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20458

Distr.  
LIMITED

IPCT.189(SPEC.)  
23 November 1993

UNITED NATIONS  
INDUSTRIAL DEVELOPMENT ORGANIZATION

ORIGINAL: ENGLISH

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DESIGN, TROPICALIZATION AND MANUFACTURING  
OF TELECOMMUNICATIONS EQUIPMENT IN  
LATIN AMERICA AND THE CARIBBEAN\*

by

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\* Mention of company names and commercial products does not imply the endorsement of the United Nations Industrial Development Organization (UNIDO). The views expressed in this report are those of the author and do not necessarily reflect the views of the Secretariat of UNIDO. This document has not been edited.

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## TABLE OF CONTENTS

I.	INTRODUCTION . . . . .	1
II.	THE TELECOMMUNICATIONS SECTOR SCENARIO IN LATIN AMERICA AND THE CARIBBEAN . . . . .	1
III.	LOCAL MANUFACTURING OF TELECOMMUNICATIONS EQUIPMENT IN LATIN AMERICA AND THE CARIBBEAN. . . . .	6
III.1	TELECOMMUNICATIONS MANUFACTURING IN ARGENTINA. . . . .	10
III.2	TELECOMMUNICATIONS MANUFACTURING IN BRAZIL. . . . .	14
III.2.1	STATISTICAL INFORMATION OF THE TELECOMMUNICATIONS INDUSTRY IN BRAZIL. . . . .	16
III.2.2	TELECOMMUNICATIONS EQUIPMENT PROVIDERS. . . . .	17
III.2.3	RESEARCH & DEVELOPMENT ACTIVITIES . . . . .	18
III.2.4	REGIONAL COOPERATION. . . . .	19
III.3	TELECOMMUNICATIONS EQUIPMENT MANUFACTURING IN MEXICO . . . . .	20
III.4	A SUMMARY OF THE STATUS OF TELECOMMUNICATIONS EQUIPMENT MANUFACTURING IN ARGENTINA, BRAZIL AND MEXICO . . . . .	24
III.5	TELECOMMUNICATIONS EQUIPMENT MANUFACTURING IN COLOMBIA . . . . .	25
III.6	TELECOMMUNICATIONS EQUIPMENT MANUFACTURING IN COSTA RICA . . . . .	27
III.7	TELECOMMUNICATIONS EQUIPMENT MANUFACTURING IN PERU . . . . .	28
III.8	TELECOMMUNICATIONS EQUIPMENT MANUFACTURING IN CUBA . . . . .	30
IV.	PROPOSED SCHEME TO STIMULATE LOCAL MANUFACTURING OF TELECOMMUNICATIONS EQUIPMENT IN LATIN AMERICA AND THE CARIBBEAN . . . . .	31
V.	CONCLUSIONS . . . . .	33
	REFERENCES. . . . .	34

## **I. INTRODUCTION**

Latin American countries are going through substantial changes in their economies as well as in their telecommunications scenarios. Local equipment manufacturing is being greatly affected by new forces in the market and by privatization and liberalization processes currently under implementation.

The establishment of a program to promote technological cooperation in the telecommunications industry in the region would contribute to create and stimulate an integration process with strategies and lines of action regarding local equipment manufacturing. The purpose then is to identify those elements that support such integration process in the light of the particular socio-economic conditions of the region.

Argentina, Brazil and Mexico have the strongest manufacturing base of telecommunications equipment in Latin America. Other countries like Chile, Venezuela, Colombia and Costa Rica show very dynamic telecommunications scenarios with great potential to contribute on a higher degree to local systems manufacturing or assembly.

Another important aspect related to equipment manufacturing is the availability of human resources with knowledge and experience in high technology disciplines. A country with more skilled human resources would be able to attract companies to install manufacturing facilities. The participation of R&D institutions in cooperation programs with local industry is an important factor to increase productivity and efficiency. In order to provide sound and cohesive results, a regional cooperation program in telecommunications equipment manufacturing will have to include the aspect of human resources.

## **II. THE TELECOMMUNICATIONS SECTOR SCENARIO IN LATIN AMERICA AND THE CARIBBEAN**

Recent modernization and regional integration projects are signs of the importance that authorities, operating companies and service providers are giving to telecommunications. In search of new models of operation, Latin America has entered in a dynamic process of privatization and liberalization in which most countries in the region are opening doors to private local and foreign funds. An avalanche of equipment vendors has established basis and partnerships with local representatives in order to take advantage of the market opportunities created by the new regulatory and socio-economic conditions.

Under this scenario, local telecommunications equipment manufacturing has undergone significant changes that in some cases have created opportunities for expansion, but in other cases has been detrimental. Competitiveness, lack of human resources and financial factors have been fundamental to assure the survival of local manufacturing in Latin America. In most cases only multinational companies on their own or with alliances with financially strong local industrial groups, have been able to create or strengthen manufacturing platforms for domestic and export purposes. There are also cases in which indigenous companies have taken advantage of current conditions to expand their base and compete at international markets.

A summary of the most significant data on telecommunications infrastructure will be presented in order to establish a frame of reference for analyzing issues related to telecommunications equipment manufacturing in Latin America. First of all, it is important to start considering the Latin American region as a whole in the context of its position in relation to the world. Although there is a more noticeable presence of new mobile satellite and terrestrial data and digital voice services for corporate and rural applications, the basic telephone infrastructure is the most significant figure to date to define the status of telecommunications in a particular region. With that in mind, table II.1 shows the distribution of the world's telephones by continent. Although the figures show that the American continent has one third of all the telephones of the world, the share of Latin America is only 6 percent of the total as can be seen in table II.2.

Some important figures are observed from Table II.2. Brazil, Mexico, Argentina, Colombia and Venezuela own 70% of the telephones in the area [1], the lesser developed countries of the Caribbean area have the lowest telephone density contrasting with other Caribbean islands with better standard of living. Correlation of socio-economic development and telephone density is well established. Furthermore, no country has achieved a higher standard of living without an adequate telecommunications infrastructure [2].

While major technological advances have been made and implemented in industrialized countries during the last two decades, most Latin American telecommunications infrastructures were not able to provide the services required by the economies of their respective countries. The obsolescence of most of the equipment associated to difficult financial situations impeded the achievement of adequate levels of competitiveness. To face the challenge of expansion and modernization of the telecommunications infrastructure to offer efficient digital services, substantial investment was required. This condition forced state-owned companies to assess the functions of Government in telecommunications. Two main factors were taken into account: the need for financial resources and the realization of the Government's inability to operate a dynamic and high technology oriented business.

In this way, the availability of investment resources and the technological changes have transformed the telecommunications sector of Latin America from its former governmental monopolistic structure into profitable national telephone operating companies. However, there is still a lot to do in order to modernize the networks and acquire a higher degree of quality to overcome the lag of the past years. Particularly, there is a great need to overcome the disparity between urban and under-privileged areas observed in most of Latin American countries.

The private telecommunications companies of Latin America have been able to take advantage of the dramatic changes of the sector providing value added and specialized services such as private satellite networks, cellular networks, electronic mail, videotext and other data processing services. The telecommunications services companies have witnessed substantial growth in the new liberalized environment and most of the time has required the use of high technology equipment manufactured abroad to satisfy the pressing demands of competitiveness and quality service. This situation has affected considerably the independent local telecommunications manufacturing companies that during the former monopolistic and closed market scenario enjoyed a privileged status as exclusive equipment providers to public and private telecommunications entities.

Table II.3 presents the status of privatization and liberalization of major Latin American telecommunications industries. Also included are indications of competition in mobile and basic services.

According to CEPAL (Comisión Económica para América Latina y el Caribe) [3], the Latin American average telephone density of 10 telephones per 100 inhabitants is planned to be raised to 20 per 100 inhabitants by the year 2000 and reach a data processing capacity equivalent to the current figure for the industrialized countries. In order to achieve that goal, each country has to invest an equivalent of 1.5% of GNP in the telecommunications sector. It would also be necessary to channel between 5 and 10% of gross capital revenue to investments in new information technologies. In summary, the necessary investment is about 2 to 3 percent of the regional GNP. This would imply doubling or increasing fourfold the resources invested in the last decade equivalent to 0.5% of the regional GNP.

