

*Coping with Globalisation*  
*An analysis of innovation capability in the Brazilian and  
Korean Telecommunications Equipment Industry*

**Dr Sunil Mani**  
**United Nations University-Institute for New Technologies**  
**Keizer Karelplein 19**  
**6211 TC Maastricht**  
**The Netherlands**

**E-mail: [Mani@intech.unu.edu](mailto:Mani@intech.unu.edu)**

# Outline

---

- Some conceptual issues
- The World Telecommunications Equipment Industry
- Brazil and Korea: cases for in depth examination
- Deregulation and liberalisation of the telecom distribution industry in Brazil and Korea
- The sectoral system of innovation
- Measuring changes in innovation capability
- Instruments of state support
- Summing up the present status of innovation capability

## Conceptual Issues

---

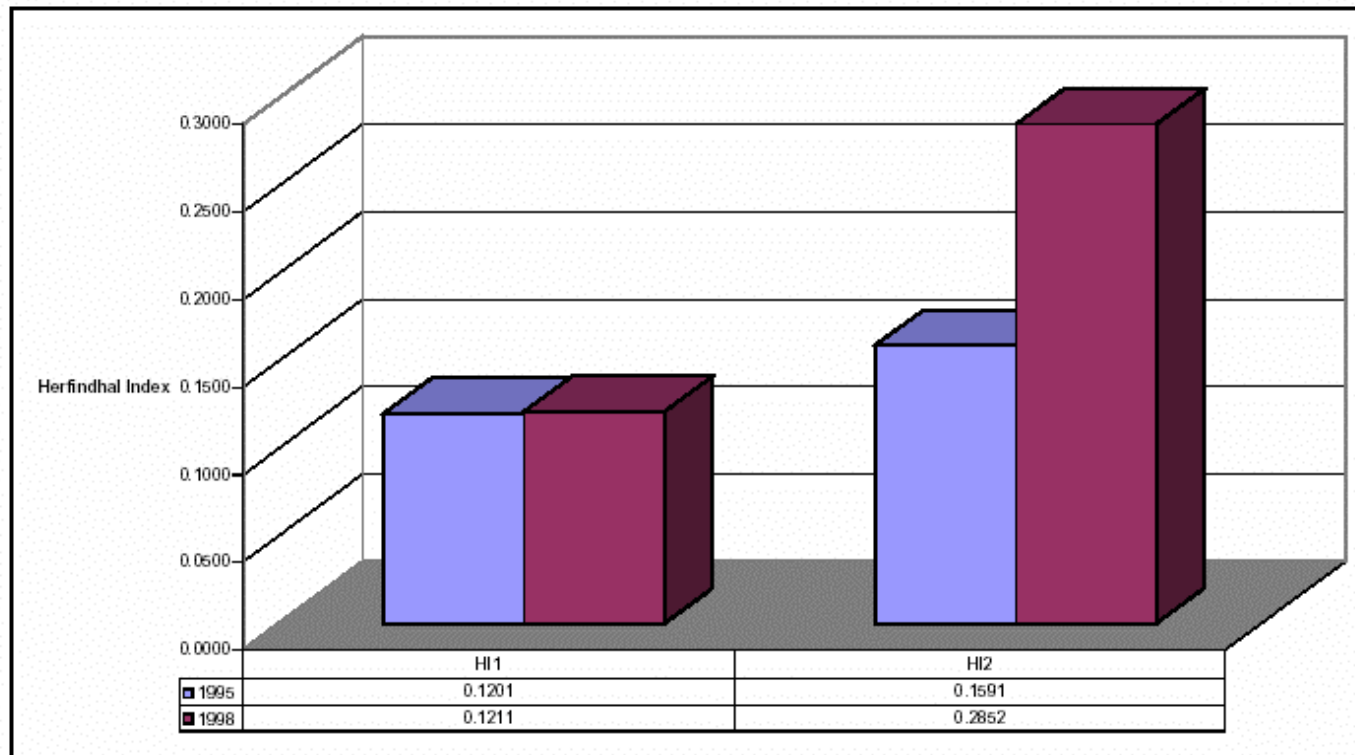
- **Globalisation:** *deregulation and liberalisation of telecom services (both fixed and mobile) and the opening up of telecom equipment manufacturing to foreign direct investments.*
- **Innovation capability:** *Ability to conceptualise, design, manufacture and sell state-of-the-art telecom equipments coupled with the ability to keep pace with changes in the world technology frontier*
- **Coping with globalisation:** *The efforts mounted by the innovation system to respond positively and benefit from the challenges posed by deregulation, privatisation and economic liberalisation.*

# The World Telecommunications Equipment Industry

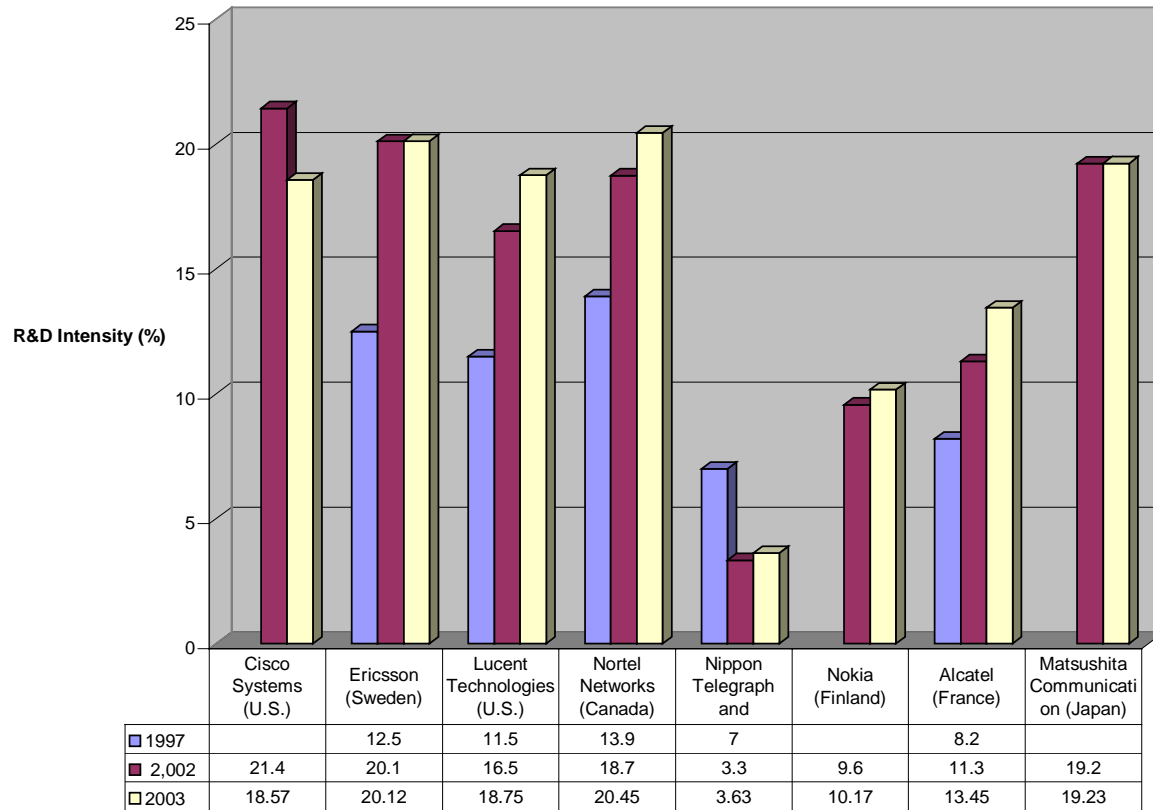
---

- The industry is becoming more oligopolistic
- The industry is becoming more innovative
- Hence more powerful

