



Telestyrelsen
National Telecom Agency

Trends in
European Telecommunication:
2001 Status Report of
Denmark's Progress in
Telecom Reform and Information
Infrastructure Development

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Trends in European Telecommunication:

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A. TELECOM REFORM

INTRODUCTION

Telecom reform began as process of restructuring the traditional telecom services sector. It has since been transformed, along with the telecom network, to encompass information infrastructure development and the steps necessary to prepare the network foundations for information economies and societies. For its first decade telecom reform in Europe was directed toward market liberalisation and the extension of telecom services. New services, e.g., mobile and Internet, have been complementary extensions of traditional telephone services. National regulatory agencies have been seen as the major vehicle for promoting liberalisation and the extension of network services. Progress has been measured in terms of benchmark indicators such as number of competitors, market shares, universal service penetration, interconnection and consumer service options and prices. Data measuring these indicators have been gathered and published by the EC, ITU, OECD and other organisations. These indicators provide useful comparisons of progress over time in individual countries, and for identifying the leaders and laggard countries in implementing various telecom reforms. As this process is far from complete in Europe, these benchmark indicators will be needed to identify and stimulate progress for some time yet.

In recent years, leading countries like Denmark, as well as the EC and other organisations have been looking beyond the conventional telecom network and services, and its benchmark indicators. They are developing and applying additional indicators of progress in information infrastructure development, i.e., the establishment of a ubiquitous, high speed telecom network that provides access to an ever widening range of information and communication services. Denmark's commitment to being a leader in developing its information infrastructure and network society is set out in a number of government reports in recent years, including The National Telecom Agency's **Report on New Access Routes to the Network Society**.² In this area, reform is much less a program to achieve a fixed set of targets, and much more a process of continuous stimulation of expansion and growth.

This year's Report on Trends in European Telecommunication provides indicators in the two main categories: (1) traditional indicators of telecom reform – market and service development, consumer pricing and competition; (2) information infrastructure and network

¹ Special thanks to the project team members for research, editorial and presentation support: Amy Mahan, Hendrik Rood, Robbin te Velde and Frederika Welle Donker from Economics of Infrastructures, TU Delft; and Søren Jensen and Alexander Øst, Center of Tele-Information (CTI), Technical University of Denmark.

² The National Telecom Agency, January 2000, www.tst.dk.

society development – investment and access technologies; internet market development; e-commerce and e-government readiness and activity. The purpose of the report is to provide a succinct overview for participants in the International Discussion Forum of the National Telecom Agency (Telestyrelsen), the telecom regulatory authority for Denmark.

The countries selected for comparison in this report are the leading reform states in Europe, plus Denmark's larger neighbours that are beginning to accelerate their reform programs after a slow start. The countries are Sweden, Finland, Norway, Netherlands, UK, Germany and France. For some indicators, where comparable data for the US and Canada exists, they are included. Readers are cautioned that the quality of the data varies substantially among the different indicators. The traditional telecom reform indicators have been used for some time and have a reasonably sound foundation for drawing comparative conclusions. The new indicators for information infrastructure and network society development can present only a very incomplete and partial picture in the very early phase of an evolution that will be underway for a long time.

B. TELECOM REFORM

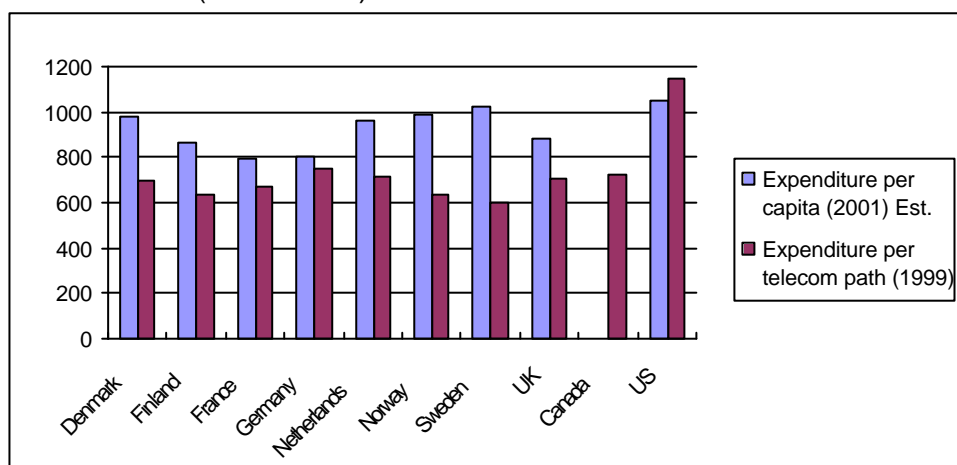
1. TELECOM MARKETS AND SERVICES

1.1 National Telecom Markets

Figure 1.1 shows the telecom expenditure per capita and per telecom network access path (fixed plus mobile connections) for the compared countries. A high level of development is demonstrated for all countries. Expenditure per capita is highest in the US where there has been an historic tendency people to use fixed network services more intensively than people in other countries, and in Scandinavia where universal service penetration rates are highest. Differences in expenditure per access path are very much influenced by developments in the mobile sector. The much lower mobile market penetration in the US is characterised by higher prices and fewer access paths.

