IDA PAPER P-2498

DIGITAL SPC SWITCHING TECHNOLOGY--FOREIGN TECHNOLOGY ASSESSMENT

Kurt Fischman

Norman D. Jorstad
Director, Critical Technologies

December 1990

Prepared for

Office of the Under Secretary of Defense for Acquisition

INSTITUTE FOR DEFENSE ANALYSES
1801 N. Beauregard Street, Alexandria, Virginia 22311-1772

DEFINITIONS

IDA publishes the following documents to report the results of its work.

Reports

Reports are the most authoritative and most carefully considered products IDA publishes. They normally embody results of major projects which (a) have a direct bearing on decisions affecting major programs, (b) address issues of significant concern to the Executive Branch, the Congress and/or the public, or (c) address issues that have significant economic implications. IDA Reports are reviewed by outside panels of experts to ensure their high quality and relevance to the problems studied, and they are released by the President of IDA.

Group Reports

Group Reports record the findings and results of IDA established working groups and panels composed of senior individuals addressing major issues which otherwise would be the subject of an IDA Report. IDA Group Reports are reviewed by the senior individuals responsible for the project and others as selected by IDA to ensure their high quality and relevance to the problems studied, and are released by the President of IDA.

Papers

Papers, also authoritative and carefully considered products of IDA, address studies that are narrower in scope than those covered in Reports. IDA Papers are reviewed to ensure that they meet the high standards expected of refereed papers in professional journals or formal Agency reports.

Documents

IDA Documents are used for the convenience of the sponsors or the analysts (a) to record substantive work done in quick reaction studies, (b) to record the proceedings of conferences and meetings, (c) to make available preliminary and tentative results of analyses, (d) to record data developed in the course of an investigation, or (e) to forward information that is essentially unanalyzed and unevaluated. The review of IDA Documents is suited to their content and intended use.

The work reported in this document was conducted under contract MDA 903 89 C 0003 for the Department of Defense. The publication of this IDA document does not indicate endorsement by the Department of Defense, nor should the contents be construed as reflecting the official position of that Agency.

This Paper has been reviewed by IDA to assure that it meets high standards of thoroughness, objectivity, and appropriate analytical methodology and that the results, conclusions and recommendations are properly supported by the material presented.

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. AGENCY USE ONLY ***(Leave blank)***

2. REPORT DATE
December 1990

3. REPORT TYPE AND DATES COVERED
Final--June 1990 to December 1990

4. TITLE AND SUBTITLE
Digital SPC Switching Technology--Foreign Technology Assessment

5. FUNDING NUMBERS
C - MDA 903 89 C 0003
T - T-C2-685

6. AUTHOR(S)
Kurt Fischman, Norman D. Jorstad

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
Institute for Defense Analyses
1801 N. Beauregard St.
Alexandria, VA 22311-1772

8. PERFORMING ORGANIZATION REPORT NUMBER
IDA Paper P-2498

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
OUSD(A)/I&IP
The Pentagon, Room 3E1082
Washington, DC 20301-7100

10. SPONSORING/MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES

12a. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution unlimited.

12b. DISTRIBUTION CODE

13. ABSTRACT ***(Maximum 200 words)***

This paper provides a foreign technology assessment of digital switching technology. Leading suppliers of digital switching technology are identified; although the United States holds a large part of the market, major companies in France, Sweden, Japan, the U.K., and Germany are also important. These countries, along with Belgium and Canada, are the most innovative and technically advanced. A listing is provided of transfers of digital switching technology to non-COCOM countries through licensing and joint ventures which reflects the widespread dissemination of this technology. Detailed technical specifications are provided for selected digital switching systems worldwide. The report concludes that considering the degree to which the technology is in place, that control of digital switching technology may not be feasible.

14. SUBJECT TERMS
technology transfer, export control, foreign technology, digital switching, telecommunications

15. NUMBER OF PAGES
55

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
UNCLASSIFIED	UNCLASSIFIED	UNCLASSIFIED	SAR

NSN 7540-01-280-5500

Standard Form 298 (Rev. 2-89)
Prescribed by ANSI Std. Z39-18
298-102

IDA PAPER P-2498

DIGITAL SPC SWITCHING TECHNOLOGY--FOREIGN TECHNOLOGY ASSESSMENT

Kurt Fischman

Norman D. Jorstad
Director, Critical Technologies

December 1990

INSTITUTE FOR DEFENSE ANALYSES

Contract MDA 903 89 C 0003
Task T-C2-685

ACKNOWLEDGMENTS

This report was written and published under contract MDA 903 89C 0003, Task Order T-C2-685, managed in OSD by the Office of the Under Secretary for Defense for Acquisition, Office of Industrial and International Programs [OUSD(A)/(I&IP)], Special Assistant for MCTL and Long Range Planning, Dr. Oles Lomacky.

We wish to thank Mr. Emil Paroulek, Mr. James Atkinson, and Mr. Charles J. Grzenda for their review of this paper. They kindly donated their time to read and criticize the manuscript and helped to correct its errors and omissions.

The invaluable assistance of Mrs. Sharon Wiley, and the technical editing and publication support of Mr. Richard A. Cheney and Ms. Anthea DeVaughan are gratefully acknowledged and deeply appreciated.

ABSTRACT

This paper provides a foreign technology assessment of digital switching technology. Leading suppliers of digital switching technology are identified; although the United States holds a large part of the market, major companies in France, Sweden, Japan, the U.K., and Germany are also important. These countries, along with Belgium and Canada, are the most innovative and technically advanced. A listing is provided of transfers of digital switching technology to non-COCOM countries through licensing and joint ventures which reflects the widespread dissemination of this technology. Detailed technical specifications are provided for selected digital switching systems worldwide. The report concludes that considering the degree to which the technology is in place, that control of digital switching technology may not be feasible.

CONTENTS

TABLES

ACRONYMS AND ABBREVIATIONS

AIC	Asian ISDN Council
BRA	Basic Rate Access
BHCA	Busy Hour Call Attempts
CCITT	International Telegraph and Telephone Consultative Committee
CCS	Common Channel Signaling
EC	European Community
ESPRIT	European Strategic Program for Research and Development in Information Technologies
HDTV	High Definition Television
IBC	Integrated Broadband Communication
IBN	Integrated Broadband Network
ISDN	Integrated Services Digital Network
LAN	Local Area Network
MAN	Metropolitan Area Network
MCP	Multi-level Call Preemption
MOU	Memorandum of Understanding

PABX	Private Automatic Branch Exchange
PRA	Primary Rate Access
POTS	Plain Ordinary Telephone Service
RACE	Research and Development in Advanced Communications Technologies for Europe
RBOC	Regional Bell Operating Companies
SP	Signaling Point
SPC	Stored Program Control
SMDS	Switched Multimegabit Data Service
STD	Signal Transfer Point
TTC	Telecommunications Technology Committee
TDM	Time Division Multiplexing
WAN	Wide Area Network

EXECUTIVE SUMMARY

A preliminary technology evaluation for MCTL Sections 9.2 and 9.3 represents an initial assessment based on an extensive but incomplete review of available information sources. For the evaluation of Digital Stored Program Control (SPC) Switching Technology, the review basically considered the countries, suppliers and products listed in Table 1.

Information used for this evaluation included technical journals, commercial product brochures, trade journals, symposia proceedings, telecommunication studies from Northern Business Information, Datapro Research and others, and discussions with knowledgeable commercial and technical experts from some of the major telecommunications companies in the world.

It becomes apparent that the subject technologies are for the most part readily available, directly or indirectly, to any country willing and able to bear the economic costs involved. With modern telecommunications being a vital part of the infrastructure and economic health of any nation, the willingness to pay the price is widespread and the ability to do so is greatly enhanced by the active support and aid offered by nations and corporations possessing these high state-of-the-art technologies.

Classification of the technologies is structured into three levels, ranging from the (highest) innovative to the (simplest) adaptive. On Level 1, the most innovative and technically advanced, Belgium, Canada, France, Germany (FRG), Japan, Sweden, United Kingdom (UK), and the United States (U.S.) must be considered. Level 2 is a varying mix of innovative and adaptive technology and is represented by Australia, Austria, Finland, Italy, Israel, Netherlands, Norway, Spain, South Korea, Switzerland, and Taiwan. Level 3 represents mostly adaptive technology capabilities as characterized by Brazil, China, Hong Kong, India, Singapore, Turkey, and Yugoslavia.

Immense expenditures for R&D are necessary for countries in Level 1. Competition is fierce and large exports on a worldwide basis sustain the high costs required to support the highest state-of-the-art technology. This is true even for corporate giants (Siemens, NEC, etc.) with a guaranteed market in their home countries. As a result and not surprisingly, many consolidations have taken place in the last few years, and many joint ventures have been formed nationally and internationally as follows:

- ATT and Phillips
- ATT and Italtel
- ATT and GTE
- Alcatel and ITT
- Siemens and GTE
- Siemens and GEC (Plessey and Stromberg Carlson)
- Consortium of Alcatel, Nokia, AEG (for digital cellular phone systems).

The ability to export to another country, large or small, established or newly industrialized, economically strong or weak is often dependent not only on the formulation of a local joint venture and manufacturing base, but almost always on an agreement to transfer the latest technology. Even in cases where no local manufacturing is required, the switch must operate with specific software. A substantial level of documentation and maintenance accompanies this effort, and of itself constitutes significant technology which is transferred.

Significant telecommunications technology is readily available worldwide from many sources, including COCOM, non-COCOM and even Eastern Bloc countries. Because of the dual nature of telecommunications technology, capabilities in the civil telecommunications structure can easily be applied to improving military telecommunications capabilities. Indeed, widespread utilization of the civil system for administrative and strategic communication by the military is a fact in all countries. While military technical specification requirements, particularly for tactical equipment, may differ from those used commercially [i.e., packaging, ruggedization, ambient and other environmental factors, transmission (crypto) security, multi-level preemption] the technology involved is not so unique that it could not be developed easily from the technologies currently and readily available.

Digital switching technology will continue to evolve in the 1990's and make the most sophisticated telecommunications services possible, including some for which no or limited commercial demand exists at the present time. The current trend to transition from separate voice and data networks to an Integrated Services Digital Network (ISDN) has been slowed by confusion, incomplete standards and uncertain users demand. There is much support for a quantum jump over narrowband ISDN to the next level, broadband influenced by economic considerations. On the horizon, around the turn of the century are the goals of IBN, the Integrated Broadband Network. Relatively sparse evidence surfaced which would support that optical switching will be the next generation technology. Although a fair amount of experimental activity can be observed, it is not expected that optical switching will be on the market commercially in the near future.