# The degree of concentration in the World Telecommunications Equipment Industry, 1985 and 1998



# R&D Intensity of Leading World Telecommunications Manufacturers



# Patenting performance of Leading World Telecommunications Manufacturers, 1995-2000

Name of company (country)	Technological Strength <sup>1</sup>		Number of patents <sup>2</sup>		Current impact index <sup>3</sup>		Science linkage <sup>4</sup>		Technological cycle time <sup>5</sup>
	2000	1995-99	2000	1995-99	2000	1995-99	2000	1995-99	2000
1. Lucent Technologies (U.S)	2485	1701	1445	881	1.72	1.93	1.31	1.78	5.4
2. Motorola (U.S)	2035	2148	1241	1193	1.64	1.80	0.63	0.76	9.4
3. Ericsson Telephone (Sweden)	1651	714	775	320	2.13	2.23	0.99	1.32	5.2
5. CISCO Systems (U.S)	911	123	133	25	6.85	4.94	1.15	0.90	5.8
7. Alcatel (France)	478	319	423	285	1.13	1.12	0.79	1.06	6.4
8. Qualcomm (U.S)	451	350	111	63	4.06	5.56	0.71	1.47	6.7
9. Cabletron systems (USA)	253	116	41	17	6.18	6.98	2.00	2.39	5.2
10. Ciena (U.S)	109	30	26	6	4.18	4.61	1.73	1.97	5.0
11. JDS Uniphase(U.S)	100	57	52	36	1.93	1.61	2.21	1.31	7.1
12. Qwest Communications International (U.S)	97	105	29	33	3.33	3.16	0.34	1.13	4.1

## The Brazil and Korean Cases

	<b>Brazil</b>	<b>Korea</b>
Population (Millions, 2001)	172.39	47.34
Per capita GDP (PPP Current International \$, 2001)	7360	15090
Number of fixed telephone lines (in Million, 2002)	39.1	28.64
Density of fixed telephone per 100 people (2002)	28.5	51.7
Number of mobile telephone lines (in million, 2002)	38.8	43.87
Density of telephones (2003, per 100 people)	21.95	1.53
Ratio of mobile to fixed lines (2003)	0.99	
Size of Telecommunications Services (2002, Millions of US \$)	20990	22663
Size of the telecommunications market (2002, Millions of US \$, Domestic sales in case of Brazil and domestic Production in case of Korea)	4395	26778

# Structure of the Fixed Telecommunications sector in Brazil: 2001

	<b>Service provider</b>	<b>Company/ (Main Shareholders)</b>	<b>Source of equipments used in the network</b>
<b>Region 1</b> Amazonas (AM), Roraima(RR), Maranhão(MA), Amapá(AP), Piauí (PI), Ceará (CE), Rio Grande do Norte (RN), Paraíba (PB), Pernambuco (PE), Alagoas (AL), Sergipe (SE), Bahia (BA), Minas Gerais (MG), Espírito Santo (ES) and Rio de Janeiro (RJ)	Local	TELEMAR (BNDESPar, Pension Funds, Andrade Gutierrez, Opportunity)	Ericsson, Siemens, Lucent, NEC and Tropicó
	Local (Mirror Concessionary)	VESPER (Qualcomm, VeloCom, Bell Canadá)	Lucent
	Local (Mirror image Concessionary)	CTBC Telecom	N/A
<b>Region 2</b> Acre (AC), Rondônia (RO), Mato Grosso (MT), Tocantins (TO), Distrito Federal (DF), Goiás (GO), Mato Grosso do Sul (MS), Paraná (PA), Santa Catarina (SC) and Rio Grande do Sul (RS)	Local	BRASIL TELECOM Incumbent (Solpart, Pension Funds, TIM, Timepart)	Ericsson, Siemens, Lucent, NEC and Tropicó
	Local (Mirror Concessionary)	GVT (Magnum Group IDB Group, Merrill Lynch Group)	Nortel
	Local (Mirror image Concessionary)	Other	N/A
<b>Region 3</b> Sao Paulo (SP)	Local	TELEFONICA (Telefonica de Espanha)	Ericsson, Siemens NEC, and Trópico
	Local (Mirror Concessionary)	VESPER (Qualcomm, VeloCom, Bell Canada)	Nortel
	Local	Other	Nortel / Lucent
<b>Region 4</b> Long Distance – National Coverage	LDI	EMBRATEL (WorldCom)	Ericsson, NEC, Lucent
	LDI ((Mirror Concessionary)	INTELIG (NGC, France Telecom, Sprint)	Alcatel, Cisco, HP and Nortel

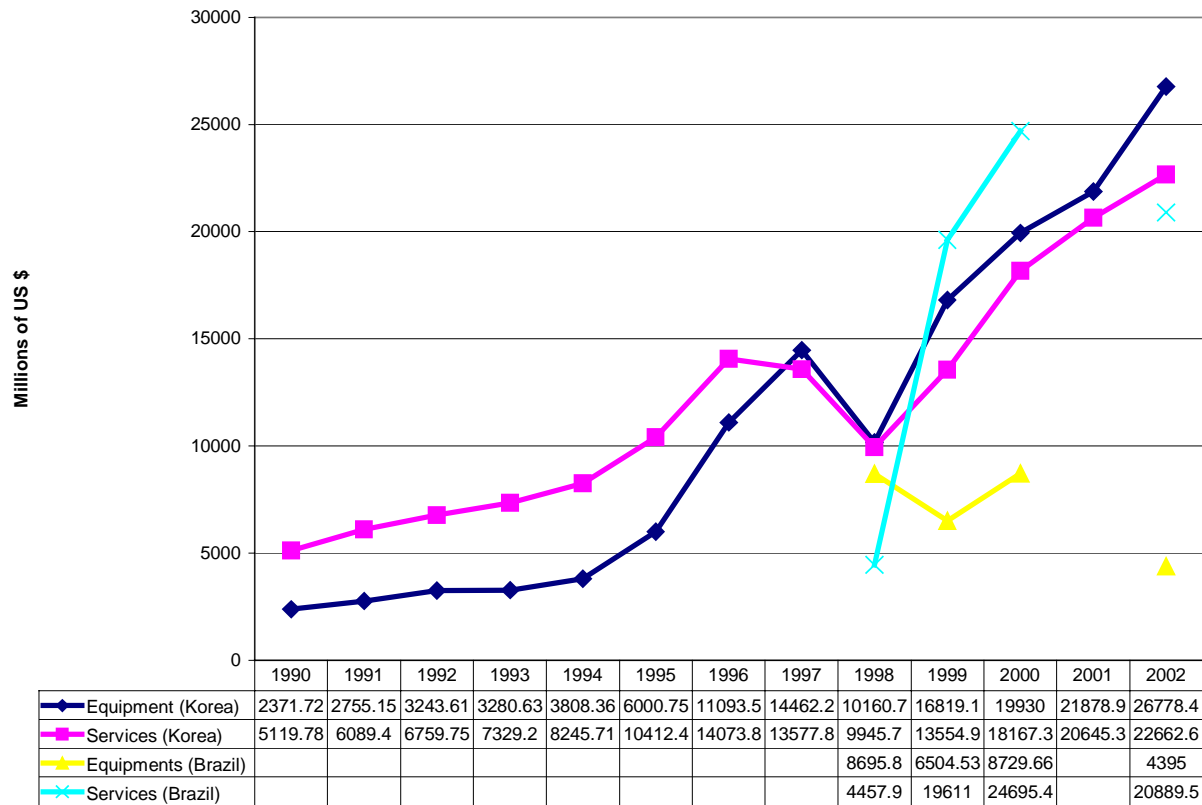
# Structure of the Telecommunications distribution sector in Korea: September 2002

Service	Service coverage	No of providers	Service provider	
<b>Local telephone</b> Value-added service	Nationwide	2	KT, Hanaro Telecom Dacom, Onse Telecom	
<b>Long-distance telephone</b> Value-added service	Nationwide	3		
<b>International telephone</b> Value-added service	Nationwide	1		
<b>International telephone</b> Value-added service	Nationwide	3		
			Hanaro Telecom	
			KT, Dacom, Onse Telecom Hanaro Telecom	
<b>Telecommunication circuit lease</b>	Domestic	7	KT, Dacom, G&G Networks, Dreamline, Hanaro Telecom, Thrunet, Space Broadband PowerComm	
	International			
	Domestic	1		
	Long distance international	3	SK Telecom, Hansol iGlobe, Onse Telecom	
	International	4	Dacom Crossing, Seoul International Telephone, Korea Level-3 Communications, Samsung Networks	
<b>Services provided over satellite teleports</b>	<b>Mobile telephone</b>	Nationwide	1	SK Telecom (18.44 million)
	<b>Personal communication service</b>	Nationwide	2	LG Telecom (11.29 million), KT Freetel (5.27 million)
	Global Mobile PCS by Satellite (GMPCS)	Nationwide	2	Dacom, Korea ORBComm
	Trunked radio system (TRS)	Regional	5	Seoul TRS (Metropolitan Area), KB Telecom (Busan, Gyeongnam), Dagu TRS (Daegu, Gyeongbuk), Power Tel TRS (Gangwon), Jeju TRS (Jeju)
	Wireless Data Communication	Nationwide	3	Air Media, In Tech Telecom, Hanse Telecom
	Radio Paging	Nationwide	1	InTech Telecom
		Regional Areas	4	Seoul Mobile Communications (Metropolitan Area), Eysel's Vision (Busan, Gyeongnam), Selim iTEch (Daegu, Gyeongbuk)
	Very high-speed wireless internet	Nationwide	1	Dacom
IMT-2000	Nationwide	3	KT iComm, SKIMT, LGTelecom	