Figure 1.1 – Telecom Market Development

(million EUR)

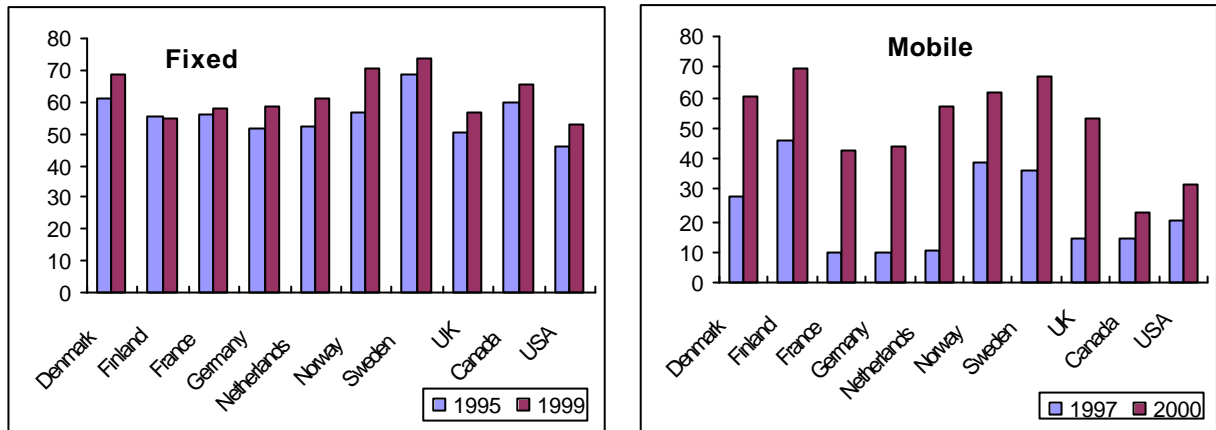


Source: EITO (2001); OECD (2001)

1.2 Network Services Coverage

The generally accepted measure for universal telephone service has been the penetration rate of fixed network main telephone lines per 100 inhabitants as shown in Figure 1.2. Although all the countries in this comparison presumably provide a universal service, the main line penetration rates range from a low of 55.1 (Finland), to a high of 73.8 (Sweden). The Finland figure is explained by the fact that many Finns (up to 20% by some estimates) have replaced their main lines with mobile service. The high figures for Sweden and Norway are explained by a significant and growing proportion of ISDN lines, which provide two or more main lines per connection. The data suggests that the Nordic countries have a higher standard of universal service coverage than the larger countries.

Figure 1.2 - Penetration Rate of Main Telephone Lines and Mobile Subscriptions
(communication channels per 100 inhabitants)



Source: OECD (2001); FT Mobile Communications (2000)

Figure 1.2 also demonstrates the rapid growth in mobile market penetration, with the Nordic countries leading Europe, and Europe a long way ahead of the US and Canada. When fixed and mobile connections are summed, the differences among countries are accentuated further. The number of network access paths per 100 population in the Nordic countries is about 25% higher than the other European countries and 50% higher than the US and Canada.

2. CONSUMER PRICING

2.1 Public Switched Telephone Network (PSTN)

Based on OECD tariff methodology, comparisons can be made using a basket of different elements needed for a particular telecommunication service. Table 2.1 indicates what residential and business users pay for a basket of services including usage and fixed charges. PSTN network charges for Denmark are relatively low for national services, both for business and residential users. For international services, Denmark's ranking has fallen several places in the last two years despite 30% per annum price reductions. These developments confirm the increasing competitiveness of the international services market.

The OECD comparisons are based on the tariffs of the incumbent telecom operators. As competition develops and the market shares of incumbents decline, this data is less indicative of prices actually paid by consumers. This probably explains the very high prices for US national services. In Denmark, for example, competitors offer some international services at prices up to 40% below the incumbent Tele Danmark prices.

Table 2.1 – OECD Basket of Total Public Switched Telephone Network Charges (US \$ PPP)^a and International Call Charges [Average of One Minute Peak (US\$)^b]