I. INTRODUCTION

An assessment and evaluation covering military criticality of foreign telecommunications technology and the switching functions as one of its most vital parts presents a particularly difficult problem. Because of the dual nature of telecommunications technology the capabilities in the civil telecommunications structure can easily be applied to improve military capabilities. The widespread utilization of the civil system for administrative and strategic communications purposes by the military to a varying degree is a fact in all countries. While military technical specification requirements, especially for tactical equipment, may differ from those needed and demanded by civil telecommunication administrations, there are many improvements and technical features of digital stored program control (SPC) switching, particularly time division multiplexing (TDM), which are attractive to both the civil telecommunications infrastructure and military command, control and communications (C^3) purposes:

- Reductions in the size of equipment and power requirements through the extensive use of microelectronics.
- Low blocking probabilities, maximum call completion.
- Immunity from noise, reduced interference.
- Enhanced encryption of end-to-end digital signals without intermediate analog/digital conversion.
- Centralized operation and maintenance centers for many exchanges enable remote number changes and automatic fault location and diagnosis.
- Adaptive routing automatically switches a call to alternative transmission paths if the original choice circuits are busy or not in operation.
- Common Channel Signaling (CCS) uses a dedicated control channel for all signalling functions (including address information, status of connection and others) resulting in greater signaling repertoire and call control flexibility, improved reliability and error control, more rapid connection, improved network control and efficiency.
- Multi-level Call Preemption (MCP) permits priority servicing on a trunk-by-trunk basis, which is important during crisis situations.

While these features are desired by the civil authorities for improving commercial telecommunication services, they are important to the military to the extent that they improve the survivability of military dedicated communication networks and increase speed, reliability and security of transmission. Therefore, certain features are still controlled under IL 1567 even as liberalized by Administrative Notes 6 and 7. For the purpose of this report, available information on the countries, national suppliers and their digital switching systems shown in Table 1 has been considered and evaluated.

Table 1. Digital Switching Inventory Foreign Availability Assessment

Digital Switching System	Supplier	Country
EWSD	Siemens	Germany
E 10	Alcatel	France
System 12	Alcatel	Belgium, Germany, Spain, Italy, Taiwan, PRC, and Australia
AXE	Ericsson	Sweden
GTD 5 EAX Domestic	ATT (Formerly GTE)	U.S.
GTD 5 EAX International	Siemens (Formerly GTE)	Germany, Italy, Belgium, Taiwan
UT 10/3	Italtel (ATT)	Italy
No. 4 ESS No. 5 ESS	ATT	U.S.
C DOT RAX C DOT MAX C DOT DSS	C DOT	India
TDX 1 TDX 10	Samsung, Goldstar Daewoo, Otelco	Korea (ROK)
System X	Plessey/GEC (Siemens)	U.K.
Fetex 150	Fujitsu	Japan
HDX 10, D 60/70	Hitachi OKI	Japan
NEAX 61	NEC	Japan
DX 200	Telenokia	Finland
DMS 10 DMS 100/200	Northern Telecom	Canada
Tropico	Elebra	Brazil
SI 2000	Iskra	Yugoslavia

II. FOREIGN TECHNOLOGY

In 1988, 32 million digital lines were placed into service throughout the world by the twelve leading telecommunications companies. While almost 13.5 million of these lines were installed in North America (U.S. and Canada), the remaining 18.5 million lines are an irrefutable indication of the rapid pace of change to digital networks and the quantum leap in telecommunications capabilities in the rest of the globe.

With the service life of electromechanical and early analog SPC switches reaching an end, it is estimated that their replacement/modernization will result in a 9 percent per year increase in digital lines, to reach 45 million per year in 1993. Because the percentage of digital lines in service is the highest in North America , most of the growth will occur in the rest of the world, with Eastern Europe and China representing the most antiquated systems and the largest unfulfilled demand.

The twelve suppliers dominating the digital switching market (in order of decreasing market share) are shown below:

Table 2. World's Leading Suppliers of Digital Switching Equipment

Company	Percent	Country
Northern Telecom	19	U.S.
ATT	17	U.S.
Alcatel	15	France
L.M. Ericsson	9	Sweden
NEC	8	Japan
GEC Plessey	7	U.K.
Fujitsu	6	Japan
Siemens	6	Germany
GTE	4	U.S.
OKI	3	Japan
Hitachi	3	Japan
Other	3	—
Total	100%	

The top six suppliers include Northern Telecom, ATT, Alcatel, Ericsson and NEC. Siemens is added because they acquired GTE's non-North American switching activities representing approximately 50 percent of GTE's portion of the market. The other 50 percent will be absorbed by ATT since they acquired GTE's domestic switching business and formed a joint venture, AG Communication Systems. Northern Telecom and ATT's share represents basically their dominance of the North American market, although both companies are increasingly active on the international scene (ATT joint ventures with Phillips and Italtel). The major players outside the U.S., and those with the most widespread international presence, are Alcatel, Ericsson, Siemens and NEC (see Table 3).

Table 3. Acquiring Countries Versus International Supplier (Digital Central Office Switching)

	Country	* Primary Suppliers	
	Austria	Siemens	Northern Telecom
x	Belgium	Alcatel	Siemens (GTE 5 I)
	Denmark	Ericsson	Alcatel
x	Finland	Nokia	Siemens Ericsson
x	France	Alcatel	Ericsson (16%)
	Greece	Ericsson	Siemens
	Ireland	Ericsson	Alcatel
x	Italy	Italtel (ATT)	Alcatel
x	Netherlands	Ericsson	Alcatel ATT Phillips
	Norway	Alcatel	(Note 1)
	Portugal	Siemens	Alcatel
	Spain	Ericsson	Alcatel
	Switzerland	Siemens Ericsson	Alcatel (Note 2)
x	UK	GEC Plessey (Siemens)	(Note 3)
x	FRG	Siemens	Alcatel (Note 4)
	Eastern Europe		
	Bulgaria	Siemens	
	Hungary	Ericsson	(Note 5)
	Poland	Alcatel	
	USSR	Alcatel	Italtel (ATT) (Note 6)
	Czechoslovakia	Alcatel	
	Egypt	NEC (Alcatel, Ericsson , ATT Phillips proposed joint venture)	Siemens
	Saudi Arabia	Ericsson	Alcatel
	Sweden	Ericsson	

* Suppliers listed first generally have the largest share of that country's market.

x Countries with indigenous switching technology developments.

(cont'd)

Table 3. (continued)

Country	* Primary Suppliers	
South Africa	Siemens	GEC Plessey
Turkey	Alcatel	Northern Telecom
Argentina	Siemens	NEC
x Brazil	Ericsson (Tropico at least 50%)	Siemens
Columbia	Fujitsu	Siemens GEC Plessey
Mexico	Ericsson	Alcatel
Venezuela	Siemens	Ericsson, NEC
Australia	Ericsson	(Alcatel Manufactures Ericsson AXE under license)
Hong Kong	Fujitsu	NEC
x India	Alcatel (E10)	NEC
Indonesia	Siemens	(See current contract)
x Japan	NEC	Fujitsu, Northern Telecom
x South Korea	Alcatel	ATT
Malaysia	Ericsson	NEC
New Zealand	NEC	
Philippines	DAEWOO	Siemens
Singapore	Fujitsu	(ATT, NEC Gateway Switches)
Taiwan	Siemens	ATT, Alcatel
Thailand	NEC	Alcatel

* Suppliers listed first generally have the largest share of that country's market.

x Countries with indigenous switching technology developments.

NOTES:

1. Alcatel owns Standard Telefon OG Kabelfabrik (STK).
2. Swiss Joint Ventures/Suppliers:
   Albis - Siemens EWSD
   Hassler - Ericsson AXE
   Standard Tel & Radio - Alcatel System 12.
3. Opening of UK telecom market broadens supplier access. Northern Telecom owns 27% of STC, ATT-Philips and Ericsson are making inroads. Primary Plessey product is "System X."
4. Alcatel acquired ITT's Standard Electric Lorenz (SEL).
5. Joint Venture with "Budavox."
6. Originally Alcatel joint venture with Yfinski Zabod Komutacione Aparaturi, proposed System 12 (without ISDN & SS7) utilizing factories in UFA and Leningrad. Current reports indicate Italtel is also being considered as a possible supplier. Further information reveals that Siemens has agreed to supply the USSR with manufacturing gear, including test and assembly equipment to enable the Soviets to build their own digital exchanges. COCOM application status is not known.
7. Canada and Sweden are supplied from their domestic sources.

This analysis concentrated on those suppliers representing a dominant presence in the largest number of non-COCOM countries for installed central office switches (Table 3), technology made available or transferred (Table 4), and joint ventures, licensees, or production line facilities in those countries (Table 5). Table 6 provides details for Voice (Circuit) switches. A separate Table 7 presents similar information for packet switching. Although many major manufacturers of circuit switches have packet switches in their product line, only information from Alcatel is available at this time. However, the models DPS 1500 and DPS 2500 are representative of products from other suppliers and have been sold to a number of countries (i.e., the DPS 1500 was sold to the Netherlands and Japan). The DPS 2500 is used in the French Packet Switching Network, TRANSPAC, reported to be the network with the largest traffic in the world. As of now, the DPS 2500 as the more advanced product, is the choice of most countries. Transfer of technology as part of export sales appears not to be required. The nature of the packet networks is such that they do not compare in size with public telephone networks. The number of switches involved is relatively small and manufacturing is not economically sound. However, some technology is unavoidably transferred in the documentation required for operation and maintenance.

X.25 is the packet switching standard recommended by the International Telegraph and Telephone Consultative Committee (CCITT) and X.25 Packet Switching Networks are installed in many countries of the world. The X.25 protocol is fairly slow and in the near future these networks will gradually be replaced by faster networks. For example, Metropolitan Area Networks (MANs) offer a new kind of fast packet switching service called Switched Multimegabit Data Service (SMDS). While operating at a fast 45 Mb/s, it is not as feature-rich as X.25. ATT is now supplying such systems in the U.S.

