

# Keskusteluaiheita Discussion papers

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FINNISH HIGH-TECH INDUSTRIES AND  
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STUDY 1: THE TELECOMMUNICATIONS  
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**ABSTRACT:** This paper analyzes the Finnish telecommunications equipment industry in an international context in relation to the EC integration process and presents future scenarios for the industry.

The EC integration has already and will continue to have an impact on the telecommunications industry. The Green paper spells out the Commission's intentions. Changes are taking place in standards and certification requirements, technological cooperation, as well as potentially in the public procurement policies. The EC measures will add further impetus to the ongoing structural change taking place in the industry.

The significance of EFTA and the Soviet Union as export markets is more pronounced than that of the EC, but the EC's importance lies primarily in the still narrow and rapidly growing sectors. In addition the various alliances in production and technology cooperation emphasize the importance of the EC for the development of the Finnish telecommunications industry. The effects of EC integration and the future scenarios are presented in the conclusions of the paper.

**KEY WORDS:** Telecommunications, EC integration, high technology

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**TIIVISTELMÄ:** Työn tavoitteena on analysoida Suomen telekommunikaatioteollisuutta kansainvälisillä markkinoilla varsinkin suhteessa Euroopan yhdentymiskehitykseen ja luonnostella tulevaisuuden skenaarioita tälle teollisuudenalalle.

Euroopan integraatiokehitys vaikuttaa, ja tulee vaikuttamaan, lähinnä standardien, teknologiyhteistyön ja mahdollisesti julkisten hankintojen alueella Suomen telekommunikaatioteollisuuteen. Merkittävät muutokset tuotantorakenteissa ovat ainakin osiltaan seurausta EY:n toimista.

EFTA:n ja Neuvostoliiton merkitys vientimarkkinoina on merkittävämpi kuin EY:n, mutta EY:n merkitys korostuu pääasiassa vielä kapeilla mutta nopeasti kasvavilla sektoreilla. Lisäksi tuotanto- ja tutkimusyhteistyö lisää EY:n merkitystä Suomen telekommunikaatiosektorin tulevaisuuden kehitykselle. EY-integraation vaikutukset ja tulevaisuuden skenaariot on esitetty yhteenvetokappaleessa.

**ASIASANAT:** Telekommunikaatio, EY-integraatio, huipputeknologia



## PREFACE

The study of the future outlook of the Finnish high-tech industries in the light of the European Community's internal market program was initiated in late 1988. The project assesses the present position in selected high-tech sectors especially in relation to the EC, and analyses the future scenarios in relation to the European integration process.

The study is carried out by Teräs-Kari Ltd Consulting with the financial support of the Ministry of Trade and Industry. The study is conducted by Research Economist Severi Keinälä, MA, MBA, under the supervision of Research Manager Harri Luukkanen, BBA.

ETLA, The Research Institute of Finnish Economy is conducting and organizing various studies related to European integration on both the microeconomic and macroeconomic levels. The present study on the telecommunications industry supports ETLA's ongoing activities in this field.

This paper will be followed by others concerning the data processing industry and the medical industry, also prepared by Teräs-Kari Ltd Consulting. The final report will be available in the beginning of 1990.

Pentti Vartia  
Managing Director  
ETLA



# TABLE OF CONTENTS

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|                                                                                                        |     |
|--------------------------------------------------------------------------------------------------------|-----|
| PREFACE.....                                                                                           | i   |
| TABLE OF CONTENTS.....                                                                                 | ii  |
| LIST OF ABBREVIATIONS.....                                                                             | iii |
| 1 Introduction.....                                                                                    | 1   |
| 2 Global Industry Background.....                                                                      | 4   |
| 2.1 Products and Market Segments.....                                                                  | 4   |
| 2.2 Markets.....                                                                                       | 5   |
| 2.3 Production.....                                                                                    | 7   |
| 2.4 Trade.....                                                                                         | 14  |
| 2.5 Main Market Segments.....                                                                          | 18  |
| 2.5.1 Fixed Line Telecommunications Equipment..                                                        | 18  |
| 2.5.2 Mobile Telecommunications Equipment.....                                                         | 22  |
| 3 Areas of Change in the European Community.....                                                       | 29  |
| 3.1 The Commission's Measures.....                                                                     | 29  |
| 3.2 Standards and Certification Requirements.....                                                      | 31  |
| 3.3 Opening of Public Procurement.....                                                                 | 32  |
| 3.4 Technology Cooperation.....                                                                        | 33  |
| 4 Finnish Telecommunications Industry.....                                                             | 34  |
| 4.1 Overall Picture.....                                                                               | 34  |
| 4.2 Producers and Products.....                                                                        | 38  |
| 4.2.1 Central Office Equipment.....                                                                    | 40  |
| 4.2.2 Transmission Equipment.....                                                                      | 42  |
| 4.2.3 Customer Premises Equipment.....                                                                 | 46  |
| 4.2.4 Dedicated Networks.....                                                                          | 51  |
| 4.3 Strengths and Weaknesses of Finnish Producers..                                                    | 53  |
| 4.4 Opportunities and Threats of EC Integration....                                                    | 58  |
| 5 Conclusions.....                                                                                     | 64  |
| 5.1 The Importance of the EC for the Finnish<br>Telecommunications Industry.....                       | 65  |
| 5.2 The Effects of the EC Integration on the Finnish<br>Telecommunications Industry in the 1990's..... | 69  |
| 5.2.1 Maximum Scenario.....                                                                            | 71  |
| 5.2.2 Minimum Scenario.....                                                                            | 74  |
| 5.2.3 Middle Way.....                                                                                  | 76  |
| REFERENCES.....                                                                                        | 77  |
| ANNEX: Telecommunications Statistics.....                                                              | 80  |

## LIST OF ABBREVIATIONS

|        |                                                                                     |
|--------|-------------------------------------------------------------------------------------|
| CEPT   | - Conference Europeenne des Admisistrations des<br>Postes et des Telecommunications |
| CMT    | - Cellular Mobile Telephone                                                         |
| COE    | - Central Office Equipment                                                          |
| CPE    | - Customer Premises Equipment                                                       |
| ECU    | - European Currency Unit                                                            |
| ETSI   | - European Telecommunications Standards Institute                                   |
| EUREKA | - European Research Coordination Agency                                             |
| GSM    | - Groupe Speciale Mobile                                                            |
| ISDN   | - Integrated Services Digital Network                                               |
| MCVD   | - Modified Chemical Vapor Deposition                                                |
| NMT    | - Nordic Mobile Telephone                                                           |
| OEM    | - Original Equipment Manufacturing                                                  |
| OVD    | - Outside Vapor Deposition                                                          |
| PABX   | - Private Branch Exchanges                                                          |
| PTT    | - Postal, Telephone and Telegraph Administrations                                   |
| RACE   | - Research and Development in Advance Communications<br>Technology for Europe       |
| TE     | - Transmission Equipment                                                            |
| VAD    | - Vapor Axial Deposition Process                                                    |



## 1 Introduction

The three key phenomena causing structural changes in the telecommunications industry are rapid technological advancement, standardization and deregulation, both in the services and equipment trade. Digital and optical technologies are expanding opportunities in voice, data and image transmission, and creating new product groups and increasing the capabilities of previous applications.

Simultaneously standardization work is being carried out increasing the potential use of scale economies; consequently, lowering the users switch over costs and increasing competition in the various sectors of the telecommunications industry. This applies especially to new and emerging sectors. Deregulation in the service sector alters the markets by allowing second operators to compete with the PTTs in previously closed markets. The liberalization in the equipment sector brings an increasing number of competitors to previously more restricted markets.

EC integration, global deregulation and liberalization, as well as standardization are all interconnected phenomena that are radically altering the structures in the international telecommunications industry and trade. Mergers, acquisitions, takeovers and strategic alliances are reshaping the competitive structures. Some information technology corporations are letting go of certain segments to concentrate on their strong areas, others are growing rapidly through acquisitions, and alliances are being constructed widely across frontiers.

The markets in the EC have for long been fragmented and dominated by the national champions. Nationalistic public procurement policies, protectionist standards and classification procedures and other forms of non-tariff trade barriers have effectively reduced the competition in the national markets in Europe. The EC Commission is promoting the common market especially in the telecommunications sector. In the Commission's view open markets would improve Europe's competitive position in relation to the USA and Japan by bringing added efficiency through increased competition and scale economies, and by improving the technological level via combined research and development activities. Further benefits are foreseen to be collected by the consumers in the form of decreased price levels.

The integration does not proceed without problems. Although the liberalization of customer premises equipment is nearly reached, the liberalization of services in the telecommunication sector has already been postponed by one year due to the resistance of several member countries. The network liberalization has influenced only the mobile sector allowing very few second operators into the markets. The opening of public procurement is widely treated with scepticism about the real intentions behind the supportive political speeches. Still the integration process has been and is an ongoing process that has and will radically alter the competitive structures in the European and even in the global perspective. These effects reach the Finnish telecommunications industry directly through:

- altered markets,
- new opportunities in technology, manufacturing  
and marketing alliances, and

- increased threats in highly competitive markets.

Preparation for these implications is an essential for succesful operations both the domestic and in the international markets in the 1990's.

This report is structured in four parts: Global Industry Backg-round, Areas of Change in the European Community, Finnish Tele-communications Industry, and Conclusions.

In the first part the nature and structures of the industry are drafted presenting the products, markets, producers, and trade within the various segments of the telecommunications industry.

The second part presents the measures of the Commission that affect the telecommunications industry.

In third part the Finnish telecommunications industry is intro-duced, strengths and weaknessess, as well as opportunities and threats in the EC integation are analysed.

In the concluding part the importance of the EC area as a source of technology and as a target area for Finnish telecommunicati-ons industry is assessed, and the implications of the EC integ-ration process are analysed.

## 2 Global Industry Background

### 2.1 Products and Market Segments

Telecommunications equipment provides the infrastructure and the customer premises equipment for the telecommunications network. The telecom equipment industry provides switching, transmission, and terminal equipment. Other divisions in the industry lies between the mobile and stationary or fixed line systems.

Switching, or central office equipment (COE) includes switching both for traditional fixed line telecommunications and for mobile telephone systems. Transmission equipment (TE) covers cables (including optical), and equipment for lines and termination points; as well as radio relay systems and satellite earth stations. Terminal equipment, or customer premises equipment (CPE) embraces a large variety of products from telephone sets both for traditional fixed line and mobile communications, key telephone systems, PABX (private branch exchanges), telex, teletex, fax machines, videotex terminals and modems. In this study the base stations and mobile telephones are included in the telecommunications category, although they are commonly treated as radio communications equipment or even as consumer electronics.

This study will concentrate on the high technology products that are being produced in Finland. Copper and coaxial cables are no longer high technology, thus not included. The following segments of the telecommunications industry will be approached:

1. Central Office Equipment (COE)
  - fixed line switching
  - mobile network switching
2. Transmission Equipment (TE)
  - optical cables
  - line and termination point equipment
  - mobile base stations
3. Customer Premises Equipment (CPE)
  - telephone sets
  - key telephone systems
  - PABX
  - mobile telephones

The statistics do not provide clear industry specific data sets on the telecommunications equipment markets and trade, especially in an internationally comparable form. Consequently, estimates of different expert studies must be utilized for estimating the market sizes. The figures should be treated as a rough indication of the relative sizes.

## 2.2 Markets

The largest markets for telecommunications equipment can be found in the USA, Europe, and Japan. These three constitute approximately 70 per cent (see Appendix, Table 2) of the World markets. The remaining 30 per cent contains the small national markets of socialist and developing countries. The Soviet Union has a significant domestic market, especially for geopolitically conveniently located Finnish suppliers.

This study concentrates on the significance of the EC area for Finnish telecommunications producers. In the following table the market sizes of the triad (Europe, the USA, and Japan) are presented.

Table 1: Global Telecommunications Equipment Markets and Market Shares

|        | 1986     |       | 1987     |       | 1988 estimate |       |
|--------|----------|-------|----------|-------|---------------|-------|
|        | USD Mil. | %     | USD Mil. | %     | USD Mil.      | %     |
| EUROPE | 16,250   | 40,6  | 19,413   | 43,5  | 20,843        | 43,9  |
| EC     | 14,364   | 35,9  | 17,063   | 38,2  | 18,346        | 38,6  |
| EFTA   | 1,886    | 4,7   | 2,350    | 5,3   | 2,497         | 5,3   |
| USA    | 17,306   | 43,2  | 18,200   | 40,7  | 19,160        | 40,3  |
| JAPAN  | 6,485    | 16,2  | 7,041    | 15,8  | 7,516         | 15,8  |
| TOTAL  | 40,041   | 100,0 | 44,654   | 100,0 | 47,519        | 100,0 |

Source: Yearbook of World Electronics Data. Years 1988 and 1989. Elsevier, Benn Electronics, BEP Data Services.

The USA is the largest single market, although the combined European market carries equal weight. The European market still remains fragmented. Even the largest European markets in West Germany, France, United Kingdom, and Italy represent only 5 to 10 per cent of the triad's markets in this comparison (see Appendix, table 1). That is only one third to two thirds of the Japanese domestic market. The Finnish domestic market reaches modest 0,6 per cent of the triad's markets.

Electronics International Corporation forecasts the annual market growth to be 6 per cent for telecommunications sector (8 per cent for TE) in the time period of 1986 to 1992. According to Dataquest estimates the overall telecommunications markets are forecast to grow 9 per cent a year over the next five years. The growth in public and private telephone exchanges is expected to be very slow, while the mobile sector and data communications

are foreseen to demonstrate explosive growth.\*

The largest optical cable markets are found in the USA, Japan and Australia. In Europe the UK, West-Germany and France each have FIM 0,8 to 1,0 billion markets (1988), Spain and Italy between FIM 0,1 and 0,3 billion, and the rest below FIM 0,1 billion markets. The growth in the optical cables segment in Europe varies in the different national markets between 5 to 30 per cent, averaging around 15 per cent per annum. Strong fluctuations have characterised the development of the optical cable demand.

