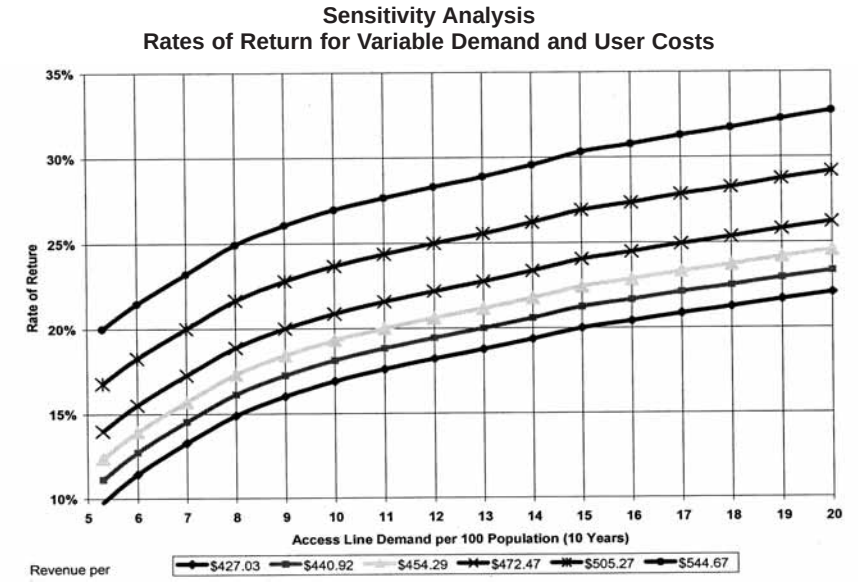


Table 3.1

Sensitivity Analysis
Summary

Access Lines per 100 Pop. in 10 Y.	Market Price Based on 20% Return	Annual Maintenance per Line	Average Cost per New Line	Total Demand in 10 Years (000)
20	$404.96	$210	$1,125	2,798
19	$408.99	$212	$1,135	2,658
18	$413.54	$215	$1,146	2,519
17	$417.69	$218	$1,154	2,379
16	$422.50	$221	$1,164	2,239
15	$427.03	$224	$1,170	2,099
14	$434.14	$228	$1,189	1,959
13	$440.93	$232	$1,203	1,819
12	$447.27	$237	$1,211	1,679
11	$454.29	$243	$1,218	1,539
10	$462.27	$250	$1,224	1,399
9	$472.47	$259	$1,233	1,259

Table 3.2

Sensitivity Analysis
Summary

Access Lines per 100 Pop. in 10 Y.	Total Equipment Cost (000)	Total Annual Maintenance (000)	Total Demand in Costs (000)	Total Growth in Demand 10 Years (000)
20	$3,149,080	$587,112	2,798	2,189
19	$3,017,131	$564,026	2,658	2,049
18	$2,887,215	$540,786	2,519	1,909
17	$2,745,571	$517,375	2,379	1,769
16	$2,606,272	$493,845	2,239	1,629
15	$2,456,314	$470,263	2,099	1,489
14	$2,328,876	$446,537	1,959	1,349
13	$2,188,431	$422,496	1,819	1,210
12	$2,033,373	$398,340	1,679	1,070
11	$1,874,392	$374,126	1,539	930
10	$1,711,956	$349,905	1,399	790
9	$1,552,819	$325,673	1,259	650
8	$1,396,403	$301,365	1,119	510
7	$1,257,711	$276,756	979	370
6	$1,096,183	$251,872	840	230
5.3	$977,605	$234,370	742	132

ETECSA

Introduction

In June 1993, Cuba decided to privatize telecommunications and invited proposals for joint venture partners. In June 1994, the Monterey, Mexico, holding company Grupo Domos Internacional (Domos), through its subsidiary CITEL (Corporación Interamericana de Telecomunicaciones), agreed to purchase a 49 percent interest in the Cuban phone system for a reported $1.5 billion.

The Empresa de Telecomunicaciones de Cuba, S. A. (ETECSA) was

separated from the Ministry of Communications and established as a private joint venture. However, the ministry regulates the phone system and sets rates, so one can assume that close ties exist between it and ETECSA.

Background

Billed as the first large-scale privatization in Cuba since 1959, the phone-system purchase agreement was announced during a one-day trip to Cuba by then-President of Mexico Carlos Salinas. In April 1995, Domos announced completion of the purchase and the sale of 25 percent of its interest to STET International Netherlands, N.V. (STET), a wholly owned subsidiary of the Italian State Telecommunication Company, for $291.2 million. ETECSA was managed jointly, with vice presidents of whom four were Cuban, three Mexican, and one Italian.

Due to the economic crisis in Mexico in 1995, Domos lost its equity. As a result, STET now controls 30 percent of ETECSA, the Cuban government 49 percent, and a coalition of banks the remainder.

The main improvements made by ETECSA are

- An increase in the number of public telephones
- A fiber ring installed in Havana
- Two digital electronic switches installed in Havana
- The installation of a National Data Transmission Network (NDTW), with six main nodes located in Havana, Pinar del Rio, Santiago de Cuba, Camaguey, Holguin, and Santa Clara
- Secondary nodes branches to the adjacent provinces
- Links running at 35Mb/s and using Alcatel equipment capable of operating at 155Mb/s
- Despite NDTW's use of X.25, which is old technology, Cuba has X.25 equipment and expertise.

The commercial offices of ETCSA are located at Calle 22 entre 3ra. and 5ta., Miramar, Playa, Havana.

Organizational Structure

The present organizational structure of ETECSA is as follows:

- Executive president
- First vice president
- Six vice presidents
- Nineteen management branches

Responsibilities and functions are as follows:

Executive President and First Vice President
Responsible for the whole firm.

Technical Vice President
Responsible for strategic planning for ETECSA; in charge of all technological activities.

Administration and Finance Vice President
Responsible for all economic and financial activities.

National Operations Vice President
Responsible for all activities of the national network.

International Operations Vice President
Responsible for all international calls and operations.

Commercial and Marketing Vice President
Responsible for ETECSA's relationships with customers.

Havana Vice President
Responsible for all operations in Havana. Havana has 15 percent of Cuba's telephones and 60 percent of all telephone lines.

Internet Services

Dedicated Links

A link is required for data transmission, line, and modem for the customer. Installation cost covers the first month's subscription. Each customer must have a proper router and license from the Ministry of Information and Communications. Services are under the domain co.cu. If another domain is desired, it must be handled through the government agency in charge, that is, CUBA-NIC.

Dedicated Links with Ratio 1-to-4

In order to have quality service, customers must not exceed 25 percent of the normal average daily traffic. The established monthly rate is valid for all dedicated links under the local perimeter closer to the node. The table below shows the bandwidth, installation cost, and monthly rate.

Bandwidth, Kbps	***Installation cost, US$***	***Monthly rate, US$***
19.2	$350	$250
28.8	$450	$350
64	$700	$600
128	$950	$850
256	$1,800	$2000
512	$3,800	$3,800
1024	$7,200	$7,200
2048	$14,000	$14,000

Dedicated Links with Ratio 1-to-1

In this case, the customer uses the entire bandwidth without restrictions. Refer to the table below.

Bandwidth, Kbps	**Installation cost, US$**	**Monthly rate, US$**
6	$2,500	$2,000
128	$4,500	$4,000
256	$7,500	$7,000
512	$15,500	$15,000
1024	$28,500	$28,000
2048	$40,000	$40,000

Commuted Links

All commuted access to InfoCom, Cuba's ISP (Internet service provider) are charged according to the time of connection to the system. The $70 installation cost covers the following:

- One payment for the current month
- Installation and configuration of software for an IBM-compatible PC
- Training for usage (60 minutes)
- Email services for international Internet link

Commuted Access to Internet (Search and Email)

Note: In the unlimited time plan, the customer must connect from only one telephone number.

Plans, hours	Minimum rate, US$	Additional hour, US$
II, up to 15	$30	$3
III, up to 40	$60	$3
IV, up to 100	100	$1
V, no time limit	$250	—

Commuted Access to InfoCom (SMTP/POP) and Search on InfoCom Web

Plans, hours	Minimum rate, US$	Additional hour, US$
5	$15	$3
10	$20	$3
40	$40	$1

Rental of Space on Web Servers (Hosting)

Some high-speed servers are available. Customers can use this infrastructure to place their web sites, for e-commerce, and so on. Refer to the tables that follow.

Additional hard drives in 10Mb capacities cost $2.50. Commuted access to InfoCom also exists for email usage and for national networks

(SMTP/POP). Service includes search on Web pages of InfoCom.

Access to Infocom also is available for email interchange in the national network.