Table 4. Digital Switching Technology Transfer to Subsidiaries and Licensees Outside of COCOM (By Country)

Country	Company	System Type	Licensee/Joint Venture/ Subsidiary	Manu- facture
Argentina	Siemens	EWSD	Siemens S.A.	Yes
Australia	Ericsson	AXE	Standard Telephone & Cable/Ericsson PTY Ltd.	Yes
Austria	Alcatel	System 12	Alcatel/Austria	Future
	Siemens	EWSD	Siemens/Osterreich	Future
	Northern Telecom	DMS	Kapsch & Schrack	Future
Bangladesh	Siemens	EWSD	Telephone Shilpa Sangstha	Future

(cont'd)

Table 4. (Continued)

Country	Company	System Type	Licensee/Joint Venture/ Subsidiary	Manu-facture
Brazil	Ericsson	AXE	Ericsson de Brazil	Yes
Colombia	Ericsson	AXE	Ericsson de Colombia	Yes
Finland	Alcatel Siemens	System 12 EWSD	Alcatel/SEP Siemens	No No
India	Alcatel	E 10	Indian Tel Industries	Yes
Ireland	Alcatel Ericsson	E 10 AXE	Alcatel Ireland L.M. Ericsson Ltd.	Yes Yes
Israel	Northern Telecom	DMS 10 DMS 100	Telrad	Yes
Malaysia	Ericsson	AXE	Pewira Ericsson SDN BHD	Future
Mexico	Alcatel Ericsson	System 12 AXE	Indetel Teleindustria Ericsson S.A.	No Yes
Pakistan	Alcatel	E 10	Alcatel CIT	Yes
Peoples Republic of China (PRC)	Alcatel	System 12	Shanghai Bell (SBTEMC)	Yes
Republic of Korea (ROK)	Alcatel Ericsson ATT	System 12 AXE IAESS, 5 ESS	Samsung Otelco Goldstar	Yes Future Yes
Republic of China (ROC) (Taiwan)	Alcatel Siemens (GTE) ATT	System 12 GTD 5 5 ESS	Taisel Ltd. Taicom Ltd.	Yes Yes Yes
Saudi Arabia	Ericsson	AXE	N/A	No
South Africa	Alcatel Siemens	E 10 EWSD	Altech Temsa Siemens S.A.	Yes Yes
Spain	Alcatel Ericsson	System 12 AXE	Standard Electrica S.A. Industrias de Tele-Communicaciones S.A.	Yes Yes
Switzerland	Alcatel Siemens Ericsson	System 12 EWSD AXE	Standard Telefon & Radio Siemens Albis Hassler AG	Future Future Future
USSR	Thompson/CSF Telenokia Iskra Ericsson	MT 20/25 DX 200 SI 2000 AXE	N/A N/A N/A N/A	Yes ? ? No
Yugoslavia	Alcatel Ericsson Siemens	E 10 AXE GTD 5I	Iskra Nikola Tesla Electronska Industrija	Yes Yes ?

NOTE: Although information exists which shows Alcatel E 10 may have been transferred to and produced in Poland, CSR and Bulgaria, details are inconclusive.

N/A = Information not available.

Table 5. Joint Ventures for Manufacturing/Assembly of Digital Switching

Country	Switch Type	Annual Capacity	Comments
SIEMENS			
Egypt	EWSD	200K 90-91 500K 1995	Joint Venture Siemens 30% interest
South Africa	EWSD		Telephone Manufacturers of South Africa (TMSA). Manufactures EWSD under license, but is owned by GEC/Plessey and local investors
Turkey	EWSD		ETMS Manufacturing
Indonesia	EWSD	150K	PT industry Telekomunikasi Indonesia (PT. INTI). (PT. INTI) Produces under Siemens license.
Taiwan	EWSD	400K (+)	Siemens acquired Taiwan factory from GTE with rights to Taiwan version of GTE's GTD 5 EAX. Although factory can also produce EWSD Taiwan DGT continues to order GTD 5. Company now Tech center for EWSD covering 13 Far East countries.
Yugoslavia	EWSD S 12000		Joint venture with Iskra. Intent to export to Comeco economic community and others
Iraq	EWSD	300K	12 year agreement, to reach capacity as early as 1991. Components to be supplied for first 150K lines of production.
ALCATEL			
Turkey	S 12	500K	Telekomunikayson Endustry Ticaret AS, Istanbul (TELETAS) - Joint Venture of PTT and BTM Belgium (Design House for System 12)
Argentina	E 10 or S 12		IATA - Joint Venture for supply of 22 exchanges, 430K lines
Australia	AXE		Manufactured under Ericsson license
China	S 12		Joint venture with Shanghai Bell Telephone Equipment Manufacturing Company
Egypt	S 12		Proposed Joint Venture
Taiwan	S 12	300 -500K	Taisel Joint Venture with DGT and local interest
Yugoslavia	E 10	100K	Alcatel El GTS Yugoslavia formed Joint venture with Elektronska Industrija.
Czechoslovakia	E 10	100K	Local manufacture under license
India	E 10	500K	Indian Telephone Industries (ITI) at Bangalor. Factory at Mankapur. Initial production 170K lines of E 10B
	E 10 Transit	60K	ITI factory at Palghat
Hungary	System 12	300K	Joint venture with Videoton, includes transfer of technology for maximum production by 1992.
Pakistan	E10	120K	Joint venture with Pakistan government, factory at Islamabad

(continued)

Table 5. (Continued)

Country	Switch Type	Annual Capacity	Comments
ERICSSON			
Australia	AXE		Also manufactured by Alcatel under license
Egypt	AXE		Proposed Joint Venture
Algeria	AXE	200K	Local production - virtual monopoly of Algeria's digital market
NEC			
Argentina	NEAX61		PECOM-NEC S.A. NEAX assembly (49% interest)
NORTHERN TELECOM			
Turkey	DMS		NETAS Joint Venture with DTT (31% interest)
ATT			
China	5 ESS		5 exchanges ($70 MIL $) given as investment
Taiwan	5 ESS	300 - 500K	ATT-Taiwan joint venture with DGT and local interest. ISDN in service.

Table 6. Comparison Matrix MCTL Section 9.2.1 Parameters Versus Technical Specifications of Selected Digital Central Office Switching Systems

	France E 10	Belgium S 12	FRG EWSD	Sweden AXE
A. Arrays of Know-How				
1. Development & Production of Space Switching Matrices having:				
a. Serial port data signaling rate exceeding 50 Mbits/s	o	x	o	o
	<------------ See Note 1 ------------>			
b. Parallel port total data signaling rate exceeding	o	o	o	o
c. Total aggregate throughput exceeding 3.5 Gbits/s	o	o	o	o
d. Optical Components	o	o	o	o
2. Development & Production of Time Division Switches having:				
a. Total aggregate throughput exceeding 50 Mbits/s	x	x	x	x
	<------ Approximately 2 GBits/s ------>			
b. Optical Components	o	o	o	o
3. Development & Production of Application-Specific Assemblies for related Switch Functions as follows:				
a. Interface functions as follows:				
1. Digital /digital interface circuit functions to provide synchronization between time multiplexed channels and the time division switch	2 MB/s	2 & 1.5 MB/s	2 & 1.5 MB/s	2 & 1.5 MB/s
2. Inclusion of any type of trans-multiplexer functions (FDM-TDM)	o	o	o	o

(continued)

Table 6. (Continued)

	France E 10	Belgium S 12	FRG EWSD	Sweden AXE
A. <u>Arrays of Know-How (cont'd)</u>				
3. Error control (detection and correction)	<--- Detection in Switching Matrix --->			
4. Protocol conversion or handling other than voice	CCITT No. 7/ ISDN-D Channel /x.25			
5. Packet assembling or disassembling (PAD)	x Note 2	o	o	o
6. Radio frequency networks and related control processing	x Digital Mobile Radio	x	o	x Digital Mobile Radio
b. Common channel signaling functions that service more than one bearer channel (CCITT definition)	x	x	x	x
c. Control systems which provide for:				
1. Call Forwarding	x	x	x	x
Network Reconstitution	x	x	x	x
Call Waiting	x	x	x	x
Priority/Preemption	o	o	o	o
Conferencing	x	x	x	x
Caller Number ID	x	x	x	x
Dynamic (not alternate) Routing	o	o	o	o
2. Operate with a BHCA greater than 300,000	800K	750K	750K	800K
	<------------ See Note 3 ------------>			
d. Detection of signal features for recovery of parameters, *except for CCITT standards, that permit* routing or modification of the switch configuration to adapt to a particular type of information being handled	o	o	o	o
e. Crosstalk less than -60 Db permitting secure and non-secure information to be handled within the same switch	<------------ 80 Db or better ------------>			
f. Digital processing to enhance low-cost bulk encryption techniques	x Digital Cellular Radio	x Digital Cellular Radio	o	x Digital Cellular Radio
4. Development & Utilization of:				
a. Software that implements or controls any of the above features, and	All systems are essentially software driven			
b. Operational & Diagnostic Computer Software for:				
1. Any switch architectures that contain any of the item A features	x	x	x	x
	<------------ See Note 3 ------------>			
2. CAD of such switch architectures, or	x	x	x	x
	Including in-house chip design capability			
3. CAD of software or firmware for such switch architectures	x	x	x	x
	Extensive libraries of software tools			
5. Development of the architecture of a switch that contains any of the item A features	x	x	x	x

(continued)

Table 6. (Continued)

	France E 10	Belgium S 12	FRG EWSD	Sweden AXE
B. Keystone Manufacturing, Inspection and Test Equipment				
1. Electronic measuring, calibrating, counting, testing, and/or time interval measuring equipment	x	x	x	x
C. Keystone Materials N.I.				
D. Goods Accompanied by Sophisticated Know-How				
1. Data bases and simulation tools with accompanying documentation required for CAD of architecture and/or software for a processor-controlled circuit switch	x	x	x	x
E. Items of Intrinsic Military Utility				
1. Stored program controlled automatic branch exchanges (PABX) which have:	Not part of these systems, but each of the suppliers have these products			
a. Digital lines	x	x	x	x
b. Multilevel call preemption	o	o	o	o
c. Common channel signalling	x	x	x	x
d. Automatic tandem trunk circuit switching with adaptive routing	x	x	x	x
e. Interconnection capability to a mobile telephone system				
f. Network management	x	x	x	x
g. Any form of integrated digital network (ISDN) access	x	x	x	x
2. Key telephone systems which provide direct dial access to a group of shared exchange lines or trunk lines and which can be upgraded to a PABX	Major suppliers usually provide this equipment either of their own design or from a large variety available in the world market.			
3. Stored program-controlled terminal and transit exchanges which have:				
a. Digital lines	ISDN basic rate access (l44 KB/s) ISDN primary rate access (2 MB/s) (1.5 MB/s) 2 MB/s and 1.5 MB/s trunks			
b. Capacities exceeding				
1. 50,000 subscriber lines	200K	100K	100K	200K
13,000 trunk circuits	60K	60K	64K	60K
2. 225,000 busy hour call attempts	800K	750K	750K	800K
	<------------ See Note 3 ------------>			
3. 5,000 erlangs	27K	27K	27K	27K
c. Multilevel call preemption	o	o	o	o
d. Common channel signalling	x	x	x	x
	CCIT #7			
e. Adaptive routing	x	x	x	x
f. Digital synchronization for networking	x	x	x	x
	Digital Trunks 2 Mb/s & 1.5 Mb/s			
g. Network management capability	x	x	x	x
	collocated with switch & remote			

(continued)

Table 6. (Continued)

	France E 10	Belgium S 12	FRG EWSD	Sweden AXE
E. <u>Items of Intrinsic Military Utility</u>				
h. Any form of ISDN access	x	x	x	x
	both primary (2MB/S) and basic rate 144 KB/s			
4. Stored program-controlled telegraph exchanges which provide services defined in CCITT Recommendation X.1 Classes 1 and 2 exceeding a baud rate of 9600	These switches are not telegraph exchanges but telex transmissions via modems can be switched by all			
5. Stored program-controlled message switches	These switches are basically voice switches (without ISDN). Suppliers have other products specifically for message switching, i.e., Alcatel DPX 4000			
a. Capabilities exceeding				
1. Data signalling rate of 4800 bits-per-second for each circuit	<—— up to 2 MB/s ——>			
2. A sum of 27,500 bits-per-second for all circuits	N/A			
b. Any form of ISDN access	<—— up to 2 MB/s ——>			
6. Software for any of the above switches, except the minimum specially designed software necessary for the use (i.e., installation, operation and maintenance) of the equipment	Many PTT's specify complete software packages including object and source code. Suppliers consider source code to be proprietary and normally will not provide. However source code can be "reverse engineered" as was done in Taiwan.			