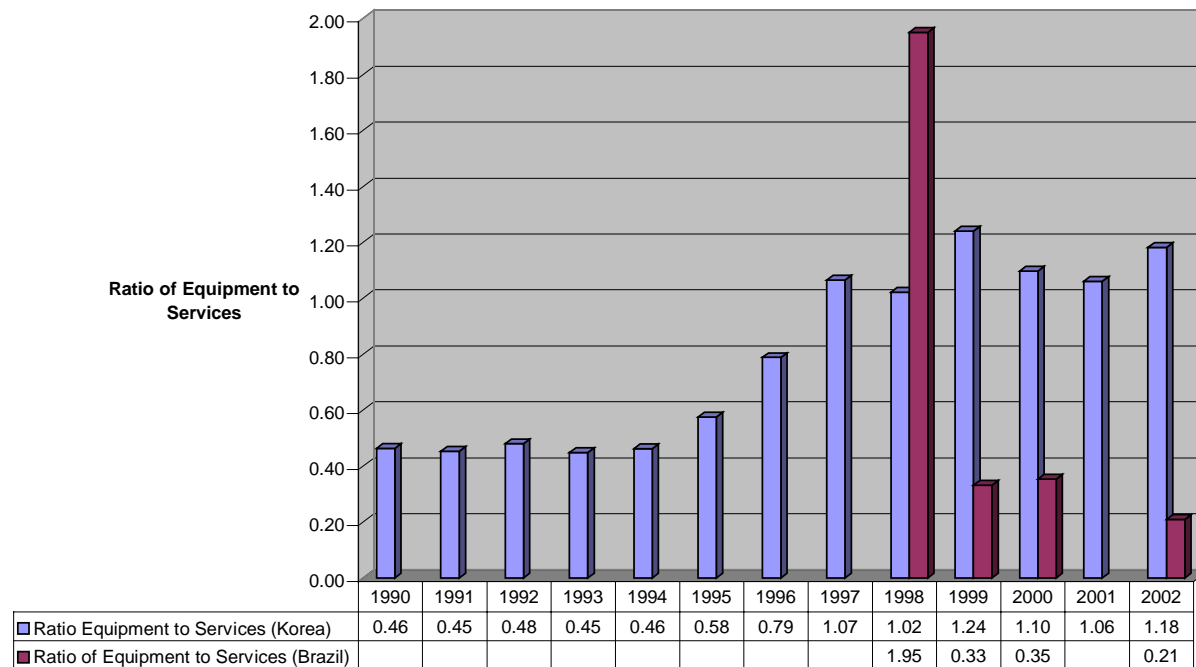
## Rate of Digitalisation of the Telecom Network: Brazil Vs Korea

	Brazil		Korea	
	Rate of digitilisation of the local network	Rate of digitilisation of mobile network	Rate of digitilisation of the local network	Rate of digitilisation of mobile network
1994	35.5		61.8	
1995	45.8		63.4	
1996	56.1		65.2	
1997	67.6		66.6	
1998	72.3	67.4	68.8	
1999	84.6		71.3	
2000	92.5		79.7	100
2001	97.2	75.9	82	100
2002	98.28	97.98		100

# Structural Changes in the Brazilian and Korean Telecommunications Industry- 1

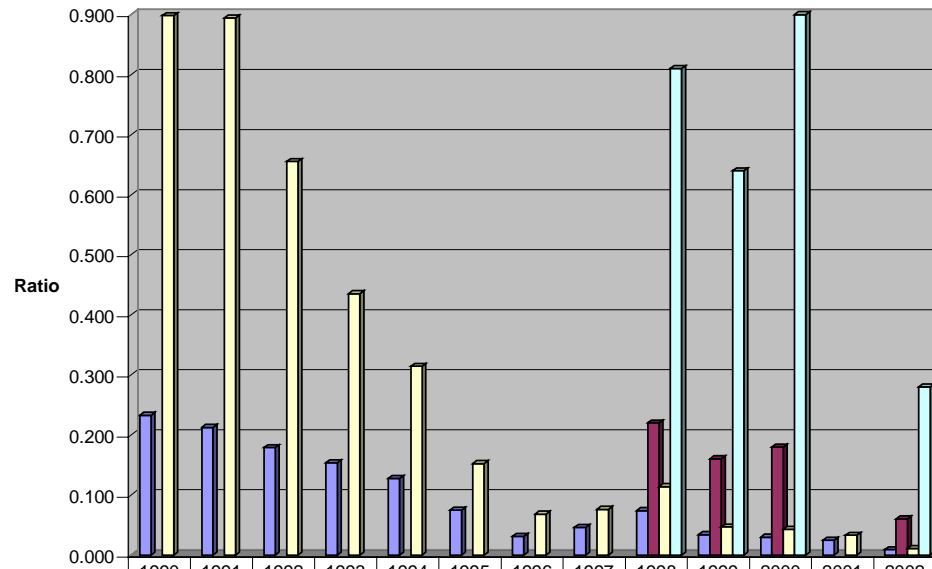


## Structural Changes in the Brazilian and Korean Telecommunications Industry- 2



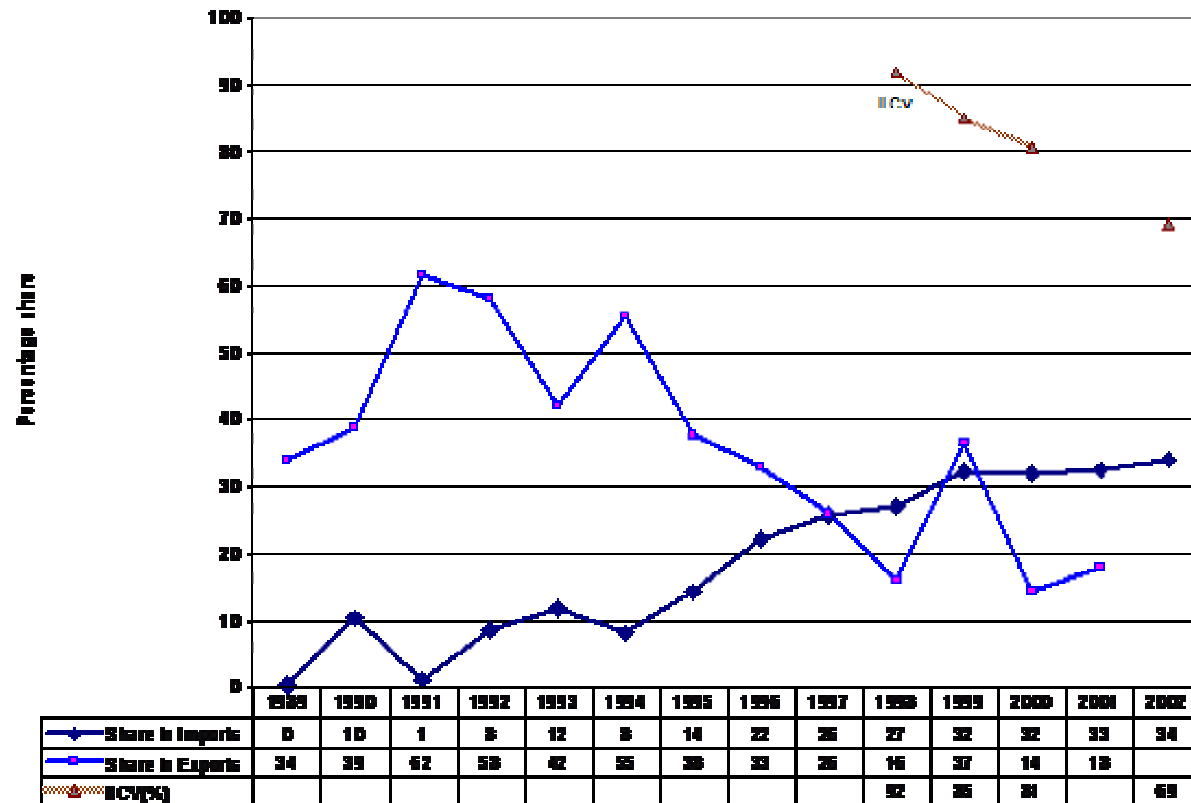
# Declining importance of public switching in Brazil and Korea