E-net, ETECSA Internet Services Divisions

E-net, the new ETECSA division, is an Internet service provider with a connection network spread all over the country and offering the following technology:

- Internet commuted access
- National and international e-messaging
- Connections devoted to corporate networks
- Additional services as shown in tables that follow

Functions

ETECSA is in charge of

Shared Usage in UNIX Servers

Categories	Small	Simple	Professional	Advanced	Commercial	Corporate[?]
Monthly rate*	$8	$15	$25	$40	$60	$75
One-time installation*	$50	$50	$70	$70	$100	$100
Hard drive space (Mb)	5	10	50	100	200	300
POP3 accounts	1	1	3	5	5	5
FTP accounts	1	1	3	5	5	5
Screen names for email accounts	1	5	10	15	15	15
Extensions of MS FrontPage	—	—	—	—	—	—
Site statistics	yes	yes	yes	yes	yes	yes
SSL encryption	yes	yes	yes	yes	yes	yes
ASP support	—	—	—	—	—	—
VBScript	—	—	—	—	—	—
JavaScrip	yes	yes	yes	yes	yes	yes
Windows Media	yes	yes	yes	yes	yes	yes
Shockwave, Flash, Quick Time, Vivo	—	yes	yes	yes	yes	yes
MIME support	yes	yes	yes	yes	yes	yes
MS access	—	—	—	—	—	—
SQL server	—	—	—	—	—	—
Oracle	—	—	yes	yes	yes	yes
Visual InterDev, 6.0	—	—	—	—	—	—
UPS	yes	yes	yes	yes	yes	yes

* All costs in US$

Shared Usage in NT Servers

Categories	Small	Simple	Professional	Advanced	Commercial	Corporate
Monthly rate*	$8	$15	$25	$40	$60	$75
One-time installation*	$50	$50	$70	$70	$100	$100
Hard drive space (Mb)	5	10	50	100	200	300
POP3 accounts	1	1	3	5	5	5
FTP accounts	1	1	3	5	5	5
Screen names for email	1	5	10	15	15	15
Extensions of MS FrontPage	yes	yes	yes	yes	yes	yes
Site statistics	yes	yes	yes	yes	yes	yes
SSL encryption	yes	yes	yes	yes	yes	yes
ASP support	yes	yes	yes	yes	yes	yes
VBScript	yes	yes	yes	yes	yes	yes
JavaScrip	yes	yes	yes	yes	yes	yes
Windows Media	yes	yes	yes	yes	yes	yes
Shockwave, Flash, Quick-time, Vivo	—	yes	yes	yes	yes	yes
MIME support	yes	yes	yes	yes	yes	yes
SQL server	—	yes	yes	yes	yes	yes
Oracle	—	—	yes	yes	yes	yes
Visual InterDev, 6.0	—	yes	yes	yes	yes	yes
UPS	yes	yes	yes	yes	yes	yes
MS	yes	yes	yes	yes	yes	yes

* All costs in US$

* National and international basic telephone services
* Radio and TV signal conduction
* Data transmission
* Telex service
* Public telephone booth services
* Added-value telecommunication services
* Interactive and multimedia services development
* Internet services (as detailed previously)

Workers

ETECSA has increased its employees to 16,850, of which 35 percent consist of university graduates and technicians in telecommunication specialties.

Public Phones

ETECSA has developed a public telephony coin and card network taking into account community call centers, national and international call centers, and telephone booths.

Summary: Post-ETECSA Takeover

Despite the improvements mentioned above, the Cuban telephone system infrastructure is obsolete and deteriorating.

Privatization Potential

Several assumptions of a sociopolitical nature were made in this study in order to increase the attractiveness of a privatized communications enterprise in post-Castro Cuba.

First, it was assumed that the new private company would not be saddled with the economic burden of offering universal service. Initially, telephone service would be provided only to towns with a population of

2,000 and higher. Telephone service would not be provided to individual farms. As wireless communications technology matures, it should become profitable to offer wireless telephone service to the smallest towns and farms.

Next, it was assumed that telephone service would be priced at a level that would cover the higher risk of capital investment (a 20 percent rate of return, compared to a risk of approximately 14 percent in the United States). In many countries in the underdeveloped world, telephone service is priced artificially low, at a level that does allow for recovery of the investment in new equipment.

The result of such a short-sighted policy is that although more people can afford telephone service, it is unavailable due to the artificially low price, and potential subscribers must wait for years to obtain a telephone line. A better solution would be to allow poor people access to telephone service via low-priced public phone service. These public telephones would provide a minimum level of service to the lower economic strata. Satellite or cellular public phones could be used in rural areas, where the cost of providing a cable infrastructure is higher than the cellular cost.

The third assumption is that because Cuba is a relatively small market, an exclusive, long-term (20-year) telephone franchise should be awarded to the highest bidder. This contract should include all local exchange communication services and domestic long distance as well. Also, although the issue is not specifically addressed in this study, a national cellular system could be part of the franchise. Revenues from the highly profitable long-distance and cellular services could be used, to some extent, to subsidize local telephone service. It is assumed that competition in the highly profitable international long distance service will best serve the subscribers. However, inclusion of this service in the exclusive franchise could be negotiated. Monopoly rates should be regulated, and some form of incentive regulation should be used to ensure efficiency.

Cellular Telephone System

The cellular telephone concept was reported in 1979 in the Bell

System Technical Journal and in the following decade experienced a virtual explosion in usage. The concept is to divide a geographic area into cells or smaller units, known as micro-cells. Each cell contains a fixed station near its center. This station receives messages from mobile transmitters within the cell and also transmits to mobile receivers within the cell.

The cell represents the area over which the signals have acceptable power levels. Therefore, it may not be uniformly shaped, and the fixed station may not be in the center. Both of these depend upon the geographic characteristics. The first commercial cellular service was implemented in the United States in 1983.

Fixed-site cellular transmitters have an output power of 25-35 watts, whereas mobile transmitters have an output of 3 watts or less. The first cellular phones used wideband FM analog modulation. Afterwards, narrowband FM analog systems, which provide a higher capacity, were used.

The present cellular system used in the United States is the Advanced Mobile Phone System (AMPS), which was developed by AT&T and Motorola. It uses the 806 to 890 MHz frequency band. The AMPS system is used by Cubacel in Cuba. A strong push now is on for the implementation of digital cellular systems that have larger user capacity.

AMPS, United States

Cubacel

Item	A service (non-wire line)	B service (wire line)
Base cell station transmit bands (MHz)	869-880, 890-891.5	880-890, 891.5-894
Mobile station transmit bands (MHz)	824-835, 845-846.5	835-845, 846.5-849
Maximum power, watts	3	3
Cell size (radius in kms)	2-20	2-20

The Beginning

In mid-1991, Luis Miguel Niño de Rivera, a Mexican businessman, visited Havana on several occasions for the purpose of introducing cellular telephony in Cuba. In September 1991, the ministry of communications formed a working group charged with doing a feasibility study. This group made several trips to Mexico to acquire experience with the cellular system.

On December 11, 1991, the Cuban government signed an administrative concession implementing a mixed corporation, Telefonos Celulares de Cuba, S.A.-Cubacel. This is a mixed corporation - Cuban and Mexican. In February 1993, Cubacel's first commercial operation started with the Occidental subsystem, which includes Havana and Varadero.

In March 1995, the Oriental subsystem came on line, covering Santiago de Cuba. In May 1996, the Oriental subsystem was extended to Moa. Also, during 1996, Cubacel expanded the Occidental subsystem by extending its coverage through the 140 kilometers of the La Habana-Matanzas-Varadero expressway. Also, new radio base stations were installed throughout metropolitan Havana to reinforce and cover all metro Havana.

In June 1997, the Central subsystem was created, starting with Cienfuegos and now covering all the central part of Cuba. Later on, the Oriental subsystem was extended, and all of Cuba now is covered by Cubacel.

The Corporation

Cubacel has a 20-year concession to operate the cellular telephone system in Cuba. The Cuban side of the Corporation is the Empresa de Radiocomunicación y Difusión de Cuba (RADIOCUBA). The foreign side is the Mexican company, registered in the British Virgin Islands, International Telecommunications Investors, Inc. (ITI).

Management

Cubacel has three levels of management:

- The board of shareholders

This is the highest-ranking group in the corporation. It consists of one representative with voting power for each shareholder, several advisors for each side, Cuba and Mexico, and the secretary-director. Several members from both sides also are included as guests. The presidency of the board is a position that alternates between sides, each term for three years.

- The administrative board

This operational group manages the corporation. It is formed by the general director, who presides over it, a secretary, and the directors designated by the board of shareholders.

- The organization

Cubacel has approximately 150 employees. The organization comprises the general directorate, operations, administration, commercial, finances, and information systems.

Services

The following services are provided by Cubacel: Cellular telephony, temporary and permanent service, voice mail, credit card validation, national and international roaming.