LEGEND:

- x Technical feature is inherent in the designated switch.
- o Technical feature is not inherent in the designated switch.

NOTES:

1. 140 Mb/s are available in the Berkom Broadband trial, Berlin, Germany.
2. For access to videotex (Minitel) via packet networks.
3. Suppliers are notorious for overstating this parameter; however, even the reduced real values are far beyond 300K BHCA .
4. Built-in automatic diagnostics reconfiguration. Remote maintenance and administration on a centralized basis.

Table 7. Comparison Matrix, MCTL Section 9.2.3 Parameters Versus Packet Switching Systems Sold in International Market

	Alcatel Packet Switching Systems DPS 1500 DPS 2500
A. Arrays of Know-How	
1. Development and production of packet switches with a throughput of greater than 153,600 octets per second less overhead. Note: The term octet is equal to an 8 bit byte or one ASCII character	4 versions of which 3 exceed 153,000 octets/second PSX 0 64K octets/second PSX 1 192K octets/second PSX 2 300K octets/second PSX 3 2,500K octets/second
2. Development and production of application-specific assemblies for related switch functions not necessarily incorporated as follows:	
a. PAD that:	
1. Operates with a throughput greater than 9,600 bits/sec	50 to 19,200 bits/sec
2. Produces packets exceeding 256 ASCII characters, excluding overhead, or	Up to 1024 ASCII characters
3. Operates with protocols other than (standard async) X.3, X.28 and X.29	Protocols Available: X.3 X.28 X.29 IBM BSC 3270 Telex access 2 Mb/second ISDN access Videotext (Minitel) Telephone Network X.32 Synchronous Access 2.4 - 64 Kb/s (256 kb/S optional) (LAP-B or LAP-X) X 2 CCITT Services
b. Line ports that operate with a rate greater than 9,600 bits/sec	Asynchronous 19,200 bits/sec Synchronous 64 kb/s and 256 kb/sec
c. Routing of packets on a packet-by-packet basis (datagram or fast select)	Not Available
d. Accounting and assembling of packets to permit reassembling of out-of-order packets	Yes Yes
e. Error control (detection and correction) other than by cyclic redundancy checks (CRC)	No error control beyond CRC
f. Concentrators with a throughput or line output that exceeds 9,600 bits/sec	8 or 32 ports. Two output links of 48 kb/s maximum, total 96 kb/s
g. Conversion of packet protocols	Not Available
h. Interfaces and control processes to radio frequency networks	Access to microwave links via G703 - 64 kb/s interface Access to public telephone network including mobile subscribers No access to RF networks
3. Development of the architecture of a switch that contains any of the above features.	This is a French development by Alcatel based on their 8300 processor including hardware and software for manufacturing, testing, installation, maintenance, etc.

Table 7. (Continued)

	Alcatel Packet Switching Systems DPS 1500	DPS 2500
A. Arrays of Know-How (cont'd)		
4. Development and utilization of:		
a. Software that implements or controls any of the above features		
1. Any switch architectures that contain any of the above features	Yes	Yes
2. CAD of such switch architectures, or	Yes	Yes
3. CAD of software or firmware for such switch architectures	Yes	Yes
B. Keystone Manufacturing, Inspection and Test Equipment		
1. Electronic measuring, calibrating, counting, testing and/or time interval measuring equipment.	Yes	Yes
C. Keystone Materials N.I.	Yes	Yes
D. Goods Accompanied by Sophisticated Know-How		
1. Data bases and simulation tools with accompanying documentation required for computer-aided design of the systems architecture and the software for a processor-controlled packet switch.	Yes	Yes
E. Items of Intrinsic Military Utility		
1. Stored program-controlled packet switches except those which conform with IEEE 802	DPS 2500 is a SPC packet switch	
2. Any form of ISDN access	DPS 2500 yes - 2 Mb/s Also ISDN access from Alcatel is E 10 and System 12 for X.25 networks	
3. Software for the above except the minimum specially designed software necessary for the use (i.e., installation, operation and maintenance) of the equipment		

The choice of Alcatel, L.M. Ericsson and Siemens products was based on the fact that their technologies represent the most innovative and advanced level and are equal to U.S. (North American) levels. In fact, Siemens and Ericsson are making efforts to penetrate the U.S. market and the leading switch models from these companies have passed the technical qualification test imposed by the Bell Companies and other U.S. (and Canadian) telephone companies. However, to date switches have been installed in relatively small numbers in North American locations. With Sweden as a non-COCOM country included, the comparison should represent a more realistic picture of the worldwide availability of state of the art digital switching technology.

A distinction made between technological levels 1 to 3 shown in Table 8 is necessary and desirable in order to assess realistically the widespread availability of digital switching technology not withstanding COCOM agreements and controls. It must be assumed that most digital switching products inherently present certain capabilities.

Certainly all are capable of providing plain ordinary telephone service (POTS) and most, if not all, provide for expansion in terms of capacity and for the eventual addition of ISDN and Signaling System No. 7[1] features. The Common Channel Signaling System is an out-of-band, inter-exchange signaling system optimized for operation in digital telecommunication networks in conjunction with SPC exchanges. The signaling information for a number of speech or data channels utilizes a separate transmission channel and is therefore common to or shared by those channels. For ISDN, the common channel signaling system may be considered as an embedded packet network. Two types of nodes exist in such a network: signaling points (SPs) that actually process signaling messages, and signal transfer points (STPs) that act only as intermediate transfer points for messages from one SP to another. An STP may be integrated into an ISDN exchange or may be a stand-alone device. SPs are an inherent part of an ISDN exchange. The signaling speed of 64 kb/s corresponds to the capacity of a standard PCM channel. The system is also suitable for operation over analog channels at lower speeds (4800 bits/s) and can be used on terrestrial or satellite links.

It is interesting to note that some of the countries in Level 2 (Finland, Netherlands, South Korea) and in Level 3 (Brazil, India, Yugoslavia) demonstrated their capability to develop their own digital switching systems without evidence of a "formal" transfer of technology from technology leaders.

Table 8. Classification of Switching Technology (By Country)

Level 1: Most Innovative and Technically Advanced	
Belgium	Japan
Canada	Sweden
France	United Kingdom
Germany (FRG)	United States
Level 2: Varying Mix of Innovative and Adaptive Technology	
Australia	Norway
Austria	Spain
Finland	South Korea
Italy	Switzerland
Israel	Taiwan
Netherlands	
Level 3: Mostly Adaptive Technology	
Brazil	Singapore
China	Turkey
Hong Kong	Yugoslavia
India	
Note: Brazil, India and Yugoslavia fostered some innovative technology but at a technological standard well below leading suppliers.	

1 Also referred to as CCITT No. 7, CCS 7, and SS 7.

Six non-COCOM countries developed digital SPC switching products indigenously and have them in serial production. While these countries, Brazil, Finland, India, Republic of Korea, Sweden and Yugoslavia each have limited export control systems, none specifically control digital SPC systems. Most of their production goes to domestic use except for Sweden.

Sweden's Ericsson is a major force in the world export market . Its AXE switching products are the highest level of technology and are in use in at least 78 countries. A more complete discussion of Ericsson's impact is presented in Appendix A. Finland's Nokia has exported the smaller DX 200 to Asian and Near East countries as well as to the Soviet Union. Brazil, India, Republic of Korea and Yugoslavia have reportedly sold their digital exchanges only to their respective telecommunications authorities, although all four are actively marketing their systems for export. Several countries have exhibited and demonstrated digital switching products at Moscow trade shows.

Digital switches have been available on the world market since the 1970's. Modern digital switches are technically similar to each other in many respects and to a considerable degree they perform the same functions in the same way (Reference Table 6). Not surprisingly, the four systems evaluated in detail against MCTL criteria, Siemen's EWSD, Alcatel's System 12 and E 10 and Ericsson's AXE, demonstrate similar functionality and interoperability. They are used by many telephone administrations and operators in the same network; for example:

- Switzerland System 12, EWSD, AXE
- France E 10, AXE
- Spain System 12, AXE
- Portugal System 12, EWSD
- China System 12, E 10, AXE.

Table 9 provides an overview of major COCOM and non-COCOM designed digital SPC switching systems that have been and are available for export to the world market. At the time of introduction of each system, their capability may have been limited in terms of line, trunk and BHCA capacity, but all were capable of providing POTS. Most systems have evolved technologically to a stage where these parameters have been vastly improved as demanded by the market place and competitive pressures. Most are now fully ISDN and CCSS No. 7 capable (albeit additional hardware and software may have to be purchased).

The systems shown in Table 9 and their associated technology are in widespread use throughout the world. A significant degree of local know-how must not only be assumed but is a fact (for example India, South Korea, Taiwan) not only for the operation and maintenance of such systems, but for design and development as well. The worldwide availability of CCITT and other standards and specifications for the technological characteristics of such systems contribute further to the result that very little, if anything, remains a secret. Although in most cases the indigenous products available from non-COCOM countries do not exceed COCOM control limits (Sweden is an exception) COCOM level technology is present in some countries. Moreover, the number of non-COCOM countries now manufacturing systems is increasing and some of these are offering products for export. (China is offering Alcatel's System 12 to Iran, Poland and Latin American countries.)

A meaningful foreign availability assessment for the Eastern Bloc countries has been a difficult undertaking. While many of the sources which compiled information must be considered reliable, verification of such data has not been possible in many cases. One source lists the digital lines installed in Czechoslovakia, East Germany (GDR), Hungary, Poland, Yugoslavia and the USSR to be as follows:

1988	1989	1990 (Forecast)
288,000	506,000	993,000

Another source reports that with the technology transfer of the French E 10 to the USSR 10 years ago, the planned production capacity for 1987 was 150,000 lines per year, for 1988 300,000 lines per year, and that an eventual full capacity of 1,000,000 lines per year would be reached in the 1989/1990 time frame. Adding to these availability figures are the relatively limited production capabilities of other Eastern Bloc countries, such as the GDR, Czechoslovakia, Poland and Yugoslavia, and increasing sales of digital switching equipment by both COCOM and non-COCOM suppliers. It is concluded that in 1987 quantities were sufficient to constitute considerable foreign availability based on both indigenous Eastern Bloc production and increased non-COCOM sales. Even without the political changes in the Eastern Bloc in the recent months, foreign availability has steadily increased since that time.