(Based on domestic output in value terms)



Ratio of public switching to total(Korea)	0.233	0.212	0.179	0.154	0.128	0.074	0.031	0.046	0.074	0.034	0.029	0.025	0.009
Ratio of public switching to total(Brazil)									0.220	0.160	0.180		0.060
Ratio of public switching to wireless(Korea)	0.898	0.894	0.655	0.435	0.314	0.152	0.068	0.076	0.114	0.047	0.043	0.033	0.011
Ratio of public switching to wireless (Brazil)									0.810	0.640	0.900		0.280

# Index of Innovation Capability in Switching Equipments (Brazil), 1989-2002

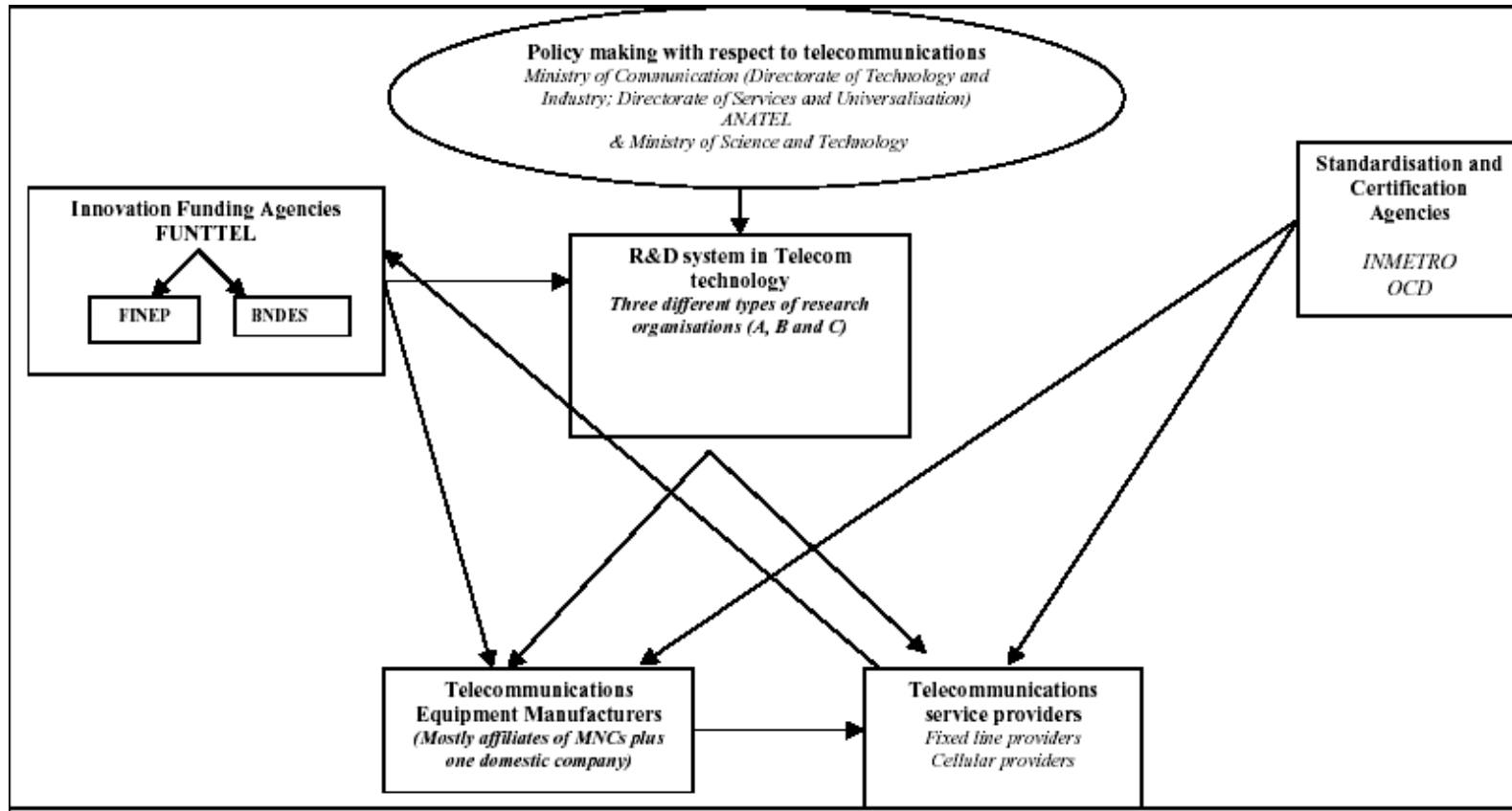


# Share of Domestically Developed Switching Technology in the Total Brazilian Telecommunications Network, (Cumulative 1987-1997 in per cent)

---

<b>Telebras Company</b>	<b>Domestic Technology (Tropico)</b>	<b>Other Technologies</b>
1. Telenorte	35.95	
2. Telecentro	34.62	
3. Telesp	24.25	
Total Telebras System	32.03	Simens (Equitel)- 22; Eicsson- 17; NEC- 17; Zetax and Batik* - 5; Others- 5