Technology and Operations

The standard for the system is AMPS. The frequency spectrum is from 824MHz to 856 MHz. The system operates in the B band. The switching is done using Ericsson-AXE Miniswitch. The initial capacity of each switch is up to 5,000 subscribers, with an average traffic of 0.05 erlangs.[13] The switch capacity can be increased to 10,000 subscribers.

Transfer repeaters are used to cover corridors between cities and urban regions of low traffic. The voice channels are analog. The radio bases are mainly omnidirectional; only a few are sectorized to 120∞.

Four centers, each with a capacity of 5,000 customers, switch calls:

Centro Comunicaciones Mobibles (CCM), two in La Habana, one in Santiago de Cuba, one in Varadero. The nine radio bases are in Habana Libre, Varadero, Santa Maria, Televilla, Buenavista, Cacahual, Santa Clara, Santiago de Cuba, and Moa.

The system has 1,000 voice channels with capacity for 20,000 subscribers without saturation. The eight repeaters are located in Havana, Matanzas, Varadero, and Santa Clara. Refer to the table below.

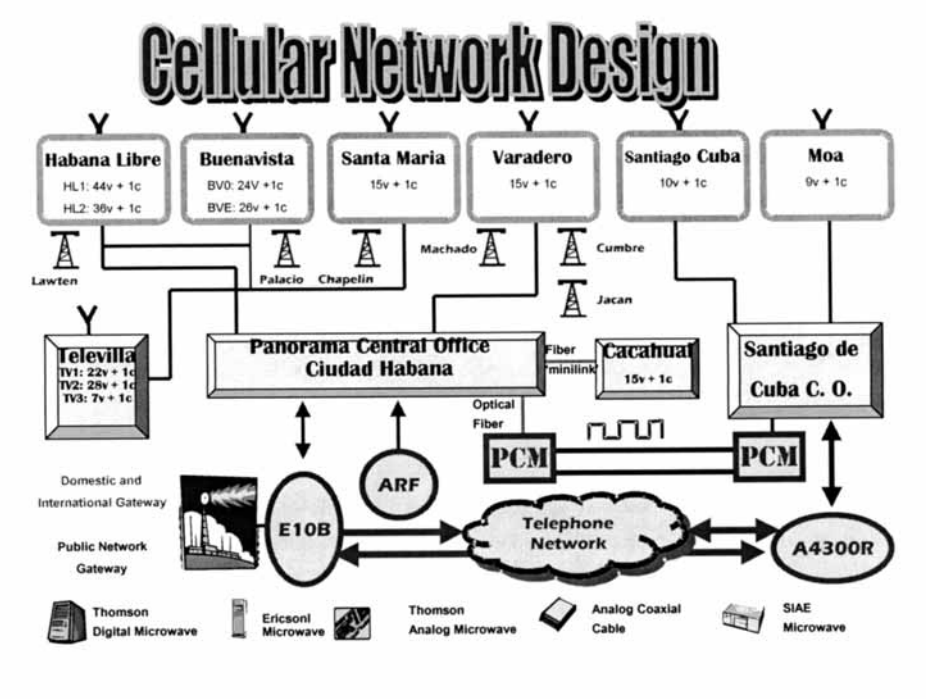
The figures below present a simplified description and areas covered by the network.

AMPS, Cubacel

Services

Mobile and Fixed Services

Item	B Service
Switching	Ericksson-AXE Miniswitch
Transmit bands, MHz	824-856
Initial capacity/switch	5,000 subscribers
Maximum capacity/switch	10,000 subscribers
Voice channels	Analog
Number of radio bases	9
Total voice channels	1,000
Capacity	20,000 subscribers



Present Coverage of Cellular System

Cubacel: Results up to 2001

Data	1997	1998	1999	2000	2001
Average subscribers	2,900	4,388	6,233	8,479	11,097
Growth	-	50.6%	42.7%	36.0%	30.4%
Monthly bill/ customer, US$	386.38	365.97	345.25	324.40	303.60
Total results, US$ (thousands)	**1997**	**1998**	**1999**	**2000**	**2001**
Total sales and income	13,420	19,758	26,599	33,998	41,490
Sales cost and operation	5,533	8,060	11,541	15,134	18,943
Sales cost	339	511	757	1,054	1,408
Cost of operation	5,194	7,549	10,784	14,079	17,535
Profit in sale	90	136	166	201	229
Gross profit in operation	8,317	11,698	15,059	18,864	22,547
Total expenses	1,342	2,484	3,595	4,584	5,978
Administrative expenses	403	573	770	982	1,395
General expenses	403	573	770	982	1,395
Sales expenses	537	1,336	2,054	2,619	3,188
Total depreciation	1,587	1,727	2,123	2,582	3,084
Depreciation expenses	1,448	1,588	1,984	2,442	2,944
Amortization expenses	139	139	139	140	140
Profit in operation	5,388	7,487	9,341	11,699	13,485
Interest income	134	191	257	327	399
Interest expenses	0	227	448	617	705
Profitability	39.9%	37.7%	34.4%	33.6%	31.8%
Total revenue	5,522	7,451	9,151	11,409	13,179

CubaCel: Cash Flow

Cash flow,	1997	1998	1999	2000	2001
Total net profit	5,522	7,451	9,151	11,409	13,179
Total depreciation and amortization	1,587	1,727	2,123	2,582	3,084
Depreciation expenses	1,448	1,588	1,984	2,442	2,944
Amortization expenses	139	139	139	140	140
Working capital requirements	304	492	570	617	624
Flow of operations	6,805	8,685	10,704	13,374	15,636
Long-term debt	0	1,600	1,600	1,800	1,800
Long-term debt payments	0	233	533	880	1,253
Investment	1,400	3,964	4,583	5,021	5,244
Net cash flow	5,405	6,088	7,388	9,273	10,741

- Wireless telephony allows communication at all times and from anywhere, if the subscriber is within the area of cellular coverage. Calls can be local, national, or international.
- The cellular phone can be used temporarily or permanently. Activation is immediate after the customer solicits it. Permanent subscribers have a contract length of more than six months. Temporary subscribers are those with contracts for less than six months.
- Wireless telephony allows data transmission and, if necessary, the installation of several extensions.

Voice Messaging

- With the voice message service, if a call comes in and the telephone is off, out of the area of service, or busy, or simply does not answer, the call is transferred to a voice message system that allows the subscriber to listen to a message at a later time.

Roaming

- National roaming enables the user to have national coverage in any place in Cuba where cellular service is available. The system is manual.
- International roaming allows activation for the subscriber in cellular networks outside Cuba.

Miscellaneous Services

- Time-of-day information
- Auto rental and repair
- Taxi services
- Hotel reservations
- Tourist information

Credit Card Validation

- This feature works in conjunction with CIMEX stores that provide cellular phone sales and service and also validate credit cards.

Additional Services

- Call waiting
- Conference calls (up to three persons)
- Transfer of calls

Agreements

Cubacel has agreements with the following companies:

- Telcel and Portatel, Mexico
- T.C.P. Argentina and Telecom Personal, Argentina
- Telefonica Moviles, Spain (Through this company, services are extended to Europe, Asia, and Africa.)
- Bell Mobility, Telus Mobility, NewTEL, and MT&T, Canada
- Cell Express Rentacel, Panama
- Telefonica Moviles del Peru (Through this company, services are extended to Venezuela, Chile, and El Salvador.)
- North-West, GSM, Russia
- Telecom Italia Mobile, Italy

Rates

Rates (in US$)

Administrative Board

As of the end of 2001, the administrative board of Cubacel was com-

Service	Activation	Basic Rate	Cost/Minute	Equipment Rental
Basic	120	40	0.30-0.40	7/day
Resalers	120	40	0.60	7/day
Embassies	120	30	0.30	7/day
Restaurants		30	0.40	7/day
Permanent, fixed	120	40	0.30	2/day
Credit card validation		40	0.15	
Special services			0.40	40/month
Temporary, mobile		3/day	0.90	7/day
Temporary, fixed			0.40	2/day

Market

Total Number of Activations, 2001

Commercial firms	9,822
Embassies and functionaries	240
International organizations	15
Foreign press	40
Tour operators	45
Corporations	150
Hotels	300
Residents	410
Others	80

prised of the following members:

- Rafael Galindo Mier, General Director, 1994-present

Having worked in several capacities in relation to cellular telephone development in Cuba, he was nominated as Cubacel's general director in 1994 and still held the position as of the end of 2001. He holds a B.S. in electrical engineering from the Instituto Superior Politéchnico José Antonio Echeverría (CUJAE) and an M.S. in electrical engineering from the University of Toronto. He is a principal researcher for the Academy of Sciences of Cuba. Starting in 1964, he worked as a telecommunications engineer in the ICR; from 1974 to 1989, he was director of the science and technology department of the Ministry of Communications. From 1989 to 1990, he was appointed director of development for the Ministry of Communications.