Table 9. Selected Digital Switching Systems - Worldwide Inventory (By Country of Design)

Country	Company	System	Year Introduced	Local/ Transit	24/32 Channels	Maximum Capacity Lines	Advertised Trunks	BHCA
Belgium	Alcatel	System 12	1980	Both	Both	100K	60K	750K
Canada	Northern Telecom	DMS 10	1977 Note 1	Local	Both	12K	–	38K
		DMS 100/200	1979 Note 2	Both	24	100		350K
France	Alcatel	E 10, E 10S	1972 Note 3	Both	Both	45K	11.5K	200K
		E 10MT	1979	Both	32			
		E 10B	1979	Both	Both	200K	60K	800K
Germany (FRG)	Siemens	EWSD	1980	Both	32	100K	60K	
Italy	Italtel (Telettra)	Protel UT	1978	Both	Both	100K	60K	
Japan	Fujitsu	Fetex 150	1979	Both	Both	240K	60K	700K
	Hitachi	HDX 10	1981	Both	Both	240K	60K	720K
	NEC	NEAX 61	1979	Both	Both	100K	60K	700K
	OKI	D60/D70	1986	Both	24			
Netherlands	Philips/ATT	NO 5 ESS/PRX	1984	Both	32	150K	60K	500K
United Kingdom (UK)	Plessey/GEC	System X	1980	Both	32	60K	–	500K
United States (U.S.)	ATT/GTE	NO 4 ESS	1976	Transit	24	–	100K	450K
		NO 5 ESS	1980	Both	24	100K	15K	300K
		GTD 5 EAX	1982	Local	Both	145K	46K	750K

Table 9. (Continued)

Country	Company	System	Year Introduced	Local/ Transit	24/32 Channels	Maximum Capacity Lines	Advertised Trunks	BHCA
NON-COCOM COUNTRIES								
Brazil	Elebra	Tropico R	1985	Local	32	4K	–	N/A
		Tropico C	1985	Local		0.192K	–	N/A
		Tropico L	1985	Both	32			
		Tropico T	1985	Transit	32			
Finland	Telenokia	DX 200	1982	Both	Both	40K	7K	100K
India	C DOT	RAX	1986	Both	32	0.512K or	0.512K	10K
		MAX	1986	Both	32	2.048K or	2.048K	40K
		DSS	1986	Both	32	16K + or 32K+	16 K without concentration 8K with concentration	
Republic of Korea (ROK)	Samsung	TDX 1 A	1985	Both	24	10.2K	2.048K	100K
	Goldstar	TDX 1 B		Both	Both			
	Daewoo	TDX 10		Both	Both			
	Otelco							
Sweden	Ericsson	AXE 10	1977	Both	Both	200K	65K	800K
Yugoslavia	Iskra	SI 2000	1985	N/A	N/A	6.4 K	0.9K	

NOTES:

1. When introduced in 1977 DMS 10 capacity was 6,000 L, increased to 8,000 L in 1983 and 12,000 L in 1985.
2. A DMS 300 designed to function as an international transit switch supports 200K BHCA.
3. There is disagreement among technical experts whether the E 10 introduced in 1972 was a SPC or wired logic switching system. In 1979 a new version of the E 10 was designated the E 10B and previous versions the E 10A. It should be noted that the switching matrix in both is similar.

N/A: Not available.

Export control agreements established with several non-COCOM countries appear to be effective in spirit but somewhat lacking in actual application of controls. Sincere attempts are made to follow U.S. policy, with adjustments or substitutions made to the manufacturing process to preclude re-export of U.S. technology. The availability of non-U.S., uncontrolled components is increasing from many sources. Other practices impact on the Soviet Bloc's access to controlled equipment. Sweden is reluctant to develop a list of critical, dual use items because limiting exports to one country would not be consistent with traditional Swedish neutrality. South Korea seeks trade with the Eastern Bloc to earn foreign exchange and to stimulate its economy. Their main concern appears to be to prevent transfer of technology to North Korea. Transfer to the Eastern Bloc is of lesser concern. Other countries (i.e., Taiwan) are similarly active in their self interest.

Since September 1988, nearly all major digital SPC exchanges listed under Interpretive Note 36 and based on Administrative Exceptions 6 and 7 have been available for export to the Eastern Bloc, although with clearly stated technological restrictions. U.S. suppliers have testified that the protection of their proprietary features is related to the control of strategically important technology. It is their practice when selling their systems to disable features not purchased and to rarely, if ever, provide source code for the software necessary to operate the system. They further believe that it is impossible for customers to modify software and so increase capacity or features. This belief may create a mistaken sense of security. Many systems are purchased in sizes far below maximum capacity. In such cases expansion is achieved by the purchase of additional hardware without the need to modify software. In some countries, systems are purchased for the forecast loading of an exchange, e.g., current loading is 4,000 lines and 20,000 line exchange is purchased. While some additional features are purely software-controlled, many require both software and hardware. To say modification of software is impossible is not realistic. There have been instances of reverse engineering of source code. Another factor that must also be noted is the large population of software designers from non-COCOM countries employed by U.S. switch suppliers, who eventually return to their home countries with a significant and comprehensive knowledge of the "protected" software design. The practices of major suppliers in other countries do not necessarily follow, which may account for the relatively poor competitive showing of U.S. suppliers in the international market.

The capability of a foreign country to produce digital SPC switching systems requires considerable lead time, even with a complete transfer of technology. Initial production is usually assembly of supplied components. The development of local sources for the supply of components meeting required quality standards may never reach the 100 percent level. Even at lower levels, two to three years is not an unusual period of time for in-house manufactured or locally purchased components. The quality of the total manufactured system faces problems as well and maximum capacity and quality usually is not reached until three to five years after start-up.

A large capital investment in old, but still operational and useful analog, non-SPC exists throughout the world. Because of the large costs involved, the installation of replacement digital equipment will be achieved on a deliberate, economically reasonable rate. This is particularly true for the Eastern Bloc countries. Their requirement for digital SPC switching is a gradual one over a period of 10-20 years. The limitation of modernization therefore is less based on the availability of technology than on purely economic grounds. It is also noted that the requirements of the civil telecommunications network is many times greater than that of dedicated military networks. As previously stated, the ability of the military to utilize the civil network cannot be denied, although little evidence is available to indicate that a significantly improved military C^3 capability would be achieved through Local Area Networks (LAN), Metropolitan Area Networks (MAN), and Wide Area Networks (WAN). Numerous suppliers in many countries which are not subject to COCOM restrictions are capable of providing the necessary hardware.

III. CONCLUSIONS AND RECOMMENDATIONS

The information assembled for this report and the data contained in the various tables indicates that digital switching SPC technology equal to U.S. technology is widely available, directly or indirectly, to any country willing and able to shoulder the heavy economic burden necessary. The analysis also reveals that technological restrictions are not always effective in the light of commercial and political realities. The independence attained by Eastern European countries, the imminent reunification of West and East Germany, and the impact of EC 92 on the telecommunication structure in that part of the world requires a new approach to the export policy and regulations in effect today. This is not to say that other parts of the world, particularly Latin America and the Far East, should be considered as less important. Next to Eastern Europe, China represents the largest unfilled demand.

It is difficult to assume that digital switching technology can be controlled and protected over the long run during the 1990's. Consider that Alcatel has supplied over 40 million lines; Ericsson has switching equipment installed in 80 countries representing almost 30 million lines; Siemens has sold its EWSD to 89 administrations and telephone companies in 37 countries; Fujitsu has 6 million lines in 13 countries and NEC 17 million lines in 53 countries. Increased political and commercial relations with formerly proscribed countries should be accompanied by lifting of restrictions covering telecommunications equipment. It is recommended that:

- The sale of digital SPC switching equipment be decontrolled to Eastern Europe including the USSR;
- Review, on a case by case basis, of technology transfers which include the provision of complete production facilities be continued;
- Consideration be given to also release restrictions on ISDN and Signaling System No 7 for reasons discussed in other parts of this report;
- Restrictions continue for the sale of the U.S. MSE communications system and similar equipment.
- Restrictions on systems which can be used for mobile application in the civil network be re-examined. ATT donated such a system to China and the USSR and several systems have already been delivered to East Germany by Alcatel.

IV. REFERENCES

Alcatel, *ISDN--Its Philosophy, Characteristics and Implementation in System 12.*

Department of Commerce Reports (John Blackburn):

"Deutsche Bundespost Organization and Research," May 5, 1989.

"ITALTEL, Italy's Largest Manufacturer of Telecommunications Equipment," March 28, 1989.

"Recent Developments in Telecommunications in Italy," March 3, 1989.

"Siemens, the German Electronics Company," May 26, 1989.

"TELETTRA, Italy's Second Largest Manufacturer of Telecommunications Equipment," March 9, 1989.

"U.S. Marketing in Europe in the Single Market of 1992 in Computers, Telecommunications, and Microelectronics."

Commercial brochures for digital switching systems shown in Table 1.

Corporate market studies from Alcatel, GTE, and L.M. Ericsson.

Datapro Research Corporation, *Public Switches*, 1988.

Deutsche Bundespost, *ISDN--The Deutsche Bundespost's Response to Telecommunications Requirements of Tomorrow.*

International Switching Symposium, 1984 Proceedings and 1987 Proceedings.

Northern Business Information, *World Public Switching Market*, 1989.

Telecommunications Research Centre, United Kingdom:

The Future of Switching

World Telecoms Research Weekly Reports.

Trade Publications:

Communications Week

Telecommunications

Telephony.

APPENDIX A

L. M. ERICSSON
(TELEFONAKTIEBOLAGET L.M. ERICSSON)

L.M. ERICSSON--PROFILE

A. BACKGROUND

L.M. Ericsson (LME), founded in 1876, is one of the world's leading telecommunication companies. Its reputation is based on leading edge technology, advanced systems capabilities, international experience and customer orientation. Ericsson is also a leading supplier of electronic defense systems. The parent company, Telefonaktiebolaget L.M. Ericsson and Ericsson's world headquarters, is located in Stockholm, Sweden. The share capital of the parent company is owned by ten Swedish investors controlling 73 percent of the shares, with shareholders outside Sweden owning 27 percent of the shares. Following a recent streamlining of its operations, Ericsson has more than 65,000 employees and operations in 80 countries. 32,000 of these employees are in Sweden. Ericsson operates as a domestic company in each market, often establishing local production and technical development facilities. Resultantly its manufacturing operations are decentralized around the globe. Ericsson's wide range of telecommunication products provides all equipment necessary for use in public telephone networks (including activities in business communications).

The company's core involves seven business areas:

- Public Telecommunications
- Radio Communications
- Business Communications
- Network Engineering and Construction
- Cables
- Components
- Defense Systems.