### 2.3 Production

Production shares indicate a similar division between the triad, although the European share is more pronounced in production than in market shares. The same applies to Japan to an even greater extent. The Finnish share of production is at the same level as the market share, 0,6 per cent (see Appendix, Table 5).

---

\*Dixon, Hugo. Telecommunications markets boom in Europe predicted. Financial Times, 24.10.1988

Table 2: Global Telecommunications Equipment Production

|        | 1986     |       | 1987     |       | 1988 estimate |       |
|--------|----------|-------|----------|-------|---------------|-------|
|        | USD Mil. | %     | USD Mil. | %     | USD Mil.      | %     |
| EUROPE | 17,747   | 42,5  | 20,837   | 45,1  | 21,865        | 45,0  |
| EC     | 15,178   | 36,4  | 17,809   | 38,5  | 18,717        | 38,5  |
| EFTA   | 2,569    | 6,2   | 3,028    | 6,6   | 3,148         | 6,5   |
| USA    | 15,315   | 36,7  | 16,060   | 34,7  | 16,730        | 34,4  |
| JAPAN  | 8,670    | 20,8  | 9320     | 20,2  | 10,030        | 20,6  |
| TOTAL  | 41,732   | 100,0 | 46,217   | 100,0 | 48,625        | 100,0 |

Source: Yearbook of World Electronics Data. Years 1988 and 1989. Elsevier, Benn Electronics, BEP Data Services.

Other studies (see Appendix) give slightly differing figures partially due to difficulties in collecting internationally comparable data, and also due to the inclusion of a different spread of goods into the telecommunications category, eg. cables. Despite these differences, the same tendencies are evident in all sources.

The "domestic" markets are highly dominated by "local" producers. In Japan, practically all companies are local. In the USA local AT&T along with Canadian Northern Telecom dominate the market, although one European (CGE) and Japanese (NEC) hold 2 to 5 per cents of the markets. In Europe the situation is similar to the USA. Markets are very concentrated. The Panorama of EC Industry estimates that the top 10 firms in Europe hold 82 per cent of production, and the in following table top 10 firms are estimated to hold 58 per cent of the world markets.



Table 3: Telecommunications Equipment  
Principle Companies in 1986

| Market share held | EUROPE                                     | USA                           | JAPAN                                      | WORLD                                        |
|-------------------|--------------------------------------------|-------------------------------|--------------------------------------------|----------------------------------------------|
| > 10%             | CGE<br>SIEMENS                             | AT&T<br>NORTH.TEL             | FUJITSU<br>NEC                             | AT&T<br>CGE                                  |
| 5 - 10%           | ERICSSON                                   | GTE                           | HITACHI<br>OKI                             | NEC<br>NORTH.TEL<br>SIEMENS                  |
| 2 - 5%            | BOSCH<br>GEC<br>PHILIPS<br>PLESSEY<br>STET | CGE<br>IBM<br>NEC<br>ROCKWELL | IWATSU<br>MATSUSHITA<br>NITSUKO<br>TOSHIBA | ERICSSON<br>FUJITSU<br>GEC<br>GTE<br>PHILIPS |
| Top 5 hold        | 50%                                        | 55%                           | 70%                                        | 43%                                          |
| Top 10 hold       | 67%                                        | 60%                           | 83%                                        | 58%                                          |

Companies listed in alphabetical order

Source: Electronics International Corporation  
Electronics in the World, 1988

The largest telecommunications firms (over 5 per cent of the world market share) sales vary between ECU 9,000 million (AT&T) and ECU 4,100 million (Northern Telecom), the medium sized firms' sales exceed ECU 1,000 million, but not ECU 4,000 million. Finnish suppliers belong to the category of small telecommunications firms with sales under ECU 1,000 million.\*

The European telecommunications industry has been fragmented with several small producers supplying to domestic markets. The integration process in the EC, as well as the high demands on research budgets have imposed pressures for concentration in this industry. Products, especially the COE, have become increasingly sophisticated, thus rapidly increasing the needs for R & D funding. Also the Commission has taken steps towards the

\* 1987 data, based on Panorama of EC Industry, 1989.

liberalization of the telecommunications markets in the EC area. These two factors have influenced the restructuring of the market.

The 7 most important events concern all of the largest European manufacturers. Alcatel (CGE) acquired ITT's telecommunications activities in 1986 bringing it up to second in the world market by USD 11 billion sales. The same year Ericsson took over CGCT of France, and acquired major parts of the Elektrisk Bureau of Norway in 1989.

In 1988 the British GEC and Plessey merged their telecommunications functions forming GPT, and IBM announced sale of its telecommunications (PABX) operations (Rolm) to Siemens although in the middle of 1989 signs of withdrawal from this transaction were experienced. The largest amount of publicity has surrounded the joint bid by GEC and Siemens for Plessey in late 1988. Still early in 1989 the bid was under investigation by the UK's Monopolies and Mergers Commission. The EC Commission decided that this takeover activity would not conflict with EC competition regulations. If this bid proceeds Siemens will acquire a 40 per cent stake in GPT and will rank third in the telecommunications producers in the world. If the bid falls GPT is likely to form a partnership with either AT&T or Siemens. AT&T found an European counterpart in Italtel. In February 1989 Italtel announced that they have chosen AT&T as a partner to modernize the Italian telephone system. This not only increased AT&T's potential in winning a big share of nearly USD 30 billion contracts during the five-year plan, but it also gave them a strong foothold in

the EC market.\*

The same tendencies can be observed in the mobile telecommunications markets as well. Alcatel, West-German AEG and Nokia have formed the ECR-900 consortium to compete for the mobile networks infrastructure. Siemens, Matra and Ericsson have formed another group to compete in the same market.

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\*Dixon, Hugo. Big test begins. Financial Times, 22.3.1989;  
Frieman, Alan. AT&T set for Italtel partnership despite  
European competition. Financial Times, 8.2.1989; et al.

Table 4: Telecommunications Industry Restructuring Events

- 
- Alcatel (CGE) acquired ITT's telecom activities in 1986.
  - Ericsson acquired CGCT (FR) in 1987.
  - GEC and Plessey merged telecom functions forming GPT in 1988.
  - Siemens acquired IBM's telecom operations (Rolm) in 1988.
  - GEC and Siemens bid for Plessey in 1988.
  - Alcatel, AEG and Nokia formed the ECR-900 consortium in 1988.
  - Ericsson entered into a cooperation with Siemens and Matra in mobile communications in 1988.
  - Ericsson acquired Elektrisk Bureau (NO) in 1989.
  - Italtel chose AT&T as partner in 1989.
- 

The production of optical cables is fully dependent on the supply of optical fibre. Earlier Corning Glass forecasted that only few works would be supplying fibre for numerous cable manufacturers, but this has proven to be a wrong estimate. The central patents in fibre production are expiring and the knowledge of processes are widely known. According to the present scenario approximately every tenth cable manufacturer will also engage in fibre production.

Optical fibers are being produced by four different processes. In the following table producers and production volumes are introduced.

Table 5: Optical Cable Production in 1988  
Fibre km

-----  
Modified Chemical Vapor Deposition Process  
Bell Laboratories (1972-74)

|                     |         |
|---------------------|---------|
| AT&T (USA)          | 500,000 |
| Northern Tele. (CA) | 250,000 |
| ITT (USA)           | 100,000 |
| Furukawa (JP)       | 100,000 |
| GEC (UK)            | 80,000  |
| FOI (FR)            | 60,000  |
| Spectran            | 50,000  |
| NKT (DK)            | 30,000  |
| Ericsson (SW)       | 20,000  |
| Nokia (FIN)         | 20,000  |

-----  
Outside Vapor Deposition Process  
Corning Glass Works (1972-74)

|                                |                        |
|--------------------------------|------------------------|
| Corning (USA)                  | 1,400,000              |
| Optical Fibres (UK)            | 325,000                |
| Siecor (WG)                    | 80,000                 |
| Fiber Ottiche S (IT)           | 75,000                 |
| Optical Waveguides (Australia) | 30,000 in construction |
| Lightwave Technology (USA)     | 30,000                 |

-----  
Vapor Axial Deposition Process  
Nippon Telephone and Telegraph (1975-77)

|                  |                        |
|------------------|------------------------|
| Sumitomo (JP)    | 240,000                |
| Furukawa (JP)    | 200,000                |
| Fujikura (JP)    | 200,000                |
| Taihan (Korea)   | 40,000                 |
| Pirelli (UK)     | 25,000                 |
| Olex (Australia) | 20,000 In construction |

-----  
Plasma-activated Chemical Vapor Deposition Process  
Philips (1977)

|              |         |
|--------------|---------|
| Philips (NL) | 200,000 |
|--------------|---------|

-----

Source: Nokia

Even though the optical fiber production is still in its infancy, the world production reached 4 million fiber kilometers in 1988, and it is expected to reach 40 million fiber kilometers by 1995. Kessler's estimates for 1995 vary from 40 to 60 million. The Finnish figures are approximately 0,2 per cent of the world figures, being 14,000 in 1988 and 100,000 estimated for 1995.

These figures might be somewhat overestimated. An international standard for optical cables was agreed in CCITT in 1987. This makes optical cables very much a "commodity" product.

The customer premises equipment sector typically has a large number of producers. In the key-telephone segment large Europeans, like Ericsson and Alcatel, compete with over 80 Japanese and few North American suppliers.

#### 2.4 Trade

The trade in telecommunications equipment is highly protected by selective public procurement, complicated certification policy, and incompatible standards. The protection bases itself not only on the standard protectionist arguments, but also on the national governments' wish to maintain the technological base within a country for strategic reasons.

The protection is quite evident when imports cover only 10 per cent of the final demand in the EC countries. Half of the imports originate from the USA and Japan. This demonstrates the low levels of intra EC trade. Exports represent 23 per cent of the production, and only a third of this remains within the EC.\*

Public procurement bias is clear especially in the COE (Central Office Equipment) market. In addition, varying standards and "input specificity" play a key role. Previous investments in

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\*INSEAD, Jürgen Müller. The Benefits of Completing the Internal Market for Telecommunication. Research on the "Cost of Non-Europe", Basic Findings, Vol 10. Luxembourg 1988.

certain proprietary technologies in the COE make an adjustment to other suppliers very costly, and this argument makes the opening of the markets difficult, even under a prevailing good will.

Transmission equipment is standardized to a higher degree, thus technical specifications do not restrict trade in the same manner as in the COE. The same can be said for the CPE (Customer Premises Equipment), although additional protection is sought for through nationally different certification standards and procedures.

Foreign trade represents some 20 per cent of the production in the triad. Japan has a clear surplus in trade, much more so than Europe, while the USA has a sizable deficit in the telecommunications equipment trade. Finnish exports in 1986 (USD 140 million) exceed the imports (USD 94 million), leaving a trade surplus in this sector.

Table 6: Telecommunications Equipment World Trade  
Imports and Exports in 1986

|        | EXPORTS     |          | IMPORTS     |          |
|--------|-------------|----------|-------------|----------|
|        | USD million | per cent | USD million | per cent |
| EUROPE | 4,065       | 49,0     | 2,474       | 38,0     |
| EC     | 2,722       | 32,8     | 1,795       | 27,6     |
| EFTA   | 1,343       | 16,2     | 679         | 10,4     |
| USA    | 1,881       | 22,7     | 3,872       | 59,5     |
| JAPAN  | 2,343       | 28,3     | 160         | 2,5      |
| TOTAL  | 8,289       | 100,0    | 6,506       | 100,0    |

Source: Yearbook of World Electronics Data. Years 1988 and 1989.  
Elsevier, Benn Electronics, BEP Data Services.

Europe carries a positive trade balance with those outside the triad markets, while its imports exceed the exports in trade

with the USA and Japan. Japan's trade balance is positive in all markets.

Table 7: Telecommunications Equipment  
Trade Balance in 1987  
USD million

| /with<br>from/ | EUR.   | USA   | JAPAN  | OTHER | WORLD  |
|----------------|--------|-------|--------|-------|--------|
| EUR.           | --     | -40   | -770   | 1,690 | 880    |
| USA            | 40     | --    | -1,270 | -600  | -1,830 |
| JAPAN          | 770    | 1,270 | --     | 1,180 | 3,220  |
| OTHER          | -1,690 | 600   | -1,180 | --    | -2,270 |
| WORLD          | -880   | 1,830 | -3,220 | 2,270 | --     |

Source: Electronics International Corporation  
Electronics in the World, 1988

In the following table the importance of foreign markets to the EFTA countries becomes evident. It also confirms the protectionist tendencies of the Japanese markets, and the relative openness of the USA and EFTA markets in the triad's trade.

Table 8: Telecommunications Equipment Trade Dependence  
Export Share of Production and Import Share of Markets

|        | Exports of<br>Production<br>% | Imports of<br>Markets<br>% |
|--------|-------------------------------|----------------------------|
| EUROPE | 22,9                          | 15,3                       |
| EC     | 17,9                          | 12,5                       |
| EFTA   | 52,3                          | 36,0                       |
| USA    | 12,3                          | 22,4                       |
| JAPAN  | 27,0                          | 2,5                        |

Source: Based on Yearbook of World Electronics Data.  
Years 1988 and 1989. Elsevier, Benn Electronics, BEP Data Services.

This concentration of the industry definitely reshapes the trade into different domestic markets as well as across frontiers. In addition various technological alliances within Europe and over



the oceans will have an impact on the competitive structures.

