



# INTERNATIONAL TELECOMMUNICATION UNION TELECOMMUNICATION DEVELOPMENT BUREAU

**WORLD TELECOMMUNICATION DEVELOPMENT  
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**PLENARY MEETING**

## **Brazil**

### **BRAZILIAN EXPERIENCES IN TELECOMMUNICATION R&D**

#### **Introduction**

This paper presents some of CPqD's noteworthy accomplishments like the TRÓPICO R and RA digital switches, a debit-card pay phone system, operations support software, optical communications devices, mainly, the fibre optics, and antennas for satellite communications. CPqD (Centro de Pesquisa e Desenvolvimento) is currently the entity in charge of the technological research activities for the TELEBRÁS System (STB), a conglomerate of State-owned regional telephone companies in Brazil. At present, CPqD applies its resources in the areas of digital switching, operations support, telecom network and service development, and more.

It also aims to open spaces for proposals of technological cooperation among developing countries that looks to speed up their economical and social development fostered by universal and good-quality telecommunication services. In this sense the use of innovative solutions can strongly contribute to this objective and, certainly, all have important experiences to share among themselves.

The ongoing changes telecommunication markets are pushing to evidence the debate on the new R&D model to this segment in many countries, also in Brazil. This polarization is due to the economy's liberalization, reduction in import tariffs, growing competition at home and mainly the forthcoming privatization of the telephone operating companies. This model is in the process of being defined by the Federal Government, considering mainly the ways of funding CPqD and its new role as the main R&D telecommunication centre in Brazil. Its agenda takes into account the schedule for the privatization of the TELEBRÁS System, dated to July 1998.

#### **Digital switches for the tropics**

Being the heart of a telecommunications system, the telephony exchanges are its more complex parts. TELEBRÁS' decision to develop switching systems aimed to dominate their technology, not only to have an indigenous technological alternative, but also to enable itself to acquire other types of switch with best acquaintance. CPqD then developed two versions of TRÓPICO switch:

TRÓPICO R and TRÓPICO RA. The project was called TRÓPICO because the switch was designed to withstand the sweltering conditions of a tropical country, such as 80 per cent humidity and temperatures up to 40°C without special air conditioning.

TRÓPICO R is a time-division digital switch under stored-program control (SPC) meant for rural areas and small urban communities with low traffic. Its small capacity means at most 4 000 subscribers and 320 Erlangs. A distinctive feature is the switch's high reliability, which it owes to a fully distributed and decentralized control network of up to 64 microprocessors. In fact, it is a multi-fault-tolerant switch, because, in the presence of several faults, it degrades gracefully. For the sake of simplicity, its program is stored in EPROM and the customer's database alone is chargeable into RAM, giving it high reliability. Functionally it comprises three modules, for switching, for handling trunk and subscriber lines, and for operation and management. Such a compact, standardized and modular structure allows orderly growth, ease maintenance, and sharp reduction of spare part inventories.

Field-tested in 1984, TRÓPICO R has been in production since 1986. By 1988, switches for more than 380 000 phone lines had been ordered by phone operating companies. Now its capacity is upgraded by manufacturers up to 10 000 terminals, and its technological evolution is assured by the competition with other technologies, including the imported ones.

Even before the development of the TRÓPICO R switch, CPqD had plans for a high-capacity version, since there was obvious demand for more subscriber lines and new features. But when the opportunity arose in the mid-1980s, local industry was unable to rise to this occasion. So CPqD tackled the development of the larger version of the switch, called TRÓPICO RA, with a total capacity of 12 000 Erlangs and 100 000 subscriber lines and completed the first prototype in 1987.

TRÓPICO RA is also a digital switch with stored-program control, used as a multi-application platform for local and long-distance telephone exchanges. Other services, beyond telephony, are continuously being tackled. Among them are Integrated Services Digital Network (ISDN) accesses, and signalling transfer point for Signalling System No. 7 - a world standard.

Comparable in quality to leading digital switches in the world, TRÓPICO RA distributes its stored-program control functions in a network of up to 1 024, all of which execute functions on the same complexity level. This also applies to TRÓPICO R, but with up to 64 processors. In contrast, other switch types usually have terminal processors for less complex functions, such as call recognition. Standard hardware and software interfaces allow the manufacturers to modify the system to track the fast evolution of technology and chargeable programs and data give flexibility to the addition of new features (TRÓPICO R is EPROM program resident).

Redundancy of essential functions is built in, so that the system can degrade gracefully in case of failures, which provides high reliability to the switch. Also, most TRÓPICO RA functions are performed by software. Hardware and installation procedures are therefore simpler than usual and the inventory of parts is smaller. In a final analysis, even though software writing and programming are labour intensive and relatively costly activities, TRÓPICO RA's price is lower than other equivalent switches in which many functions are made by hardware.

Because of large orders of TRÓPICO switches, their average price per subscriber line has fallen to \$US 200. Average prices mean prices at home, competing with other switches of small or high capacities. On the other hand, "large orders" mean 2 400 000 terminals for TRÓPICO RA contracted until January 1998, being 2 224 508 already installed. Summing up, with over 1 200 000 terminals of TRÓPICO R, TRÓPICO technology is close to 50 per cent of the Brazilian digital network, and 35 per cent of these are TRÓPICO RA.