Of these, public telecommunications represented almost 44 percent, radio communications 15 percent, business communications 11 percent, and the others the remainder of Ericsson's total business. Only a small percentage of its total business comes from Sweden (in 1988) even though the company represents 70 percent of the total electronics output in its homeland. Unlike major suppliers in other countries, Ericsson never had the protection of a large home market and therefore has always been forced to export. L.M. Ericsson is active on every continent of the world with production facilities in Europe, Latin America, Australia, India, Malaysia, and Iran. Including its manufacturing facilities, LME has a presence in almost 80 countries worldwide.

B. TECHNOLOGICAL AND COMMERCIAL FACTORS

LME is strong in Applied Telecommunications Research, and weak in primary (component technology) research. As far as semiconductors are concerned, LME purchases much more than it makes. Research and development expenditures amount to about 11 percent of LME's sales, which in 1988 was approximately $584 million. This relatively large amount actually is small compared to other major companies. AT&T spends three times as much for R&D and Alcatel, Northern Telecom or Siemens spend twice as much. It is reported that 10,000 of LME's 65,000 employees are engaged in R&D activities worldwide, but since LME labels activities like Engineering and Sales Support, Guideline Development, and production of documentation as R&D activities, the number of people assigned to R&D appears to be inflated. R&D facilities exist chiefly in Sweden, but also in Italy, Australia, Norway, Brazil and Spain. However, the foreign (to Sweden) locations are normally only responsible for equipment adaptations for local markets, sales and engineering support. All major R&D is Swedish. The company which developed the AXE technology, ELLEMTEL, is jointly owned by LME and Televerket, the state-owned PTT, which in Sweden has a monopoly on telecommunications for the transmission of voice, text and data.

LME's worldwide reputation and competitive strength is its AXE switching technology. The AXE 10 digital switch is used in 78 countries, with almost 2000 exchanges in service and 720 more on order. In terms of digital access lines, this represents 19 million lines installed and 9 million lines on order, excluding mobile subscribers, which has 800K installed subscriber lines and 600K on order. The AXE system's application areas includes:

- Local (Central Office) Exchanges
- Transit Exchanges for National and International Traffic
- Combined Local/Transit (Trunk) Exchanges
- Exchanges for Rural and Suburban Areas and Small Towns

- Exchanges for Cellular Mobile Subscribers
- Operator Subsystem for Call Assistance
- Network Management System for Real Time Network Supervision.

The architecture of the AXE is that of a fully digital SPC switching system including:

- Two levels, with both central and distributed control
- Central control with one duplicated central processor (parallel synchronous mode) with two different central processor structures:
  - -- APZ 211 (16 bits) for small to medium applications
  - -- APZ 212 (32 bits) for high capacity requirements, including ISDN applications
- Distributed control with several duplicated processors (front end or regional)
- TST duplicated digital group switch
- Remote digital subscriber unit with CCS No. 7.

LME's Common Channel Signaling System No. 7 (CCS No. 7) equipment, first tried in Sweden in 1983, has found wide acceptance and is installed in more than 20 countries. Table A-1 shows LME's worldwide CCS No. 7 installations for year-end 1987 and those which were planned for 1988 and which by now are no doubt in operation.

The AXE digital switch with its unified architecture is fully "modular." All hardware- and software-defined functions exist as independent modules that form the building blocks of the central switch. The switching system consists of several regional computers controlled by a fully duplicated central processor.

There are two basic model systems. The smaller version, available in several sizes depending on the number of lines to be served, is based on the proprietary APZ 211 Central Processor, with a call handling capacity of 50K to 150K Busy Hour Call Attempts (BHCAs). The larger switch is based on the APZ 212 Central Processor with a capacity of up to 800K BHC's. The larger system is the one designated for ISDN use.

The AXE was one of the earliest digital switches on the market, introduced in the mid 1970's. Since that time, it has been gradually updated, and is now fully ISDN-compatible. This early start gave Ericsson the opportunity to test and perfect innovations in actual use when many other digital switching systems were still in development.

Table A-1. Ericsson's AXE 10 CCS No. 7 Installations (By Country)

Country	Service Data	Signaling Points
Sweden	4/83	78
Saudi Arabia	11/83	3
Finland	6/84	19
Denmark	7/84	66
China	6/85	8
United Kingdom	6/85	75
Italy	6/85	2
United Arab Emrts.	2/86	15
Ecuador	3/86	8
Botswana	8/86	5
Australia	12/86	25
Uruguay	12/86	9
Bahrain	2/87	3
Brazil	4/87	11
Cyprus	6/87	6
Ireland	8/87	1
Mozambique	10/87	5
Zimbabwe	12/87	1
Kuwait	1988	20
Liberia	1988	2
Mexico	1988	2
Suriname	1988	1
United States	1988	9
TOTAL		374

Source: L. M. Ericsson

Note: Significant additional U.S. orders have been placed by the Regional Bell Operating Companies (RBOC).

LME's traditional good standing and reputation, particularly in Third World countries, can be traced to its technology transfer and export policies. Over 95 percent of digital switching equipment produced by LME is sold outside of Sweden. Further, the company's neutral image of a Swedish company, Swedish majority shareholders and Swedish top management has a significant impact as one company, one system and a powerful, homogeneous organization. Long term continuity is emphasized in LME's relationship with its employees, customers, agents and joint venture partners.

It should be noted the LME has had a long-standing relationship with the USSR and that transactions with the Soviets and the Eastern Bloc countries are not shown as such in the company's business and financial reports.

APPENDIX B

INTEGRATED SERVICES DIGITAL NETWORK (ISDN)

INTEGRATED SERVICES DIGITAL NETWORK (ISDN)

The technical advance from analog to digital switches over the last dozen years resulted from the convergence of telecommunications and computer technologies. The voice-only mode of communications has been replaced by all kinds of data traveling over the same lines and through the same switches.

As the next phase in the evolution of the switching function and as one where currently an inordinate amount of technological effort is being expended, ISDN offers integrated access to advanced data and voice services by transporting voice and data signals simultaneously over a single high-bandwidth channel.

To be able to achieve the stated purposes of ISDN the formulation of international standards and compatible national standards is a must. Such standards have been developed by the CCITT (International Telegraph and Telephone Consultative Committee) and the ISO (International Standards Organization). In the United States ANSI (American National Standards Institute) is also involved. The CCITT recommends international standards for compatible voice communication. The ISO recommends the standards for data communications on an international level. ANSI applies these standards to North America (including some countries which have adopted the North American Standard). Since the mid 1970's establishing these ISDN standards continues to be an ongoing project. The recommendations of these organizations are updated and published every four years (the CCITT Red Book in 1984 and the Blue Book in 1988). ISO and ANSI publish updates as required. The relatively limited standards established so far are well known by switching technology design and development experts throughout the world. However, the growth of ISDN so far has been slow, basically due to still incomplete standards and lack of economically mature applications and terminals.

Because of the importance of such capabilities to the telecommunication infrastructure the level, volume and intensity of technological and public policy debates is very high. It is not surprising that some view ISDN as a "product" while others perceive ISDN as "a set of universal standard processes and new services" and as "international protocol and interface standards."

The concept of ISDN is a single network that provides universal communication facilities between many different types of users. An efficient ISDN uses a common transmission system for all kinds of traffic, and provides a standard access to the network for all the different types of terminal equipment that it must serve. Existing but non-compatible terminals are converted to support this standard access by the use of terminal adapters whereas terminals designed for ISDN automatically conform to it. The main aim of ISDN is to provide open systems interconnection and communication. It constitutes the next state-of-the-art advance and brings together into one integrated network the range of services currently offered individually on different types of public networks. Figures B-1 and B-2 depict the range of services and the technological evolution in digital switching networks. While there is general agreement on the desirability of the services made possible by ISDN, there is much confusion if the development path to Broadband ISDN and beyond should be direct or by the way of evolution over narrowband ISDN. The time frame by which each phase of technological advance is to be implemented and the economic viability of each approach are also in question.

Basic Rate Access (BRA) ISDN is narrowband ISDN structured in the 2B+D format and comprises two duplex 64 kb/s B channels for voice and data and one associated duplex 16 kb/s D channel for signaling (and optional low-speed packet data) for an aggregate channel capacity of 144 kb/s. Primary Rate Access (PRA) ISDN is structured in the 23B+D format (30B+D in most countries outside the U.S.) and comprises 23 duplex 64 kb/s B channels for voice and data and one associated duplex 64 kb/s D channel for signaling with an aggregate channel capacity of 1.5444 Mb/s. Current available T1 transmission (the first level of multiplexing; a 24-voice channel signal operating at 1.544 Mb/s) provides almost similar capacity, but lacks the advantages of common channel signaling (CCS No. 7). Broadband ISDN (B-ISDN) is the next state-of-the-art phase by providing dynamically configurable channels or packets at rates of 150 Mb/s or greater via optical interfaces. Unlike basic and primary rate ISDN, which are based on synchronous fixed channel techniques designed for the wire pair, the idea behind broadband is to provide a universal, flexible transport technique over optical fiber for both voice and data and at the same time accommodate the higher bandwidth requirements of broadcast quality TV, including high definition television (HDTV).

Much of the diverse opinion about the utility of (narrowband-64 kb/s) ISDN is not only based on technological, but also increasingly on economic factors. There are more