This same goal of reaching a telephone density of 20 in Latin America was proposed in a document entitled the Acapulco Declaration adopted at the Regional Telecommunications Development Conference for the Americas held in Acapulco, Mexico in June 1992. The basic elements of this statement are the following:

#### **ACAPULCO DECLARATION**

- Accelerate the expansion of telecommunications networks to duplicate at least the number of telephone lines in each Latin American and

Caribbean country in order to reach a regional density of 20/100 inhabitants at the beginning of the 21st century.

- \* Provide telephone access to rural communities and to all underprivileged urban areas through special programs that take advantage of the opportunities that new telecommunications technologies offer.
- \* Promote regional integration through the interconnection of all the countries in the American continent through modern telecommunications systems like fiber optics, satellite and digital networks.
- \* Strengthen audio and image broadcast systems incorporating new technologies as well as expanding the area of coverage to take advantage of radio and TV for distribution of information and for cultural and educational broadcast.
- \* Stimulate the generation of human resources and improvement of institutional structures to assure sustainable development of telecommunications infrastructure to guarantee efficient operation and quality service.
- \* Modernize the regulatory, legal and economic structure to create an environment of fair competition to induce public and private investment for the development of telecommunications.
- \* Achieve an accelerated pace of expansion and modernization of telecommunications on the basis of financial self sufficiency through tariff schemes that gradually adjust to cost and incorporating new financial strategies adequate for the region.

**TABLE II.1**  
**THE WORLD'S TELEPHONES**

Continents	Lines (millions)	Population (millions)	Density (Lines per 100 inhabitants)
America	184.088	739.2	24.91
Europe	186.102	505.1	36.84
Ex-USSR	32.844	295.3	11.12
Asia	108.223	3,047.3	3.55
Oceania	10.103	27.2	37.14
Africa	8.945	810.8	1.10
World	530.305	5,424.9	9.77

Source: Siemens, ITIJ & TelePress (publications cited)

**TABLE II.2**  
**LATIN AMERICA'S TELEPHONE NETWORK**

Country	Total Lines (thousands )	Tel. density (Lines/100 inhabitants)	Per Capita Income (US\$)	Population (thousands)
Brazil	10,020	6.56	2,640	152,705
Mexico	6,670	7.81	3,211	85,490
Argentina	3,880	11.17	2,740	33,050
Colombia	2,750	8.74	1,176	31,440
Venezuela	1,787	8.23	3,538	19,250
Chile	1,112	8.13	2,040	13,670
Puerto Rico	1,033	27.34	6,355	3,750
Uruguay	623	19.96	2,936	3,120
Peru	601	2.64	2,175	22,730
Ecuador	520	4.54	1,267	10,780
Dominican Rep.	385	4.75	773	7,270
Costa Rica	384	12.43	1,701	3,089
Cuba	366	3.41	2,604	10,710
Panama	245	8.92	2,334	2,420
Guatemala	223	2.08	838	9,200
Bolivia	221	2.36	666	7,400
Trinidad & Tobago	182	14.15	4,131	1,230
Bahamas	1143	57.01	6,654	250
El Salvador	125	2.38	781	5,250
Martinique	122	35.88	3,083	340
Guadeloupe	118	34.70	5,446	340
Paraguay	112	2.61	1,275	4,280
Jamaica	97	4.00	1,149	2,420
Honduras	88	1.72	869	5,110
Barbados	83	31.92	5,658	280
Netherlands Antilles	63	25.11	5,446	200
US Virgin Is.	62	55.00	9,279	111
Nicaragua	52	1.34	976	3,870
Haiti	45	0.89	374	480
Bermuda Is.	41	65.66	16,071	63
Suriname	37	8.61	3,115	430
French Guyana	32	30.76	1,256	104
Guyana	25	3.04	351	822
Belize	23	8.90	1,327	195
St. Lucia	15	11.80	1,231	150
Cayman Is.	12	46.12	11,429	26
St Vincent &Grenadine	10	9.10	980	110
Dominica (France)	9	10.84	1,184	83
Montserrat	7	53.84	3,230	13
Antigua & Barbuda	6	7.20	1,453	80
Aruba	5	7.20	3,880	80
Grenada	4	4.10	985	98
UK Virgin Is.	4	30.80	6,667	12
St. Kitts & Nevis	3	6.50	1,413	7
Anguila	2	29.00	1,143	7
Turks/Caicos Is	1	6.70	3,750	8
Latin America	32,448	7.31	—	443,338

Source: Siemens, ITU & TelePress (publications cited)



**TABLE II.3  
TELECOMMUNICATIONS LIBERALIZATION AND PRIVATIZATION**

Country	Partial or Full Privatization	Mobile Communications Competitions	Basic Services Competition
Argentina	C	C	P
Brazil		P	
Chile	C	C	C
Mexico	C	C	P
Venezuela	C	C	P

C – Complete

P – Planned

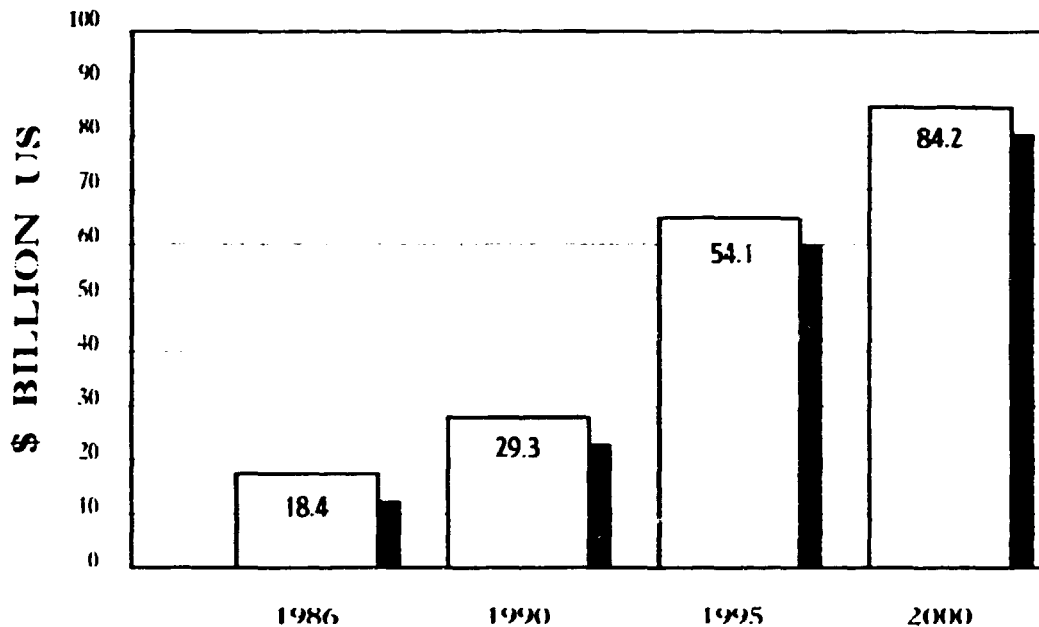
Source: Privatization International, various issues; W. H. Davidson, R. Hubert, and E. St. Croix, *Telecommunications Policy and Performance*, University of Southern California, January 1993; company documents.

### **III. LOCAL MANUFACTURING OF TELECOMMUNICATIONS EQUIPMENT IN LATIN AMERICA AND THE CARIBBEAN**

Privatization and liberalization throughout the Latin America has stimulated the marketplace and has proved to be the key to encourage huge investments from the world's major lending banks for the improvement of telecommunications services. This in turn has affected the process of local manufacturing of new information technologies in the area. The dynamics of the market have established a situation in which local manufacturers find difficult conditions to compete or even subsist. The urgent needs of restructuring and in some cases create complete network from scratch has required the deployment of telecommunications equipment that in most of the cases local manufacturing firms can not develop with the specifications and time frame defined by the telecommunications operators. Only the multinational telecommunications companies with significant presence in Latin America have been able to produce equipment necessary for the modernization of the networks through the participation of their foreign manufacturing base or by establishing an integration or assembly scheme. There are some cases in which local manufacturing and software development have been fundamental to obtain important contracts for both indigenous and multinational companies.