# The Present (c2003) Innovation System of the Brazilian Telecommunications Industry

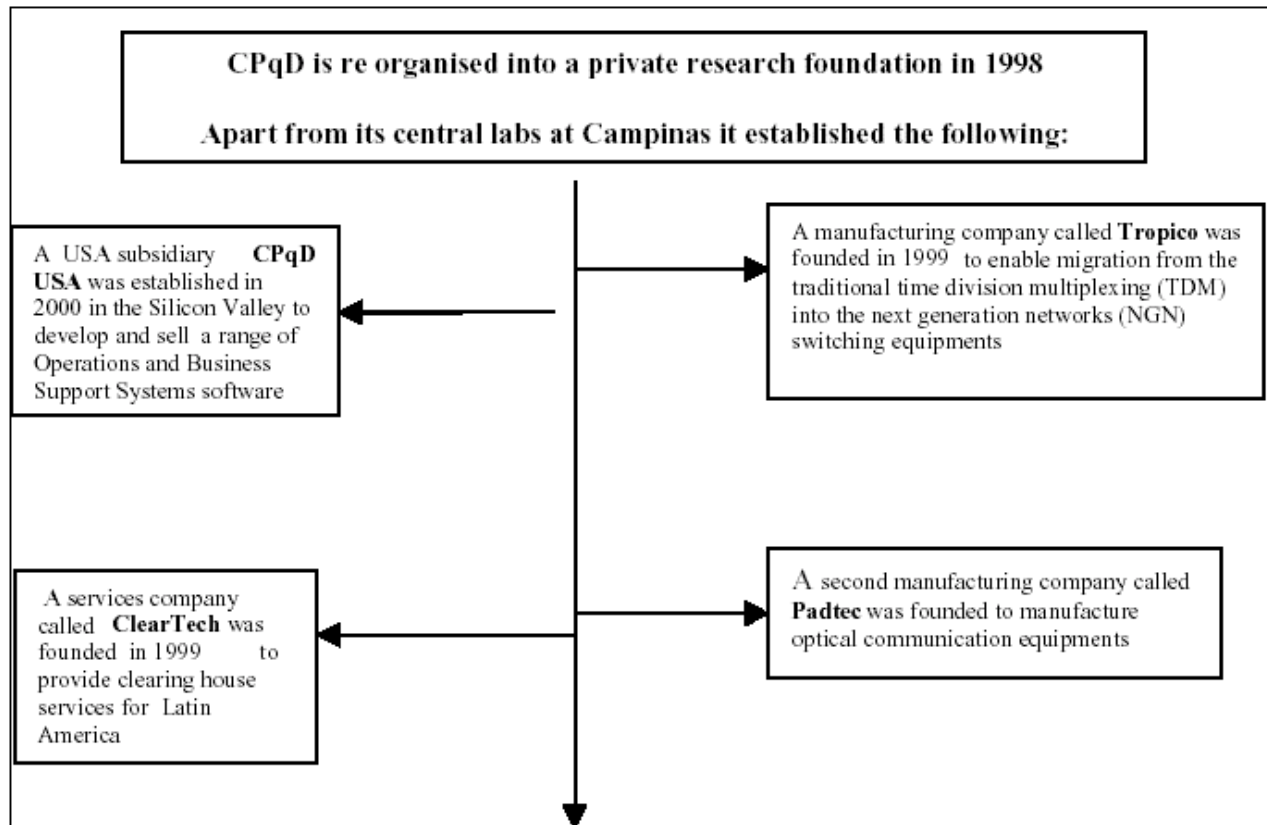


## CPqD's (Brazil) Strategy: Before and After Privatisation

---

Before privatisation (1976-1997)	After privatisation (1998-2003)
<ul style="list-style-type: none"><li>• <b>Budget:</b> assured research grants from Telebras;</li><li>• <b>R&amp;D strategy:</b> technology development for hardware (Tropico Family of digital switching systems, optical fiber for Transmission, terminal equipment such as payphones Telephone cards)</li><li>• <b>Marketing strategy:</b> transfer of technology to Brazilian private sector enterprises at nil rates of interest.</li></ul>	<ul style="list-style-type: none"><li>• <b>Budget:</b> Up to middle of 2001 largely based on self generation. From middle of 2001, 30 per cent from FUNTTEL research grants and 70 per cent through self generation.</li><li>• <b>R&amp;D strategy:</b> Generation of both software and hardware technologies for NGN, Business and Operation Support System and optical communication technology.</li><li>• <b>Marketing strategy:</b> Establishing four companies and through strategic partnerships between these companies and clients. CPqD also makes a direct commercialisation of its systems and technologies.</li></ul>

## New Company Formation by CPqD (Brazil)



## Changes in the professional workforce of CPqD

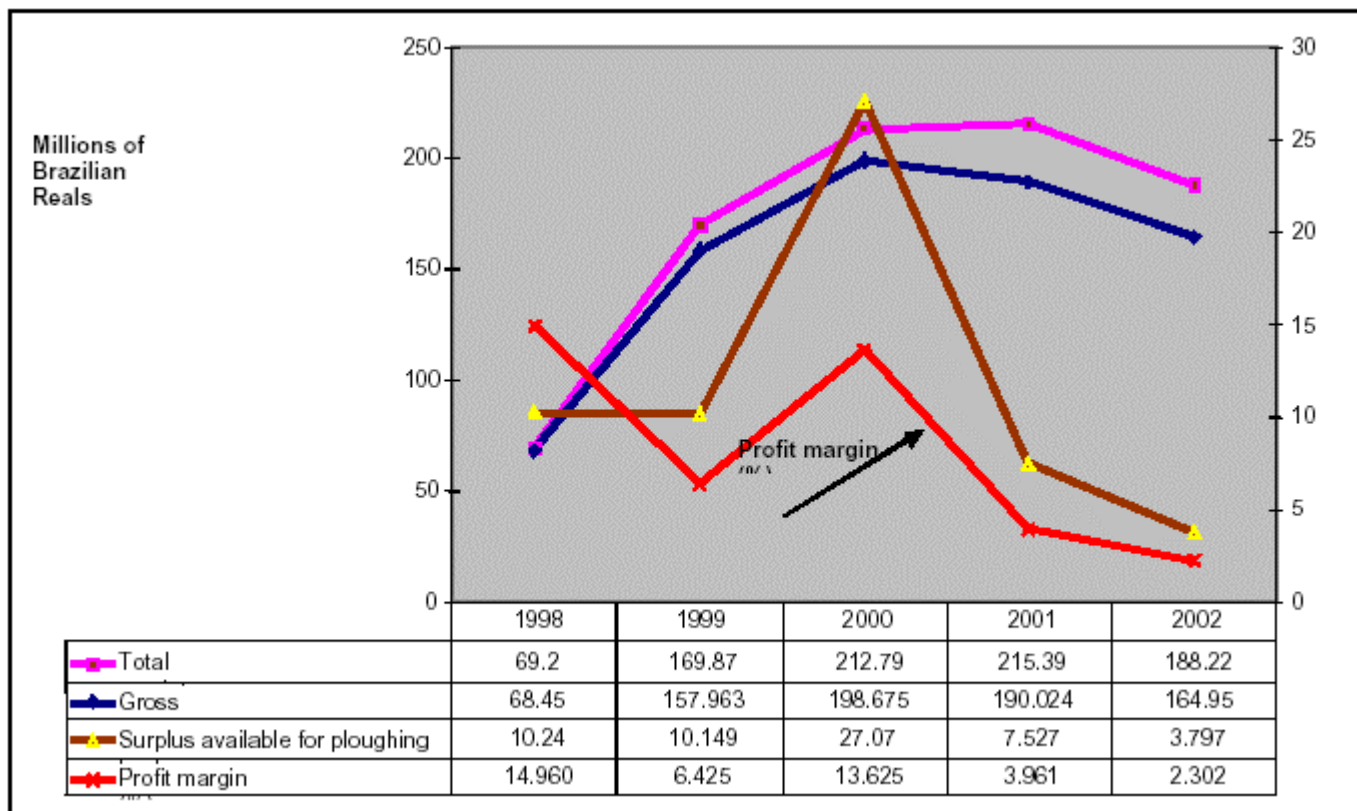
(Number of employees)

---

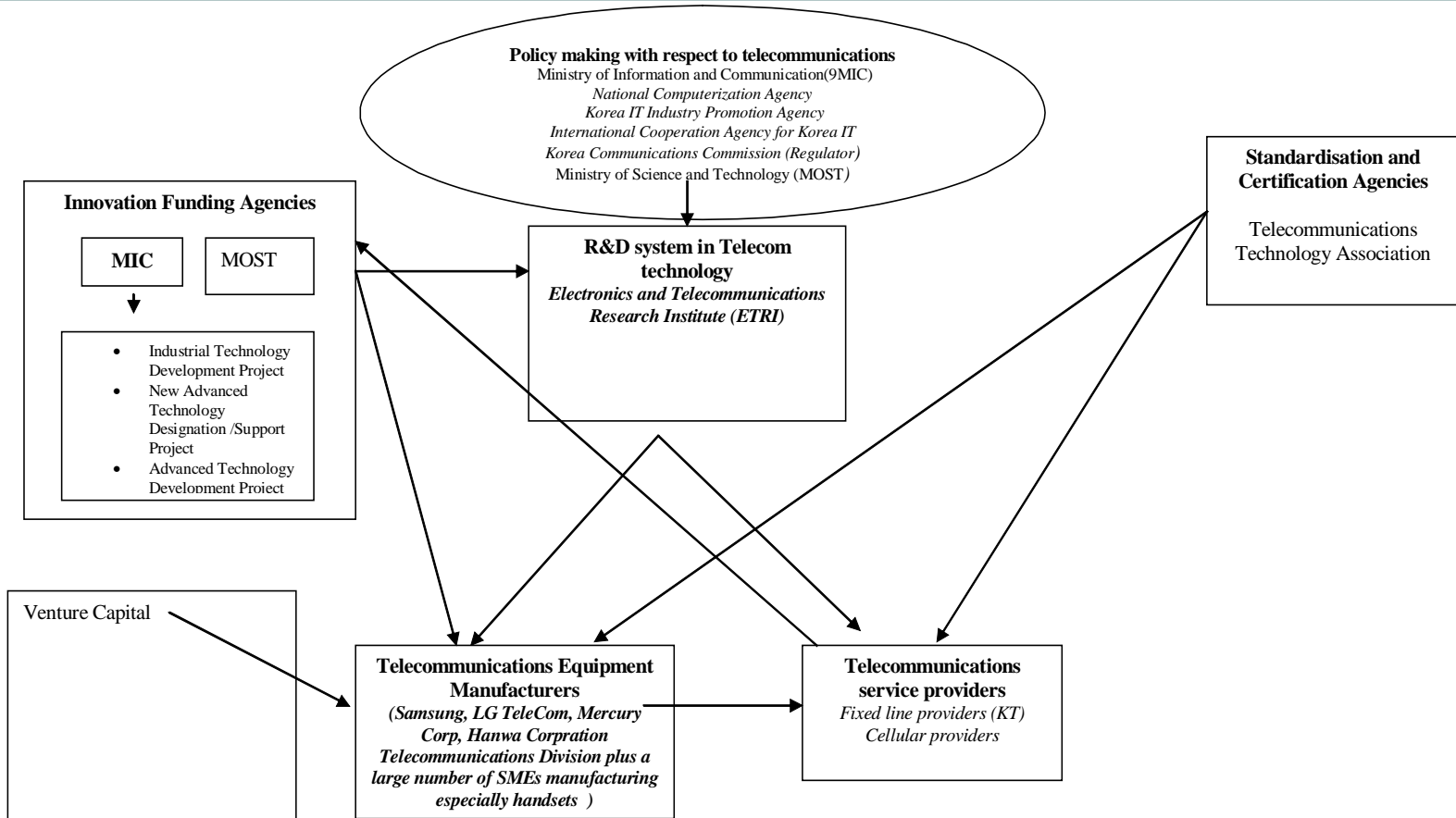
	<b>R&amp;D</b>	<b>Client Operation</b>	<b>Administration and Support</b>	<b>Total</b>
1998	6 (1)	601(67)	288(32)	895 (100)
1999	6 (1)	589 (68)	277 (32)	872 (100)
2000	40 (4)	712 (71)	248 (25)	1000 (100)
2001	149 (14)	671 (65)	220 (21)	1040 (100)
2002	382 (41)	338 (36)	211 (23)	931 (100)
2003	469 (43)	419 (38)	215 (19)	1103 (100)