| | National Business | | | National Residential | | | International Call Charges ^c | | |
|-------------|-------------------|--------|---------|----------------------|--------|---------|---|------|---------|
| | Aug-98 | Aug-00 | %change | Aug-98 | Aug-00 | %change | 1998 | 2000 | %change |
| Denmark | 468 | 499 | 7 | 301 | 293 | -3 | 0.60 | 0.42 | -30 |
| Finland | 558 | 554 | -1 | 408 | 319 | -22 | 0.75 | 0.56 | -25 |
| France | 976 | 723 | -26 | 420 | 355 | -15 | 0.40 | 0.28 | -30 |
| Germany | 984 | 841 | -15 | 419 | 360 | -14 | 0.56 | 0.38 | -32 |
| Netherlands | 636 | 619 | -3 | 376 | 344 | -9 | 0.36 | 0.21 | -42 |
| Norway | 497 | 484 | -3 | 314 | 306 | -3 | 0.39 | 0.27 | -31 |
| Sweden | 473 | 490 | 4 | 280 | 258 | -8 | 0.56 | 0.23 | -59 |
| UK | 826 | 743 | -10 | 367 | 286 | -22 | 0.60 | 0.54 | -10 |
| Canada | 744 | 583 | -22 | 327 | 349 | 7 | 0.88 | 0.31 | -65 |
| USA | 1037 | 892 | -14 | 340 | 466 | 37 | 1.55 | 0.27 | -83 |

Source: OECD (1999, 2001)

^a Average annual spending, excluding tax

^b (One minute + 3 extra minutes) / 4

2.2 Mobile Services

The OECD has developed a common methodology for national mobile services.³ Table 2.2 shows that the Nordic countries continue to enjoy the lowest prices for mobile services, and prices are continuing to decline at a rapid rate in all countries.

Comparative data on mobile call termination prices in the EU countries is unavailable. However, there is increasing evidence that these prices are extremely high, not regulated effectively, if at all, and are providing a bottleneck for continued mobile service development, particular international roaming. Studies have estimated call termination charges to be 40-70% higher than cost. This could have a major constraining effect on future growth rates.

Table 2.2 – OECD National Mobile Basket
(US \$ PPP)

| | Carrier | Fixed | | Usage | | Total | | |
|-------------|----------------|-------|------|-------|------|-------|------|----------|
| | | 1999 | 2000 | 1999 | 2000 | 1999 | 2000 | cagr (%) |
| Denmark | TeleMobil | 132 | 131 | 293 | 100 | 425 | 231 | -46 |
| Finland | Sonera | 39 | 32 | 340 | 120 | 379 | 152 | -60 |
| France | France Telecom | 193 | 198 | 641 | 223 | 834 | 421 | -50 |
| Germany | T-Mobil | 421 | 189 | 370 | 166 | 791 | 355 | -55 |
| Netherlands | KPN | 261 | 130 | 320 | 148 | 581 | 278 | -52 |
| Norway | Telenor | 188 | 64 | 196 | 142 | 260 | 206 | -21 |
| Sweden | Telia | 194 | 120 | 494 | 58 | 688 | 178 | -74 |
| UK | Cellnet | 438 | 308 | 134 | 9 | 572 | 317 | -45 |
| Canada | BellMobility | 613 | 350 | 40 | 29 | 653 | 379 | -42 |
| USA | US West; AT&T | 396 | 273 | 47 | 20 | 443 | 293 | -34 |

Source: OECD Cellular Mobile Pricing Structures and Trends (2000), OECD (2001)

2.3 Leased Lines

Leased lines allow high volume users to take advantage of lower prices than those offered for the PSTN and, in addition, to have control over their own telecom facilities and traffic. Leased lines facilitate entry to telecom markets for companies interested in providing value-added services, including ISPs concerned with building backbone networks for Internet services and large customers accessing ISP facilities. High tariffs for leased lines have represented an important barrier to entry for these different user groups.

Within the EU, the prices for leased lines have been a major concern for users for a considerable time. Since 1 July 1996, the provision of leased line services has been

³ At present the personal basket includes 568 calls per annum and the business basket 1169 calls per annum.

liberalised, but competition has been slow to develop. Based on the Interconnection Directive (97/33/EC), fixed operators identified as having significant market power have the obligation of providing cost-oriented leased line services to other operators.

Denmark has been at the forefront of liberalising this market segment and providing leased lines on a more competitive basis. Table 2.3 reflects the OECD basket of national leased line charges. Figure 2.1 provides comparisons among specific national leased line prices for services of different distances and bandwidth. Denmark ranks high in all the comparisons and continues to be a leader in driving leased line pricing reforms. The prices in Denmark and Finland are dramatically lower than most other countries. The enormously wide variations in leased line rates demonstrate there is still an urgent need for major pricing reforms in most countries.