In order to establish a frame of reference to discuss local manufacturing of telecommunications equipment in Latin America, some figures related to the condition of the market are important. Table III.1 shows a projection for the year 2000 of the total telecommunications expenditure in equipment for the Latin American region. Latin America including the Caribbean countries plan to install 85 million telephone lines for an estimated population of 514 million. Achieving this figure will require investments of around US\$ 90 billion to obtain a telephone density of 20/100 inhabitants in the region. The level of investment reflects the marketing opportunities. The challenge to access a rapidly accelerating market along with the new regulatory conditions has forced local indigenous and multinational telecommunications firms to rethink their role as systems and services providers affecting dramatically their manufacturing plans in which the aspects of human resources availability and R&D are key elements in their short and long term growth strategies.

TABLE III.1



TOTAL TELECOMMUNICATIONS EXPENDITURE  
(EQUIPMENT) - CENTRAL AND SOUTH AMERICA  
AND THE CARIBBEAN.

SOURCE: TRC TELECOMMUNICATIONS RESEARCH

Local manufacturing in Latin America is also affected by the growing presence of the biggest telecommunications operators in the world which in some cases play only a role of distributing their equipment in the countries, in other cases have ownership stake in specialized service centers as well as ownership stake in the national common carriers. Table III.2 shows a matrix of the growing influence in Latin America of multinational telecommunications operators. Every time that this influence is more apparent, the manufacturing

plans are not defined on the basis of national priorities, but more on market forces and corporate strategies determined at the foreign headquarters of the multinational corporation. It is important to mention that in some cases manufacturing facilities have been established when multinational companies offer local manufacturing or assembly of telecommunications systems or components as a marketing strategy to obtain important contracts and to create a regional base for export.

Not only have multinational telecommunications operators expanded their presence in Latin America, but some have established joint ventures with local strong financial groups or with local specialized companies with experience in the manufacturing or service area. The status of manufacturing of telecommunications equipment in Latin America varies from country to country and according to the local market and liberalization scheme. However, three main categories of telecommunications companies can be observed (see figure III.1) in the main manufacturer countries of Latin America: Argentina, Brazil and Mexico. Countries such as Chile, Costa Rica and Venezuela have also very dynamic telecommunications markets but their industrial base in telecommunications is not as significant as in that group of countries. In fact Chile was the first country in Latin America to privatize telecommunications in 1987. Since then and as a consequence of an aggressive investment, Chile has strengthened its telecommunications infrastructure installing fiber optic and satellite links for national and international long-distance services as well as cellular telephone service. The telecommunications local participation has been focused in the area of services and software development.

Telecommunication in Venezuela was privatized at the end of 1991. By the end of 1993, CANTV plans to increase by 50 percent the telephone lines installed during the past 50 years. With an impressive investment in 1993 they plan to achieve the goal of 18 lines per 100 inhabitants by the year 2000, doubling the present telephone density. There are potentials for increasing local participation in the services area in software development.

Costa Rica has the highest telephone density in Latin America (13/100 inhabitants) with a significant telecommunications infrastructure in which also the services and software development areas constitute important niches for local participation.

Considering then Argentina, Brazil and Mexico the most active countries in telecommunications manufacturing in Latin America, a basic description of current activities and trends following the structure of figure III.1 will provide a picture and a frame of reference to propose a program for regional cooperation in the area. A summary of telecommunications equipment manufacturing activities in Colombia, Costa Rica, Cuba and Peru is included.

TABLE III.2

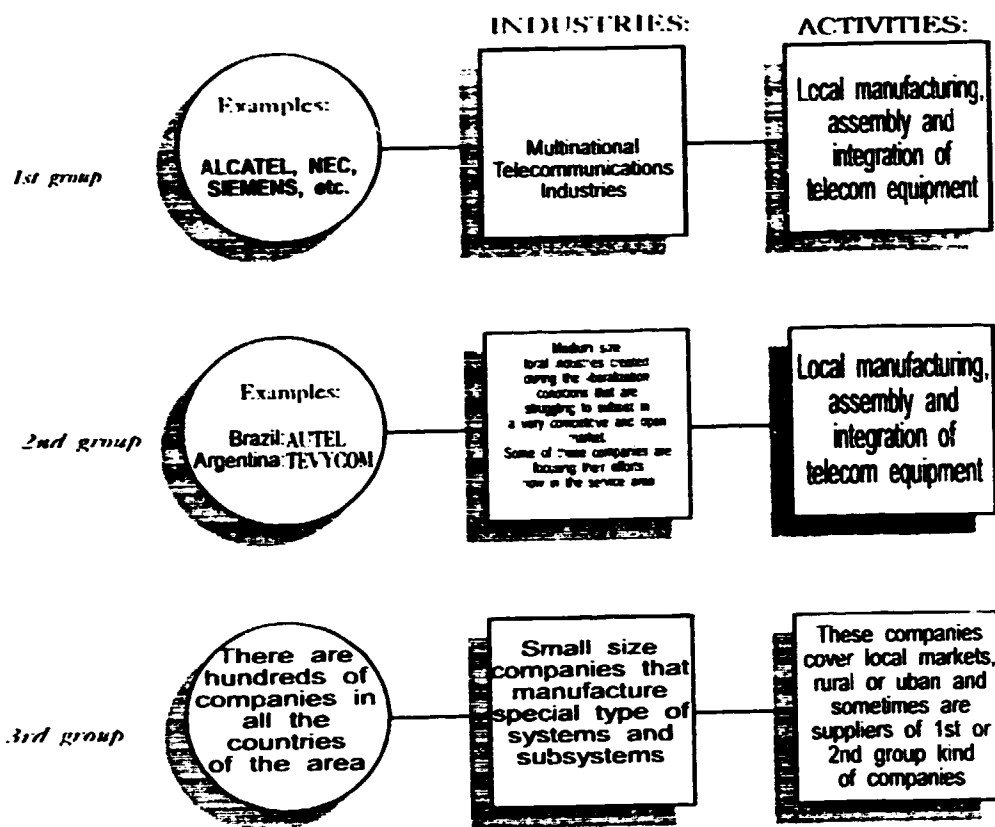
PRESENCE OF TELECOMMUNICATIONS OPERATORS IN LATIN AMERICA

○ = No ownership role   ● = Ownership stake in specialized service center   ⊕ = Ownership stake in common carrier

AT&T   Bell   South   International   Mexico   IBM   STN   World   US   West   GE   Bell   AT&T   GTE   SBC   Telecel   France   Compu   CC  
Canada   Latin   America   America   Mexico

Latin America	AT&T	Bell	South	International	Mexico	IBM	STN	World	US	West	GE	Bell	AT&T	GTE	SBC	Telecel	France	Compu	CC	
Chile	○	●	○	○	○	○	○	○	○	○	○	○	○	○	○	○	⊕	○	○	○
Venezuela	⊕	●	○	○	○	○	○	○	○	⊕	○	○	○	○	○	○	⊕	○	○	○
México	○	●	○	○	○	⊕	○	○	○	○	○	○	○	○	○	○	○	⊕	○	○
Argentina	○	●	○	○	○	○	○	○	○	○	○	○	○	○	○	○	⊕	⊕	○	○
Puerto Rico	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	⊕	○	○	○
Belize	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
Uruguay	○	●	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○

SOURCE: PYRAMID RESEARCH, INC.



**Figure III.1**

### III.1 TELECOMMUNICATIONS MANUFACTURING IN ARGENTINA

A turning point in Argentina's telecommunications development occurred in 1991 when the government sold its state-owned telephone company through public auction and two companies were created to service the Argentine market: one for the northern region: TELECOM ARGENTINA formed by

Stet	(Italy)
France Telecom	(France)
Grupo Pérez-Compagnon	(Argentina)
J.P. Morgan	(U.S.A.)

and one for the southern region: TELEFONICA DE ARGENTINA formed by

Telefónica	(Spain)
Inversora Catalinas	(Argentina)
Citicorp	(U.S.A.)