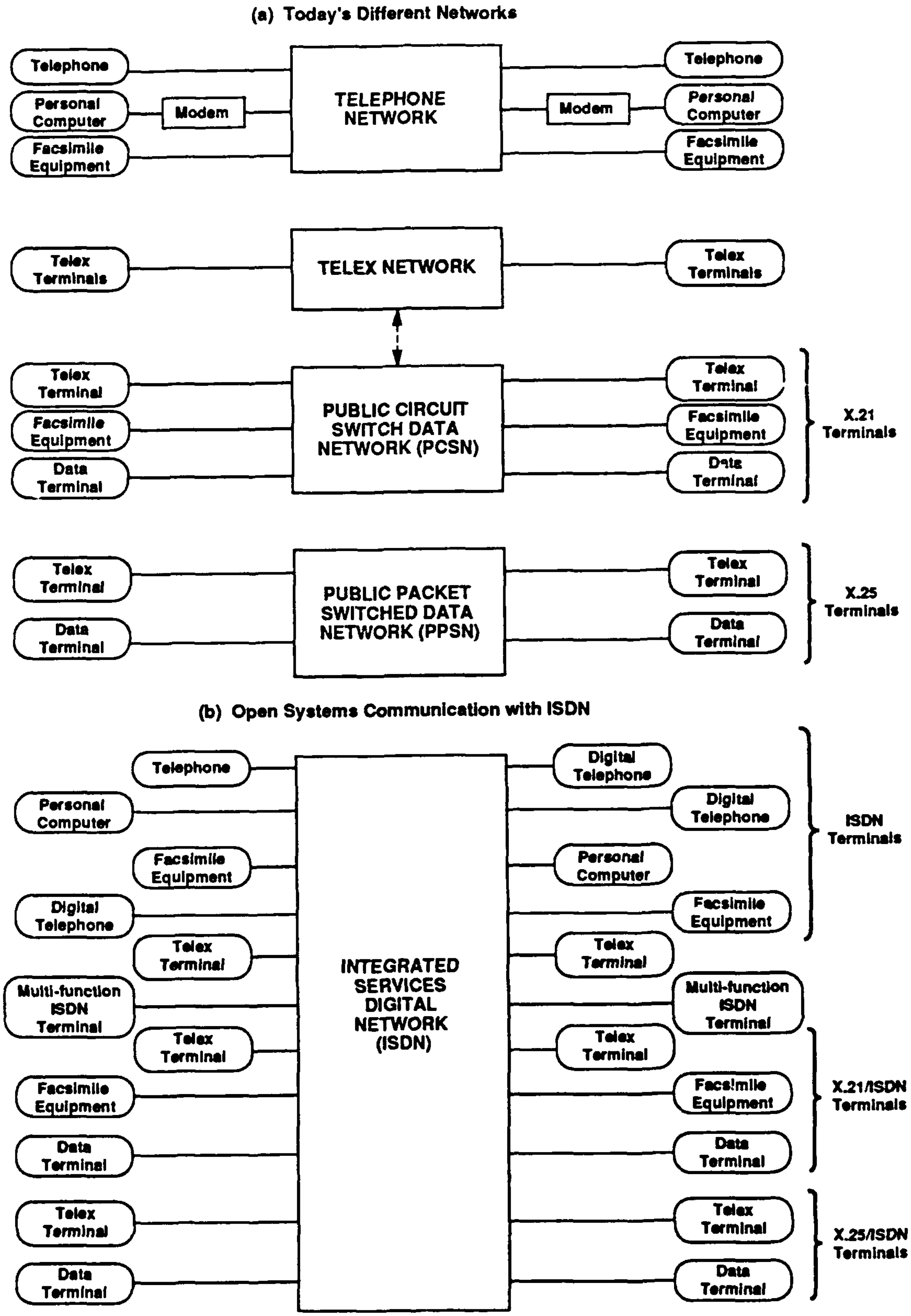


Figure B-1. Current Networks Versus ISDN

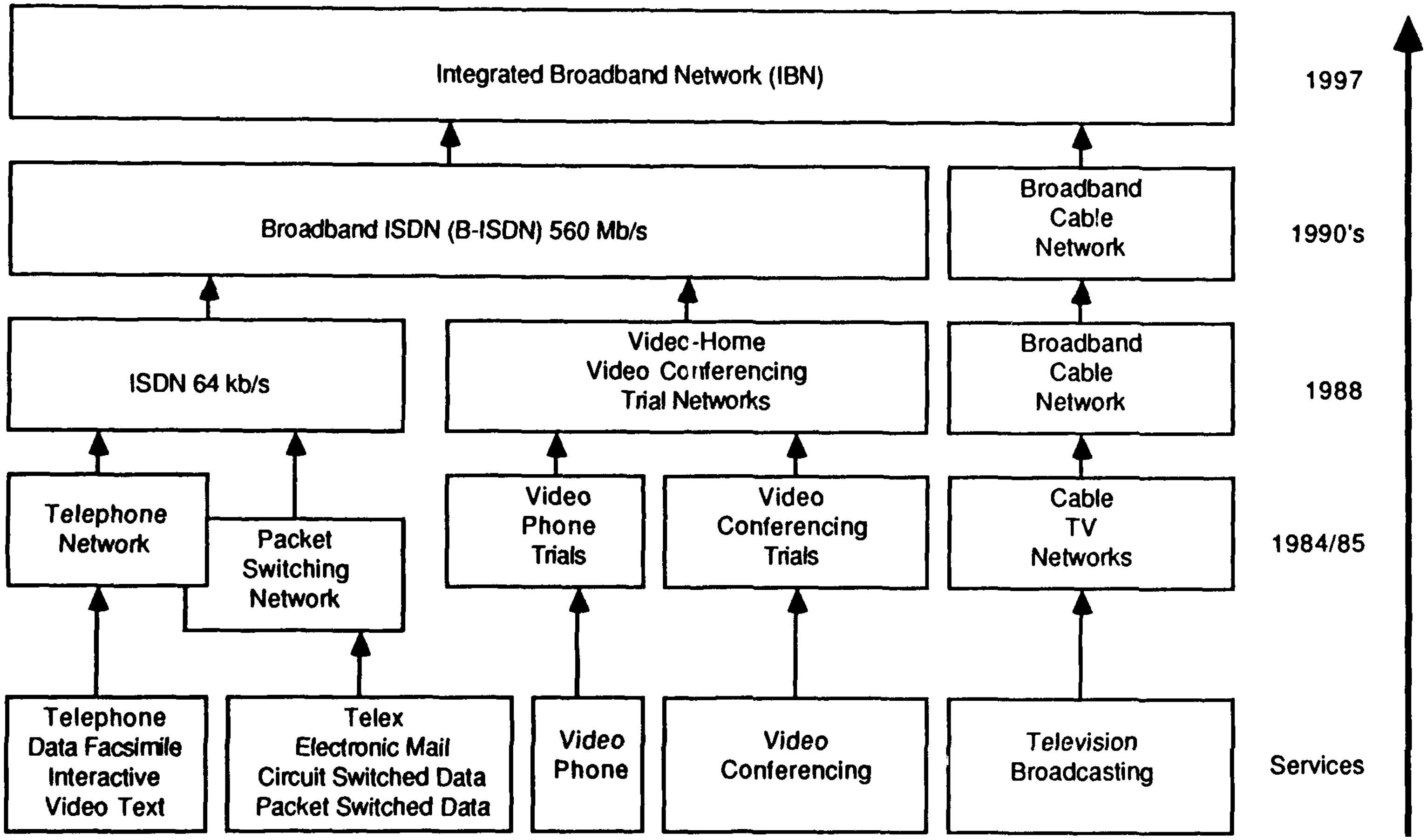


Figure B-2. Digital Switching Network Evolution

and more indications that narrowband ISDN will not provide benefits commensurate with its considerable cost. Indeed some of the largest telecommunications companies are having second thoughts about committing such large resources to providing the ISDN function for its own switch model at a time when the demand for such services is not entirely clear. They also are concerned that the current focus on narrowband development ignores the next step, broadband ISDN which promises enhanced functions and performance for its costs. GTE recently announced cancellation of its ISDN development for the GTD 5 EAX and is relying on open interface equipment currently on the market rather than pursuing a far more costly but proprietary solution. There is a preponderance of opinion that today's narrowband ISDN effort is likely to become obsolete before it is implemented. The opinion also widely held is that the United States is falling behind in the implementation of ISDN and that most European nations and Japan are pushing full speed ahead on broadband ISDN. The European community launched the "European Strategic Program for Research and Development in Information Technologies" (ESPRIT) in 1984 with the aim of providing the European information industry with the technology to become and remain competitive in world markets in the 1990's. The ESPRIT program was followed in 1988 with the "Research and Development in Advanced Communications Technologies for Europe" program (RACE). The goal of RACE is to prepare Europe for the introduction of Integrated Broadband Communication (IBC) by 1995 based on the evolving ISDN technology. The current broadband BERKOM trial being conducted in Berlin illustrate these efforts. BERKOM, Berliner Kommunikationsystem, is the largest B-ISDN project in the world. It was started in 1986 by the Deutsche Bundespost (PTT), the Senate of Berlin, Siemens, and Standard Electrik Lorenz (SEL), formerly part of ITT, now an Alcatel subsidiary, and others. The system, based on Alcatel's System 12 digital switch, utilizes a broadband module and operates in a synchronous mode. Recently Siemen's announced the world's first application of broadband switching based on Asynchronous Transfer Mode (ATM) technology which they developed for the BERKOM test network.

The material presented in Attachment 1 to Appendix B provides an outline of the "Single European Act and Pan-European ISDN Service Plan." It emphasizes important economic, competitive and regulatory considerations, provides the organizational framework for standardization planning and attempts to establish a time frame for ISDN implementation by the European Community (EC) countries.

Prior to this plan European administrations followed various strategies for their networks only claiming to aim at a Europe-wide ISDN. With the implementation of ETSI

(European Telecommunications Standards Institute) and the Memorandum of Understanding (MOU) on Pan-European ISDN they have agreed to the following:

- ISDN subscriber interfaces,
- International CCS No. 7 ISDN signaling,
- Sets of services and features.

Since the original time schedule for ETSI specification was postponed it is obvious that the introduction dates for initial connection and installation will be delayed as well.

In Europe the international ISDN connectivity is still a much discussed topic. The Quadipartite (France, Germany, Italy and the UK) agreed on an interim standard to achieve early connectivity. The MOU specified a version of CCITT CCS No. 7 as the standard to be used beginning in 1992 by all EC countries. Based on the interim standard connections will be available between:

- France and Germany — February 1990
- UK to be connected — November 1990
- Italy to be connected — December 1990.

By late 1989 an ISDN local exchange based on German protocol was installed in Rotterdam, the Netherlands, and connected directly to a toll exchange within the German (Bundespost) network. British Telecom/UK is installing an international Gateway for connections with ATT/U.S. and KDD-NTT/Japan to be operational by the mid 1990s. It does not seem probable that the Quadripartite will change to the later standard after only a relatively short period of operation. Instead, pressure is being brought on the other members also to implement the interim standard if for no other reason than to result in a longer transition period (until 1993/94). As of December 1989 more than 45 European ISDN exchanges representing the equivalent of 116,000 B-channels were in service or installation.

While there is much activity in the U.S., the speed of introducing country-wide ISDN service is still depending on commercial customers acceptance and needs. Many connectivity tests are in progress and/or have been completed. ATT 5ESS and Northern Telecom DMS 100 digital switches are being used to test the different interworking protocols of the regional and long-distance telephone companies. Based on the results, the integration of the various ISDN "islands" should be completed during 1991. In February 1990 ATT successfully demonstrated 64 kb/s dial-up international ISDN service in collaboration with KDD-NTT/Japan. CCITT No. 7 signaling was used for end-to-end circuit establishment and control. ATT first offered switched digital international service at 56 kb/s to France in 1988 and to the UK, Jamaica and Japan in June 1989.

Japan's NTT launched commercial ISDN service in April 1988 with standards based on CCITT recommendations and drawn up by the Telecommunication Technology Committee (TTC). Japan and Korea have also "founded" the Asian ISDN Council (AIC) to motivate the Asian countries to adopt their implementation standards. Other members include Indonesia, Philippines, Singapore, Thailand, Borneo and China. The clearly expressed aim of AIC is to implement a third ISDN center and try to create a captive "Far East Home Market."