Table 2.3 – OECD Basket of National Leased Line Charges

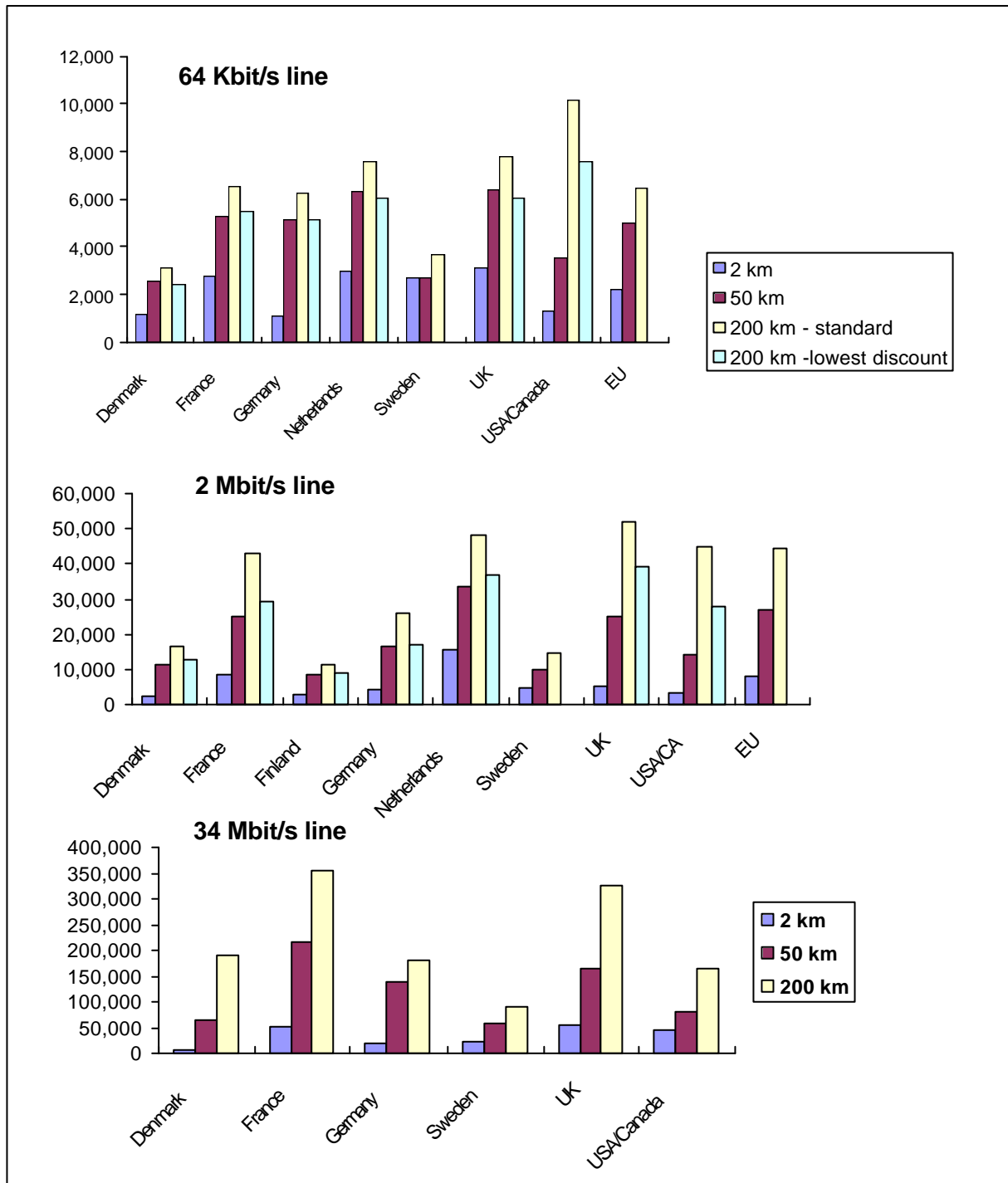
(1.5/2Mbits) (US \$ PPP)^a

| | 1998 | 2000 | cagr |
|-------------|-------|-------|-------|
| Denmark | 1,150 | 682 | -40.7 |
| Finland | 885 | 614 | -30.6 |
| France | 2,152 | 2,124 | -1.3 |
| Germany | 3,149 | 2,138 | -32.1 |
| Netherlands | 2,680 | 2,823 | 5.3 |
| Norway | 1,956 | 1,279 | -34.6 |
| Sweden | 1,041 | 845 | -18.8 |
| UK | 1,857 | 2,052 | 10.5 |
| Canada | 1,630 | 3,997 | 145.2 |
| USA | 1,212 | 2,065 | 70.4 |

Source: OECD (1999, 2001)

^a Excluding tax

Figure 2.1 – Annual Leased Line Rentals



Source: EU 6th Report on the Implementation of the Telecommunications Regulatory Package (2000/2001)