Source: Figures in parentheses indicate percentage share of the total

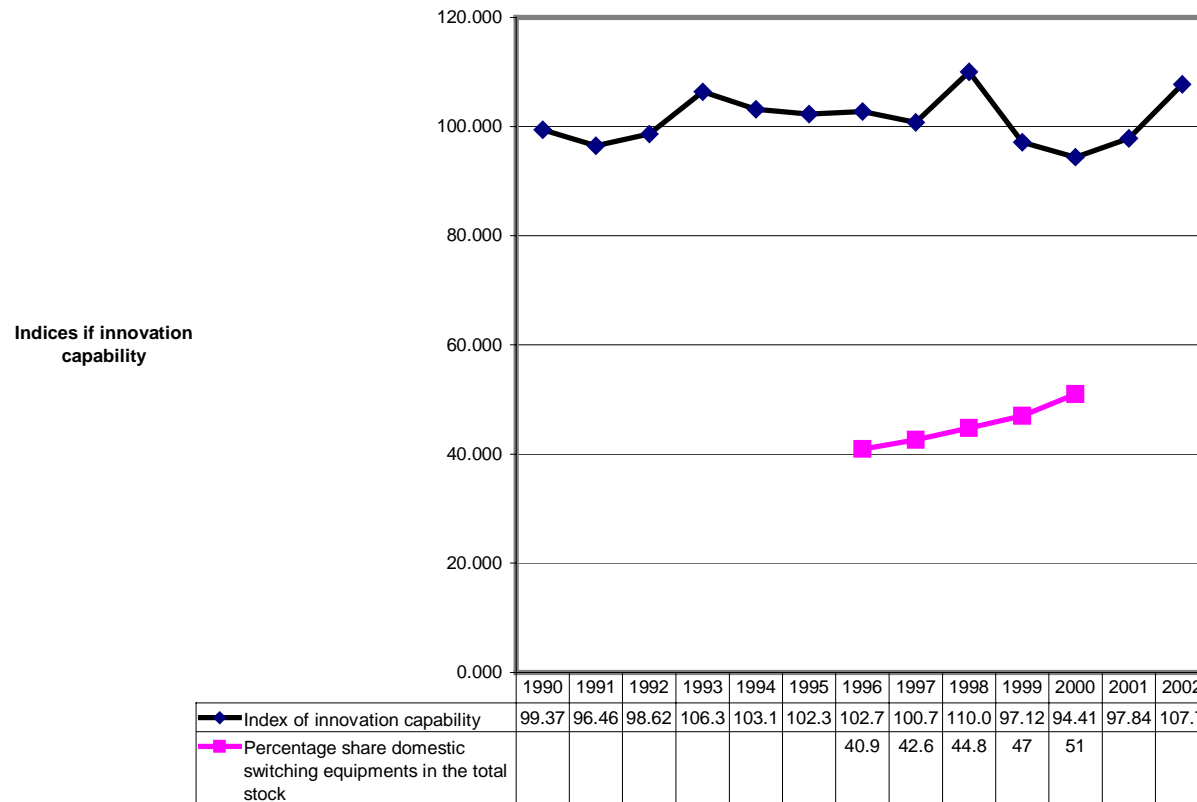
## Financial performance of CPqD, 1998-2002



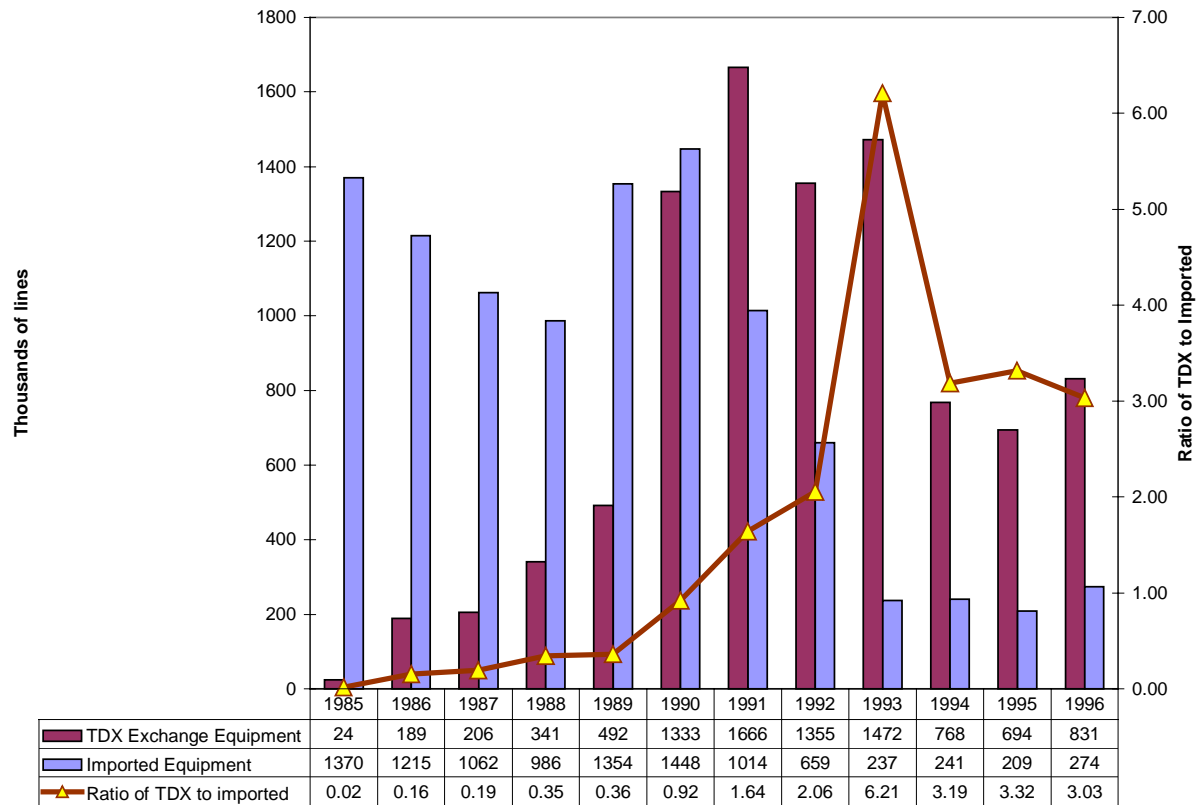
# The Present (c2004) Innovation System of the Korean Telecommunications Industry