- Waldo Reboredo Arroyo, Technical Director, 1994-present

Appointed as technical director in 1994, he received a B.S. in electrical engineering in 1973 from CUJAE, joined the Ministry of Communications in 1974, and served as assistant professor at Havana University from 1976 to 1980. From 1976 to 1992, at the Ministry of Communications, he worked in several capacities, including director of telecommunications for Cayo Coco.

- Silvia Garcia Costa, Finance Director, 1992-present

Since 1963, she has worked for the Ministry of Communications in accounting and finance. In 1974, she was appointed director of accounting and auditor for the Ministry of Communications. In 1992, she was appointed as director of finance.

- Loretta Núñez Ardavin, Business Director, 1994-present

The holder of a B.S. in electrical engineering from CUJAE in 1992 and an M.S. from the Instituto Tecnológica Autónomo de México (ITAM) in 1994, she joined Cubacel in 1992 as sales and customer relations director. She was appointed director of roaming in 1993 and business director in 1994.

Company Value

Subscriber Growth in Latin America

Total Wireless Subscribers by Country

Country	1995	2000	2005-Estimates
Argentina	405,395	6,670,212	14,530,214
Brazil	1,460,000	23,410,363	48,808,478
Chile	205,023	3,461,240	7,819,021
Colombia	271,990	2,256,801	7,648,769
Ecuador	51,000	470,180	1,258,198
Mexico	690,201	14,175,100	34,004,744
Peru	69,872	1,259,540	3,791,320
Venezuela	356,500	5,150,962	10,862,008
Central America	78,149	2,075,933	5,741,410
Total Latin America	3,653,400	60,631,256	138,106,637

The value of Cubacel at the end of 2001 was $32,220,247.

Potential Market Comparison for a Post-Castro Cuba

Cellular telephony has a brilliant future in a democratic and free market economy Cuba. The table above, on subscriber growth, shows the growth of this industry in Latin America. Projections for the market in Cuba after a transition estimate a total of 3.5 million subscribers, including both temporary and fixed customers, after the first three years of the transition.

Endnotes

Appendix

Table 1: Telecommunications Demand Profile for Various Countries Based on Various Sources Including Reported Figures for Most Carriers Serving Latin America All Demand and Population Data in (000)

								Per 100 Pop. (2002)			
Country	Population (000)	Telephone (000)	Cellular (000)	Television (000)	Data From Year	BellSouth 4Q01 Latin Am.	Estimate Cell 2002	Tel	Cell	Tel + Cell	TV
Argentina	32,713	7,500	1,800	8,000	1997	1,587	2,635	23	8	31	24
Australia	17,661	9,200	5,290	10,150	1998		7,041	52	40	92	57
Bahamas	264	77	2	67	1993		5	29	2	31	25
Belize	249	30	2	41	1995		4	12	1	13	16
Brazil	150,367	19,000	4,000	16,500	1998	2,723	5,324	13	4	17	11
Chile	13,599	2,603	197	3,150	1995	860	860	19	6	25	23
Colombia	27,838	5,433	1,800	5,000	1998	1,126	2,396	20	9	29	18
Costa Rica	2,489	451	47	525	1996		75	18	3	21	21
Cuba	**10,744**	**553**	**2**	**2,700**	**1995**		**4**	**5**	**0**	**5**	**25**
Dominican Republic	5,546	569	33	770	1995		58	10	1	11	14
Ecuador	10,741	748	50	1,550	1995	353	353	7	3	10	14
El Salvador	6,123	380	14	600	1995		24	6	0	6	10
France	57,527	35,000	11,078	34,800	1998		14,745	61	26	87	60
French Guiana**	173	47	1	30	1995		2	27	1	28	17
Germany	79,365	46,500	15,318	51,400	1999		18,535	59	23	82	65
Guatemala	9,197	342	30	640	1995	75	75	4	1	5	7
Honduras**	6,250	190	1	570	1995		2	3	0	3	9
Jamaica	2,392	292	45	460	1995		80	12	3	15	19
Mexico	81,250	9,600	2,300	25,600	1998		3,061	12	4	16	32
Nicaragua	4,813	140	4	320	1995	156	156	3	3	6	7
Panama	2,563	325		510	1995	283	283	13	11	24	20
Paraguay	5,586	167	16	515	1995		28	3	1	4	9
Peru	27,013	1,509	504	3,060	1998	405	810	6	3	9	11
Portugal	9,846	3,724	887	3,310	1999		1,073	38	11	49	34
Spain	39,141	17,336	8,394	13,100	1999		10,157	44	26	70	33
Surinam	439	58	4	63	1995		7	13	2	15	14
United States	276,333	178,000	55,312	219,000	1997		90,000	71	34	105	88
Uruguay	3,094	622	40	782	1995	137	137	20	4	24	25
Venezuela	20,249	2,600	2,000	4,100	1998	3,112	3,112	13	15	28	20

- Estimate is based on 10 percent growth rate as reported in BellSouth Annual Report. This is the current growth rate for cell phones. This rate was much higher in the past. It is not known if Honduras and Belize currently have cellular service.
- In the United States, Cingular (BellSouth/Southwestern Bell) reports a rate of 10.9 per 100 population in the markets the company serves (approximately 200 million population), and Verizon, the largest U.S. carrier, reports 27.5 million customers in its serving area. Verizon also serves approximately 11 customers per 100 population. AT&T Wireless has more than 16 million customers in the United States and serves about 8 customers per 100 population in its market area. Sprint has 15 million subscribers and covers a population area of more than 90 percent of the U.S. market. Most U.S. markets have three to five wireless carriers. Some of the reported data include the U.S. Virgin Islands and Puerto Rico. The four major carriers serve approximately 80 million subscribers in the United States. Various minor carriers, such as Qwest Communications, serve approximately 10 million subscribers. Some of the numbers might be inflated because of cross-ownership of systems, resulting in double counting of some consumer demand, but it is safe to assume that the U.S. market has 80 to 90 million subscribers and has an annual growth rate of more than 10 percent.

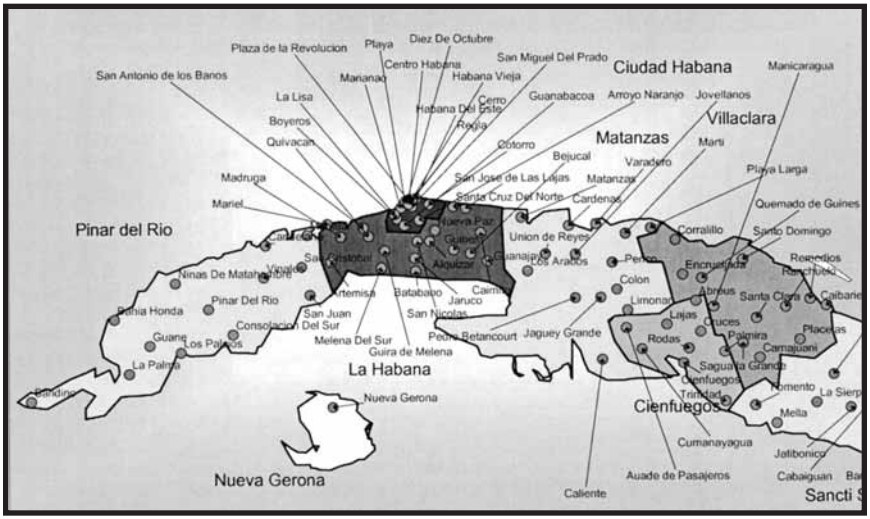
Table 2: Demand, Cost, Revenue, and Rate of Return
Study Details for 169 Population Centers
(Cities or Subdivisions)
Page 1 of 3