3. COMPETITION

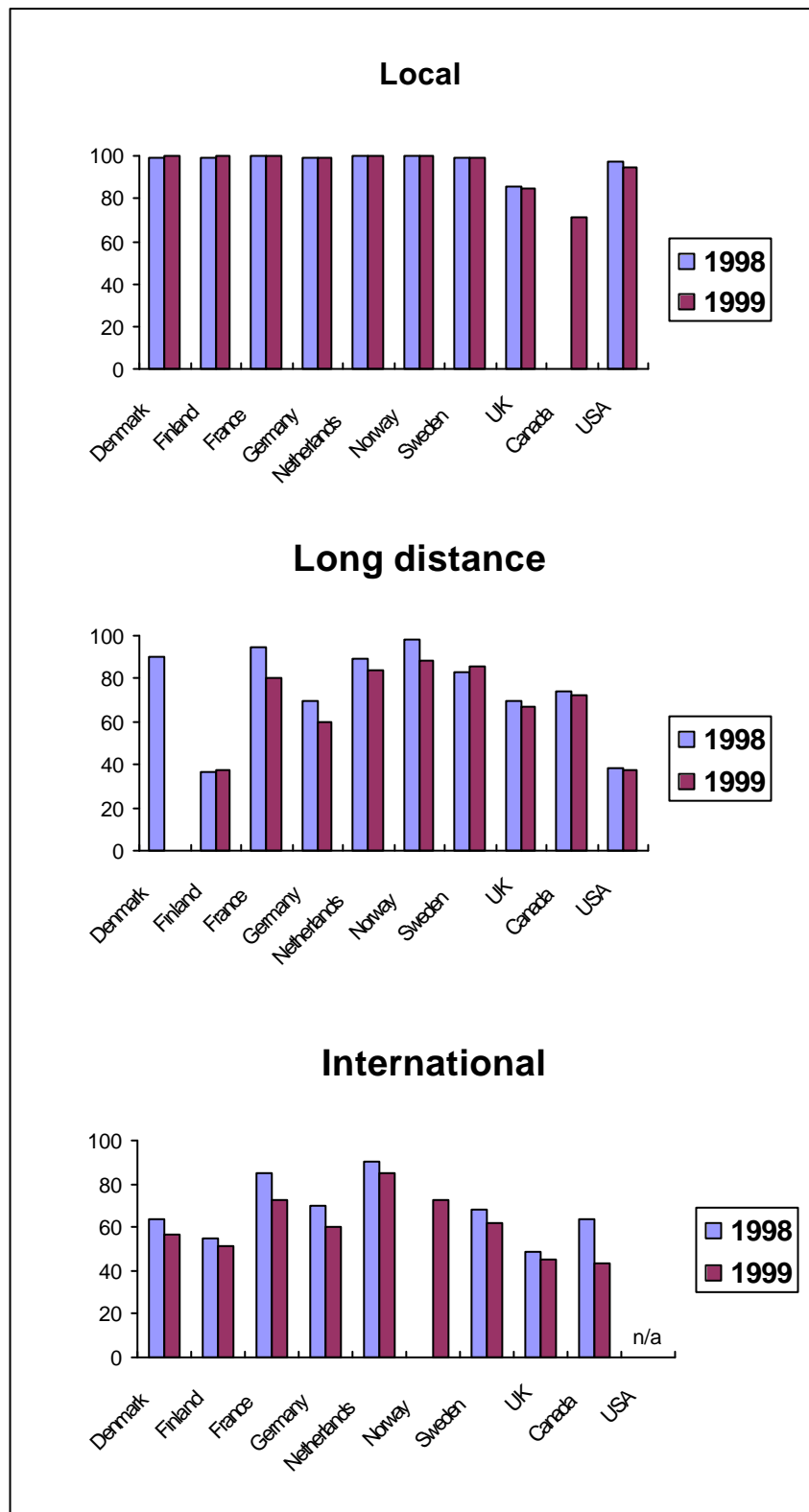
3.1 Public Fixed Voice Telephony

Denmark has been a leader in liberalising entry to the market, as new entrants are not required to receive authorisation or even make special filings. Denmark has been a leader in reducing barriers to entry by introducing carrier (pre-) selection, number portability, and unbundling the local loop well ahead of EC deadlines.

With respect to actual market competition, at the present stage of market development the incumbent's market share has been demonstrated to be a reasonably good indicator. Comparisons of incumbent market shares for local, long distance and international services are shown in Figure 3.1. By this measure, competition is having an impact in most of the compared countries in international services, in a few countries for national long distance, with only a significant impact in Canada and a modest one in the UK for local services. North American markets are more competitive than Europe, and the UK remains the most competitive market overall within Europe.

The Finland data for long distance implies much greater competition than actually exists because of the large number of local operators who also provide long distance services in their respective regions. As a small country that employs only one dialing area code, Denmark's national long distance market tends to have similar characteristics to a large local market, unlike larger countries. Denmark ranks relatively high in international service competition.