The purchase agreement granted exclusive license to each company to provide basic telephone services to its respective areas. The exclusivity

feature will last for seven years ending at the end of 1997 with possibilities to extend it for three more years. Telefonica de Argentina and Telecom Argentina are supervised by the independent government agency CNT (Comisión Nacional de Telecomunicaciones) to ensure compliance with the operating license and to approve equipment and technical standards.

Due to the fact that each of the operating companies has undertaken a major investment program to increase the number of lines, to update the equipment and to increase the operating efficiency on the service, significant amount of telecommunications systems (hardware, software and external plant infrastructure) have been required to achieve the modernization goals set for the first years of operation.

The demand for new telecommunications equipment has been so overwhelming that in some cases old infrastructures have been completely dismantled and new digital systems have been set in place.

Local industry has been able to respond in external plant requirements (air conditioning, power supply, cabinets and controls) and in services related to the installation of new telephone lines both public and private. Telecommunications equipment related to switching, processing and transmission has been supplied by the following sources in order of importance.

- \* Foreign sources of multinational character of company affiliates or business associates of the two telecommunications operators (Example ALCATEL, Telettra Española).
- \* Local manufacturing of multinational companies working independently or under joint ventures with Argentine financial groups (Example SIEMENS, PECOM-NEC).
- \* Medium size local manufacturing firms to cover specialized switching and transmission needs with low or medium capacity systems for urban or rural applications (Example Tevycom-Fapeco).

As a strategy to cover local and regional markets, some big multinational companies like NEC and ALCATEL have established joint ventures with local partners creating groups like PECOM (Pérez - Companc) - NEC and Techint - ALCATEL. In the case of PECOM-NEC they have established one of the most modern telecommunications manufacturing plants in the world in the province of Buenos Aires.

Even in the area of services, the two telephone operators have a strong position through the presence of companies that serve the public and private sector like STARTEL, a telecommunications service oriented venture property of Telecom and Telefónica.

The modernization trend has forced to import a great amount of telecommunications systems affecting the development and local manufacturing of equipment. The medium size local telecommunications firms and local multinational manufacturers that before 1991 constituted major providers of equipment have had to restructure their manufacturing base and rethink their role in the new privatization and liberalization scenario. Some former manufacturers have closed production lines (modems, multiplexers) to become distributors of foreign systems, while others have simply turned themselves into service providers.

Medium sized manufacturing companies have become "endangered species" and new schemes of government support to stimulate technology development are necessary to provide minimum subsistence to maintain and create a revitalized national industrial base.

On the other hand, joint ventures of local financial groups with multinational telecommunications companies have been firmly established with aggressive strategies to cover local demand and participate in export of high technology systems manufactured and/or assembled in their plants.

Important opportunities like MERCOSUR and the launching and operation of the domestic satellite NAHUEL I can be important stimuli for local manufacturing if proper policies and audacious initiatives are established.

More cohesive University - Industry programs have to be established to take advantage of the excellent level of Argentine engineers and scientists before the technological gap becomes a greater obstacle for local participation.

A sample of representative telecommunications manufacturing industries consists of those companies associated to CADIE (Cámara Argentina de Industrias Electrónicas). A list of such companies in alphabetical order is the following:

- Arbelaz, S.A.  
Small manufacturer of radiocommunication supplements.
- Ariema, S.A.I.C.Y.F.  
Small manufacturer of equipment and accessories for TV reception.
- Cambe  
Small manufacturer of passive electronic components.
- Carvajal, S.A.I.C.  
Small manufacturer of antennae and accessories.

- **DESEL NEUQUEN, S.A.**  
Medium sized company, manufacturer of power supply systems for communications equipment.
- **Eastel, S.A.I.C.**  
Small to medium sized company, manufacturer of telephone and radiocommunications equipment.
- **IATA/ALCATEL**  
Medium to high capacity manufacturer of public and private telephone switching radiocommunications and fiber optic systems, recently has widened its base through its acquisition from ALCATEL of other product lines. The joint venture with Techint has positioned as one of the most important communications companies in Argentina.
- **Italtel**  
Medium to high capacity manufacturer of public and private switching, multiplexing and radiocommunications systems.
- **Kombi Electronica, S.A. – Trasa**  
Medium sized company, manufacturer of rural telephony and radiocommunications systems.
- **LACI**  
Small manufacturer of printed circuits.
- **MACH Electronics**  
Small manufacturer of radiocommunications systems.
- **MAURO Comunicaciones**  
Small to medium sized manufacturer of radiocommunications systems and accessories.
- **PECOM-NEC**  
Argentine-Japanese Company manufacturer of public and private switching systems and transmission equipment recently PECOM- NEC expanded its industrial base and became an important manufacturer for the local and export markets.
- **SIEMENS**  
German company manufacturer of public and private switching systems and assembler of other telecommunications systems for the local and international markets. Siemens is one of the most important manufacturers of telecommunications equipment in Argentina.



- **TECSEL**  
Small manufacturer of systems and components for private and public telephony.
  
- **TEVYCOM/FAPECO, S.A.**  
Medium sized company, manufacturer of switching equipment, concentrators, multiplexers, radiocommunications and data transmission systems.

### **III.2 TELECOMMUNICATIONS MANUFACTURING IN BRAZIL**

Brazil has a telephone network of 10.5 million lines. With a population of 150 million, this corresponds to a telephone density of 7 per 100 inhabitants. With these figures, Brazil is number eight in telephone density in Latin America and number forty in the world. Although the privatization and liberalization processes have not been as open as in the case of Argentina, Chile and Mexico, the telecommunications scenario in Brazil is very dynamic. Cellular trunking and value added data services are becoming popular and important alternatives to conventional services.

The Ministry of Communications (MINICOM) is the highest communications authority in the country. TELEBRAS is the national carrier controlling 27 regional operating companies and EMBRATEL, the long distance and international carrier.

The recent liberalization process that expanded the base of multinational companies and opened the door for new ones along with the new industrial policy issued in April 1993, will play an important role in the regulation and structuring of the telecommunications manufacturing scenario of the country.

The restrictions related to new information technologies imports defined in the Informatics Law (Ley de Informática) have been modified to make the incorporation of foreign sophisticated components in locally manufactured systems [4] more flexible. The modifications also include some tax incentives for high technology local manufactured products.

Brazilian Telecommunications authorities and telephone companies have always been aware of the importance of local equipment manufacturing issuing standards for operation and tropicalization and advising domestic companies to comply with international regulations to create an export base.

As an example of this fact, out of the total US \$ 3 billion investment by TELEBRAS in 1993, US\$ 180.4 million will be used for installation of TROPICO R switches. This switch is currently manufactured by ALCATEL do Brasil and originally developed at the TELEBRAS research branch CPqD (National Research and Development Center) in Campinas.

In spite of the restrictions of the past Informatics Law, local telecommunications firms have been very competitive and export oriented. Although they captured and dominated the local market, some of them had the impulse to look for foreign clients. Medium size companies have been experiencing pressures from the increasing participation of advanced international telecommunications firms in the Brazilian market.

In some cases the medium size companies have been able to establish alliances with international partners, in other cases they had re-oriented their manufacturing base with new products and sometimes have been able to sell part or most of its stock to local multinational companies. There are also cases of former manufacturers that have turned themselves into equipment distributors and system integrators.

There is no doubt that Brazil has the strongest telecommunications manufacturing base in Latin America. The former Informatics Law on the one hand limited the advancement and production of new and sophisticated telecommunications systems. On the other hand it strengthened the manufacturing infrastructure and was an important element to relate user needs with industry and research and development. It is in Brazil where we have the best examples in Latin America of R&D prototypes turned into products throughout the participation of local manufacturing firms with universities and research centers. Engineering schools produce high quality engineers with capacity to absorb and adapt new telecommunications technologies (hardware & software) to the Brazilian environment.