## 2.5 Main Market Segments

### 2.5.1 Fixed Line Telecommunications Equipment

According to following table, the switching equipment (COE) captures roughly half of the telecommunications markets. COE is also the most complex part and the heart of the entire network system. Transmission and terminal equipment each cover roughly 20 per cent of the markets, and the remaining 10 per cent constitutes other miscellaneous equipment.

Table 9: Telecommunications Equipment Product Segmentation in 1986-7

| Per Cent               | BIPE<br>1) | FROST &<br>SULLIVAN<br>2) | EIC<br>3) | ELSEVIER<br>4) |
|------------------------|------------|---------------------------|-----------|----------------|
| Switching Equipement   | 52         | 47                        | 51,7      | 43,1           |
| Public Switching       | (37)       |                           |           |                |
| Private Switching      | (15)       |                           |           |                |
| Transmission Equipment | 22         | 13                        | 17,4      |                |
| Terminal Equipment     | 24         | 24                        |           |                |
| Telephone Sets         | (9)        |                           | 13,5      |                |
| Other Terminals        | (15)       |                           |           |                |
| Other Equipement       | 2          | 15                        | 17,4      | 56,9           |
| Total                  | 100        | 100                       | 100       | 100            |

1) 1987 Europe, 2) 1986 Europe, 3) 1987 World, 4) 1988 Europe

Source: Panorama of EC Industries, INSEAD, EIC, ELSEVIER

The demand for telecommunications equipment is derived from telecommunications services. Presently the service demand constitutes mainly the traditional voice segment (80 to 90 per cent) and the data transmission (including telex) varies around 10 per cent. The voice segment is growing at 5 to 6 per cent per annum, data applications grow at a much faster rate, at 15 to 20 per cent per annum. It has been estimated that data transmission could reach 30 per cent of the total demand by the end of the

century. This will reflect on the equipment demand in an increased relative demand for CPE.\*

COE and transmission equipment is mainly purchased by the public sector, while the CPE tends to be procured in private markets. COE and TE segments are characterised by nationalistic procurement policies and national standards. The CPE market is restricted by certification rules and incompatible standards more than in the case of COE and TE.

COE is technically the most complex category, and the economies of scale are highest for COE. Modern digital exchanges are specially designed high performance computers for traffic switching and network control. Software costs cover over 75 per cent of the value added. This element is independent of market size for given switches. Other fixed cost elements include tools for software and hardware testing, and custom-designed components. Large European firms produce 0,8 to 1,6 million (Alcatel 3,8 million) access lines per annum. This is considerably lower compared to AT&T in the USA that produces 7 million access lines per annum at one plant. European plants are small and do not fully exploit the economies of scale. Comparing a plant of 7 million lines capacity p.a. to one of 1 million lines p.a., the cost disadvantage is equivalent to 20 - 30 per cent.\* The EC Commission's studies on the benefits of EC integration have widely been criticized for over optimism. With the same token these estimates have potentially overestimated the cost advantages of larger production units.

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\*INSEAD, Jürgen Müller. The Benefits of Completing the Internal Market for Telecommunication. Research on the "Cost of Non-Europe", Basic Findings, Vol 10. Luxembourg 1988.

The distribution of COE manufacturers in Europe is operating from small units in fragmented markets where economies of scale are not fully exploited. Nationalistic public procurement policies also encourage firms to establish production units in several markets to gain access to protected markets. This could contribute to scattered production patterns of such complex units as the COE.\*

Restructuring in the European production patterns has increased the size of European companies. Alcatel acquired ITT's telecommunications activities reaching 3,8 million lines output. Similarly the GPT merger, Ericsson's acquisition of CGCT, and Siemens/GTE cooperation have all reached over 1 million lines in 1987.

Table 10: Shipment of Public Telephone Lines in Europe  
in 1987

|               | million |
|---------------|---------|
| Alcatel       | 3,8     |
| GPT           | 1,6     |
| Ericsson/CGCT | 1,6     |
| Siemens/GTE   | 1,0     |
| Italtel       | 0,8     |
| Others        | 0,8     |

Source: Dataquest/Financial Times 8.2.1989.

Transmission equipment includes cables, repeaters and amplifiers. In cable production the economies of scale are significant, but not to the same degree as COE. Setup costs for a plant are high, R & D costs are lower than for COE, and variable costs constitute a larger share of total production costs. Repeaters

\*INSEAD, Jürgen Müller. The Benefits of Completing the Internal Market for Telecommunication. Research on the "Cost of Non-Europe", Basic Findings, Vol 10. Luxembourg 1988.

and amplifiers are similar to COE in their scale economies.

In 1979 the first optical cables were installed in public telecommunications networks and today optical cables are competing in long distance communications with satellite connections. In 1988 an optical cable connection was built across the Atlantic ocean, and in 1989 a connection from the USA to Japan was initiated. The latter connection is capable of transmitting over 40,000 simultaneous phone calls.

In the CPE category the production of PABX equipment is characterized by significant economies of scale. In the production of handsets and simple key telephones variable costs play a much larger part in the production costs; consequently, the economies of scale are not as significant. In this segment the use of standardized components is more common. Lower economies of scale and lower trade barriers are reflected in a large number of suppliers and access to wide markets for the majority of the producers (Appendix, Table 10).

Overall in the telecommunications equipment production economies of scale could be exploited to far larger extent in Europe by the specialization between companies. Presently this is restricted by fragmented and protected national markets.

Presently the European market for fixed line telecommunications equipment is functioning under imperfect competition biased by protectionist standards and certification requirements, and above all, by nationalistic public procurement policies resulting in relatively higher cost structures for users.

### 2.5.2 Mobile Telecommunications Equipment

It is estimated that there are approximately 4 million mobile telephone subscribers in the world, and that the number will grow to 15 million in 10 years.\* Other estimates see a much larger potential in mobile sector estimating the European subscription base to reach 10 to 14 million by the year 2000.\*\* The growth of the European market was 70 per cent in 1988, which brought the total up to 1.5 million mobile phones in Europe, from which the Nordic share was over 600,000. The UK figure increased to over half a million sets, while the French and West German levels stayed below 100,000 each.\*\*\* In the USA investments in mobile networks started earlier, with the subscriber base already having reached 1,6 million.\*\*\*\*

In the following table the distribution of mobile telephones in Europe can be observed. The UK is the largest single market, while the Nordic countries have highest market penetration figures.

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\*Nokia-Mobira ja AT&T yhteistyöhön matkapuhelimissa. Tekniikka ja Talous, 23.1.1989.  
 \*\*Mårtenson, Gunnulf. Nokia Telecommunications.  
 \*\*\*Matkapuhelimien myynti kasvoi 65 prosenttia. Kauppalehti, 1.3.1989.  
 \*\*\*\*Bradshw, Della. Mobile Communications. Financial Times, 12.9.1988.

Table 11: Mobile Telephone Subscribers in Europe  
in June 1988

| Country     | No of Subscribers<br>1,000 | Penetration<br>per 1,000 |
|-------------|----------------------------|--------------------------|
| Belgium     | 20                         | 1.27                     |
| Denmark     | 90                         | 16.98                    |
| France      | 74                         | 1.12                     |
| Ireland     | ..                         | ..                       |
| Italy       | 30                         | 0.34                     |
| Germany     | 75                         | 1.05                     |
| Greece      | ..                         | ..                       |
| Netherlands | 35                         | 1.93                     |
| Portugal    | ..                         | ..                       |
| Spain       | 10                         | 0.17                     |
| UK          | 330                        | 5.79                     |
| EC Total    | 664                        | Average 4,76             |
| Austria     | 36                         | 3.83                     |
| Finland     | 85                         | 17.46                    |
| Norway      | 130                        | 31.85                    |
| Sweden      | 200                        | 23.67                    |
| Switzerland | 19                         | 2.04                     |
| EFTA Total  | 470                        | Average 15,77            |

Source: Financial Times 20.7.1988/"European Mobile Communications"

The high Nordic share is explained by an early initiation of mobile telephone systems. The Nordic countries started already in 1981 adopting the Nordic Mobile Telephone (NMT) systems, while the Central European countries joined in 1985.

Table 12: Nordic Mobile Telephone Markets

| Country<br>(in 1000 units) | Sales<br>1988 | Cumulative<br>subscriptions | Forecast<br>1989 |
|----------------------------|---------------|-----------------------------|------------------|
| Sweden                     | 75            | 190                         | 90               |
| Norway                     | 35            | 140                         | 35               |
| Finland                    | 33            | 120                         | 35               |
| Denmanrk                   | 24            | 100                         | 30               |
| Iceland                    | 1.5           | ..                          | ..               |
| Total                      | 168.5         | 550                         | 190              |

Source: Kauppalehti 1.3.1989

The mobile telecommunications market is not very large in real terms, but it is expanding rapidly. The development of the world markets has been extremely patchy. The Nordic and the UK markets have developed rapidly, while large only slightly exploited markets exist in Japan and other European countries. Some small countries like Bahrain, Kuwait and Hong Kong already have developed substantial networks.\* Dataquest estimates that the subscriber base in Europe will grow to 5 million by the end of 1992, and the growth of cellular equipment will increase by 25 per cent a year.\*\*

Mobile telecommunications are made up of two distinct markets: one to provide the operators with the infrastructure (base stations and switches) and the other in selling phones. Each market is estimated to exceed USD 230 million per annum in Europe in the 1990s.\*\*\*

Mobile telecommunications have been characterised by several differing standards. At present six different and incompatible versions of cellular systems prevail in Europe. The Pan-European GSM standard that has been agreed upon by 18 European countries will increase competition in the European market and allow a higher utilization of economies of scale. Unit prices are rapidly falling and imposing demands on production costs. Component costs and availability are very significant factors in handset production, but the importance of R & D input cannot be ignored.

The worldwide markets for handsets are divided largely by little

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\*Mobile Communications. Financial Times, 12.9.1989. \*\*Dixon, Hugo. Telecommunications markets boon in Europe predicted. Financial Times, 24.10.1988.

\*\*\* Mobile Communications. Financial Times, 12.9.1989.



over ten suppliers, with Finnish Nokia Mobile Phones leading with a 13.4 per cent market share. In the following table the market shares of the major producers are presented.

Table 13: Mobile Telecommunications  
World Market Shares of Mobile Phones  
May 1988

|                          | per cent |
|--------------------------|----------|
| Nokia Mobile Phones (SF) | 13,4     |
| Motorola/Storno (US/DK)  | 12,8     |
| NEC (JP)                 | 11,2     |
| Toshiba/Audiovox (JP/ )  | 9,5      |
| NovAtel (CA)             | 8,4      |
| Panasonic (JP)           | 8,0      |
| OKI (JP)                 | 7,0      |
| Mitsubishi (JP)          | 6,7      |
| Ericsson (SW)            | 3,9      |
| Phillips (NL)            | 3,6      |
| Siemens (WG)             | 3,1      |
| Others                   | 12,4     |
| Total                    | 100,0    |

Source: Financial Times, 12.9.1988

The three leading firms Nokia Mobile Phones, Motorola and NEC, with over 10 per cent of the world market all have been well established in the USA with a 10 to 20 per cent market shares. They are all well represented in Europe as well. Over 5 per cent of the market share group is dominated highly by Japanese producers, while the three large European companies LM Ericsson, Phillips and Siemens, have a 3 to 4 per cent market share each.

The mobile communications infrastructure production is mainly controlled by established telephone exchange producing companies. They have the required know-how to develop switches for mobile communications, and often they also possess experience in radio transmission.

The CMT infrastructure market is a relatively open market, much more open for foreign competition than the protected traditional COE markets. This is particularly clear in the UK where the infrastructure equipment has been purchased from non-UK suppliers. Cellnet (British Telecom) has selected Motorola of the USA, while Vodafone turned to Swedish Ericsson and British Orbitel. Motorola's success can be largely credited to its production unit in the UK. France and West Germany have both placed orders to the ECR-900 consortium of Nokia (SF), Alcatel (FR) and AEG (WG); and France has placed orders to the other group of Matra (FR), Ericsson (SW), and Siemens (WG) as well.

Motorola has also gained a foothold in the Nordic markets by entering Norwegian markets through its Danish subsidiary Storno, an acquired Danish telecommunications equipment concern. Ericsson is the leading infrastructure supplier in the Nordic markets\* followed by Nokia Cellular Systems.

In the USA the leading switch manufacturer AT&T captured 37 per cent of the USD 555 million market in 1987. The market is expected to grow to USD 750 million in 1988. Motorola is slightly behind by 36 per cent and Northern Telecom has gained a 14 per cent market share, while Ericsson has some 3 per cent of the USA market.

The openness of the mobile infrastructure markets is emphasized by Motorola's move into Japan.\*

The GSM system that will standardise the European cellular

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\*Mobile Communications. Financial Times, 12.9.1989.

communications will be adopted in the early 1990s. The system will service the entire EC area and the value of markets have been estimated to exceed FIM 6 billion annually, half in infrastructure and the other half in mobile telephones. The construction of the new GSM network will require several hundred exchanges, over 5000 base stations and new subscribers are estimated to exceed 10 million.\* Several network operators are aiming to open services in 1991. This requires deliveries in exchanges and base stations already in 1990. For competing suppliers the initial deliveries are crucial to establish strong customer relations that will open the door for future markets.

Already the limits of the CMT have been met in the areas of high utilization of mobile communications. The wavelengths in radio communications are a limited resource. Temporary relief for this is seen in second generation GSM system based on half rate speech coding, but only the next generation will be able to solve the problem. The cordless Telepoint system is the initial step towards the personal communications networks, that are based on small and inexpensive telephones and a dense cellular network. At this stage the telepoint system cannot receive calls and can make them only in a very small range (1-200 meters) around the base. A new generation of the so-called Race mobile is being developed in the Commission's RACE programme.