### **Low-cost pay-phone inductive card**

The availability of affordable, easy-to-use, yet robust to fraud debit cards encouraged the spread of reliable public pay phones across Brazil, especially to answer a strong social demand by telephone-less people in urban areas and scattered populations in rural ones. This need led CPqD to develop an inductive-type telephone card. It is made of an array of conductor loop (secondary circuits), covered by a soft plastic material, each of which corresponds to a credit unit of \$US 0.06. The current induced in them destroys these loops. This current is generated in a primary circuit of the pay phone's static card reader. The longer the call, the more of these secondary circuits are destroyed. The complete system includes the pay phone itself, the inductive card and the Centralized Automatic Supervision (CAS).

Because the inductive card is less expensive to produce than the typical magnetic-strip card, it costs only about a third as much to produce. Moreover, advertising on both sides of the card should add to revenue and lower its cost even further. As for the pay phone, it is about 30 per cent of the cost of the typical magnetic-card pay phone, and 50 per cent of the cost of a typical token-based pay phone. The lack of moving parts accounts for the price differential.

This novel technology was launched to the public in June 1992, in Rio de Janeiro, during the Earth Summit (Rio '92), and it was well received by the public. About 320 000 pay phone sets are already in operation in Brazil. Four manufacturers for the inductive cards produce 40 million of them every month. By December 1997, more than one billion cards had been acquired by phone companies in Brazil. Meanwhile CPqD is working on a second generation of cards, introducing new services and features in the pay phone, and the possibility of use memory cards and credit cards as well.

### **Antennas**

One of the oldest and consolidated areas in CPqD, with a significant mass of accumulated knowledge and technology transferred to the local manufacturers, is of antennas, mainly to satellite communications. The boom of this communication means in Brazil took place from the beginning of the '80s, with the transmission and reception of TV signals, data for corporate systems, and with data and telephony services in remote areas. As an immediate consequence, this boom generated a big demand for earth station antennas, mostly provided with the CPqD-developed products. The CPqD's antenna development program made it possible for Brazilian technological independence in this area, due to, among other conditions, the low cost of the local manufacturing and the market boom. One of the most important results of this program directly applied to CPqD was the installation of an Antenna Laboratory for tests and development, equipped with the most modern technological resources, and operated by a well-trained team.

### **Optical communications**

In the optical communications area, CPqD has worked jointly with the University of Campinas (UNICAMP) since 1973. UNICAMP is one of the best universities in Brazil, sited in the neighbourhood of CPqD, which allows strong cooperation between their researchers. This cooperation led to the first optical-link development in Brazil - a 34 Mbit/s system using 850 nm multimode fibre and linking two exchanges in Rio de Janeiro. Deployed in 1982, this system was among the first of this kind in South America. Later in 1984, CPqD transferred this technology to a local manufacturer. Afterwards, in 1986, CPqD transferred to local manufacturers the technology of single-mode fibres.

Additional efforts were invested in the development of optical devices, and, in 1987, local manufacturers received technology to produce gallium-arsenide and indium-phosphide lasers and fotodetectors devices, as well. More recently, in 1994, optical amplifier equipment was successfully field tested, making it possible to increase optical link distances. Local manufacturers have been producing this equipment since 1995.

### **Operation support systems**

Among the changes in telecommunications that have been occurring worldwide in the last years, is the decision of the telephone companies to concentrate their R&D efforts on technologies directly applicable to the operation of their networks and to the management of their business. These changes affected the CPqD's R&D program, in 1990, to include the development of software for operations support (OS). Priorities were then given to automate plant management, number administration and equipment management systems.

Through the Outside Plant Automated Management System - SAGRE - operating companies are able to integrate information on the subscribe access lines in the phone network. Planning, design, and operation of the lines are all pulled together in a common database shared by networked workstations, in order to add more productivity, reliability and speed. Several modules are already installed in the operating companies, and already show positive impacts of reducing operation costs.

The Accommodations and Number Administration System - SADAN - automates the process of assigning phone numbers - which at present is done manually - and makes the assigning more agile and more secure. Number assignment depends only on traffic capacity and number terminal, but also on switching technology.

The Equipment Management System - SGE - provides more agile and efficient control of the inside plant management activities. Through reports and information available in the system, a manager can get a clear picture of what employees and vehicles are doing, and determine whether they are being used in the best manner. The software also includes equipment performance indicators to help the managers decide on the efficient manner of the expansion and modernization plans for the inside plant.

It is a great challenge to provide operating companies with a complete set of operations support systems when they involve developments of more than 50 million lines of codes. As a result, CPqD is using strategic partnerships with other companies for joint development of new operations support systems, as well as the acquisition and its adaptation to individual company needs.

### **Final considerations**

In the developing countries there are no economic conditions to provide telecommunication services to all levels of population, an indispensable factor to the economical and social development. This requires the use of modern technologies and a deep knowledge of the economical and social conditions in several regions of the country, with the purpose of reducing the costs and making feasible a policy of subsidies, if needed.

To the developing countries, as important as awareness of the technologies developed in the industrialized countries is, it is the cooperation with others in similar conditions aimed at saving resources and reducing time to search regionalized solutions. CPqD, in its twenty years of R&D works, often working jointly with many local manufacturers and laboratories of national universities, can contribute to the development of the telecommunication infrastructure of other countries using its accumulated experience. This contribution can be implemented as proposed in the paper entitled "Brazilian Experience in Human Resources Training - Training Centers".

It is also important to point out the support of ITU/UNDP cooperation, collaborating with the start of the CPqD activities and its consolidation as a modern and worldwide telecom R&D centre. This support is detailed in the paper entitled "A Cooperative Background of Projects Developed by Brazil with the Support of ITU and UNDP".

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