Figure 3.1 Incumbents Market Share in Public Fixed Voice Telephony

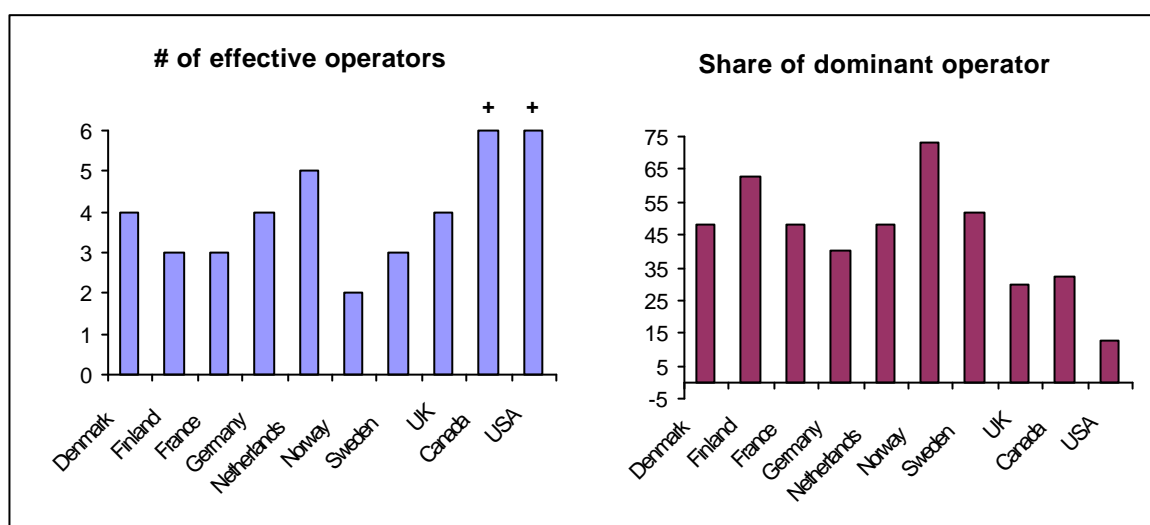


Source: OECD (2001)

3.2 Public Mobile Services

Competition in mobile services has increased more rapidly than fixed network services. With each generation of mobile, more competitors have been licensed in Denmark and most other countries. It was the first country in Europe to introduce virtual mobile network services (VMNS). An indication of the significance of competition can be seen from the dominant operator market share data provided in Figure 3.2. Although competition has had a significant impact in all the countries, within Europe it has been greatest in the UK where BT has been displaced by Vodafone as the leading operator. The US data tends to overstate the

Figure 3.2 – Mobile Telecommunications Revenue Share



Source: LIRNE.NET Estimates

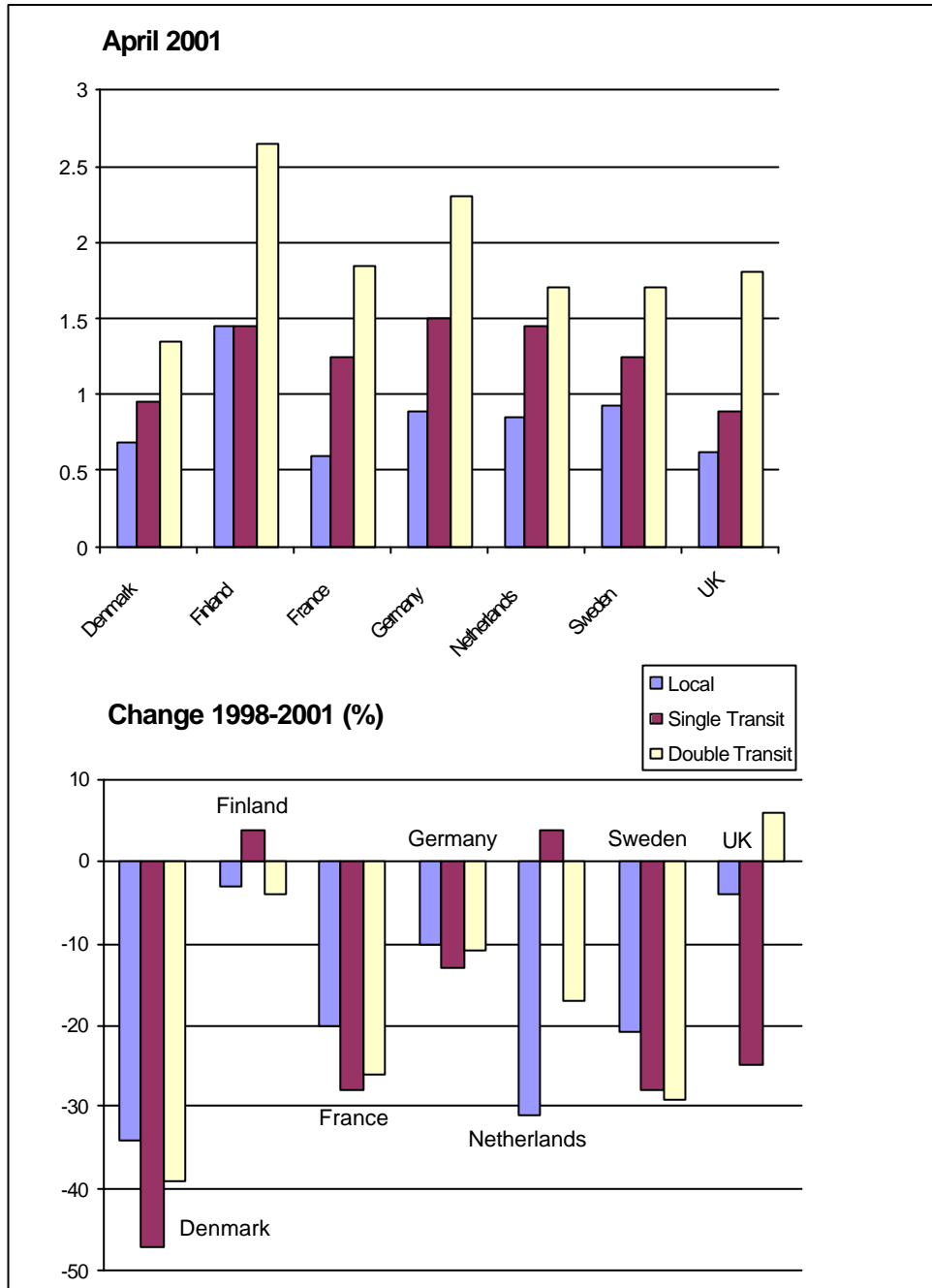
degree of competition, as most mobile markets are regional, not national. More recent developments include the issuing of additional licenses for 2G, 3G and/or fixed wireless services in many countries, and plans to issue further licenses in the near future.