Rk[14]	City	Popu-lation (000)	Current Demand (000)	Ultimate Demand (000)	Rev. Req. Extg. Eq. ($000) Annual	Rev. Req. New Eq. ($000) Annual	Existing Equip. ($000) Capital	New Equipment ($000) Capital	Per Line Existing Equip. Ann. Rev.	Revenue per line New Equip.	Rate of Return New Equip.
	TOTALS	**11,498**	**609**	**2,099**	**280,350**	**896,245**	**210,992**	**2,458,312**	**$ 427**	**$ 427**	**20.0%**
135	Abreus	31.0	1.26	4.0	954	2,412	541	6,068	$ 756	$ 596	9.1%
147	Alquizar	28.9	1.18	3.8	931	2,291	511	5,684	$ 792	$ 607	8.4%
89	Amancio	49.0	1.99	6.4	1,148	3,453	798	9,360	$ 576	$ 540	12.6%
165	Antilla	15	0.61	2.0	780	1,487	314	3,143	$ 1,279	$ 759	-0.3%
5	Arroyo Naranjo	221.0	17.33	67.3	4,658	23,293	4,583	68,349	$ 269	$ 346	28.3%
38	Artemisa	83.9	3.41	11.0	1,526	4,772	1,294	11,958	$ 447	$ 436	19.6%
125	Auade de Pasajeros	35.1	1.43	4.6	998	2,649	600	6,818	$ 699	$ 578	10.2%
54	Baguanos	69.0	2.81	9.0	1,365	4,610	1,082	13,017	$ 486	$ 512	14.5%
88	Bahia Honda	49.2	2.00	6.4	1,150	3,465	800	9,396	$ 575	$ 539	12.7%
30	Banes	101.0	5.48	17.6	2,075	6,950	2,017	18,588	$ 379	$ 395	23.4%
32	Baracoa	97.0	3.95	12.7	1,668	5,334	1,481	13,669	$ 423	$ 421	20.9%
132	Baragua	31.2	1.27	4.1	956	2,424	544	6,105	$ 753	$ 595	9.1%
60	Bartolome Maso	64.0	2.60	8.4	1,311	4,321	1,011	12,102	$ 503	$ 517	14.1%
128	Batabano	34.0	1.38	4.4	986	2,586	584	6,617	$ 713	$ 582	9.9%
27	Bayamo	110.0	5.97	19.2	2,205	7,465	2,188	20,156	$ 370	$ 390	23.9%
144	Bejucal	29.5	1.20	3.9	937	2,325	520	5,794	$ 781	$ 604	8.6%
159	Bolivia	19	0.77	2.5	824	1,718	370	3,874	$ 1,066	$ 692	3.3%
7	Boyeros	163.0	18.64	59.9	4,924	20,833	4,910	60,861	$ 264	$ 348	28.1%
120	Buey Arriba	38.0	1.55	5.0	1,029	2,817	641	7,348	$ 666	$ 568	10.8%
139	C. Mauel de Cespedes	31.0	1.26	4.0	954	2,412	541	6,068	$ 756	$ 596	9.1%
48	Cabaiguan	78.0	3.17	10.2	1,462	4,519	1,210	11,187	$ 461	$ 444	18.8%
78	Cacocum	54.0	2.20	7.1	1,202	3,742	869	10,274	$ 547	$ 531	13.2%
55	Caibarien	68.0	2.77	8.9	1,354	4,552	1,068	12,834	$ 490	$ 513	14.4%
162	Caimanera	10.5	0.71	2.3	807	1,631	349	3,600	$ 1,135	$ 714	2.1%
98	Caimito	43.4	1.77	5.7	1,088	3,129	718	8,336	$ 616	$ 552	11.8%
117	Caliente	39.0	1.59	5.1	1,040	2,875	655	7,531	$ 656	$ 564	11.1%
57	Calixto Garcia	65.0	2.64	8.5	1,321	4,378	1,025	12,285	$ 500	$ 516	14.2%
8	Camaguey	275.0	12.78	56.8	3,733	19,818	3,446	57,770	$ 292	$ 349	28.0%
39	Camajuani	83.0	3.38	10.8	1,516	4,734	1,281	11,840	$ 449	$ 437	19.5%
66	Campechuela	61.0	2.48	8.0	1,278	4,147	968	11,554	$ 515	$ 521	13.9%
158	Candelaria	19.7	0.80	2.6	831	1,759	380	4,002	$ 1,038	$ 684	3.9%
34	Cardenas	89.0	3.62	11.6	1,581	4,991	1,367	12,624	$ 437	$ 429	20.1%
156	Cauto Cristo	21	0.85	2.7	845	1,834	399	4,240	$ 990	$ 669	4.7%
4	Centro Habana	232.0	18.20	70.7	4,833	24,393	4,799	71,702	$ 266	$ 345	28.4%
11	Cerro	171.6	13.46	52.3	3,870	18,348	3,615	53,295	$ 288	$ 351	27.8%
94	Chambas	48.0	1.95	6.3	1,137	3,395	783	9,177	$ 583	$ 542	12.5%
40	Ciego De Avila	83.0	3.38	10.8	1,516	4,734	1,281	11,840	$ 449	$ 437	19.5%
25	Cienfuegos	115.0	6.24	20.0	2,277	7,751	2,283	21,026	$ 365	$ 387	24.2%
83	Cieto	51.0	2.07	6.7	1,170	3,569	826	9,725	$ 564	$ 536	12.9%
121	Colombia	38.0	1.55	5.0	1,029	2,817	641	7,348	$ 666	$ 568	10.8%
49	Colon	78.0	3.17	10.2	1,462	4,519	1,210	11,187	$ 461	$ 444	18.8%
44	Consolacion Del Sur	81.0	3.29	10.6	1,494	4,648	1,253	11,579	$ 454	$ 439	19.2%
23	Contramaestre	117.0	6.34	20.4	2,306	7,865	2,321	21,375	$ 363	$ 386	24.3%
138	Corralillo	31.0	1.26	4.0	954	2,412	541	6,068	$ 756	$ 596	9.1%
21	Cotorro	70.2	5.51	21.4	2,083	8,199	2,027	22,393	$ 378	$ 383	24.5%
115	Cruces	40.0	1.63	5.2	1,051	2,933	669	7,714	$ 646	$ 561	11.2%
161	Cubitas	17.5	0.71	2.3	807	1,631	349	3,600	$ 1,135	$ 714	2.1%
82	Cumanayagua	51.0	2.07	6.7	1,170	3,569	826	9,725	$ 564	$ 536	12.9%
1	Diez De Octubre	335.0	26.27	102.1	7,609	35,876	7,069	104,091	$ 290	$ 351	27.8%
61	El Salvador	63.0	2.56	8.2	1,300	4,263	997	11,919	$ 507	$ 518	14.1%
101	Encrucijada	43.0	1.75	5.6	1,083	3,106	712	8,263	$ 619	$ 553	11.8%
124	Esmeralda	37.0	1.50	4.8	1,018	2,759	627	7,165	$ 677	$ 571	10.6%
150	Florencia	27.5	1.12	3.6	916	2,210	491	5,428	$ 819	$ 615	7.9%