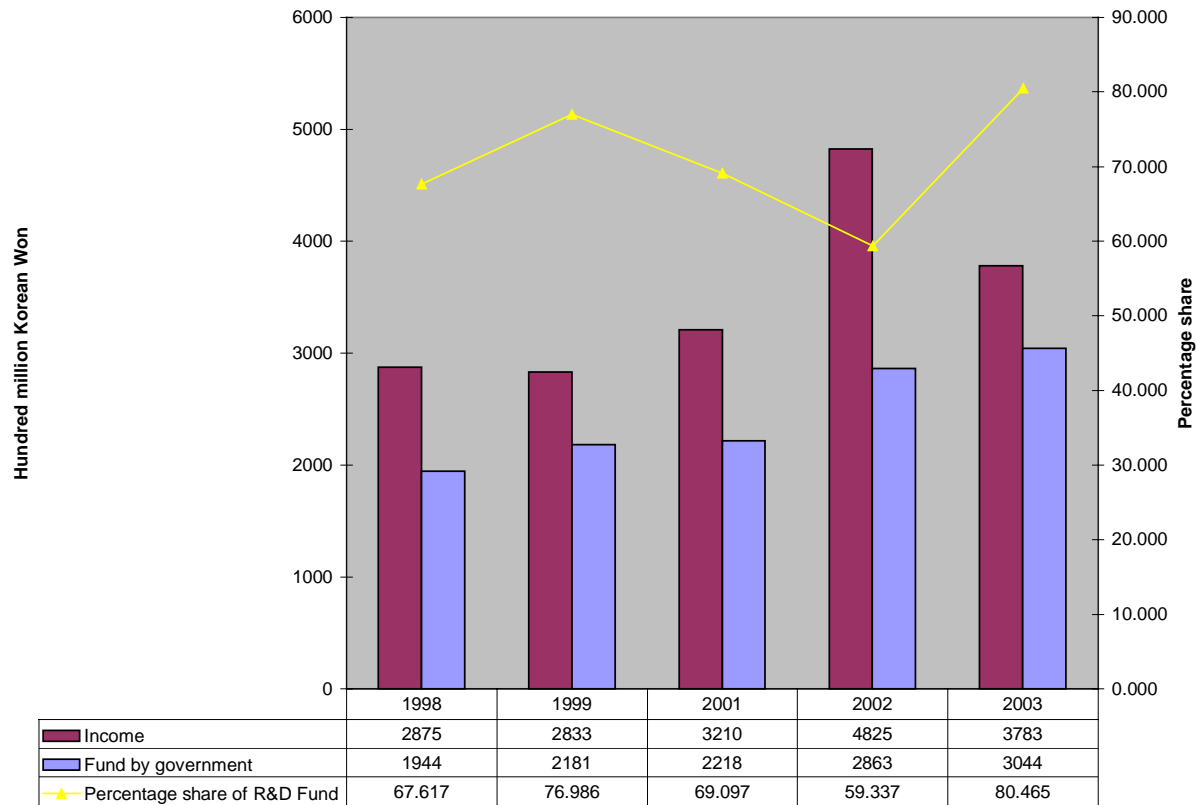
# Index of Innovation Capability in Switching Equipments (Korea), 1990-2002



# Increasing import substitution due to the production of TDX technology



## Source of income to Korean ETRI, 1998-2002



# Indicator's (Physical) of ETRI's (Korea) Performance, 1985-2002

	Number of research staff	Patents granted		Royalty received (millions of Korean Won)	New companies spun off from ETRI	
		International	National		During the year	Cumulative
1985		-	14			
1986		2	9			
1987		-	48			
1988		14	86			
1989		32	209			
1990		44	352			
1991		56	388		21	
1992		36	349		24	3
1993		47	615		32	8
1994		252	945		39	7
1995		126	1032		46	7
1996		267	1117		60	14
1997		334	1367	224	72	12
1998	1280 (82.74)	313	752	108	110	38
1999	1360(84.4)	144	785	152	136	26
2000	1645(86.3)	442	643	147	201	65
2001	1722 (87.1)	200	843	180	221	20
2002	1633( 87.1)	150	1390	205	233	12

# Major R&D achievements of ETRI with respect to Telecommunication Technologies

---

<b>Year</b>	<b>ETRI's R&amp;D Achievement</b>
1986	Beginning of the TDX-1 system
1989	Operated the first ISDN MODEL SYSTEM IN Korea
1990	Development of the TDX-1ISDN model switching system
1992	Development of the 155 Mbps grade synchronous optical transmission system
1993	Development of the 2.5 Gbps grade optical transmission system
1994	Development of digital mobile communication system
1995	Development of ATM switching system for very high speed bed network
1996	Development of world's first ATM multimedia switching Chip (MCS)
1996	Commercialized the CDMA digital mobile communication system
1998	Development of ATM switching system
1999	Development of RF CMOS IC for cellular telephones
2000	Development of ATM switching system

## ETRI: Two major achievements

---

- TDX family of digital switching systems
- First to commercialise CDMA mobile communication technologies

# ETRI (Korea): The TDX Family of Digital Switching Systems

---

Major Series	Use of system	Capacity (lines)
TDX-1(A)	-PSTN services for rural areas	10,000
TDX-1(B)	-PSTN and ISDN services for small cities	20,000
TDX-10	-PSTN, ISDN and Packet services for metropolitan areas. -Can easily adopted for IN and PLMN	100,000

## **ETRI has also enabled Korea to be the leader in mobile communications**

---

- Commercialised CDMA technologies in 1996
- Introduced CDMA-PCS service in 1996
- Launched cdma2000 1x service in October 2000
- Provided cdma2000 1x EV-DO service in May 2002
- The exports of CDMA systems and terminals by Korean companies have been steadily growing since the successful 1996 commercialisation. During the year 2002, exports have exceeded 4.2 billion dollars. In particular exports of cdma2000 1x products have been increasing rapidly.
- The development of GSM and TDMA technologies is a valuable by product created by the successful commercialisation: exports of GSM terminals reached 7.3 billion dollars in 2002 while TDMA terminals exceeded 15 million dollars.

## **Main difference in the sectoral system of innovation between Brazil and Korea**

---

- Active involvement in the research and its commercialisation by  
would be manufacturers in the case of Korea while the Brazilian  
manufacturers had very little participation up to 1998.

## **Instruments of State Support: Brazil**

### **1. Fiscal instruments to promote local generation of technology**

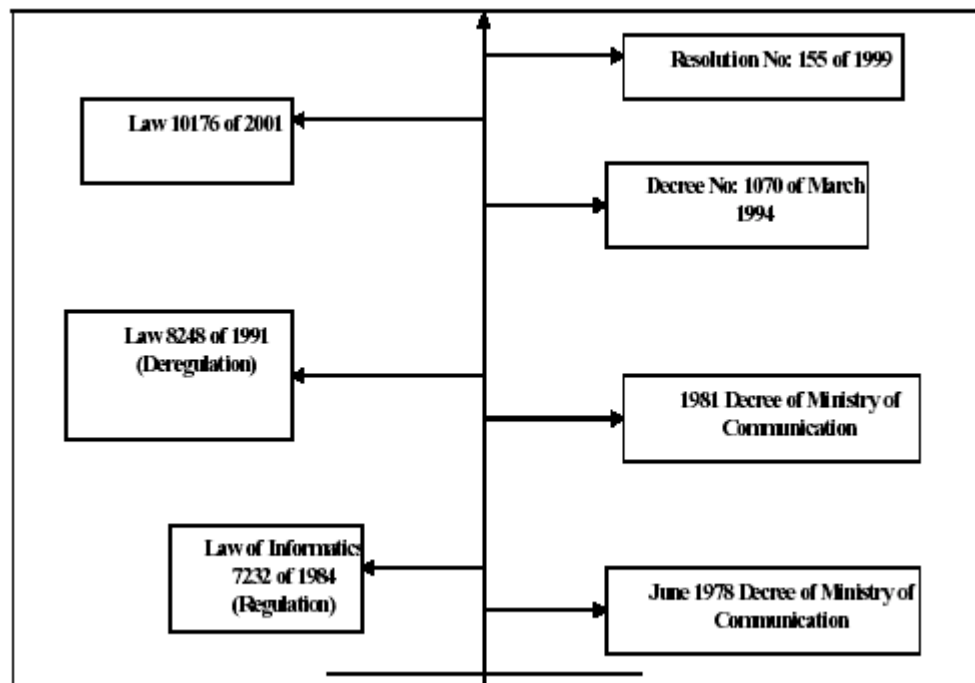
---

- Provision of research grants: the establishment of FUNTTEL
- Provision of tax incentives
- Provision of deferred credit facilities