Presently the Europeans and Americans are strong in the CMT markets, while Japanese have remained relatively quiet. It can be expected that they are aiming at the huge market of much

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\*Sjöström, Mikael. Nokialle oma gsm-koejärjestelmä. Tekniikka & Talous, 23.1.1989.

smaller and cheaper personal communications network telephone systems that are expected to bring the mobile communications from the professional elite to the common man.

### 3. Areas of Change in the European Community

The EC Commission has recognized the dominance of state owned monopoly postal and telecommunications organizations (PTTs), and the differing national standards and certification requirements. It has taken an active role in diminishing the trade distorting measures to allow stronger competition in the community. Through the measures described below the Commission is aiming to increase the effectiveness of production and international competitiveness of European producers by creating a single market for the telecommunications sector.

The Panorama of EC Industry expects that the establishment of the internal market and deregulation will stimulate the slow intra-Community trade (annual growth estimated to exceed 15 %) and that the private markets will constitute significant and highly competitive opportunities for European suppliers.

#### 3.1 The Commission's Measures

Initially the Commission's efforts concentrated on trying to develop common equipment standards for terminal equipment. The first directive was adopted in 1986. During the same year the standard for the Integrated Services Digital Network (ISDN) was introduced. Under the ISDN national telecommunications and specialized data networks should be integrated into an EC system handling voice, text, facsimile and data transmission by 1993. This was followed by the 1987 measure aiming for a common digital cellular radio standard that is to be applied in the EC from

1991.\*

In June 1987 the Green Paper on telecommunications services and equipment was published, the aim being the creation of a single market for the industry in question. Based on the Green Paper the Telecommunications Council endorsed a programme to implement the liberalization and market-opening policies of the Commission. The programme aims for:\*

- full liberalization of the market for terminal equipment,
- common standards (European Telecommunications Standards Institute - ETSI has been established to ensure the process),
- complete separation of PTTs' regulatory and operational functions,
- a free market in value-added services (non-discriminatory access to the network),
- full application of the competition provisions (this is to ensure that PTTs do not abuse their dominant position, and to ensure transparency in public procurement),
- more extensive Europe-wide services (EC's policy goals include implementations of RACE, coordinated introduction of ISDN, and the full application of public pan-European cellular digital mobile communications), and
- a liberalized environment for point-to-point satellite telecommunications.

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\*Telecommunications Fact sheet 8. The Department for Enterprise (UK). The single market, The Facts.

The objective of the Commission, according to the Green paper, is to "develop the conditions for the market to provide European users with a greater variety of telecommunications services, of better quality and at lower cost, affording Europe the full internal and external benefits of a strong telecommunications sector".

### 3.2 Standards and Certification Requirements

Differing national standards (in connection with restrictive public procurement policies) has prevented the utilization of economies of scale in the European telecommunications industry. In the early 1980s CEPT's attempts did not achieve the desired results due to its lack of resources and because its membership largely was formed of the national PTTs. ETSI was established to create the Europe-wide standards. Permanent staff and funding, backed up by wide membership including the manufacturers creates a more favorable environment for the development of standardization in the telecommunications sector. ETSI was involved in forming the directive on terminal equipment standards, and it will be working on the pan-European digital mobile system and ISDN.

The effects of standardization will be felt strongest in the COE segment, where eight different systems currently prevail in Europe. Standardization will mainly influence the industry restructuring, closer collaboration between different manufacturers, and the development of new switching systems. More standardized COEs would allow easier switching from one supplier to

another, consequently increase competition, and reduce prices. INSEAD estimates this to result in as high as ECU 0.4-0.7 billion savings per annum in the public market for COE.

Transmission equipment is already highly standardized to ensure interoperability in the international networks, and the same applies for the CPE as well.

### 3.3 Opening of Public Procurement

The opening up of the public procurement markets in the EC area would impose potentially the greatest changes in the telecommunications equipment trade. Trading in more standardized products in liberalized public procurement markets would allow for easier change to other suppliers and increased competition; consequently, decrease the prices, force the producers to increase their efficiency, and allow them to utilize the economies of scale to a greater extent. INSEAD estimates that this could reduce the number of major COE suppliers from present 8 to perhaps 5 in the next 3 to 5 years. Further they estimate that the purchasers of telecommunications equipment would achieve savings worth of ECU 2.2 billion if the markets are 40 per cent liberalized, and total of ECU 3.7 billion in the 100 per cent liberalized telecommunication markets in the EC area.

Considerable restructuring has already taken place among the European telecommunications producers, although the opening of the public markets has not advanced significantly. Yet it remains to be seen if the barriers in public procurement will



really come down, or if the PTTs will continue to give preferential treatment to national suppliers. The Commission is promoting the opening of the public markets, but considerable political opposition can be expected.

### 3.4 Technology Cooperation

Compared to the USA and Japan, European producers are in a disadvantageous position in technology development. R & D efforts are fragmented and operate with relatively small resources. To improve the European position the Commission is promoting technology cooperation between the European producers and research centers.

RACE (Research and Development in Advance Communications Technology for Europe) performs the precompetitive development of equipment and services through cooperation between European research centers and companies. It also supports the development of ISDN and standardization work of CEPT. At the end of 1988 Finland participated in 13 RACE projects.

## 4 Finnish Telecommunications Industry

The Finnish telecommunications industry produces technologically very advanced equipment in each major category of telecommunications equipment. This includes the latest digital exchanges, optical fibres and cables, line and termination point transmission equipment, base stations, cable television equipment, key telephones, PABX (Private Branch Exchanges) equipment, modems, mobile telephones, and to some extent regular telephone sets and even video phones.

In this section an structures of the production and foreign trade of the telecommunications sector are presented, followed by the introductions of individual producers and product groups in more detail. Finally the strengths and weaknesses, as well as opportunities and threats in EC integration are analysed.

### 4.1 Overall Picture

The Finnish telecommunication sector is characterised by a strong domestic production and openness of the markets. Foreign companies have had an access to domestic markets increasing the competition. Finnish firms have not had the benefit of a protected domestic market like most of the European producers. On one hand this has deprived domestic producers from an easier overhead in domestic markets, but on the other hand it has forced the companies to sharpen their competitiveness already in the domestic operations and forced them to seek growth in the foreign markets.

This can be seen in the following table. Although the domestic market and production have grown steadily, the foreign supply to the domestic markets have remained at slightly below half with a couple of exceptions. In the 1980's the production grew faster than the markets. The domestic market share did not grow in proportion, but the growth was found in exports. The share of exports grew rapidly reaching over half by 1982 and remaining at 55 to 60 per cent since. Imports and exports were quite well at the same level up to 1985, but since the trade balance in telecommunications equipment has been clearly positive for Finland. This is expected to continue in the near future.

Table 14: Finnish Telecommunications Industry 1979 - 1990  
FIM million

| Year   | Production<br>Value | Import<br>(cif) | Export<br>(fob) | Market<br>Value | Production<br>to Finland<br>/Market | Export/<br>Production |
|--------|---------------------|-----------------|-----------------|-----------------|-------------------------------------|-----------------------|
|        | MFIM                | MFIM            | MFIM            | MFIM            | %                                   | %                     |
| 1979   | 616                 | 304             | 209             | 711             | 57,2                                | 33,9                  |
| 1980   | 804                 | 368             | 329             | 843             | 56,3                                | 40,9                  |
| 1981   | 855                 | 417             | 417             | 855             | 51,2                                | 48,7                  |
| 1982   | 958                 | 525             | 481             | 1002            | 47,6                                | 50,2                  |
| 1983   | 1087                | 537             | 674             | 950             | 43,5                                | 62,0                  |
| 1984   | 1371                | 589             | 783             | 1177            | 50,0                                | 57,1                  |
| 1985   | 1752                | 805             | 1030            | 1527            | 47,3                                | 58,8                  |
| 1986   | 2747                | 869             | 1523            | 2093            | 58,5                                | 55,4                  |
| 1987   | 3200                | 1000            | 1826            | 2374            | 57,9                                | 57,1                  |
| 1988   | 3229                | 1158            | 1791            | 2596            | 55,4                                | 55,5                  |
| 1989F  | 3681                | 1298            | 2098            | 2881            | 54,9                                | 57,0                  |
| 1990F  | 4233                | 1462            | 2497            | 3198            | 54,3                                | 59,0                  |
| 1993FS | 4364                | 1561            | 2531            | 3394            | 54,0                                | 58,0                  |
| 1993FF | 5474                | 1893            | 3339            | 4028            | 53,0                                | 61,0                  |

Statistics 1979..88 current prices

F Forecast 1988 prices

FS Forecast Slow

FF Forecast Fast

Source: VTT 1989

The importation of telecommunications equipment is clearly dominated by Sweden, Japan and West Germany by approximately 60 per cent share. Swedish Ericsson and West German Siemens have gained a strong foothold in Finnish markets by local production and marketing units, and the Japanese supply large shares of customer premises equipment and components.

Table 15: Imports of Telecommunications Equipment  
FIM million

| 1987   |        | 1988   |        |
|--------|--------|--------|--------|
| 1. SW  | 230,1  | 1. SW  | 245,7  |
| 2. JP  | 221,3  | 2. JP  | 230,9  |
| 3. WG  | 219,0  | 3. WG  | 182,2  |
| 4. SU  | 76,9   | 4. SU  | 105,2  |
| 5. DK  | 69,7   | 5. UK  | 85,8   |
| 6. UK  | 56,7   | 6. DK  | 62,7   |
| 7. US  | 33,3   | 7. US  | 60,7   |
| 8. FR  | 27,2   | 8. FR  | 24,4   |
| 9. NL  | 25,7   | 9. NO  | 16,9   |
| 10. NO | 23,0   | 10. HK | 14,4   |
| OTHERS | 57,5   | OTHERS | 88,6   |
| TOTAL  | 1040,3 | TOTAL  | 1117,6 |

Source: VTT 1989

Finnish exports remain to large extent in Eastern and Western Europe. Exports to the Soviet Union grew from 30 per cent in 1985 to 56 per cent in 1987, but fell back to 43 per cent in 1988. Although exports to Sweden have not declined much in real terms, the relative importance of Sweden has declined from over a third to only 15 per cent in 1988.

The 1988 situation exhibits the importance of Soviet trade to the Finnish telecommunications industry. Even the largest West European countries combined do not outweigh the Soviet Union. The six EC countries in the following table represent only 13

per cent, EFTA nations nearly 22 per cent, and these combined some 32 per cent (Denmark included in both categories). Other export markets include the USA (3,3 %) and the developing countries.

Table 16: Exports of Telecommunications Equipment  
FIM million

|        | 1985  | 1986   | 1987   | 1988   |
|--------|-------|--------|--------|--------|
| SU     | 233,6 | 491,1  | 803,3  | 669,0  |
| SW     | 266,0 | 285,2  | 213,2  | 237,6  |
| UK     | 85,3  | 51,3   | 40,4   | 73,8   |
| FR     | 4,6   | 11,5   | 4,6    | 56,2   |
| US     | 17,2  | 29,8   | 21,2   | 52,2   |
| NO     | 55,3  | 52,8   | 78,3   | 50,8   |
| DK     | 20,8  | 16,5   | 35,4   | 48,9   |
| NL     | 1,4   | 13,9   | 8,1    | 22,2   |
| WG     | 3,4   | 3,4    | 3,0    | 5,4    |
| IT     | 2,0   | 2,7    | 4,7    | 3,7    |
| JP     | 0,3   | 0,1    | 0,1    | 2,6    |
| OTHERS | 79,0  | 132,9  | 211,2  | 339,8  |
| TOTAL  | 768,7 | 1091,2 | 1423,3 | 1562,4 |

Source: VTT 1989

The fast pace of the technological development in the telecommunication sector combined with the highly competitive nature of the industry has imposed considerable demands on R & D activities in Finnish firms. The R & D percentages of production value have increased to over 15 per cent and over a quarter of the labor is employed by R & D activities. Strong input in R & D has resulted in a high share of domestically developed products with a relatively low dependency on foreign technologies.

Table 17: R &amp; D Activity of Telecommunications Sector

|                                                | 1986 | 1987  | 1988  |
|------------------------------------------------|------|-------|-------|
| R&D percentage<br>of gross production<br>value | 9,9% | 10,5% | 15,8% |
| R&D personnel in<br>production firms           | 1418 | 1707  | 1303* |
| R&D personnel/<br>total personnel              | 25%  | 28%   | 25%*  |
| *not fully comparable with 86 and 87 data      |      |       |       |

Source: VTT 1989

#### 4.2 Producers and Products

The volume of Finnish telecommunications production is dominated by Nokia corporation and its subsidiaries. Nokia Telecommunications embraces Public Networks (switching and transmission equipment), Dedicated Networks (private networks) and Nokia Cellular Systems (mobile communications infrastructure). In addition Nokia Mobile Phones, Nokia Data Systems (data transmission and CPE) and Nokia-Cables (copper and optical cables) supply telecommunications equipment.

Three internationally large-scale telecom corporations have established production subsidiaries in Finland, namely LM Ericsson (switches and telephones), Siemens (switches), and Alcatel (switches and telephones). In addition Benefon produces telephones and mobile handsets, Helkama optical fibres, Teleste key-telephones and antennas, and Vistacom video-phones. The telecommunications industry employs also a wide group of suppliers to the primary producers of telecommunications equipment.