Rk[14]	City	Popu-lation (000)	Current Demand (000)	Ultimate Demand (000)	Rev. Req. Extg. Eq. ($000) Annual	Rev. Req. New Eq. ($000) Annual	Existing Equip. ($000) Capital	New Equipment ($000) Capital	Per Line Existing Equip. Ann. Rev.	Revenue per line New Equip.	Rate of Return New Equip.
35	Florida	86.0	3.50	11.2	1,549	4,862	1,324	12,232	$ 443	$ 433	19.8%
85	Fomento	51.0	2.07	6.7	1,170	3,569	826	9,725	$ 564	$ 536	12.9%
126	Frank Pais	35.0	1.42	4.6	997	2,643	598	6,800	$ 700	$ 578	10.2%
45	Gibara	80.5	3.27	10.5	1,489	4,626	1,246	11,514	$ 455	$ 440	19.2%
62	Guaimaro	63.0	2.56	8.2	1,300	4,263	997	11,919	$ 507	$ 518	14.1%
96	Guama	44.0	1.79	5.7	1,094	3,164	726	8,445	$ 611	$ 551	11.9%
14	Guanabacoa	120.0	9.41	36.6	3,122	13,184	3,394	37,570	$ 332	$ 361	26.8%
107	Guanajay	41.5	1.69	5.4	1,067	3,019	691	7,988	$ 632	$ 557	11.5%
102	Guane	42.7	1.74	5.6	1,080	3,089	708	8,208	$ 622	$ 554	11.7%
17	Guantanamo	190.0	10.30	33.1	3,228	12,040	2,826	34,087	$ 313	$ 364	26.5%
36	Guines	85.0	3.46	11.1	1,538	4,819	1,310	12,102	$ 445	$ 434	19.7%
106	Guira de Melena	41.7	1.70	5.4	1,069	3,031	694	8,025	$ 630	$ 557	11.6%
72	Guisa	58.0	2.36	7.6	1,246	3,974	926	11,005	$ 528	$ 525	13.6%
16	Habana Del Este	107.0	10.30	33.1	3,228	12,040	2,826	34,087	$ 313	$ 364	26.5%
12	Habana Vieja	145.5	11.41	44.3	3,454	15,736	3,103	45,341	$ 303	$ 355	27.4%
15	Holguin	196.0	10.63	34.1	3,294	12,383	2,907	35,132	$ 310	$ 363	26.6%
134	Imias	31.0	1.26	4.0	954	2,412	541	6,068	$ 756	$ 596	9.1%
71	Jababo	59.0	2.40	7.7	1,256	4,031	940	11,188	$ 524	$ 523	13.7%
86	Jaguey Grande	50.0	2.03	6.5	1,159	3,511	812	9,542	$ 570	$ 538	12.8%
109	Jaruco	41.3	1.68	5.4	1,065	3,008	688	7,952	$ 634	$ 558	11.5%
81	Jatibonico	52.0	2.11	6.8	1,181	3,627	840	9,908	$ 558	$ 534	13.0%
93	Jesus Menendez		1.95	6.3	1,137	3,395	783	9,177	$ 583	$ 542	12.5%
63	Jiguani	63.0	2.56	8.2	1,300	4,263	997	11,919	$ 507	$ 518	14.1%
164	Jimaguayu	16	0.65	2.1	791	1,545	328	3,326	$ 1,216	$ 739	0.7%
64	Jovellanos	63.0	2.56	8.2	1,300	4,263	997	11,919	$ 507	$ 518	14.1%
13	La Lisa	123.5	9.69	37.6	3,195	13,534	3,490	38,636	$ 330	$ 360	26.9%
24	la Maya	115.0	6.24	20.0	2,277	7,751	2,283	21,026	$ 365	$ 387	24.2%
119	La Palma	38.4	1.56	5.0	1,034	2,840	647	7,421	$ 662	$ 566	10.9%
160	La Sierpe	18	0.73	2.4	813	1,660	356	3,691	$ 1,110	$ 706	2.6%
145	Lajas	29.0	1.18	3.8	932	2,296	513	5,703	$ 790	$ 606	8.4%
42	Las Tunas	82.0	3.34	10.7	1,505	4,691	1,267	11,710	$ 451	$ 438	19.3%
154	Limonar	23.1	0.94	3.0	868	1,955	429	4,624	$ 924	$ 648	5.9%
148	Los Arabos	28.8	1.17	3.8	930	2,285	510	5,666	$ 794	$ 607	8.4%
104	Los Palcios	42.0	1.71	5.5	1,073	3,048	698	8,080	$ 628	$ 556	11.6%
108	Madruga	41.3	1.68	5.4	1,065	3,008	688	7,952	$ 634	$ 558	11.5%
105	Maisi	42.0	1.71	5.5	1,073	3,048	698	8,080	$ 628	$ 556	11.6%
143	Majagua	29.5	1.20	3.9	937	2,325	520	5,794	$ 781	$ 604	8.6%
110	Majibacoa	41.0	1.67	5.4	1,062	2,990	684	7,897	$ 637	$ 558	11.4%
113	Manati	41.0	1.67	5.4	1,062	2,990	684	7,897	$ 637	$ 558	11.4%
37	Manicaragua	84.0	3.42	11.0	1,527	4,777	1,296	11,971	$ 447	$ 435	19.6%
133	Mantua	31.2	1.27	4.1	956	2,424	544	6,105	$ 753	$ 595	9.1%
29	Manzanillo	105.0	5.69	18.3	2,133	7,179	2,093	19,285	$ 375	$ 393	23.6%
10	Marianao	177.0	13.88	53.9	3,956	18,889	3,721	54,940	$ 285	$ 350	27.9%
92	Mariel	48.2	1.96	6.3	1,140	3,407	786	9,213	$ 581	$ 541	12.5%
140	Marti	30.4	1.24	4.0	947	2,377	533	5,959	$ 766	$ 599	8.9%
22	Matanzas	121.0	6.56	21.1	2,364	8,094	2,397	22,071	$ 360	$ 384	24.4%
20	Mayari	139.0	7.54	24.2	2,623	9,123	2,738	25,206	$ 348	$ 377	25.2%
90	Media Luna	49.0	1.99	6.4	1,148	3,453	798	9,360	$ 576	$ 540	12.6%
152	Melena Del Sur	26.5	1.08	3.5	905	2,152	477	5,245	$ 840	$ 622	7.5%
137	Mella	31.0	1.26	4.0	954	2,412	541	6,068	$ 756	$ 596	9.1%
112	Moa	41.0	1.67	5.4	1,062	2,990	684	7,897	$ 637	$ 558	11.4%
74	Moron	56.0	2.28	7.3	1,224	3,858	897	10,640	$ 537	$ 527	13.4%
163	Najasa	16.5	0.67	2.2	797	1,574	335	3,417	$ 1,187	$ 730	1.2%
155	Nicento Perez	21.0	0.85	2.7	845	1,834	399	4,240	$ 990	$ 669	4.7%
114	Ninas	40.2	1.63	5.3	1,053	2,944	672	7,751	$ 644	$ 561	11.3%
97	Ninas De Matahambre	43.9	1.79	5.7	1,093	3,159	725	8,431	$ 612	$ 551	11.9%
84	Niquero	51.0	2.07	6.7	1,170	3,569	826	9,725	$ 564	$ 536	12.9%
68	Nueva Gerona	60.0	2.44	7.8	1,267	4,089	954	11,371	$ 519	$ 522	13.8%
151	Nueva Paz	27.0	1.10	3.5	910	2,181	484	5,337	$ 829	$ 618	7.7%
99	Nuevitas	43.0	1.75	5.6	1,083	3,106	712	8,263	$ 619	$ 553	11.8%
19	Palma Soriano	140.0	7.59	24.4	2,638	9,180	2,757	25,380	$ 347	$ 377	25.2%

Rk[14]	City	Popu-lation (000)	Current Demand (000)	Ultimate Demand (000)	Rev. Req. Extg. Eq. ($000) Annual	Rev. Req. New Eq. ($000) Annual	Existing Equip. ($000) Capital	New Equipment ($000) Capital	Per Line Existing Equip. Ann. Rev.	Revenue per line New Equip.	Rate of Return New Equip.
127	Palmira	34.0	1.38	4.4	986	2,586	584	6,617	$ 713	$ 582	9.9%
122	Pedro Betancourt	37.5	1.53	4.9	1,024	2,788	634	7,257	$ 671	$ 569	10.7%
131	Perico	33.0	1.34	4.3	975	2,528	570	6,434	$ 727	$ 586	9.7%
95	Pilon	44.0	1.79	5.7	1,094	3,164	726	8,445	$ 611	$ 551	11.9%
26	Pinar Del Rio	110.0	5.97	19.2	2,205	7,465	2,188	20,156	$ 370	$ 390	23.9%
33	Placetas	93.0	3.78	12.1	1,624	5,163	1,424	13,146	$ 429	$ 425	20.5%
3	Playa	239.2	18.76	72.9	6,227	26,288	6,766	74,896	$ 332	$ 361	26.8%
157	Playa Larga	12	0.81	2.6	835	1,776	385	4,057	$ 1,026	$ 680	4.1%
6	Plaza de la Revolucion	205.0	16.08	62.5	4,403	21,691	4,270	63,473	$ 274	$ 347	28.2%
142	Primero de Enero	30.0	1.22	3.9	943	2,354	527	5,885	$ 773	$ 601	8.8%
43	Puerto Padre	81.0	3.29	10.6	1,494	4,648	1,253	11,579	$ 454	$ 439	19.2%
149	Quemado de Guines	28.5	1.16	3.7	926	2,268	506	5,611	$ 799	$ 609	8.3%
130	Quivacan	33.5	1.36	4.4	981	2,557	577	6,525	$ 720	$ 584	9.8%
70	Raael Freyre	60.0	2.44	7.8	1,267	4,089	954	11,371	$ 519	$ 522	13.8%
50	Ranchuelo	76.0	3.09	9.9	1,440	5,015	1,182	14,297	$ 466	$ 505	14.9%
31	Regla	53.3	4.18	16.2	1,730	6,508	1,563	17,243	$ 414	$ 401	22.8%
67	Remedios	61.0	2.48	8.0	1,278	4,147	968	11,554	$ 515	$ 521	13.9%
77	Rio Cauto	54.5	2.22	7.1	1,208	3,771	876	10,365	$ 545	$ 530	13.3%
118	Rodas	38.5	1.57	5.0	1,035	2,846	648	7,440	$ 661	$ 566	11.0%
80	S. Antonio de los Banos	53.6	2.18	7.0	1,198	3,719	863	10,201	$ 550	$ 531	13.2%
47	Sagua de Tanamo	79.0	3.21	10.3	1,473	4,562	1,225	11,318	$ 458	$ 442	19.0%
56	Sagua la Grande	68.0	2.77	8.9	1,354	4,552	1,068	12,834	$ 490	$ 513	14.4%
111	San Antonio Del Sur	41.0	1.67	5.4	1,062	2,990	684	7,897	$ 637	$ 558	11.4%
59	San Cristobal	64.8	2.64	8.5	1,319	4,367	1,022	12,249	$ 501	$ 516	14.2%
52	San Jose de Las Lajas	69.5	2.83	9.1	1,370	4,639	1,089	13,108	$ 485	$ 511	14.5%
73	San Juan	57.6	2.34	7.5	1,241	3,950	920	10,932	$ 530	$ 525	13.6%
28	San Luis	110.0	5.97	19.2	2,205	7,465	2,188	20,156	$ 370	$ 390	23.9%
123	San Luis	37.2	1.51	4.9	1,021	2,771	630	7,202	$ 675	$ 570	10.7%
9	San Miguel Del Prado	185.0	14.51	56.4	4,084	19,689	3,877	57,378	$ 281	$ 349	28.0%
153	San Nicolas	26.0	1.06	3.4	899	2,123	470	5,154	$ 851	$ 625	7.3%
41	Sancti Spiritus	82.0	3.34	10.7	1,505	4,691	1,267	11,710	$ 451	$ 438	19.3%
103	Sandino	42.0	1.71	5.5	1,073	3,048	698	8,080	$ 628	$ 556	11.6%
18	Santa Clara	190.0	8.39	32.6	2,851	11,883	3,037	33,608	$ 340	$ 364	26.4%
116	Santa Cruz Del Norte	39.8	1.62	5.2	1,049	2,921	667	7,677	$ 648	$ 562	11.2%
53	Santa Cruz del Sur	69.5	2.83	9.1	1,370	4,639	1,089	13,108	$ 485	$ 511	14.5%
2	Santiago de Cuba	400.0	27.11	87.1	7,780	30,943	7,278	89,071	$ 287	$ 355	27.3%
58	Santo Domingo	65.0	2.64	8.5	1,321	4,378	1,025	12,285	$ 500	$ 516	14.2%
87	Segundo Frente	50.0	2.03	6.5	1,159	3,511	812	9,542	$ 570	$ 538	12.8%
129	Sibanicu	34.0	1.38	4.4	986	2,586	584	6,617	$ 713	$ 582	9.9%
79	Taguasco	54.0	2.20	7.1	1,202	3,742	869	10,274	$ 547	$ 531	13.2%
100	Tercer Frente	43.0	1.75	5.6	1,083	3,106	712	8,263	$ 619	$ 553	11.8%
46	Trinidad	79.5	3.23	10.4	1,478	4,584	1,232	11,383	$ 457	$ 441	19.0%
75	Union de Reyes	55.0	2.24	7.2	1,213	3,800	883	10,457	$ 542	$ 529	13.3%
76	Urbano Noris	54.5	2.22	7.1	1,208	3,771	876	10,365	$ 545	$ 530	13.3%
91	Varadero	14.5	1.97	6.3	1,141	3,415	788	9,238	$ 580	$ 541	12.6%
146	Venezuela	29.0	1.18	3.8	932	2,296	513	5,703	$ 790	$ 606	8.4%
69	Vertientes	60.0	2.44	7.8	1,267	4,089	954	11,371	$ 519	$ 522	13.8%
141	Vinales	30.0	1.22	3.9	943	2,354	527	5,885	$ 773	$ 601	8.8%
51	Yaguajay	75.4	3.07	9.8	1,434	4,980	1,173	14,187	$ 468	$ 506	14.9%
65	Yara	62.0	2.52	8.1	1,289	4,205	983	11,737	$ 511	$ 519	14.0%
135	Yeteras	31.0	1.26	4.0	954	2,412	541	6,068	$ 756	$ 596	9.1%