In the area of telecommunications manufacturing, the biggest and most important companies are NEC do Brasil and Equitel y Matec (member of the Ericsson Group). These companies dominate the local market of switching and transmission and have important export participation in the Latin American market. For example NEC do Brasil has plans to arrive to 16% in export volume out of all total shipments in the next five years.

There is an important group of medium size local companies that develop high technology telecommunications equipment for local manufacturers and recently have advanced themselves to strong positions in the export markets. Out of the total affiliates to ABINEE (Brazilian Association of Electrical and Electronics Industry) the following manufacturing companies play an important role in the telecommunications manufacturing scenario of Brazil.

**Alfatest:**

Develops automatic testing equipment for the Ericsson group and has plans to export systems to Middle East countries. It projects around 50% of exports from total sales.

**Autel:**

Manufacturer of analog and digital radios, multiplexers and other radiocommunications systems. Autel has recently expanded its export base

from Latin America to Thailand. It had obtained around 15% of exports out of total sales during the last three years.

**Celtec:**

Software developer of cellular products that has established important business relations with American manufacturer Plexsys.

**Leucotron:**

This company has developed its own technology in the area of micro PABX for local and export purposes.

**Linear:**

Manufacturer of microwave telecommunications systems for UHF, TV and satellite applications.

**Telemulti:**

Developer of transmission systems with participation of TELEBRAS CPqD.

**Zetax:**

Digital switching manufacturer with technology developed at CPqD.

**III.2.1 STATISTICAL INFORMATION OF THE TELECOMMUNICATIONS INDUSTRY IN BRAZIL**

The most important statistical data regarding the telecommunications sector in Brazil is shown below. The TELEBRAS system provides more than 90% of the services and units described.

INDICATOR	UNIT	1982	1988	1991	1992
Telephone lines	thousands of lines	6,425	9,082	10,780	11,680 *
Locations with telephone services	locations	6,862	13,264	15,922	17,020 *
Public telephones	number of lines	69,767	211,496	251,334	275,327 *
Telex lines	number of lines	65,900	121,200	151,900	138,200
Telex calls	thousands of minutes	624	562	639	517
Dedicated data communications network	Data Terminal Units	6,461	12,281	30,179	33,203
Packet data communications network (RENPAc)	---	---	2,984	12,540	14,204

(\*) Estimated

It is important to note that mobile cellular telephone services were introduced in Rio de Janeiro in 1990 and by March 1993, 49,000 terminals were operating in four states: Rio de Janeiro, Distrito Federal, Paraná and Santa Catarina.

### III.2.2 TELECOMMUNICATIONS EQUIPMENT PROVIDERS

Brazil has an industrial base that covers locally almost all needs in telecommunications equipment.

Following, a summary with the number of providers, all based in Brazil, which have products certified by the TELEBRAS is presented:

#### Switching

High capacity	7
Low capacity	2

#### Transmission

Radio	11
Multiplexers	10
Fiber Optics	6

#### Cables

Copper or aluminum	16
Fiber optics	8
External network	49

#### Energy

Rectifiers	9
Batteries	5

#### Terminal equipment

Telephones	9
Public Telephones	5
Modems	17

### **III.2.3 RESEARCH & DEVELOPMENT ACTIVITIES**

In Brazil, R&D activities are carried out by universities, research institutions, industries and the Research and Development Center of TELEBRAS (CPqD). The projects of CPqD represent over 90% of Brazil's effort in the area.

The Research and Development Center of TELEBRAS was created in 1976 in the city of Campinas, state of Sao Paulo, in the south-east region of the country. This region concentrates more than 50% of the GNP, the most advanced universities and the biggest telecommunications industries of the country.

Since its creation and through nearly 15 years, CPqD has emphasized on technology transfer to the industry. At that time, the industrial policy of the country was based on the "import substitution" strategy. Products developed by CPqD and transferred to the industry received protection from the market and were acquired by TELEBRAS Operating Companies, without competing with foreign products.

Since the beginning of the 1990s, and with the abandonment of the import substitution industrial policy, Brazil has adopted a macroeconomic policy based on the principle of "competitive participation in the international market". In the telecommunications sector this fact was reflected in a liberalization of equipment acquisitions by the TELEBRAS Operating Companies, this meant that CPqD products would be competing in price and quality with products available in the world market.

In this way, CPqD started working more selectively on product development and has emphasized efforts concerning R&D projects whose results can be directly transferred to the TELEBRAS Operating Companies with goals oriented to the new forces of the market, to new services, increase of customer base, cost reduction and optimization of investments.

A summary of achievements of CPqD up to the end of 1992 is presented as below:

- \* 77 products transferred to 72 industries
- \* joint ventures with 12 universities and 4 industries
- \* 252 technology transfer contracts
- \* 6 national technological cooperation agreements
- \* 11 international technological cooperation agreements
- \* 1187 employees working in CPqD
- \* 111 contracted personnel at CPqD
- \* 812 employees with university degree
- \* US\$ 85 million budget for 1993

Currently, the major R&D activities of CPqD are following:

- \* Digital switching (TROPICO)
- \* Networks and services management
- \* Optical Networks
- \* Intelligent networks
- \* Cellular and personal communications
- \* Radio and satellite systems
- \* Terminals
- \* External networks

The first three areas are priority; they jointly consume over 50% of the annual budget of CPqD and include activities supporting developments in microelectronics and opto-electronics.

Summarizing, CPqD is a R&D center, basically oriented towards the telecommunications area, has a long history of interaction with industries and, traditionally, keeps technological cooperation links with entities in several countries.

### **III.2.4 REGIONAL COOPERATION**

Following are presented some developments that could constitute areas for cooperation between countries from Latin America and the Caribbean, aiming to promote local production of telecommunications equipment and systems.

#### **\* *LOW COST TELECOMMUNICATIONS***

In this respect, CPqD is developing telecommunications systems and equipment for the needs and specific requirements of the market, traffic and operating conditions of the countries of the region.

This topic, which has been referred in ITU's report "The Missing Link", is the focus for development activities in Brazil. The following projects are the most important:

#### **\* *TROPICO***

Digital switching systems of medium and high capacity adapted to the operational conditions of the region.

#### **\* *LOW CAPACITY SWITCHING SYSTEMS***

Several Brazilian industries are developing and producing low cost computer controlled switching systems to serve regions with low population density.

#### **\* *UAS (User Access Service)***

For applications in low traffic per user conditions.

\* *CLAD (Distributed users line concentrator)*

To serve small locations and rural communities at a low cost.

\* *TP-CARTAO (Card operated public telephone)*

Apply technology, adapted to the requirements of the region's operating conditions.

• *APL-2 (Digital Radio Transmission System)*

Two voice capacity system, using the same frequency band of traditional monochannel equipment.

### **CERTIFICATION AND TESTING**

The activities of certification and testing of telecommunications systems and equipment, specially of those based on software, constitute a great challenge for regional telecommunications administrations. The needed investments are high and the technical complexity involved is considerable. Regional cooperation in this area would be undoubtedly advantageous to all participants and could take place with exchange of:

- testing software
- testing procedures
- training courses

### **III.3 TELECOMMUNICATIONS EQUIPMENT MANUFACTURING IN MEXICO**

Mexico's telephone company TELMEX was privatized in 1990 and cellular operations provided by private companies were permitted. The concession given to TELMEX to operate as a privatized monopoly will end in the summer of 1996, this fact along with the eventual North American Free Trade Agreement (NAFTA) will revolutionize the telecommunications scene in Mexico.

Today, after three years of market liberalization in telecommunications equipment imports, the medium size national telecommunications manufacturers have practically disappeared, remaining only the multinational companies and a myriad of small size manufacturers that provide support to local industries.

Before the liberalization process, the model of import substitution supported the participation of a group of medium size national telecommunications manufacturers that took advantage of a closed market and that unfortunately did not achieve a competitiveness level to subsist after the aperture of the market. These medium size companies showed a slow productivity growth where industrial production grew fundamentally because facilities and

equipment also grew, but efficiency stagnated and R&D investments were not properly allocated.