Table 18: Main Telecommunications Producers and Products  
in Finland

|                                                                                                                                                                         |                                                    |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------|
| =====                                                                                                                                                                   |                                                    |
| Central Office Equipment                                                                                                                                                |                                                    |
| fixed line                                                                                                                                                              | Nokia Telecommunications,<br>LM Ericsson, Siemens  |
| mobile                                                                                                                                                                  | Nokia Telecommunications                           |
| -----                                                                                                                                                                   |                                                    |
| Transmission Equipment                                                                                                                                                  |                                                    |
| optical cables                                                                                                                                                          | Nokia-Cables, Helkama                              |
| line and terminal equip.                                                                                                                                                | Nokia Telecommunications                           |
| base stations                                                                                                                                                           | Nokia Telecommunications (NCS),<br>Teleste Antenna |
| -----                                                                                                                                                                   |                                                    |
| Customer Premises Equipment                                                                                                                                             |                                                    |
| telephones                                                                                                                                                              | Alcatel, Benefon, LM Ericsson                      |
| key telephones                                                                                                                                                          | Nokia Data Systems, Teleste Slocon                 |
| PABX                                                                                                                                                                    | Nokia Data Systems                                 |
| CMTs                                                                                                                                                                    | Nokia Mobile Phones, Benefon                       |
| picture phones                                                                                                                                                          | Vistacom Industries                                |
| alarm transmission                                                                                                                                                      | Sondi                                              |
| =====                                                                                                                                                                   |                                                    |
| Others: ABB Strömberg Service, Amertronics, Computec, Genelec,<br>Landis & Gyr, LK-Products, MM-Elektro, Pohjanmaan Tele, Salora,<br>Tecnomen, Telemetalli, Esmi, Aspo. |                                                    |

#### 4.2.1 Central Office Equipment

Switching equipment is produced in Finland by Nokia Telecommunications as well as by multinationals LM Ericsson and Siemens. Alcatel previously has had production in Finland. The production units of LM Ericsson and Siemens supply Finnish markets and their sales to other markets are channelled through the main offices. Nokia Telecommunications is the sole Finnish COE producer.

Nokia Telecommunications produces the DX 200 family of exchanges that has been developed domestically initially in the state owned Televa Oy and further in Nokia. In addition to the DX 200 for fixed line switching the family includes the DX 200 MTX for cellular mobile communications in NMT networks, and later the DX 200 MSC for European GSM networks.

Nokia has produced some 800 DX 200 exchanges. The exchanges for fixed line communications have mainly been sold to Finland and the Soviet Union, with a few deliveries to developing countries such as China, Sri Lanka, Thailand and the United Arab Emirates. Sweden has purchased Nokia's exchange for their Mobitex network. The expanding mobile networks have opened up new opportunities for Nokia's switches. In addition to Finland the DX 200 MTX has been installed in France, Turkey and China. The DX 200 family switches presently operate in nine countries.

The turnover of the COE segment was approximately FIM 1 billion and it employed some 2400 persons. The domestic market absorbed less than 30 per cent of the production.



The Soviet Union is the single most important export market, exceeding even the domestic sales in volume. According to customs statistics the Soviet Union represented in 1987 92,8 per cent of Finnish exports of telecommunications exchanges, and in 1988 the figure was 67,6 per cent. The entire EFTA exports are shipped to Sweden. As stated before, no fixed line exchanges have been sold to the EC area and only one delivery of DX 200 MTX to France has taken place. Switches have not been exported to the USA or Japan, and roughly one fifth is directed to other markets. The market shares in all but the domestic market are insignificant.

Nokia Telecommunications has a sales unit in the United Kingdom. The UK is a natural choice since this market has been liberalised further than other national EC markets. Additional sales units in the EC area are quite possible in near future.

DX 200 exchanges have been developed domestically and direct technology cooperation does not exist presently either. Participation in several of the Community's R & D projects is coordinated through the Nokia research center.

The Finnish COE has not been actively marketed to the public networks of the EC area. This is partially due to existence of strong national COE producers, and also to nationalistic public procurement policies. In Europe the potential markets for Finnish exchanges lie in private and mobile networks, where niches can be located.

#### 4.2.2 Transmission Equipment

Finnish high technology TE products include optical cables by Nokia Cables and Helkama, line equipment by Nokia Telecommunications, and base stations by Nokia Cellular Systems and Teleste Antenna.

Both Nokia and Helkama produce optical cables, but only Nokia has the capability to produce optical fibre. Nokia's production is at its early stages with a FIM 40 million turnover and over 20 per cent R & D input. Exports represent only 10 per cent and have been shipped mainly to developing countries. The exports operations are yet at very early stages. The 10 per cent consists of deliveries along with Nokia Telecommunication's systems and small amounts of direct export. Future target areas include the traditional cable export market of Soviet Union, as well as a strong emphasis in the EC area. Presently some technology cooperation with European counterparts has been initiated and expansion in this field of activity is sought for.

Nokia's fibre production is based on MCVD (Modified Chemical Vapor Deposition) technology initially developed by Bell Laboratories in 1972-74. Corning Glass OVD and Nippon Telephone and Telegraph VAD are competing technologies in the world. The MCVD technology utilised by Nokia is developed domestically. The low capacities at the initial stages of production have kept the export levels low. In the near future the central patents are expiring and the market demands and, consequently, the capacities are rapidly increasing. The present capacity is 20,000 fibre kilometers and it will be boosted to 50,000 km. Present

location allows up to 100,000 km production.

Nokia has developed the production equipment and processes of fibre production internally in collaboration with Technical Research Center of Finland. In the process Nokia has accumulated technological know how that could well be utilized further by establishing a production unit inside the EC area. Besides optical fibre and cables, the production equipment could become a profitable export item.

Helkama produces optical cables from imported fibre mainly for domestic markets. Only some five per cent of the production is exported to Sweden, and occasional small deliveries go to other West-European countries.

Nokia Telecommunications provides small and medium capacity transmission systems for trunk and junction networks. Nokia has 20 years of experience in transmission systems, and the present product line represents the fifth generation of equipment. Multiplexers, branching and radio relay equipment represent state-of-the-art technology in transmission equipment. Multiplexers hold the dominant position in Nokia's TE segment.

Nokia Telecommunications' transmission equipment production is roughly FIM 500 million, from which over 20 per cent remains in domestic markets. Exports follow a similar pattern than the switching equipment, although Swedish and EC shares are more pronounced. The EC share is presently only FIM 10 to 15 million, but it is expected to grow rapidly with the introduction of the fifth generation of Nokia's transmission equipment, expected to

reach FIM 100 million within three years. Concluded sales to British Telecom and Dutch PTT, and also to Spain and Portugal have opened the channels to the EC markets.

The importance of the EC market for the TE segment is emphasised by the Nokia Telecommunications' R & D center and sales unit being opened in the UK.

Nokia Cellular Systems (NCS) supplies the infrastructure for the mobile communications, namely base stations and exchanges. The turnover for the unit is FIM 300 million and personnel 400. The CX 200 MTX exchanges are included in the figures. Domestic markets represent 40 per cent. The exports are distributed mainly between EFTA (55%) and EC (35%, France) markets with minor deliveries to the Peoples Republic of China and Turkey.

In the base station segment Nokia has gained a strong position with market shares ranging from 35 to 40 per cent. Ericsson is a considerable competitor in Nordic NMT markets, and large national operators such as Siemens and AT&T are Nokia's main competitors in their home markets.

Besides Ericsson, Motorola is a serious competitor for Nokia's mobile systems in international markets. Both of them have established a strong foothold in the UK market; Ericsson through cooperation with local Orbitel, and Motorola through local production unit.

The production is still carried out domestically, but the introduction of the GSM system can impose strong pressures on initia-

ting production within the EC area. NCS has sales subsidiaries in the UK, West Germany, France and Turkey, while South-East Asia also is under consideration.

NCS has also entered into the ECR-900 consortium with Alcatel and West German AEG. This enables NCS to approach the EC markets with an increased local presense. The tradition of nationalistic procurement policies would have made the entry of a purely Finnish firm to European markets quite impossible. Through the consortium French and German counterparts acquired access to the technologies developed at Nokia. Also the development of the GSM system requires yet considerable R & D efforts before the specifications are finalized. In the consortium the sizable R & D investments can be distributed, the work divided, and the benefits combined into a common system. Naturally a decentralised R & D programme has its difficulties, but the organisation is likely to increase the competitiveness of all parties. Another problem in the consortium is the excess supply of exchanges.

The primary markets for mobile base stations lie in Western Europe, especially with the introduction of the GSM system. Nokia has technologically very advanced products, but the political and cultural distance makes the position difficult. Through the ECR-900 consortium Nokia has an opportunity to establish a strong foothold in the emerging European market. This has already resulted in orders of exchanges and base stations for the consortium from France and West-Germany in the fall of 1988, and from Netherlands in early 1989. An interesting point is that the clients were the national PTTs. It can be assumed that without local partner (Alcatel, AEG) the contract

would have been quite impossible to reach.

In future the possibilities of increased cooperation, acquisitions and possible own production within the EC are surely to be considered to ensure sufficient local presence in the large EC markets.

#### 4.2.3 Customer Premises Equipment

Customer premises equipment concentrates mainly on mobile telephones and small exchanges (key telephones and PABX), with the exception of Ericsson that produces regular telephone sets. Picture telephones and alarm transmission systems are small and specialized segments.

Nokia Mobile Phones and Benefon produce Cellular Mobile Telephones (CMTs) in Finland. Benefon is a newcomer, and is not yet operating internationally.

Nokia Mobile Phones is the market leader in the world by 13.4 per cent market share, followed by Motorola/Storno and NEC close behind. The sales have increased rapidly during the 1980s reaching FIM 1,2 billion in 1988. Nokia Mobile Phones is also engaged in the development of analog and digital cordless telephone technology.

Table 20: Nokia Mobile Phone sales

|      | FIM million |
|------|-------------|
| 1979 | 50          |
| 1980 | 69          |
| 1981 | 86          |
| 1982 | 135         |
| 1983 | 215         |
| 1984 | 285         |
| 1985 | 642         |
| 1986 | 872         |
| 1987 | 1084        |
| 1988 | 1200        |

Source: Nokia Mobile Phones

Exports cover some 80 to 85 per cent of the sales. Nokia has roughly a quarter of the Nordic NMT markets; "significant" shares of the USA AMPS and UK TACS markets; together with Matra 50 per cent of the French R2000 market; and it has entered the West-German Netz-C market. Besides the European and North-American markets Nokia is selling to Turkey, South-East Asia and the Pacific Basin.

Table 21: Exports of Mobile Phones  
in 1988

|       | FIM million | %   |
|-------|-------------|-----|
| EFTA  | 240         | 20  |
| EC    | 360         | 30  |
| USSR  | --          | --  |
| USA   | 480         | 40  |
| JAPAN | --          | --  |
| OTHER | 120         | 10  |
| TOTAL | 1200        | 100 |

Source: Nokia Mobile Phones

This data is rapidly becoming outdated with the introduction of the Pan-European GSM market that will radically increase the weight of Europe in the above table in the near future.

Nokia has production cooperation with Tandy (Tandy Mobira Communications Corporation) in South Korea. This is the largest production unit producing Nokia's mobile telephones with annual capacity of approximately 200,000 units. The CMTs are marketed through Tandy's distribution channels in the USA.

The second largest unit operates in Salo, Finland. In early 1989 Nokia announced the plans to open a mobile telephone production plant in Bochum, West Germany. Nokia's television production operates from same location. The plant will employ some 150 persons. The capacity is planned to exceed 10,000 unit already during the initial year, climbing to over 100,000 units during the first full year of operations. Nokia's total production for 1989 is estimated to climb over 400,000 units.

Cooperation with Matra has resulted in an assembly unit in France, Matra Nokia Radiomobiles S.A.. Cooperation has been initiated with Ducat Radiotelecomunicazioni to produce CMTs for Italian RTMS network.

Besides production, marketing cooperation is also practiced within the above mentioned alliances. In addition Nokia has sales units in the Nordic markets, the UK, Austria, and in the future also in Spain.

Nokia Mobile Phones' R & D expenditure is 12 to 14 per cent of the turnover, and various alliances in this sector have been established. The high costs of R & D force all producers to seek for alliances besides the pan-European EUREKA projects and EC research programmes.



Nokia Mobile Phones has a cooperation agreement with AT&T of the USA for the development of microcircuits for digital CMTs, and also another alliance with an European counterpart in the developing strategic semiconductor area. They have also entered into a cooperation with the Japanese in the development of components.

The importance of European and North American technology cooperation is essential in the development of products for differing standards. Japanese cooperation has been ongoing through the 1980's first through Salora and later with Nokia Mobile Phones. Japanese cooperation is not equally crucial to the other two, but it is growing. Japanese dominance in the advanced component technologies makes it the most attractive cooperation partner.

Participation in the development of a common standard for the Pan-European digital CMT network has been practiced since the early 1980's; and cooperation in the development and manufacturing of cordless telephones with Shaye Communications has been initiated. Nokia is also the second largest owner of Shaye Communications after the Norwegian Fred Olsen, and before Motorola.

Teleste Slocon has initiated its production of key telephones in 1987. The product has been developed (R & D input 7-8%) from the experience gained in the production of internal telephones. The total turnover for 1988 exceeded FIM 30 million with a 30 per cent export share of the production. The markets for internal telephones are stable with approximately half of the production going abroad. Slocon 2000 key telephone provides the growth

potential for the company.

Slocon 2000 sales domestically grew from FIM 7 million to 14,1 million in 1988. Exports started in 1988 with FIM 3,7 million order to Norway. The Norweigan CPE markets were liberalized a year before the other Nordic markets; consequently, the exports were initiated there. Teleste acquired the internal-telephone production unit from Sweden (originally ITT's) and further attacks on the Swedish markets with the Slocon 2000 are expected. The EC markets will be approached subsequently.

Nokia Data is producing PABX exchanges and key telephone systems on licence from GPT in UK. A large majority of the production is done in the UK and the assembly conducted in Finland. The Dixi exchange is largely manufactured in Finland. Only occasionally are these products exported as a part of Nokia's systems.