3.3 Interconnect Prices

With the EC Interconnection Directive (97/33/EC, national regulatory authorities for telecom (NRAs) received an important role in securing adequate interconnection of networks. In order to facilitate decreases in interconnect prices, the EU Commission has adopted recommendations defining “recommended price ceilings”, and “best current practice”.

Figure 3.3 presents the most current EU data on interconnection charges for fixed-to-fixed voice services. The prices for all countries are within the EU best current practice range, with the exception of, (1) Finland, which has prices above the top of the range for local and double transit; (2) Germany, which has prices above the top of the range for double transit; and (3) Denmark which has prices below the bottom of the best practice range for double transit, about half the price in Finland. Denmark’s price reductions over the past three years have been the greatest in all three categories. Overall Denmark and the UK have the lowest interconnection prices.

Figure 3.3 – Interconnect Charges for Fixed-to-fixed Voice
Per minute (Euro cents)



Source: ONPCOM01-14

3.4 Unbundled Access to Local Loops

A fundamental bottleneck restricting the development of public switched network competition has been the difficulty of providing direct access to customers for new service providers. National regulatory authorities in a few countries, including Denmark, have taken the lead in requiring the incumbent operator to provide unbundled access to local loops. Table 3.1

provides a summary of the status of local loop unbundling in the compared countries and the prices per voice grade copper pair.

Table 3.1 – Unbundled Local Loop: Implementation Date and Rental Prices

30 March 2001, EURO

| | Implementation date | Unbundled Access (Monthly) | Shared Access (Monthly) | Line Rental (Monthly) |
|-------------|---------------------|----------------------------|-------------------------|-----------------------|
| Denmark | Jul-98 | 8.23 | 6.17 | 12.10 |
| Finland | 1996 | 12 – 17.50 | 7.5 – 13.0 | 11.76 |
| France | Jan-01 | 14.48 | 6.10 | 12.55 |
| Germany | Jan-98 | 12.48 | n/a | 10.94 |
| Netherlands | Jun-00 | 12.50 | n/a | 15.50 |
| Sweden | Mar-00 | 9.30 | n/a | 11.00 |
| UK | Aug-00 ^c | 16.00 | n/a | 13.40 |

Source: EC ONPCOM 01-10, May 2001

Unbundled access to local loops is a key element not only in the development of the next phase of competition in EU countries, but also in preparing the telecom network for information infrastructure development and the network society services envisioned in Danish government policy documents, and similar policy statements by the EC and other national governments. The evidence suggests that Denmark prices are among the lowest of compared countries for unbundled access to local loops.

ASSESSMENT: TELECOM REFORM

By all the standard indicators, Denmark compares extremely well among the leading countries with respect to progress in telecom reform. Its national telecom market development, and the service coverage of its basic telephony and mobile services rank among the best in the world, along with the other Nordic countries. Denmark's prices rank almost as well. Overall its leased line prices are among the lowest of the compared countries. Its PSTN and mobile service prices are in the top group of countries. Its weakest performance has been in international call charges where major reductions in several other countries have been introduced even faster than the significant reductions in Denmark in the last two years.

With respect to competition, all countries still have a long way to go before their telecom services markets are fully competitive. Mobile and international services show evidence that significant competition is developing in all the compared countries. In the mobile market, the incumbent is no longer the leading player in the UK and Germany, and mobile has begun to displace fixed services in Finland. National long distance competition is developing more slowly and local service competition has barely begun. Although Denmark is among the leaders in developing competition in international services, like most other countries, national local and long distance competition has been slow to develop.

Denmark's performance ranks much higher on prices and market development than it does in the development of actual competition. When viewed in the context of Denmark's leadership in minimising barriers to entry, its high ranking on interconnect prices and its leadership position in unbundling access to the local loop, this could indicate that Denmark's good performance is being driven more by the regulator than by competition.