ATTACHMENT 1

Single European Act and Pan-European ISDN Service Plan

- Europe 92 and the Green Paper
- European Standards
- ISDN Services and the Memorandum of Understanding
- International Connectivity
- Open Network Provision

Europe 92: The Single European Act

- Legally binding on all 12 EC member states:
  Free movement of:
  - People
  - Capital
  - Goods
  - Services

  throughout all EC member states
- In particular the Single Market will be implemented for some until now mostly regulated sectors
  - Financial and insurance markets
  - Transport
  - Telecomunications
- A study suggested that this Single Market could
  - Create 5 M New Jobs
  - Cut PRICES by 4.5 percent
  - Increase Gross National Product by 7 percent

Europe 92: Competitive Community-Wide Telecommunications will be a Major Backbone for European Economy

- Due to the transformation into digital technology telecommunication and data processing are merging into a huge single economic sector
- Regulation changes are inevitable to ensure the optimum environment for:

- Users
  - Telecom operators

In the fields of:

- Terminals
  - Telecom infrastructure
  - Value added services

- The "Green Paper" defines the overall policy and has been approved by the European Parliament

EC Green Paper on the Development of the Common Market for Telecommunications Services and Equipment

- Aim: Creating more freedom for users, industry, and telecom administrations
  - Greater variety of services
  - Better quality
  - At lower cost
- Coordinated introduction of ISDN
- Promotion of telecom investment in peripheral regions
- Exclusive rights for the provision of the basic network infrastructure
- Opening of the terminal and services market to competition
- Cost-oriented tariffing

EC Green Paper: Schedule of Actions

December 1989:	Progressive opening of telecom services market (voice, telex and data communications are not included in this phase)
December 1990:	Free Competitive terminal market
January 1991:	Liberalization of data communications
January 1992:	Review of implemented status on cost-oriented tariffing
January 1992:	Complete opening of procurement within EC member states

- Harmonized Open Network Provision conditions (ONP) are the ultimate aim for that progressive process

European Bodies of Standardization

- European Conference of Postal and Telecommunications Administrations (CEPT)
- Member countries inside and outside the EEC
  - Creating European telecommunications standards
- Group Analyse Et Prevision (GAP)
  - Established in 1985 by European governments and PTTs
  - GAP report recommends a phased program of ISDN introduction
- Normes Europeenes de Telecommunications (NET)
  - Formally converted CEPT technical recommendations for terminal equipment
  - Mandatory to all signatory countries (18), will supersede any prior national specifications
- Technical Recommendations Applications Committee (TRAC)
  - Guiding the technical working groups dealing with NETs
- European Telecommunications Standards Institute (ETSI)

European Telecommunications Standards Institute (ETSI)

- ETSI run by CEPT, industry and users
- Most standards work will be transferred from CEPT to ETSI
- Concerned with three areas:
  - Telecommunications
  - Telecom and information technology
  - *Telecom and broadcasting*
- Output documents called European Telecom Standards (ETS)
- ETSI will bring together the work of main European bodies
  - ITSC
  - CEN
  - CENELEC
  - EBU
  - TRAC

Standards Covered by NET
(Normes Europeenes de Telecommunications)

NET 1:	X.21 circuit-switched data-network access
NET 2:	X.25 packet-switched data-network access
NET 3:	ISDN basic-rate access
NET 4:	PSTN basic access
NET 5:	ISDN primary rate access
NET 6:	X.32 access (for packet switching)
NET 9:	ISDN terminal adapter (initially X.25)
NET 10:	Access to GSM
NET 11:	GSM mobile terminal
NET 20:	Modem Class 1 (General)
NET 21:	V.21 modems
NET 22:	V.22 modems
NET 23:	V.22 bis modems
NET 24:	V.23 modems
NET 30	Group-3 facsimile
NET 31:	Group-4 facsimile
NET 33.	ISDN digital telephony

Memorandum of Understanding (MOU) and
ETSI Strategy for European ISDN Service

Agreed target date for commencement: 1992

Service to be opened by all parties: December 1993 at the latest

International Connections

- Early connections: TUP/(CEPT T/CS 43 01/02) used by bilateral agreements)
- 1992/93: CCIT CSS No. 7 ISUP Blue Book rev. ETSI

User Network Interfaces

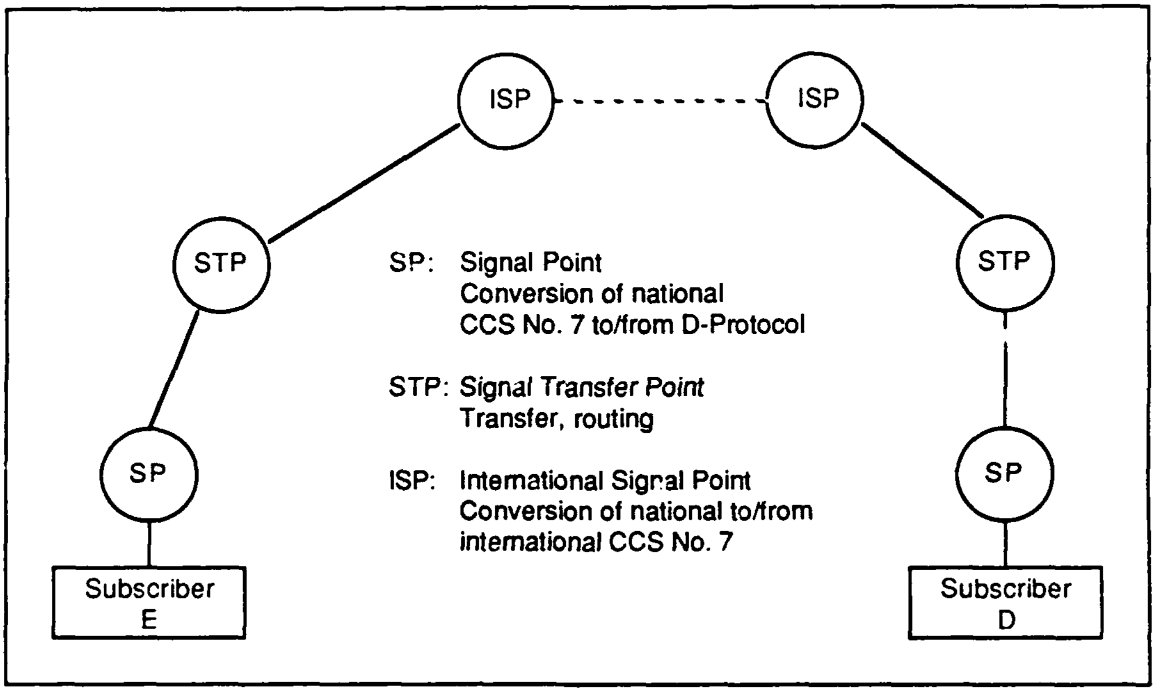
- Basic Access acc. to NET 3
- Primary Rate Access acc. to NET 5

ETSI: European Telecommunication Standard Institute
NET: Normes Europeenes de Telecommunications

European ISDN: Supplementary Services Uniform Standards Applied to

- Conference Services
  - Conference call, add-on
  - Meet-me conference
  - Three party service
- Call Waiting
- Call completion to busy subscriber
- Closed user groups
- User-to-user signaling

International ISDN CCS No. 7 Connection



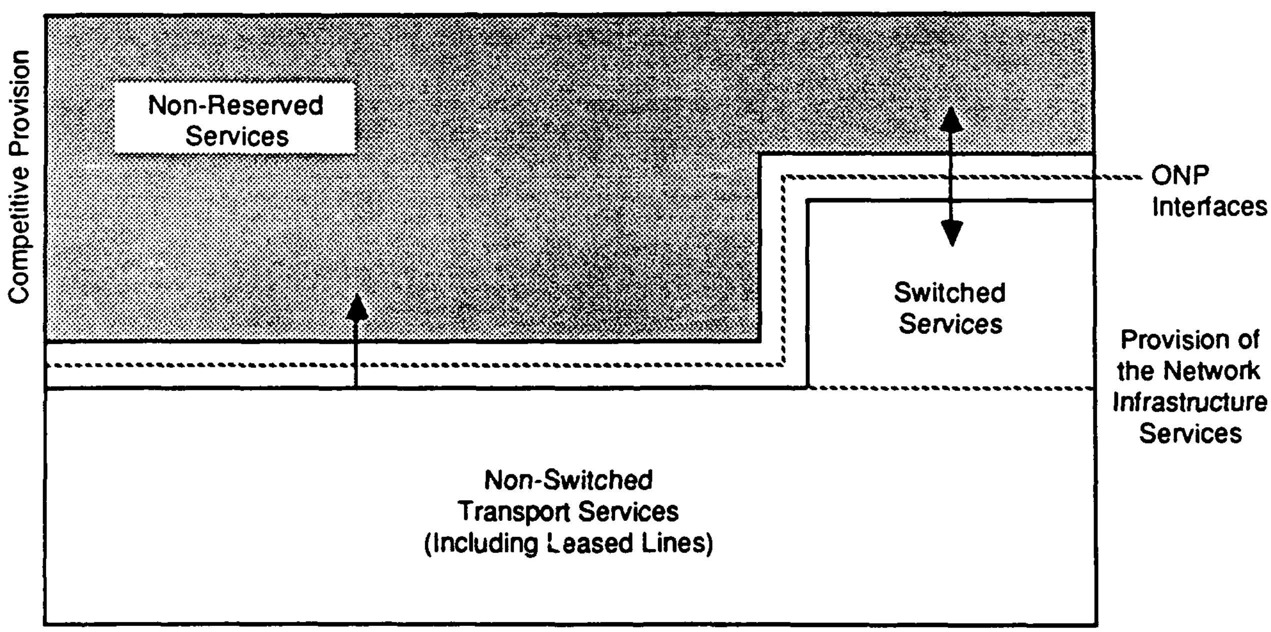
International ISDN Connectivity

- Early connections: Bilateral agreements on CCS No. 7-TUP+
  - France, Germany, Netherlands: end of 1989
  - Quadripartite (France, Germany, Italy, UK): mid 1990
- Pan-European ISDN for 1992/93:
- CCIT CCS No. 7 ISUP Blue Book rev. ETSI
- Connectivity with Japan and USA under discussions

Open Network Provision (ONP)

- *Applied for open access to and open use of public network infrastructure and public services*
- Conditions may include:
  - Technical interfaces
  - Conditions of use
  - Tariff principles
- Conditions must:
  - Be objective
  - Be transparent and published
  - Guarantee equal access and nondiscriminatory
- EC directives on ONP conditions will include:
  - Schedules for implementation
  - Details of conditions of use
  - Details of harmonized tariff principles
- The process for specifying ONP is flawed:
  - GAP first proposals (Jan. 89) under heavy discussions
  - Telecom administrations dominate the process
  - The 9-step process is inherently long and complex

ONP Provides Basic Interfaces to Telecom Administrations Offering



Conclusions

- ISDN is considered as the telecom backbone for the 1992 Single European Market
- European States have agreed to implement this backbone access to European standards fitting to CCITT recommendations
- The European community opts for a liberalized telecommunication environment in a market of about 350 million people