Vistacom Industries Oy has initiated the production of video-phones. They have invested FIM 5 million in R & D already. Turnover in 1988 was FIM 2 million and next year's projected turnover is FIM 20 million. Production for first 100 units has been initiated, the aim being 500 units annually. The unit price is approximately FIM 60,000. The Rotator company has put in use the first FIM 4 million system. Exports are projected to be approximately half of the production, mainly to the USA market, but also to Canada, the UK, and throughout the Nordic countries. The main competitors include Fujitsu and Mitsubishi, and USA firms.

#### 4.2.4 Dedicated Networks

Dedicated networks provide another potential market for the Finnish telecommunications industry. Nationalistic public procurement policies do not bias the market to the same extent than in the public networks, and even a small supplier can find attractive opportunities in this segment. Customers include power utilities, oil and gas companies, railways, police, taxi and military.

Nokia's dedicated networks unit accumulated a FIM 200 million turnover with a personnel of 340. It is a thin slice of the total telecommunications pie, but the potential for a small telecommunications enterprise are promising. In 1988 domestic sales reached FIM 80 million exports being 120 million. Nokia is in the top three suppliers of dedicated networks in some European markets along with Motorola and Philips.

In 1989 domestic sales are foreseen to be one third with a 70 per cent market share and exports are estimated to be distributed mainly to the EC, China, South-East Asia, the Soviet Union, and to some extent to EFTA nations.

Table 22: Exports of Dedicated Networks  
in 1989 (estimates)

|       | FIM million | Per Cent |
|-------|-------------|----------|
| EFTA  | 15          | 8,8      |
| EC    | 60          | 35,3     |
| USSR  | 45          | 26,5     |
| USA   | --          |          |
| JAPAN | --          |          |
| OTHER | 50          | 29,4     |
| TOTAL | 170         | 100,0    |

Source: Nokia

EC exports consist of sales to the UK and Spain, and the EFTA share comes from Sweden. In these three national markets Nokia has gained position among the top three suppliers. Large potential exists in other large national markets in Europe.

Manufacturing is purely domestic. Sales subsidiary has been established in the UK and sales office in Sweden and Spain. Foreign operations were initiated in 1986-87 and the establishing of footholds in different European markets has only been started. Original equipment manufacturing (OEM) agreements have been utilized to a small extent and further possibilities in this area are being looked into.

### 4.3 Strengths and Weaknesses of Finnish Producers

This section is largely based on the experiences gained during the interviews with the representatives from the telecommunications industry in Finland; consequently, the bias is on the strengths rather than weaknesses.

Table 23: Strengths and Weaknesses of Finnish  
Telecommunications Producers

| Strengths:                                             | Weaknesses:                                            |
|--------------------------------------------------------|--------------------------------------------------------|
| - small but flexible and fast organisation             | - small unknown organization                           |
| - short distance between customers and R&D dept.       | - low R&D resources                                    |
| - product quality                                      | - small economies of scale                             |
| - peak products                                        | - lack of human resources                              |
| - sharpened competitiveness due to open domestic mrkts | - peripheral location                                  |
| - segmentation                                         | - cultural distance                                    |
| - follower position                                    | - low local presence in export markets                 |
| - support of Nokia's wide product range                | - quality of marketing                                 |
| - support of Nokia's reputation to separate units      | - vulnerability as a market leader (Mobile Telephones) |
| - market leader position (Mobile Telephones)           |                                                        |

The strengths and weaknesses in the Finnish telecommunications sector stem partially from the same source, the small size of Finnish home markets and production units. Finnish telecommunications firms are definitely small and quite unknown in international markets with the exception of Nokia Mobile Telephones.

The size of the Finnish economy does not allow for extensive basic research as in the USA, Japan or even in the still fragmented European markets. The difference is emphasised by sizable military spending on R & D in several countries of the triad, while this kind of support for Finnish high technology industries is practically non-existent. Also the Finnish telecommunications suppliers are very small in international comparison, thus not able to exploit the scale economies in a comparable degree as large competitors.

Segments that operate in areas of rapid technological development and international expansion also face the limited human resources problems. Funds and available personnel are both at much lower levels than in competing nations.

On the other hand huge organizations easily grow bureaucratic and slow. This is not a problem for Finnish producers. Even the domestic giant Nokia is organized into numerous separate and relatively individual departments or legal entities. The strength in the smallness lies in flexibility and speed of operations. Relative to the size of the order a small supplier is able to and has to provide closer customer contact. When the product qualities do not differ significantly this becomes a very considerable factor in gaining customer preference. The

distance between the customer and the R & D department of the firm is shorter, and specialized applications and adaptations are easier to achieve. Smallness has forced the firms to think about the markets as defined segments for which the products are adopted.

Although Finnish national and corporate R & D resources are much lower compared with the large competitors the industry has been able to develop high quality products that compete successfully with the most advanced technological fronts. Finnish firms are not able to generate basic inventions and technological breakthroughs to be used as a competitive edge in international markets. Instead they have adopted a follower position. In product development they apply the existing and available technologies and components to create marketable products.

Flexible organizations exploiting the follower position have kept up with technological advancement. Digital exchanges, optical fibre production and domestically developed production lines were introduced at an early stage, and the entire mobile communications segment has been leading in global developments. Overall the product qualities and applications of advanced technologies are only emphasised by peak products that are technologically very advanced in narrow product categories.

Not only are the individual product qualities a strength, but the wide product selection under Nokia's umbrella is a supporting factor. The weakness in the smallness of operations is relieved to some extent by a high concentration of telecommunications segments under Nokia corporation. Being able to supply

systems and the whole range of telecommunications equipment gives a competitive advantage over firms that supply only one or few product categories.

Nokia's name is strengthening as an independent and reliable supplier. Support of a larger reference organization improves the international position of the individual units while at the same time allowing the independent units to reap the benefits of the small and flexible organizations. The concentration also allows for a more efficient and flexible utilization of R & D resources. This is becoming increasingly important with the shortening life cycles of high technology products and higher inputs required for advancement of technological qualities. The accumulation of the stock of knowledge within Nokia increases the ability to remain at the forefront of development.

The only segment where Finnish telecommunications producers can claim a leading position in world markets is mobile telecommunications. In mobile phones Nokia Mobile Phones has the largest market share and in base stations Nokia is surely amongst the leading firms.

This position of market leader is a strength for Nokia Mobile Phones, but the pioneer position also makes the firm more vulnerable. The competition for the market leader position is fierce. It requires increasing resources for product development and marketing functions. The follower position cannot be benefitted from. The fact that the mobile phones are being manufactured for all different standards strengthens the market leader's position, but it is also weakens scattered resources both in R & D and



production.

Nokia Mobile Phones is the only segment that does not suffer from being small or an unknown supplier. The markets are still small enough that even the market leader can benefit from flexibility and fast decision making in a relatively small organization. On the other hand they meet with the limited human resources restrictions stronger than other segments in the Finnish telecommunications industry. The markets for mobile phones are growing explosively; consequently, Nokia Mobile Phones must expand rapidly to hold the leading position. This imposes growing demands on personnel, capital, and components and the domestic market does not provide sufficient amounts of any of them. The expansion of R & D efforts and production internationally has been essential. A strong dependency on the foreign component suppliers (mainly Japanese) is also a weakness for the entire Finnish telecommunications equipment industry. This reflects the lack of a strong and wide electronics industry in Finland, especially compared to the Far East and the USA.

The openness of the Finnish telecommunications market has increased the competition in the domestic market to a much higher level than in most European countries. On one hand this has deprived Finnish firms from easy profitable domestic operations that could have financed R & D operations and given a spring board for international competition. But in the long run this has been an advantage and sharpened the competitiveness of Finnish producers and forced the organizations to the efficiency that the EC Commission is intending to inject into Central European companies.

Finland's peripheral location is seen as a major weakness not only for the telecommunications sector. On the other side of the coin the geopolitical position on the world map has granted Finland an access to large markets in the Soviet Union. This is especially clear in the total telecommunications trade. In the European context the peripheral location is a clear disadvantage.

Not only is Finland located in a corner of Europe, but the cultural distance is also greater than between other European nations. Adding to this the short history of the Finnish telecommunications industry and the unfamiliarity of Finnish producers in international markets, it is not surprising that marketing is not a strong point of the industry. Finnish firms have weaker personal and organizational connections in Europe compared with continental and even North American competitors. In addition local presence in the form of sales, manufacturing or R & D units is not yet at a satisfactory level, especially in comparison to older and more established competitors.

Strengths offer opportunities and weaknesses impose threats to the Finnish telecommunications industry. Adding to the picture the new opportunities and threats created by the EC integration process we start approaching the real effects of EC integration on the Finnish telecommunications sector.

#### 4.4 Opportunities and Threats of EC Integration

Opportunities and threats imposed on the Finnish telecommunica-

tions producers by EC integration largely depend on the degree of Finland's integration with the Community. The threat of being "left out" would have far reaching implications by placing Finnish suppliers in an unfavorable position on the home continent. The industry wishes to see political decisions lead Finland to a high degree of economical integration with the EC to provide Finnish suppliers with as equal a footing with the EC suppliers as possible.

Under the present developments the majority of the interviewed persons (5 out of 7) perceived the integration process more as an opportunity. One viewed it as neither, and one saw it as more of a threat. Also when asked about the significance of the integration process for their firm, the industry they represent, and for the Finnish economy as a whole the answers concentrated on the upper end of the scale between significant and very significant.

Table 24: Answers to question "How significant is the EC integration process for your firm/unit, for the industry you represent (telecommunications), and for the Finnish economy as a whole?"

|                   | 1. | 2. | 3. | 4. | 5. |
|-------------------|----|----|----|----|----|
| Firm/Unit         | -  | -  | 2  | 5  | -  |
| Telecom. Industry | -  | -  | 1  | 2  | 4  |
| Finnish economy   | -  | -  | -  | 4  | 3  |

1 = not significant, 2 = slightly significant, 3 = significant  
4 = quite significant, 5 = very significant

It is quite clear that the integration process effects the Finnish telecommunications equipment industry significantly. The opportunities and threats of these altered conditions are summa-

rized in the following.

Table 25: Opportunities and Threats of EC Integration

| Opportunities                                                              | Threats                                                                       |
|----------------------------------------------------------------------------|-------------------------------------------------------------------------------|
| - access to a large single market                                          | - Finland is being "left out" from EC integration                             |
| - operations in narrow segments in single Europe                           | - Fortress Europe                                                             |
| - standardization                                                          | - increased competition in Europe among European, American and Japanese firms |
| - possibly opening public procurement markets                              | - market agreements between large firms                                       |
| - privatization, second operators                                          | - EC integration favor large units                                            |
| - rationalized production and R & D activities                             | - takeover by a large competitor                                              |
| - open competition that Finnish suppliers have experienced in home markets |                                                                               |
| - alliances in R & D and production                                        |                                                                               |

The main concern in the EC integration is the much discussed "fortress Europe" scenario. The possibility that integration will give additional preference to EC suppliers either by increased barriers around the EC area or through preferential procurement would be a major treat not only to Finnish suppliers, but

also to other non-EC suppliers. This is said very shortly, but the implications of this outcome would be devastating for the future of the Finnish telecommunications industry.

The process of creating a large single market has caught the attention of not only European firms, but also the North American and Japanese interests in Europe as a potential market have increased. Inside Europe the industry is undergoing a major structural change increasing the unit size and also the competition in traditionally quite protected markets. Both the internal changes and added external interest of the EC area are apt to increase competition within the EC. There is a potential for Europe becoming a battlefield of the giants, where mergers, acquisitions and hostile takeovers would reshape the competitive structures. The reactions of large corporations could even result in market arrangements where small peripheral Finnish suppliers would have no room. The small suppliers could also loose ground since the EC integration clearly favors large and very large corporations that can fully benefit from the scale economies in a large single market.

The time element in the rapidly changing economic environment becomes a threat as well if Finland and Finnish companies are not in position to react promptly. Identification of relevant changes and preparation for emerging situations requires quality information and prompt readjustments. Compared to EC member countries and firms within the EC area, Finnish counterparts receive information with a time lag. Even large USA and Japanese firms have a stronger local presence in the EC and larger resources available to evaluate and adjust to ongoing changes.

Painting a horror picture might be premature, but it is an essential element in realizing the potential threats of the being "left out" scenario and the slow reaction from both the public bodies and the firms themselves. Still these threats must be put in context of the entire Finnish foreign trade in telecommunications equipment. Our main markets still remain in the Soviet Union and Nordic countries, although the EC is being viewed as an area with the strongest growth potential.

The opportunities of the integration are quite much the same for Finnish suppliers than for EC suppliers: access to a large single market where even a thin segment would provide a large enough market for small supplier (although competition even in small segments is expected to increase), advantages of standardization, possibilities in the opening of public markets, tendencies for privatization, and new markets created by allowing second operators besides the PTTs. In addition the large single market allows for rationalized production and R & D activities. These are also the opportunities advertised by the EC Commission for the member nations.

For Finnish suppliers these opportunities are conditional. These opportunities can be beneficial provided that the Finnish economy will be integrated with the EC to a sufficient extent, and also that Finnish firms have established a strong enough local presence to be able to enjoy the single European market.

The openness of the Finnish telecommunications markets has sharpened the competitiveness of domestic producers, while many European suppliers have been operating in protected markets with

minimal competition. The experience gained in open competition place Finnish suppliers in a favorable position in relation to producers that have relied on protected markets in the opening EC markets.

The internationalization of Finnish industry is being boosted by the EC integration process. Potential treats have forced the firms to expeditate the already ongoing process of increasing their local presence in export markets, especially in the EC. Investments in manufacturing and R & D units have increased in Europe and the systematical search for strategic alliances with European suppliers have been intensified. The image of "local" supplier is often seen as an advantage. The visions of "fortress Europe" have further emphasised this point.