Figure 1: Population Centers



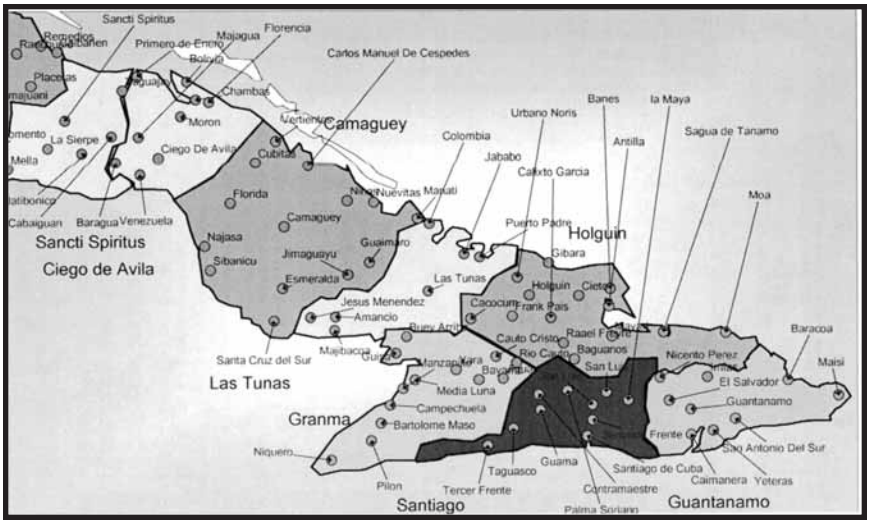


Table 3: Analysis of Cellular Demand in the United States and Application to the Cuban Network Design

Year	Cell Sites	Direct Emp.	Subscribers	Total Capital Investment ($000)	Average Inv. per Subs.	Average Subs. per Site	Direct Empl. per 10,000 Subsc.	Rev. Per Line	Total Monthly Revenues ($000)	Annual Growth Rate	Per 100 pop
1985	599	1,697	203,600	588,751	2,892	340	83				
1986	1,194	3,556	500,000	1,140,163	2,280	419	71			146%	0.2%
1987	1,732	5,656	883,778	1,724,348	1,951	510	64			77%	0.3%
1988	2,789	9,154	1,608,697	2,589,589	1,610	577	57			82%	0.6%
1989	3,577	13,719	2,691,793	3,675,473	1,365	753	51			67%	1.0%
1990	4,768	18.973	4.368.686	5.211.765	1.193	916	43			62%	1.6%
1991	6.685	25.545	6.380.053	7,429,739	1,165	954	40			46%	2/3%
1992	8.901	30.595	9.892.535	9.276.139	1.043	999	34			39%	3.2%
1993	11,551	36,501	13,067,318	12,775,967	978	1,131	28	75.00	980,049	47%	4.7%
1994	14,740	45,606	19,283,306	16,107,921	835	1,308	24	61.50	1,185,923	48%	7.0%
1995	19,844	60,624	28,154,415	21,721,711	772	1,419	22	56.21	1,582,560	46%	10.2%
1996	24,802	73,365	38,195,466	26,707,046	699	1,540	19	51.00	1,947,969	36%	13.8%
1997	38,650	97,039	48,705,553	37,454,294	769	1,260	20	47.70	2,323,255	28%	17.6%
1998	57,674	113,111	60,831,431	50,178,812	825	1,055	19	42.80	2,603,585	25%	22.0%
1999	74,157	141,929	76,284,753	66,782,827	875	1,029	19	39.43	3,007,908	25%	27.6%
2000	95,733	159,645	97,035,925	76,652,358	790	1,014	16	41.24	4,001,762	27%	35.2%
2001	114,059	186,317	118,397,734	99,728,965	842	1,038	16	45.27	5,359,865	22%	42.9%

Notes:
1. Data from CTIA's semiannual survey as of December 2001 sponsored by the Federal Communications Commission.
2. Revenue per line has been declining as has the revenue per average investment.
3. The cost to gain an additional line (margical cost per line) has averaged $833 per subscriber since 1995. The cummulative average is $842.
4. Average monthly minutes per subscriber was 1,689 in 2001 and 88 in 1995. Utilization has doubled and price has declined.
5. The busy hour utilization can be estimated using 22 peak days per month and 12 peak daily hours. The current use is 3.8 ccs/subscriber about the same as the wire line network.
6. The US utilization is .11 erlangs (3.8/36) which is moe than 2 times the utilization in the CubaCel Network or .05 peak elrlang 7. design.
7. A typical Cell site in South Florida has 144 channels with a capacity of approximately 1,300 subscribers per site based on 3.8 ccs.
8. A cellular design for La Habana assuming current population density of over 100,000 per square mile and a 10% demand requires one cell site per square mile with 672 (OC-1) channels per antenna, and one digital switch to handle the cellular demand.
9. Approximately 100 towers are required to provide a ubiquitous cellular network for the island.