It is obvious then that after the liberalization, the balance trade has been highly deficit concentrating telecommunications manufacturing to assembly or "maquiladora" operations and to the big multinational companies like Ericsson, Alcatel, NEC, Northern Telecom and others. Unable to compete with foreign manufacturers, the medium size national telecommunications industries turned themselves into importers or equipment distributors, systems integrators or service providers.

So far the telecommunications scenario is still very dynamic in spite of the presence of a privatized monopoly in basic telephone services. The presence of cellular and other value added companies provide alternatives for the pressing demand of services. The launching of the Morelos Satellite System in 1985 brought important alternatives for corporate communications. To date, the satellites are almost 100% full and the second generation of Mexican satellites due to go into operation in the first semester of 1994 will provide substantial capacity for data voice and image transmission to cover the demand along with the modernization projects of TELMEX. TELECOM the decentralized wing of the Ministry of Communications and Transport (SCT) is in charge of satellite operations in the country having transferred the microwave national network for TELMEX operation. The need to improve the average telephone density of Mexico of around 7/100 inhabitants and the increasing demand of services at corporate and social interest areas (rural, underprivileged, suburban) are the most important factors to induce investment in telecommunications for the next couple of years. Government policies and support to create or stimulate national telecommunications manufacturing in a highly competitive and open scenario are necessary to improve in a medium or long term the current balance of trade in telecommunications.

Important developments in several states of the country, particularly in regard to industrial incubators, technology parks, new schemes of R&D and university-industry programs, will be fundamental in creating a new generation of dynamic small industries either for the export market or subcontracting for the multinational telecommunications companies. At the present, the Mexican Institute of Communications (IMC) is in the process of formulating a new program for stimulating national participation in telecommunications manufacturing as well as in telecommunication software development.

To date, according to CANIECE (Cámara Nacional de la Industria Electrónica y de Comunicaciones Eléctricas) the following companies are the major telecommunications manufacturers in the country:

**ALCATEL INDETEL.**

Manufacturers of public and private switching, telephone systems, transmission equipment



**MITEL de Mexico**

Manufacturers of private switching and telephone systems

**MOTOROLA**

Manufacturers of radiocommunications systems and accessories

**NEC de Mexico**

Manufacturers of switching and transmission systems

**NORTHERN TELECOM**

Manufacturers of private switching and telephone systems.

**ROLM Telecomunicaciones**

Manufacturers of private switching and telephone systems.

**TELEINDUSTRIA ERICSSON**

Public and private switching and telephone systems, software development for switching applications.

Besides these major manufacturers, there are, according to CANIECE, 362 small size companies in the area of electronic components, communications and telecommunications systems. In this group we can find small manufacturers, service providers, systems integrators and "maquiladora" assemblers.

In order to summarize the condition of the telecommunications industry in Mexico, Table III.3.1 and III.3.2 show the value of the telecommunications market in Mexico as well as the telecommunications imports from 1985 to 1992. These two tables show the effect of liberalization policies set in motion by the Mexican Government at the beginning of this decade. These policies, as it was mentioned before, affected the telecommunications manufacturing process in the country.

**TABLE III.3.1****TELECOMMUNICATIONS MARKET (millions of dollars)**

	1988	1989	1990	1991	1992e/	1993e/	1994 e/
Public Switching	77	131	220	236	265	296	344
Transmission	159	217	444	455	173	204	192
Cable	138	244	212	341	91	446	503
Private Switching	33	33	40	44	55	64	69
Voice Terminals	34	54	94	150	205	281	307
Radiocommunications	1	43	31	319	356	175	373
Data Terminals	6	44	44	50	61	62	74
<b>Total</b>	<b>448</b>	<b>786</b>	<b>1085</b>	<b>1894</b>	<b>1706</b>	<b>1626</b>	<b>2062</b>

Source: Caniece

e/ estimate

**TABLE III.3.2**  
**TELECOMMUNICATIONS IMPORTS (millions of dollars)**

	1985	1986	1987	1988	1991/e	1992/e
Telephone Systems	5.2	12.9	9.7	28.3	46.9	60.9
Transmission Systems (Radio & TV.)	37.8	70.5	22.2	44.3	73.4	95.4
Data Transmission Equipment	1.5	1.0	3.6	5.7	9.5	12.3
<b>Total</b>	<b>44.5</b>	<b>84.4</b>	<b>35.5</b>	<b>78.3</b>	<b>129.8</b>	<b>168.6</b>

Source: Carrieco e/ estimated

In the area of telecommunications R&D there are universities and research centers that work in several fields like design and manufacturing of integrated circuits, telecommunications software, network design and rural communications.

The following R&D institutions are the most important in the country:

- **IMC, SCT**  
 Instituto Mexicano de Comunicaciones,  
 Secretaría de Comunicaciones y Transportes,  
 México, City
- **CICESE, Research Center**  
 Centro de Investigación Científica y de Educación Superior de  
 Ensenada,  
 Ensenada, Baja California
- **CINVESTAV, Electrical Engineering Department**  
 Centro de Investigación y Estudios Avanzados del Instituto Politécnico  
 Nacional  
 México, City
- **DEPFI, UNAM**  
 División de Estudios de Posgrado de la Facultad de Ingeniería de la  
 Universidad Autónoma de México  
 México, City
- **ITESM**  
 Instituto Tecnológico y de Estudios Superiores de Monterrey,  
 Monterrey, Nuevo León.

It is important to mention the impact that IMC has had in advancing telecommunications R&D in Mexico in recent years. This effort has involved

the promotion of joint activities with the participation of R&D institutions along with public & private enterprises.

IMC has been able to establish links of several R&D centers to develop projects like planning of the second generation of Mexican satellites, the SOLIDARIDAD systems, national manufacturing of micro-satellites, videotext systems, satellite networks and others.

IMC is in the process to establish a Project Development Unit with support of the United Nations Development Program (UNDP), to link telecommunications industries with government agencies and R&D centers in the country. The new unit will provide information on the current situation of the national market and technological niches with potentiality to enhance national participation in the development and production of telecommunications equipment and software.

### **III.4 A SUMMARY OF THE STATUS OF TELECOMMUNICATIONS EQUIPMENT MANUFACTURING IN ARGENTINA, BRAZIL AND MEXICO.**

As it was mentioned before, the telecommunications markets of these three countries are very promising and dynamic showing different conditions of privatization and liberalization. Due to the fact that the most important telecommunications companies are of multinational nature, R&D activities are mostly concentrated in the main laboratories of such companies although software development and modifications and adaptations to local needs are performed locally. Medium size national telecommunications manufacturers face a challenging and difficult condition to subsist if proper schemes for governmental support or new and creative niches are found to increase their efficiency and productivity.

Table III.4.1 summarizes the status of telecommunications manufacturing in Argentina, Brazil and Mexico.

**TABLE III.4.1  
THE CURRENT STATUS OF TELECOMMUNICATIONS MANUFACTURING**

Country	Status of liberalization	Presence of major multinational telecommunications companies	Condition of medium sized national telecommunication manufacturing companies
Argentina	Completed	Important presence, major alliances with local industrial groups	Endangered, policies to stimulate production and increase competitiveness are necessary
Brazil	In Evaluation	Presence growing in importance, increasing technology imports	Facing challenge of market access with export possibilities to Latin America and other industrialized countries
Mexico	Almost completed	Important presence with major export plans when NAFTA is in operation	Practically disappeared, incubators and other schemes in process to be established

### **III.5 TELECOMMUNICATIONS EQUIPMENT MANUFACTURING IN COLOMBIA**

The development of the telecommunication's equipment industry in Colombia is very recent, most of the industry has been created in the last fifteen years. The production of equipment in this industry can be classified in four groups:

#### ***POWER EQUIPMENT***

This includes the development of power supply systems for telecommunications equipment using some local manufactured components (racks, printed circuits and transformers) and importing almost all of the integrated circuit components (transistor, integrated circuits and switches). It is worth noting that, although the quality of the local manufactured components is acceptable, its high price reduces competitiveness in this industry.