In the long run successful developments in the EC integration and Finnish relations with it can create a situation where "front yard" markets are expanded from the present Soviet and Nordic markets to include all of Europe. This would definitely increase the importance of the "front yard" as a market, but also provide a sturdier stepping stone to global markets.

## 5 Conclusions

The EC integration is a reality that has already and will further alter the international scene of the telecommunications industry. The liberalization of telecommunications services is spreading in Europe and second operator possibilities are opening up. The terminal equipment market has opened for competition in several national markets and the Commission's aim is to extend it to the entire EC area. Standardization work has been escalated by ETSI, technology cooperation has brought nearly all major telecommunications producers in the EC research projects, and possibilities for opening public procurement to some degree are not out of question. In addition other measures by the Commission to create a single EC market further escalate the rate of changes in the telecommunications industry.

The effects of the changes are strongly felt in the telecommunications equipment industry. Mergers, acquisitions and take overs have become commonplace in the headlines, alliances are being built not only within the EC but also with North American and EFTA suppliers, the GSM standard has been agreed upon for mobile communications and the ISDN standard is being seriously considered, and technology cooperation is extending beyond EC programmes.

How does this all effect Finnish producers? Will the single market extend the Finnish "front yard" from the Soviet and small Nordic markets to the huge pan-European field where the peripheral producer can find profitable segments to grow and prosper in, or will the restructuring process result in a oligopoly of a



few giants that dictate the market and eat tiny competitors? What about the possibility of being left outside of the "fortress Europe"?

#### 5.1 Importance of the EC for the Finnish Telecommunications Industry

Looking at the aggregate figures of Finnish foreign trade in the telecommunications equipment industry one could easily conclude that the EC does not carry much weight in the total performance. Exports represent over 55 per cent of the production and the share of the six largest EC countries is only 13 per cent. The EC contributes only slightly over 7 per cent of the total demand of Finnish production. The importance of Soviet Union and EFTA countries is far more pronounced, 43 and 22 per cent of the total exports respectively.

This picture is quite accurate when observing the traditional fixed line infrastructure markets. The Soviet Union is by far the single most important export market for central office equipment (69 %). When attention is shifted to the segments that are presently small in volume, but have considerable growth potential, the importance of the EC seems quite different. Dedicated networks have the main markets in the EC (35%) and Sweden (10%), although the Eastern European countries are not insignificant (25%). The future growth is expected to be found in the yet unexploited markets of West Germany and France. A similar pattern can be seen in the mobile communications sector. Nokia Cellular System's main markets are in EFTA countries (55%)

with the EC as a good second (35%) with no exports to Eastern Europe. The mobile sector can also be credited for selling the only Finnish exchange to the EC area. Nokia Mobile Phones has its largest market in the USA (40%), but the European markets (EC 30%, EFTA 20%) are about to experience explosive growth along with the introduction of GSM standard.

The EC's importance is further emphasised by the various alliances, production and R & D units as well as technology cooperation within the area. Earlier French Alcatel had its impact on the development of Finnish digital exchanges. The development of exchanges is presently done in Finland and also in the Nokia Telecommunication's R & D unit established in the UK. Dedicated network operations have sales units in UK, Spain and also in Sweden.

The mobile communications segment has its strongest ties to the EC area. Nokia has entered into a cooperation with Alcatel and AEG in the ECR-900 consortium to develop and market cellular infrastructure in the EC. Nokia Mobile Phones has subsidiaries in the Nordic countries and the USA, and in the UK. Recently Nokia Mobile Phones announced the opening of a production unit in West Germany. They also have a cooperation agreement with Matra in France in the assembly of mobile telephones, and a cooperation agreement with Italian Ducati Radiotelecomunicazioni has been initiated. Nokia also has strong ties (25 per cent ownership) to Shaye Communications of the UK that is developing and manufacturing cordless telephones.

Besides direct R & D activities with other producers Nokia has

entered into numerous EC and pan-European research projects developing optical technology and new generations in mobile communications. Nokia has also been involved in the formulation of pan-European cellular standards.

Presently the EC area does not generate a very large share of the Finnish telecommunications sector's export earnings, but the industry is strongly connected to the EC markets in various forms of cooperation, and the area has a very considerable potential as a source for technological cooperation. One can not neglect the fact that the over USD 20 billion market (1988) in Finland's "front yard" is liberalizing to a yet uncertain degree, and that the growing and emerging sectors have the greatest growth potential in this area. The expansion of direct investments into the EC area demonstrate the determination to exploit this market.

In the following table the main connections of the Finnish telecommunications industry to the EC area are summarized.

Table 25: Nokia's Main Ties to the EC in  
Telecommunications Industry

Production:

-----

Nokia Mobile Phones

- own production unit in Bochum, West-Germany
- assembly in Matra Nokia Radiomobiles S.A., France
- assembly with Ducati Radiotelecomunicazioni, Italy
- 25% of cordless telephones at Shaye Communications

Nokia Cellular Systems

- production under licence at Alcatel ATR

Teleste Antenna

- acquired Labgear Cablevision Ltd. in the UK

Sales:

-----

Nokia Public Networks

- sales subsidiary in the UK with Dedicated Networks and Nokia Cellular Systems
- small office in Denmark
- offices planned for Netherlands and Spain for 1989

Nokia Dedicated Networks

- in addition to the UK and Danish units, office in Spain
- project cooperation with various European counterparts

Nokia Cellular Systems

- sales through the ECR-900 consortium (Alcatel, AEG)
- sales units in the UK, France, West Germany

Nokia Mobile Phones

- sales unit in West Germany and the UK
- sales unit planned for Spain
- sales through production cooperation partners in France and Italy

Technology Cooperation:

-----

Nokia

- EC's RACE programmes
- EUREKA

Nokia Telecommunications

- R & D unit in the UK

Nokia Cellular Systems

- R & D cooperation within the ECR-900 consortium

Nokia Mobile Phones

- development of strategic semiconductors with an European counterpart

Nokia Data Systems

- licences for PABX and key telephones from GPT (UK)

## 5.2 Effects of the EC Integration on the Finnish Telecommunications Industry in 1990's

The EC integration process does not only have an effect on the EC market, but it is a large enough phenomenon to have an impact on the Finnish domestic markets and potentially on the global telecommunications trade. Increasing the technological weight of Europe through integration is one of the main aims of the Commission. The changes in this field can be felt in the development of new technologies in Finland as well.

In a very short span of time, one to two years, the integration process is not likely to have more than a slight impact on Finnish domestic markets or third markets (the Soviet Union, EFTA, North America, developing countries). The Finnish market has been openly competed for and multinational corporations are already strongly established in Finland. Established customer relations and traditions in third markets make radical changes in the short term quite unlikely.

One very clear short term impact is the increased attention to the EC markets. The awareness to the great potential of the EC as a single market has increased along with the Commissions promotional programmes. New connections have been and will be built in the EC by establishing more production and sales units, and by increasing technology cooperation with individual firms as well as by joining relevant EC and pan-European R & D programmes. This trend is very clear in Finnish industry in general, especially in the telecommunications industry. EC integration has already increased the tendency to seek a stronger local

presence. The opening of new production units and additional acquisitions within the EC area can be expected in near future.

The short term impact is mainly effecting the dedicated networks and mobile communications that already operate strongly in the EC. Fixed line will not feel the integration's effects in the short term to the same degree. European standards in mobile cellular communications open large new markets, but also increase the competition. Nokia is in a good position to exploit this opportunity through the ECR-900 consortium as well as through its own production unit of mobile telephones in West Germany.

In the short term opportunities are much more visible than potential threats. Finland is highly integrated to the EC economically and new barriers have not been established between the EC and Finland. The possibility of threats together with the needed increase of local presence is forcing the industry to shift production inside the Community.

The European telecommunications industry has been reshaping its producer structures during recent years and this will continue in the near future. Restructuring requires great amounts of organizational energy and it will take some years before the benefits of the larger units and scale economies can be reaped. It is only in the medium term, 3 to 5 years, that the wider effects of the structural changes initiated by the integration process will be realized.

In various sources it has been estimated that the growth of the telecommunications sector will escalate in Europe along with the

integration process. Products are expected to be further standardized, telecommunication services liberalized, and public procurement markets opened to a yet unknown degree. The process is expected to increase competition and reduce the number of suppliers considerably.

The decreased in suppliers can be a result of actual mergers and acquisitions, or of various alliances between separate legal entities that allow for specialization within the industry. This development allows better utilization of scale economies and increased R & D resources resulting in increased technological and price competitiveness of European suppliers in global markets. Fewer suppliers functioning efficiently in competitive markets provide telecommunications equipment and consequently services at lower prices for the end user - that is the aim of the integration process in the telecommunications industry.

In the following two scenarios the future of the Finnish telecommunications industry will be drafted. The maximum scenario outlines potentially the most favorable outcome for Finnish firms in the restructuring of European markets, while in the minimum scenario the worst possible future is estimated. Both scenarios assume that the EC integration process will advance towards a highly integrated single market.

#### 5.2.1 Maximum Scenario

In the maximum scenario the Finnish telecommunications industry would be further integrated with the EC markets through increa-

sed technology cooperation with firms and Community R & D programmes, stronger local presence and increased weight of the EC of Finnish foreign telecommunications operations as a whole.

Mobile communications have already established strong connections in the EC area. According to this scenario the technological cooperation with the ECR-900 consortium would result in a strong foothold in the EC's mobile communications infrastructural markets. Increased participation in the Community R & D programmes would allow Finnish producers to prepare for the coming generations of mobile communications. The production unit of mobile telephones in West Germany would be expanded enough to reach competitive scale economies and a high market penetration through the reputation of an advanced, reliable "local" producer. R & D cooperation with the ECR-900 consortium would lead in the division of specialization where Finnish producers would concentrate on base stations leaving the switches for French and West German partners. R & D efforts would be partially shifted to EC area, as well as some amount of production. Even in the maximum scenario the exchanges would not have much room in the EC, since strong producers exist in the Community and scale economies are emphasised in this segment.

Dedicated networks would also grow rapidly. The large EC market would allow for specialization and segmentation. Finnish producer would dominate certain segments while the present competitors would control others. Still the competition would remain strong keeping the organizations efficient and force them to provide specialized state-of-the-art systems for the segment they operate in. Across the continent operations would most



likely require additional production within the EC and possibly alliances with other suppliers.

In fixed line communications the exchanges would be quite unlikely to enter EC markets to any considerable degree. EC production is already restructuring to larger units and nationalistic procurement policies are not expected to shift totally, at least not in favor of external producers to the EC.

In this scenario the optical cables production would expand to the EC area. The production technology developed in Finland would produce competitive cables and with the support of other Finnish telecommunications trade be able to gain needed market shares for profitable operations. Cables are already very much of a "commodity" product that are highly standardized, very similar in quality and compete strongly with price. This is likely to require large production units where scale economies would provide competitive priced products. To achieve this cooperation with EC producers could be essential. Also the domestically developed optical fibre production lines would become a profitable export item in addition to fibre and cable sales. A similar logic would apply to other transmission equipment, namely line and termination point equipment.

Customer premises equipment would be limited to a few PABX and key telephone units, while simpler mass production equipment production would not be produced by Finnish firms. Even in PABX and key telephone sector the products would be specialized items for narrow segments. Nokia's PABXs produced under British licence would not be marketed to the EC area, but Teleste's products

would find narrow segments in large the EC market.

Even in the maximum scenario the Finnish telecommunications industry would not grow to the size of the huge multinationals, but would become a considerable independent supplier of specialized products for a narrow segment in large European markets. Although independent, the industry would be strongly connected to other European suppliers. Technology development would have a base in pan-European pre-competitive R & D cooperation with additional collaboration with various firms to produce commercial products as a part of a common communications system. The large integrated European market would provide a "home" market to develop technologies and marketing expertise that could be utilized to approach similar segments in global markets.

#### 5.2.2 Minimum Scenario

According to the minimum scenario the integration process would produce oligopolist competition within the fortress Europe that would not leave room for peripheral Finnish independent suppliers.

Especially in the fixed line communications the Finnish penetration of the EC markets presently is not significant. At the same time the EC producers are restructuring. Various forecasts see fewer suppliers operating from a much larger production unit. Combined technology development of the four or seven dominant suppliers would improve their technological position in relation to North American and Japanese competitors, leaving the

Finnish telecommunications industry further back in its follower position. Disclosure of Finnish producers from the development of the latest applications and forming of Euro-nationalist public procurement would limit Finnish operations to a few deliveries to second operators, provided that they could compete with larger and more efficient producers of the triad.

Optical cables have not yet entered the EC or even the Nordic markets and a strong local supplier base has been established already. There is no indication that Finnish technology or marketing could gain a strong position in the EC or EFTA optical cable markets.

In the mobile communications segment Finnish producers have gained a strong position in NMT markets in the Nordic countries, and the future for the GSM system has had a promising beginning. Even in the minimum scenario the mobile segment would maintain a decent market share. The position is strong especially in the mobile phone segment. The main competitors, Motorola and NEC, are also from outside the Fortress Europe, but Nokia has already production within the EC.

Stronger EC suppliers and increased competition from the USA and Japan could make maintaining the leading position in mobile telephones quite impossible. Also the organizational capabilities of Finnish suppliers have not yet been tested on a very large global scale.

According to the minimum scenario the Finnish share of EC markets would not grow, but rather diminish. The direct investments

would not prove to be competitive with the large producers of the triad, and would gradually be bought up by the competitors. The strengthening of the EC telecommunications industry could threaten the Finnish position in the Nordic countries, and ultimately in Finland. Also recent developments in the Soviet Union and the lowering of Cocom embargo barriers could lead to direct trade links between the Soviet Union and Central Europe. This would jeopardize the Finnish position in its main market area. Ultimately this would gradually lead to a situation where the take-over of the main Finnish telecommunication industries by European competitors would become a reality. Such is not unheard of in other Finnish industries.