Table 4
Worldwide Telecommunications Demand

	Population Million	Age Dist. 15Y-65Y	Tel. Per 100 Pop	TV per 100 Pop	Internet per 100P	Cell 1998 per 100P	Cell Now	Bell South 4Q2001
Africa	571	51.5	3.1	6.6	0.5	0.6		
Asia (excluding Japan)	3,163	60.8	9.1	18.8	2.2	4.4		
Japan	125	69.8	48.5	69.5	21.7	51.3		
Australia	21	66.4	54.1	57.2	43.2	33.1		
Europe (Eastern)	234	58.6	25.9	111.0	8.0	10.4		
Europe (Western)	412	66.4	51.9	51.5	19.6	23.3		
Canada	28	67.3	67.5	78.4	48.5	15.3		
United States	278	65.3	75.2	84.9	57.4	26.8	43.0	
Rest of America	441	59.0	12.9	20.3	3.5	4.0		
Oceania	2	52.7	30.6	11.4	1.2	3.7		
World Wide Averages		60.5	17.3	28.8	7.3	8.0		
Totals in Millions	5,275		914.3	1,517.3	382.7	419.4		
Cuba (Current)	12	68.4	5.3	23.1	0.5	0.0	0.1	
Cuba (+10 Years)			15.0	23.0	10.0	10.0		
Latin America								
Argentina	33	61.0	22.9	27.5	2.8	9.2	8-10	4.2
Bolivia	6	54.2	5.1	14.0	0.5	1.8	3-5	
Brazil	150	60.1	11.3	24.3	5.8	2.9	6-10	6.0
Chile	14	63.3	19.1	23.2	4.6	6.9	9-11	5.6
Colombia	28	60.0	19.5	16.5	2.2	6.5	8-10	2.6
Costa Rica	2	58.9	18.1	21.1	6.0	5.7	6-10	
Dominican Republic	6	55.9	10.3	13.9	0.5	2.4	3-5	
Ecuador	11	57.8	8.4	14.4	0.2	1.5	5-7	2.7
Guatemala	9	51.4	7.2	14.4	0.7	7.2	7-8	0.6
Honduras	4	49.7	5.5	13.4	0.5	0.3	2-5	
Mexico	81	56.9	11.8	31.5	3.1	2.5	6-10	
Nicaragua	4	51.3	3.7	8.5	0.5	0.2	5-7	3.1
Panama	3	61.2	15.5	19.9	1.8	0.7	8-10	7.4
Paraguay	4	56.1	7.2	24.5	0.5	12.6	12-15	
Peru	22	59.0	6.9	13.9	1.8	2.3	5-7	1.6
Uruguay	3	62.6	27.5	25.3	9.7	9.7	12-15	6.5
Venezuela	20	58.5	17.3	20.2	2.0	9.9	15-18	13.9

Note for BellSouth Demand:

BellSouth had a 10% growth rate in cell phones in South America. Argentina and Chile lost lines, and the countries with low demand increased from 6% in Panama to 50% in Ecuador. BellSouth is the sole provider in some countries, but has one competitor in most countries. In Brazil, BellSouth only serves major cities.

Note on data Sources:

1. The US 2001 update is based on FCC data; all other information comes from Year, End 1998 data from the CIA world.
2. The data for Cuba is based on the detailed annual report for CubaCel.
3. All non cellular demand is based on year end 200 data based on the CIA reports for year end 2001 (www.CIA.gov).

[1] Empresa de Telecomunicaciones de Cuba Sociedad Anonima (ETECSA) is a company formed by a Mexican company to supplement the Cuban Telecommunications Company. In conjunction with Cubacel, ETECSA recently has made improvements in data wireless, data, and Internet services in Cuba.

[2] Step-by-step switching systems are direct dial control switching systems based on the Stroger switch developed in the very early 1900s. The step-by-step system was the first automatic dialing system widely deployed worldwide. The last new step-by-step office in the United States was placed in service in the mid 1950s. This electro-mechanical analog system is not capable of handling multifrequency Touch-Tone signals and cannot provide Enhanced Automatic Number Identification necessary for E911 service. The step-by-step offices were removed from the U.S. network during the 1970s and early 1980s due to their limitations in providing Touch-Tone service and their lack of capability for providing the custom-calling features that were marketed to consumers.

[3] Crossbar systems are nonelectronic program control systems that use relays for logic storage. Western Electric introduced this type of system in the United States in the mid-1950s as the No. 5 crossbar system. Other manufacturers worldwide made cross-bar equipment until the early 1980s. The crossbar office can provide Touch-Tone service, but cannot handle custom calling features requiring electronic stored program control. These systems are not compatible with E911 service and were removed from the United States network in the late 1980s. Crossbar systems can be used for local exchange offices and toll tandem offices.

[4] All cord-boards (manual attended switching positions) were replaced in the United States during the early 1970s and replaced with toll tandem switching systems. The Cord-boards were the foundation of toll telephony until the early 1950s.

[5] The world has two Pulse Code Modulation (PCM) standards. The American standard uses T-Carrier at 1.544 megabits per second providing 24 channels per system. The European standard (CCITT) uses 2 megabits with 32 channels per system. Digital carrier systems were introduced in the early 1960s on copper-based trunk facilities and originally were used for interoffice facilities. Currently, the systems are deployed using fiber-based facilities and are used for both interoffice facilities and local subscriber facilities.

[6] Digital switching systems were introduced in the early 1980s to switch PCM signals in the toll and local networks. These switches are electronic program control systems with decentralized processors and are considered state-of-the-art switching systems. These switching systems have been used to replace electromechanical switching systems and are currently being used to replace analog electronic systems. By the year 2005, more than 95 percent of total demand in the United States will be served by digital switching systems, according to current plans.

[7] Microwave systems require line of site between offices. These systems are impacted by atmospheric conditions. Repeater locations can be used to extend the range of systems where line of site cannot be obtained.

[8] Coaxial cables are used to host pulse code modulation systems. This type of system is subject to signal loss due to impedance and inductance. Repeaters are required to regenerate the signal. Coaxial technology was widely used in the United States until the advent of fiber-based systems. The United States plans to replace all microwave systems and coaxial-based systems by the end of the twentieth century. Since 1980, the interoffice facility of choice has been fiber. Fiber is also being introduced in the feeder network.

[9] The system uses a 24-channel N-3 type analog carrier system. The terminal equipment in Key West terminates in the second floor of the BellSouth local office and is transmitted over BellSouth Facilities to the AT&T toll office in Miami. This is the only N carrier system in service in the United States. All other systems were replaced by 1977.

[10] A voice channel is equivalent to 64,000 bits per second. The theoretical maximum transmission rate for data via voice channel is 56,000 bits per second because 8,000 bits per second are used to provide routing information. The objective in the United States is to transmit data at 56,000 bits per second over the telephone network using a data modem without need of a separate data network.

[11] A voice channel is 64 Kb/second. The 35-megabit per second system has capacity for 544 voice channels. The U.S. transmission standard is 45Mb/s, known as OC-1 (Optical Carrier-1). Most metropolitan subscriber systems operate based on OC-3 (3 OC-1 signal). Long-distance carriers in the United States transmit at OC-96 and in some cases at up to OC-192.

[12] The typical network is composed of the switch, outside plant, interoffice facilities, and toll network. The switch can range from electromechanical analog systems, such as the step-by-step or crossbar switches, to digital electronic. Its function is to concentrate customer demand, to reduce the number to channels, and to connect customers. The outside plant network consists of two components, with the feeder network providing an efficient interface to the switch based on distributed demand parameters. This network can be copper-designed based on transmission standards with thicker copper conductors for longer distances, or fiber using a digital multiplexed signal for transmission. The “distribution” network is a less efficient network connecting the customer to the feeder network. This network usually is provisioned in anticipation of demand, with each house connected to the feeder network (the U. S. standard is two pairs per living unit). Interoffice facilities interconnect switches (wire centers) and are sized on the basis of point-to-point demand. The toll network includes both switch equipment and facilities and also is sized on demand. In some cases, local and toll networks can share the same switch or facilities.

[13] An erlang is a unit of time that refers to the percentage of an hour that the telecommunications equipment is in use; for example, .05 erlang refers to 1/20 of an hour or 2 minutes per hour. The United States uses the centium call second (ccs) to measure telecommunications use. A typical residential line in the United States has a 3 ccs traffic rate. A typical business line has a 7 ccs traffic rate. A typical wireless line has a 1.5 ccs rate, which is slightly higher than .05 erlang. The trunk facility networks are

designed based on a Poisson probability distribution, but can be approximated as the reciprocal of the utilization rate expressed in erlangs. Therefore, a .05 rate of use results on a traffic-carrying capacity of approximately 20 customers per channel. This figure is used to estimate the number of customers in the network.

[14] Rank refers to the profitability of serving the market. Numbers range from 1 to 169, with 1 as the highest rate of return. All population centers in Havana are listed by geographic subdivision, for example, Diez De Octubre, Centro Habana, and so on.

About the Author

Manuel Cereijo, an engineer with many years of experience in control systems and communications, was a professor of engineering at Florida International University for 28 years. Now he is president of his own consulting company, Professional Advancement Corporation.

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