# Instruments of State Support: Brazil

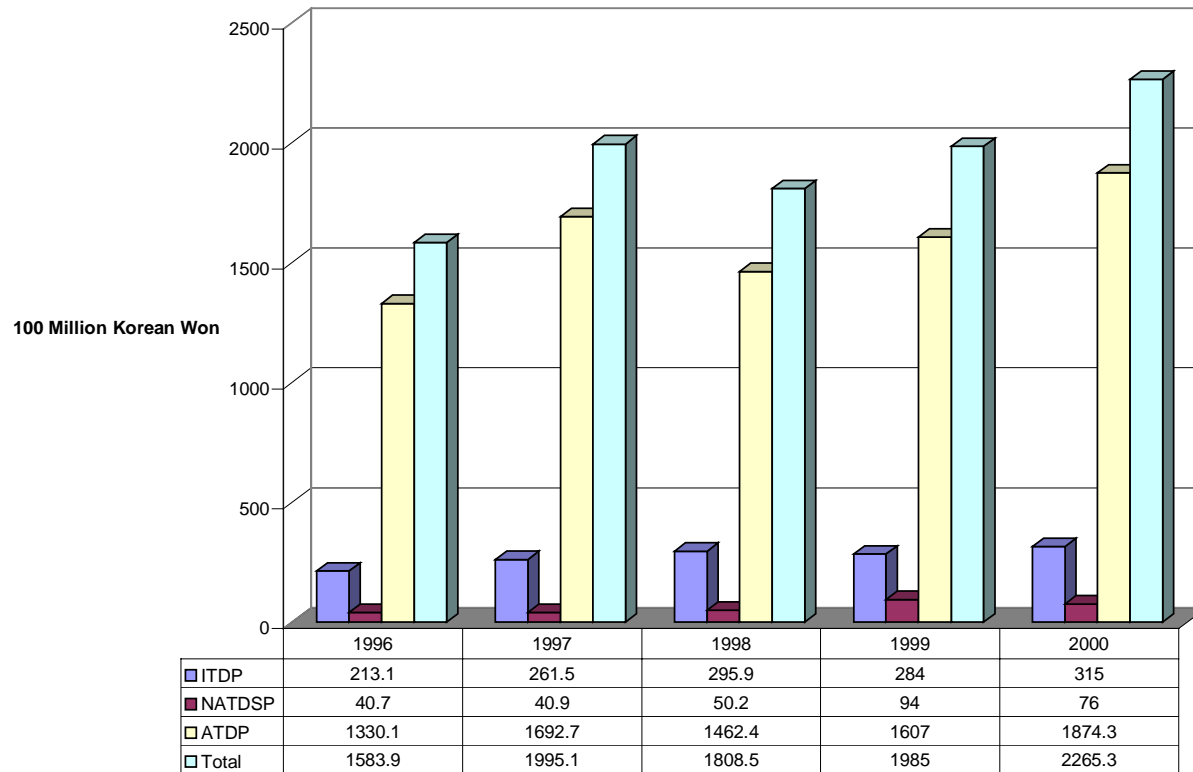
## 2. Legal instruments for domestic technology procurement

---



# Instruments of state support: Korea

## 1. Fiscal incentives for technology creation



# Instruments of state support: Korea

## 2. Public technology procurement

---

- It is clear that some form of technology procurement is still practised given the virtually monopolistic position of KT.
- This is evident from the increase in market share of domestically developed public switches.

# Comparison of Brazilian and Korean R&D initiatives in Telecommunications Technology

	Brazil	Korea
	CPqD	ETRI
1. Year of establishment	1976	1976
2. Mode of organization	<ul style="list-style-type: none"> <li>Two phases</li> <li>Phase 1: 1976 to June 30 1998: Stand alone public laboratory. Technology developed by the lab is transferred to Brazilian private sector companies at nil rates of royalty</li> <li>Phase 2: July 1 1998 onwards: Private Foundation. It consists of the central laboratory, two manufacturing companies and two service oriented companies</li> </ul>	<ul style="list-style-type: none"> <li>Three phases</li> <li>Phase 1: 1976- 1984: The Telecommunication Development Task Force decided to invest in the development of electronic switching systems. The TD X 1 (8000 lines) was developed by 1984.</li> <li>Second phase 1985- 1998: ETRI was established in 1985 and in 1992 its affiliation was changed from the MOST to MIC.</li> <li>Third phase: 1998-. It was restructured three times in April 1998, April 2001 and finally for the third time in April 2002. Currently it is organised into 6 technology laboratories, 3 divisions and 1 affiliated organisation.</li> </ul>
3. Annual budget (Average amount in US \$ during 1992-2002)	<ul style="list-style-type: none"> <li>US \$ 81 million (<i>Ratio of CPqD's R &amp; D budget to the R &amp; D expenditure of Ericsson in 2002- 0.0179</i>)</li> </ul>	<ul style="list-style-type: none"> <li>US \$ 315.25 million (Ratio of ETRI's R &amp; D budget to the R &amp; D Expenditure of Ericsson in 2003 is: 0.09)</li> </ul>
4. Mode of financing	<ul style="list-style-type: none"> <li>Phase 1: 100 per cent research grants from its parent telecom service provider, Telebras</li> <li>Phase 2: 70 per cent self generation through sale of technology and services; 30 per cent research grants from the government. Has now beginning to learn to stand on its own feet.</li> </ul>	<ul style="list-style-type: none"> <li>About 60 per cent research grants from its parent Ministry of Information and Communication. The lab also receives royalty from manufacturers.</li> </ul>
5. Number of R & D scientists and engineers (as of 2002)	<ul style="list-style-type: none"> <li>469 (41 per cent of total employees)</li> </ul>	<ul style="list-style-type: none"> <li>1600 ( 87 per cent of total)</li> </ul>
6. Main areas of technological strength	<ul style="list-style-type: none"> <li>Family of digital switching systems of varying capacities best suited to Brazilian conditions.</li> <li>Has a clear strategy for migrating to New Generation Network Switches</li> <li>Optical Networking Products</li> <li>Telecom software development</li> </ul>	<ul style="list-style-type: none"> <li>Family of digital switching systems of varying capacities best suited to Korean conditions, for Rural Automatic Exchanges. Sizeable amount of this have been exported to other developing and transition countries</li> <li>No telecom software manufacturing on its own.</li> <li>Very strong interaction with local manufacturing companies.</li> </ul>
7. Capability in mobile telecommunications technology	<ul style="list-style-type: none"> <li>Weak. Traditional strength only in Fixed Telephony. No clear strategy. Appears to have lost out to MNCs</li> </ul>	<ul style="list-style-type: none"> <li>Very strong. Was the first to commercialise CDMA technology. Currently working on 4G</li> </ul>
8. Patenting record and exports (cumulative since inception)	<ul style="list-style-type: none"> <li>109 patents were granted within Brazil and 50 were granted abroad. No major exports.</li> </ul>	<ul style="list-style-type: none"> <li>Strong patenting record. A total of 10, 796 national and 2469 patents to its credit since 1976.</li> </ul>

## Comparison of Brazilian and Korean R&D initiatives in Telecommunications Technology- II

---

9. Instruments of state support	<ul style="list-style-type: none"> <li>• Fiscal instruments for supporting R&amp;D</li> <li>• Legal instruments for continuing to assure a potential markets for its technology within the domestic economy</li> </ul>	<ul style="list-style-type: none"> <li>• Fiscal instruments for supporting R&amp;D;</li> <li>• Public procurement under strain owing to privatisation of telecom services</li> </ul>
10: Future scenario	<ul style="list-style-type: none"> <li>• Learning to adjust to the external environment characterised by increased competition from MNCs and freer imports</li> </ul>	<ul style="list-style-type: none"> <li>• Marching forward, although the restructuring since 1998 did affect it adversely. The changed policy forced it to be short-term in its research focus. However, the most recent restructuring is placing it once again on a sound footing.</li> </ul>