### 5.2.3 Middle Way

Both of the scenarios presented above are possible although not very likely. The probable future outcome of the Finnish telecommunications industry lies somewhere in the middle of the two extremes. The scenarios are drafted to demonstrate alternatives of the effects of the EC integration process on the Finnish telecommunications industry. Presently the picture of EC integration is becoming clearer, but the final outcome is still very uncertain. Central issues of public procurement, taxation and others are not yet clarified. EC membership has the potential of extending to some EFTA nations. Also technology development has become quite unpredictable in the medium and long term, while the integration process has been boosted and the future of it relies highly on a favorable economic climate in the EC and the world.

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Table 1  
Telecommunications Equipment  
Market Shares

|        | 1986     |       | 1987     |       | 1988 estimate |       |
|--------|----------|-------|----------|-------|---------------|-------|
|        | USD Mil. | %     | USD Mil. | %     | USD Mil.      | %     |
| D      | 3,332    | 8,3   | 3,925    | 8,8   | 4,214         | 8,9   |
| FR     | 3,669    | 9,2   | 4,303    | 9,6   | 4,572         | 9,6   |
| UK     | 2,709    | 6,8   | 3,077    | 6,9   | 3,377         | 7,1   |
| IT     | 2,191    | 5,5   | 2,851    | 6,4   | 3,079         | 6,5   |
| ES     | 850      | 2,1   | 1,028    | 2,3   | 1,131         | 2,4   |
| NL     | 673      | 1,7   | 865      | 1,9   | 908           | 1,9   |
| BE     | 629      | 1,6   | 650      | 1,5   | 683           | 1,4   |
| DK     | 170      | 0,4   | 197      | 0,4   | 206           | 0,4   |
| GR     | ..       | ..    | ..       | ..    | ..            | ..    |
| PO     | ..       | ..    | ..       | ..    | ..            | ..    |
| IR     | 141      | 0,4   | 167      | 0,4   | 176           | 0,4   |
| LX     | ..       | ..    | ..       | ..    | ..            | ..    |
| EC     | 14,364   | 35,9  | 17,063   | 38,2  | 18,346        | 38,6  |
| SW     | 602      | 1,5   | 783      | 1,8   | 840           | 1,8   |
| SC     | 412      | 1,0   | 578      | 1,3   | 613           | 1,3   |
| AU     | 341      | 0,9   | 394      | 0,9   | 411           | 0,9   |
| NO     | 289      | 0,7   | 331      | 0,7   | 345           | 0,7   |
| FIN    | 242      | 0,6   | 264      | 0,6   | 288           | 0,6   |
| IS     | ..       | ..    | ..       | ..    | ..            | ..    |
| EFTA   | 1,886    | 4,7   | 2,350    | 5,3   | 2,497         | 5,3   |
| EUROPE | 16,250   | 40,6  | 19,413   | 43,5  | 20,843        | 43,9  |
| USA    | 17,306   | 43,2  | 18,200   | 40,7  | 19,160        | 40,3  |
| JAPAN  | 6,485    | 16,2  | 7,041    | 15,8  | 7,516         | 15,8  |
| TOTAL  | 40,041   | 100,0 | 44,654   | 100,0 | 47,519        | 100,0 |

Source: Yearbook of World Electronics Data. Years 1988 and 1989.  
Elsevier, Benn Electronics, BEP Data Services.



Table 2  
Telecommunications Equipment World Market

|             | 1984   |       | 1986 1) |       |
|-------------|--------|-------|---------|-------|
|             | bn USD | %     | bn USD  | %     |
| Belgium     | 0.7    | 1.0   | 0.8     | 0.9   |
| Denmark     | 0.3    | 0.4   | 0.4     | 0.4   |
| France      | 3.1    | 4.4   | 4.2     | 4.6   |
| Ireland     | 0.1    | 0.1   | 0.1     | 0.1   |
| Italy       | 1.4    | 2.0   | 1.7     | 1.9   |
| Germany     | 2.9    | 4.1   | 3.6     | 3.9   |
| Greece      | 0.2    | 0.3   | 0.2     | 0.2   |
| Netherlands | 0.6    | 0.8   | 0.6     | 0.7   |
| Portugal    | 0.2    | 0.3   | 0.2 2)  | 0.2   |
| Spain       | 1.3    | 1.9   | 1.6     | 1.7   |
| UK          | 3.3    | 4.7   | 4.1     | 4.5   |
| EC total    | 14.0   | 20.0  | 17.5    | 19.1  |
| US          | 26.4   | 37.7  | 34.5    | 37.8  |
| Japan       | 6.8 2) | 9.7   | 7.9     | 8.6   |
| Other       | 22.7   | 32.6  | 31.4    | 34.5  |
| Total       | 70.0   | 100.0 | 91.3    | 100.0 |

1) 1986 estimate in 1985 USD    2) 1985

Source: Arthur D. Little (WTIP) / INSEAD

Table 3  
Telecommunications Equipment  
Market Shares

|        | 1986     |       | 1987     |       | 1988 estimate |       |
|--------|----------|-------|----------|-------|---------------|-------|
|        | USD Mil. | %     | USD Mil. | %     | USD Mil.      | %     |
| EUROPA | 16,250   | 40,6  | 19,413   | 43,5  | 20,843        | 43,9  |
| EC     | 14,364   | 35,9  | 17,063   | 38,2  | 18,346        | 38,6  |
| EFTA   | 1,886    | 4,7   | 2,350    | 5,3   | 2,497         | 5,3   |
| USA    | 17,306   | 43,2  | 18,200   | 40,7  | 19,160        | 40,3  |
| JAPAN  | 6,485    | 16,2  | 7,041    | 15,8  | 7,516         | 15,8  |
| TOTAL  | 40,041   | 100,0 | 44,654   | 100,0 | 47,519        | 100,0 |

Source: Yearbook of World Electronics Data. Years 1988 and 1989.  
Elsevier, Benn Electronics, BEP Data Services.

Table 4  
Telecommunications Equipment  
Market and Production Shares 1987

|        | Market | Production |
|--------|--------|------------|
| USA    | 32%    | 29%        |
| JAPAN  | 16%    | 21%        |
| EUROPE | 33%    | 34%        |

Source: Electronics International Corporation  
Electronics in the World, 1988

Table 5  
Telecommunications Equipment  
Production Shares

|        | 1986     |       | 1987     |       | 1988 estimate |       |
|--------|----------|-------|----------|-------|---------------|-------|
|        | USD Mil. | %     | USD Mil. | %     | USD Mil.      | %     |
| D      | 3,981    | 9,5   | 4,806    | 10,4  | 4,939         | 10,2  |
| FR     | 4,050    | 9,7   | 4,689    | 10,4  | 4,892         | 10,1  |
| UK     | 2,506    | 6,0   | 2,623    | 5,7   | 2,803         | 5,8   |
| IT     | 2,175    | 5,2   | 2,723    | 5,9   | 2,863         | 5,9   |
| ES     | 750      | 1,8   | 990      | 2,1   | 1,089         | 2,2   |
| NL     | 567      | 1,4   | 751      | 1,6   | 828           | 1,7   |
| BE     | 822      | 2,0   | 866      | 1,9   | 919           | 1,9   |
| DK     | 127      | 0,3   | 127      | 0,3   | 136           | 0,3   |
| GR     | ..       | ..    | ..       | ..    | ..            | ..    |
| PO     | ..       | ..    | ..       | ..    | ..            | ..    |
| IR     | 200      | 0,5   | 234      | 0,5   | 248           | 0,5   |
| LX     | ..       | ..    | ..       | ..    | ..            | ..    |
| EC     | 15,178   | 36,4  | 17,809   | 38,5  | 18,717        | 38,5  |
| SW     | 1,421    | 3,4   | 1,526    | 3,3   | 1,588         | 3,3   |
| SC     | 408      | 1,0   | 515      | 1,1   | 534           | 1,1   |
| AU     | 269      | 0,6   | 359      | 0,8   | 368           | 0,8   |
| NO     | 218      | 0,5   | 276      | 0,6   | 298           | 0,6   |
| FIN    | 253      | 0,6   | 352      | 0,8   | 369           | 0,8   |
| IS     | ..       | ..    | ..       | ..    | ..            | ..    |
| EFTA   | 2,569    | 6,2   | 3,028    | 6,6   | 3,148         | 6,5   |
| EUROPE | 17,747   | 42,5  | 20,837   | 45,1  | 21,865        | 45,0  |
| USA    | 15,315   | 36,7  | 16,060   | 34,7  | 16,730        | 34,4  |
| JAPAN  | 8,670    | 20,8  | 9320     | 20,2  | 10,030        | 20,6  |
| TOTAL  | 41,732   | 100,0 | 46,217   | 100,0 | 48,625        | 100,0 |

Source: Yearbook of World Electronics Data. Years 1988 and 1989.  
Elsevier, Benn Electronics, BEP Data Services.

Table 6  
Telecommunications Equipment  
Markets in 1987 by Segment

|                                 | EUR.   | USA    | JAPAN | WORLD  | %     |
|---------------------------------|--------|--------|-------|--------|-------|
| Switching                       | 10,200 | 10,200 | 3,100 | 29,700 | 51,7  |
| Transmission                    | 3,100  | 2,800  | 2,100 | 10,000 | 17,4  |
| Telephones                      | 2,800  | 2,000  | 1,400 | 7,800  | 13,5  |
| Oters                           | 2,800  | 3,400  | 2,400 | 10,000 | 17,4  |
| Total Telecom.<br>(rounded off) | 18,900 | 18,400 | 9,000 | 57,500 | 100,0 |

Source: Electronics International Corporation  
Electronics in the World, 1988

Table 7  
Telecommunications Equipment  
Production in 1987 by Segment

|                                 | EUR.   | USA    | JAPAN  | WORLD  |
|---------------------------------|--------|--------|--------|--------|
| Switching                       | 11,500 | 10,000 | 4,000  | 29,700 |
| Transmission                    | 3,300  | 2,400  | 2,500  | 10,000 |
| Telephones                      | 2,500  | 1,300  | 2,400  | 7,800  |
| Oters                           | 2,500  | 2,900  | 3,300  | 10,000 |
| Total Telecom.<br>(rounded off) | 19,800 | 16,600 | 12,200 | 57,500 |

Source: Electronics International Corporation  
Electronics in the World, 1988

Table 8

The Presence of Major Central Office Equipment Suppliers  
in EES excluding Greece, Luxemburg, and Iceland

|              | EC  |    |    |    |    |    |    |    |    |    | EFTA |    |    |    |
|--------------|-----|----|----|----|----|----|----|----|----|----|------|----|----|----|
|              | FRG | FR | UK | IT | ES | NL | BE | DK | PO | IR | SW   | AU | CH | NO |
| Ericsson     |     |    | x  | x  | x  | x  | x  |    | x  |    | x    | x  |    | x  |
| GTE          |     |    |    | x  |    |    |    |    |    |    |      |    |    |    |
| Alcatel      | x   | x  |    | x  | x  | x  | x  | x  | x  | x  |      | x  |    | x  |
| ATT-Philips  |     |    |    |    |    | x  |    |    |    |    |      |    |    |    |
| GEC-Plessy   |     |    | x  |    |    |    |    |    |    |    |      |    |    |    |
| Siemens      | x   |    |    |    |    |    | x  |    | x  |    |      | x  | x  |    |
| Italtel      |     |    |    | x  |    |    |    |    |    |    |      |    |    |    |
| Northern/STC |     |    | x  |    |    |    |    |    |    |    |      |    | x  | x  |
| Teli         |     |    |    |    |    |    |    |    |    |    | x    |    |    |    |

x = one or more plants in a country

Source: INSEAD

Table 9

The Major Suppliers of Transmission Equipment in the EES  
excluding Greece, Luxemburg, Ireland and Iceland

|          | EC  |    |    |    |    |    |    |    |    | EFTA |    |    |    |
|----------|-----|----|----|----|----|----|----|----|----|------|----|----|----|
|          | FRG | FR | UK | IT | ES | NL | BE | DK | PO | SW   | AU | CH | NO |
| Ericsson |     | x  |    | x  | x  |    |    | x  | x  | x    |    | x  | x  |
| Alcatel  | x   | x  |    | x  | x  | x  | x  |    | x  | x    | x  |    | x  |
| Marconi  |     |    | x  |    |    | x  |    | x  |    |      |    |    |    |
| Philips  | x   | x  | x  |    |    | x  | x  | x  | x  |      |    |    |    |
| Siemens  | x   |    |    | x  |    | x  | x  | x  | x  |      | x  | x  | x  |
| Telettra |     |    |    | x  | x  |    |    | x  |    |      |    |    | x  |

#### Other Suppliers

|                |                                 |
|----------------|---------------------------------|
| Sweden:        | Relicana, STA/Teeli, Nokia, NEC |
| Austria:       | Kapsch                          |
| Belgium:       | ACEC                            |
| Spain:         | Indelec, AEG (Rail)             |
| France:        | Matra                           |
| Great Britain: | GEC, Plessy, STC                |
| Portugal:      | CAEp                            |
| West Germany:  | ANT                             |
| Switzerland:   | Northern Telecom                |

Source: INSEAD

Table 10  
The Major Customer Premises Equipment Suppliers in the EES  
excluding Greece, Luxemburg, Ireland and Iceland

|              | EC  |    |    |    |    | EFTA |    |    |    |    |    |    |    |
|--------------|-----|----|----|----|----|------|----|----|----|----|----|----|----|
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