#### ***TELEPHONE SYSTEMS***

Manufacturing of these systems is limited to public telephones (free and coin operated) and desk-top telephones (dial-up and touch-tone), meanwhile cellular phones are not manufactured in the country and there are no projects to develop them. Manufacturing of public card-operated telephones is an area where some projects have emerged. These projects however may have limited success due to the little or null participation of operators in the product development. The recent publication of the "Science and Technology Laws" could help to overcome this deficiency, allowing the creation of contracts or joint ventures between operating companies and private manufacturers. As in the case of other products, complex or large scale integrated elements are imported, while printed circuits are nationally manufactured. It is worth noting that these printed circuits have international-level quality and are exported to countries such as the United States.

#### ***SWITCHING SYSTEMS***

This group includes public switching systems of high, medium and low capacity, as well as private switching systems. Although there are serious obstacles for local development of switching systems, the local manufacturers, Microtel Electronica and Teleconsulta, S.A. Have developed low capacity public digital switching systems for less than 1000 users. There are some good opportunities for local development of small rural systems. In this area there has been some cooperation between countries of Latin America. For example, Microtel Colombia teamed up with Microtel Venezuela to design rural switching systems, acquiring the software from international sources

or in some cases developing it locally. In a broader context, cooperation with multinational companies is very limited as they tend to look at such product developments as competing with their own products.

### ***OTHER TELECOMMUNICATIONS SYSTEMS***

There is local manufacturing of a wide range of components such as elements for modernization of central switching systems, signaling equipment, automatic dialing equipment and unattended repeaters; also high technology equipment such as monochannels and hexachannels for rural telephony. Other communications systems like facsimiles are not locally manufactured, and there are no plans to develop them.

Given that at this moment there is no industrial policy available that promotes industrial development, there is an alternative of undertaking joint ventures for equipment manufacturing. However, the scenario for such projects faces serious obstacles that sometimes are insurmountable. One of such obstacles is the fact that companies with technological knowledge do not want to take the risk of allowing other companies to share this knowledge. Other obstacles are the low degree of participation of network operators in product development and little support from governmental agencies and technology management institutions. In the area of technology management and development, the Center for Telecommunications (CINTEL) plays a major role. Founded in 1993, CINTEL aims to promote the design, research and development of processes and products. CINTEL is also a non-for-profit organization that undertakes a wide range of technology innovation and management activities for the telecommunications industry.

It is necessary to mention that a discussion about the perspective of the telecommunications industry in Colombia should be made in a broader sense, defining the role that it could play to position Colombia favorably in the world market. In this aspect CINTEL plays a very relevant role, being committed to identify "niche markets" of feasible local development; if this is not achieved, the manufacturing effort would be reduced only to absorption and adaptation of technology focused to improve the efficiency and quality of service procurement.

CINTEL's strategies include projects to promote joint participation of service providers, equipment manufacturers and universities. Likewise, CINTEL, in cooperation with Red Caldas (Colombians residing in foreign countries), is designing an "International Network for Technical Cooperation" that looks for the identification of financial, professional, research & development, and scientific cooperation entities in different countries, as well as making the pertinent contacts.

Following is a list with the names of CINTEL's partners, updated to June 1993.

- 1.- CARVAJAL, S.A. - División de Electrónica
- 2.- CEAT GENERAL
- 3.- COLOMBIANA DE LUMINARIAS Y COMUNICACIONES "CELSA S.A."
- 4.- ENERGIA INTEGRAL ANDINA, E.M.A., S.A.
- 5.- ELECTRA ELECTRONICA AVANZADA
- 6.- FACOMEC, S.A.
- 7.- FADETEL, LTDA.
- 8.- INDUSTRIA DE TELECOMUNICACIONES, S.A. "INTELSA, S.A."
- 9.- MICROTTEL ELECTRONICA, S.A., E.M.A.
- 10.- REPRESENTACIONES E IMPORTACIONES ELECTRONICAS LTDA "RIMEL LTDA".
- 11.- INGENIERIA Y SERVICIO ESPECIALIZADO DE COMUNICACIONES, "ISEC, S.A."
- 12.- TELCONSULTA LTDA.
- 13.- URIBE Y GARCIA INGENIERIA LTDA "U y G"

### III.6 TELECOMMUNICATIONS EQUIPMENT MANUFACTURING IN COSTA RICA

The Telecommunications Services Sector in Costa Rica is characterized for being mono-institutional. The Costa Rican Institute for Electricity (ICE) is the telecommunications provider and also responsible for electrical energy supply in the whole country.

The following figures illustrate the supply and demand of this sector:

Capacity in Operation # lines	Installed Capacity # lines	Unsatisfied Demand # lines
309,025	378,525	(90,843 urs 309,025) Real: 21,343

Digital lines: 135,345                      Analog lines: 243,180

International traffic: 36 million minutes annually

Employees : 3250

After the incorporation of the first 83 thousand digital lines, 243 thousand users of the old analog central remained without touch-tone dialing DTMF service. Under this situation, ICE issued the Public Licitacion No. 5212 which was granted to CIBERTEC, S.A. in 1985.

CIBERTEC, a local Costa Rican manufacturer has oriented its efforts to telecommunications equipment design with products accepted favorably at the international area. CIBERTEC has been awarded several national prizes.

As an example of CIBERTEC's achievements, it could be mentioned that international companies such as AT&T, MCI and Northern Telecom, among others, have accepted CIBERTEC's signaling conversion equipment, which competes in price, quality and design with companies from the U.S. and Europe. Another point worth noting is the fact that CIBERTEC has installed products in several countries not only in Latin America, but also in other countries such as Ukraine and Syria.

### **III.7 TELECOMMUNICATIONS EQUIPMENT MANUFACTURING IN PERU**

The Ministry of Transport, Communications, Housing and Construction (MTC) is the Peruvian entity responsible for legislating, controlling and enforcing the telecommunications law, as well as promoting the development of telecommunications. This development has been oriented towards the establishment of an Integrated Network of Services and Systems.

Among the entities providing communications services, the following are the most important:

\* Instituto Nacional de Investigación y Capacitación de Telecomunicaciones (INICTEL)

It is a public organization decentralized of the telecommunications subsector of MTC, responsible for promoting research, training and engineering studies in the telecommunications area.

\* Organismo de Inversión Privada en Telecomunicaciones (OSIPTEL)

It is an autonomous organization which has as its major responsibility the supervision of free and loyal trade operations in the telecommunications sector, informing investors about regulations currently existing in the country by means of the Fund for Investment in Telecommunications (FITEL), OSIPTEL will carry out the "Plans for Expansion of Rural Communications".

\* Empresa Nacional de Telecomunicaciones del Peru, S.A. (ENTEL PERU, S.A.)

ENTEL is a 100% public company whose major function is to provide telecommunications services through a microwave network, as well as by satellite and radio links in Peru. This company has undertaken a project

called: National Plan for Rural Communications" which will help with the integration of the country.

\* Compañía Peruana de Teléfonos, S.A. (CPT, S.A.)

CPT, is a private company that, like ENTEL PERU, provides telecommunications services. To date CPT continues modernizing its services, as well as optimizing technical and management administrative personnel.

The following table shows the scenario for supply and demand of telephone services in Peru. Such table clearly shows that the total index of telephone service offered by CPT and ENTEL is inferior to the demand, being also the lowest in America.

		YEARS		
		1992	1996	2000
ENTEL	CAPACITY	22,602	343,869	
	DEMAND	513,600	624,300	758,900
CPT	CAPACITY	381,734	698,264	
	DEMAND	702,893	878,250	
TOTAL (PERU)	CAPACITY	604,336	1'042,133	
	DEMAND	1'216,493	1'502,550	

It is also known that CPT and ENTEL will not be able to satisfy the existing demand on a short term basis, this is why an attractive choice would be to allow other companies to participate.

In 1987, by request of the Hispano American Association of Research Centers and Companies for Telecommunications (AHCJET), INICTEL carried out a poll to survey the companies of the telecommunications sector in Peru, recording 17 companies in the city of Lima. Currently, due to difficult conditions, the whole majority of such companies has not been able to subsist or to adapt to new economic conditions. Among the recorded companies, VALTRON and INTELE, S.R.L. are considered the most significant manufacturing entities.

The small number of manufacturing companies of telecommunications equipment in Peru has limited INICTEL and ENTEL PERU to participate in technology transfer projects. However, INICTEL, through its Administration of Research and Technology, has undertaken at least 10 projects in the area of technological development as well as in applied research. It is expected that the result of such work should be later transferred to the industry for eventual marketing.

In the area of certification and testing of telecommunications equipment INICTEL has gained some experiences through its Administration of Research and Technology with a Department for Homologation, Normalization, Testing and Certification. Currently officers of INICTEL



perform negotiations with MTC to assume national responsibilities for homologation, normalization and certification of telecommunications equipment.

In the area of technical cooperation, the following could be of interest for cooperation between different countries:

- Homologation, normalization and certification of telecommunications equipment.
- Telephone systems: ANTARA switch

### **III.8 TELECOMMUNICATIONS EQUIPMENT MANUFACTURING IN CUBA**

Telecommunications activities in Cuba are totally ruled by the Ministry of Communications (MINCOM) which has several administrations in charge of formulating policies and regulations in their respective areas.

Currently there are neither plans for restructuring the general activity of MINCOM nor for privatization in a short or medium term. However, the Law Decree 50 of 1983 authorizes the creation of "Mixed Associations" in the country, with participation of up to 49% foreign capital and 51% national capital. Obviously, any creation of companies or associations implies a previous study, analysis and approval from MINCOM.

As examples of companies with different levels of foreign participation we have:

#### **INTERTEL**

Operation of International Communications

#### **CUBACEL**

Operation of Cellular Telephone Services

#### **COTEINSA**

Marketing of Communications Equipment

In respect to telecommunications equipment manufacturing with national participation, we have:

- Instituto de Investigación y Desarrollo de las Telecomunicaciones
- Unidad Técnica para el Desarrollo
- Empresa Industrial de Comunicaciones
- Fábrica de Componentes Electrónicos
- Fábrica de Cables
- Empresa de la Industria Electrónica
- COPEXTEL
- Fábrica de Circuitos Impresos

There are no concrete figures concerning the level of response to the demand in telecommunications services, but it is known that this level is low, being this a reason why the acceptance of requests has been limited. Keeping in mind that this demand could not be satisfied with the mere import of equipment and systems, the Cuban policy in this way intends to create its own technological developments that not only substitute imports, but also contribute to collaboration and integration of the countries from Latin America and the Caribbean.

There are several areas of research and development that MINCOM is currently developing which are related to manufacturing possibilities in existing facilities. The MINCOM also has an Institute for Research and Development in Telecommunications which has professional and highly qualified personnel that is dedicated to research activities focused on enhancing the quality, reliability and efficiency of telecommunications services. This Institute has received important prizes from AHCJET.

The MINCOM promotes research and application of locally developed technologies with the goal of utilizing the existing capacities of the local industry and with participation of other countries from the region. For such participation there is availability of skilled human resources: over 1700 graduates specialized in all areas of communications.

In general, the country has industrial capacity to develop joint projects with other Latin American countries in the manufacturing area, equipment certification and telecommunications software development. The financial aspect is the first and more important obstacle for telecommunications equipment manufacturing.

#### **IV. PROPOSED SCHEME TO STIMULATE LOCAL MANUFACTURING OF TELECOMMUNICATION EQUIPMENT IN LATIN AMERICA AND THE CARIBBEAN**

In spite of the dynamic telecommunications scenario in Latin America and the presence of multinational companies in the region, the manufacturing infrastructure is insufficient. It is necessary to create programs to strengthen the current manufacturing activities taking into account the following basic elements:

- Research & Development, Human Resources & Manufacturing Strategies
- Certification & Test procedures Compliance with international (open) standards
- Regional cooperation programs to strengthen telecommunications manufacturing.

In regards to Research & Development, it is necessary to carry on a diagnosis of those public and private telecommunications research centers, laboratories and universities focusing on telecommunications. This diagnosis will provide strategies and lines of action to:

- Create new entities of R&D
- Strengthen those R&D entities with current programs in telecommunications
- Define plans and recommend actions to establish links between industries and research centers working in telecommunications.

The fact that there is an insufficient industrial base in Latin America is related to lack of experience in certification and test procedures. It is important to encourage participation of Latin American industries, research centers, governmental agencies and individuals in international committees working in standards.

Some of the countries in the area have programs and agencies to homologate high technology equipment but their regulations and normativity are fixed according to foreign patterns and normally are not adapted to the fast international technological pace that the industry requires.

The rapidity and explosive growth in the use of telecommunications technology in Latin America - particularly after the liberalization processes - have created the need of managing the electromagnetic spectrum in a more adequate and efficient manner. It is important then to develop comprehensive and well structured spectrum management policies to cope with the dramatic use of wireless telecommunications systems. The lack of proper spectrum management facilities would limit the use of new communications technologies that have potential for applications in corporate and social interest environments.

Regional cooperation could play an important role in strengthening telecommunications manufacturing in Latin America. Recommendations to stimulate regional cooperation in the area are the following:

*To create a data base or directory of those Latin American manufacturers of telecommunications equipment and distribute it among the manufactures themselves as well as in other private and public agencies, telecommunications carriers and service providers to create possibilities of mutual exchange.*

*To explore the possibilities through the Industry Associations, universities and industries to strengthen or create programs for human*

*resources generation to support regional manufacturing in Latin-America.*

*Look for special niches that can be considered for participation of the Latin American industry.*

*Identify the forté of the manufacturing industries to take advantage of their capabilities in the region.*

*Issue a series of recommendations to support medium or small scale manufacturing companies so they can coexist and subsist in a very demanding and competitive area. Stimulate and create new schemes of support for micro and small size high technology companies according to their own regulatory and industrial environment.*

These recommendations have to be analyzed and discussed to define in a short term an action plan of regional range with priorities to allocate the financial resources required to implement the strategies delineated in such plan.

## **V. CONCLUSIONS**

The trend of liberalization of telecommunications services in the Latin American countries has created a deficit balance of trade due to considerable increase of imports and decrease of local development and production of telecommunications equipment.

The lack of competitive and aggressive local telecommunications manufacturing infrastructures, whether national or multinational, has the danger to turn a complete region into technology users or technology absorbers. The Latin American countries cannot afford in medium or long term to stop developing telecommunications technology and offer only the economic incentive of cheap labor to create assembly or maquiladora kind of operations.

*Latin America cannot base its development platform on raw products export only.*

*There is a great need to establish creative human resources programs focused on new information technologies. Although Latin American engineers and scientists have excellent capacity and great potential for technology production, comprehensive and practical school-industry programs are also necessary to take advantages of the opportunities of the market.*

*There is also a need to identify niches with possibilities to obtain a high degree of competitiveness and allocate adequate financial resources into well planned projects.*

*Initiatives like NAFTA and MERCOSUR bring important opportunities for Latin American manufacturers to position themselves as exporters of telecommunications equipment. If adequate policies and programs are not established, the benefits of open markets will only be for a few countries and in the long term the dependency created on high technology products will be detrimental to encourage sustainable development of telecommunications manufacturing in the area.*

*Software development has been seen as an area of great potential to participate in telecommunications manufacturing. Countries like India and Israel have created programs to stimulate this fundamental aspect of the new information technology disciplines.*

*New schemes of operation besides maquiladora and incubators are necessary to create and stimulate small and medium size national telecommunications companies. Although maquiladora operations in Brazil and Mexico are fundamental elements for the export of manufactured or assembled technology products, cheap labor can not be or continue to be the only attractive to establish manufacturing facilities.*

Incubator or technology parks have to be restructured and adapted to the conditions of the region with market oriented programs and adequate and timely financial support required in high technology areas like telecommunications.

The technology gap is overwhelming and grows at a very rapid pace, however, crisis and opportunities are always together. Telecommunications technology plays an important role to improve the quality of life of human kind. To participate in cooperative regional programs in the processes of "Know How" and "Know Why" related to telecommunications design and manufacturing will contribute to Latin American integration preparing the area to face the challenge of creating a fair and more stable society.

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