Overall, one does not find a direct correlation between the development of competition and the lower prices and greater market coverage that one would expect. In direct contrast to Denmark, the UK has been the clear leader in the development of competition throughout the entire telecom reform process of the last 14 years. This correlates well with UK leadership in reducing interconnect prices, but UK consumer prices and market penetration rank surprisingly low among the compared countries. A major issue for the EC and the NRAs for the immediate future will be to determine what steps are necessary to ensure the reasonableness of national and international mobile call termination charges.

For the future, Denmark has prepared the ground well for information infrastructure and network society development by establishing the lowest barriers to entry in Europe. The key indicators of preparation for information infrastructure development for the next several years are leased line and interconnect prices, and unbundled access to local loop. These have been key factors helping to explain the rapid growth in US information infrastructure and Internet services during the 1990s. As Denmark is the only country in a leadership position in all three areas in Europe, it is well positioned to build on that in the development of the information infrastructure for its network society.

B INFORMATION INFRASTRUCTURE AND NETWORK SOCIETY DEVELOPMENT

The transformation of national and international telecom networks into information infrastructures capable of providing advanced communication/information services is generally associated with two developments: an increasing variety of Internet services; and the supply of increased bandwidth of varying capacity to carry the newer and more sophisticated Internet services. Insufficient bandwidth can be a constraint limiting the access of residence and business customers to certain more advanced services, e.g., interactive video. But a great many Internet services can be supplied effectively at much lower prices over digital telephone lines. Today the vast majority of Internet use is email and web site access over single or multiple (ISDN) digital telephone lines. But as service opportunities and consumer demand grows, higher bandwidth capacity is needed. The pace of market development is governed by the interaction of these demand and supply factors.

Thus, information infrastructure and network society development involves several interdependent components:

- 1) Internet services development which helps stimulate demand for new services;
- 2) preparation for applications of new Internet services throughout the economy and society to business, government, education, entertainment, etc.;
- 3) an expansion of the bandwidth capacity in national and international networks to reduce unit networking costs and provide for higher capacity services;
- 4) an expansion of bandwidth for local connections to business and residence users to facilitate the increasing demands for higher speed services.

This evolutionary process of network and market development will proceed faster for certain segments of society than others. The concern of policymakers and regulators is to facilitate the process by preparing a foundation that will promote the development and application of new services. This section of the report provides some preliminary data on, (1) information infrastructure supply, capacity and access; (2) Internet development, uses and users; and (3) applications for network society development - e-commerce and e-government readiness and activity.

4. NETWORK INVESTMENT AND CAPACITY

As the convergence of telecom, computing and media proceeds, increased attention is focused on the capacity of national telecom networks to meet the demands of future multi-media, e-commerce and other Internet services. Capacity requirements concern the bandwidth necessary for local connections to the home, as well as the capacity of national and international networks. National network investments are related to the expansion of traditional telecom services, the growth of relatively new services (e.g. mobile), and preparation for expanding growth in Internet services, both narrowband and broadband. Most Internet traffic between European countries still travels via the US.

4.1 National Network Investment Trends

Investment trends in national networks are shown in Table 4.1. For most countries average investment per capita is increasing, reflecting the increasing need for upgrading and expanding capacity. The US and Norway have the highest investment per capita in recent years. The Netherlands had a major increase in 1999 stimulated by new mobile networks. The pattern for Germany in the early and mid-1990s has been determined by the enormous requirements of rebuilding the former East German network. Investment per capita in Denmark was among the lowest among the compared countries during the early 1990s, but has increased substantially in the later 1990s, reflecting the rollout of mobile networks and the upgrading of local networks for the Internet bandwidth economy.

Table 4.1 – Public telecommunication investment per capita

(In USD millions)

| | Average 1988-90 | Average 1991-93 | Average 1994-96 | 1997 | 1998 | 1999 | Average 1997-99 |
|-------------|-----------------|-----------------|-----------------|------|------|------|-----------------|
| Denmark | 96 | 81 | 106 | 128 | 213 | 166 | 169 |
| Finland | 135 | 101 | 124 | 162 | 116 | 111 | 130 |
| France | 81 | 106 | 106 | 110 | 110 | 95 | 105 |
| Germany | 118 | 197 | 156 | 145 | 132 | 137 | 138 |
| Netherlands | 77 | 104 | 98 | 95 | 171 | 299 | 188 |
| Norway | 118 | 113 | 139 | 180 | 305 | 229 | 238 |
| Sweden | 127 | 134 | 136 | 109 | 105 | 103 | 106 |
| UK | 84 | 65 | 84 | 171 | 151 | 216 | 179 |
| Canada | 127 | 117 | 95 | 134 | 149 | 171 | 151 |
| US | 93 | 100 | 141 | 200 | 244 | 324 | 256 |

Source: OECD Communications Outlook 2001

4.2 The Trans-Atlantic Capacity Explosion

Figure 4.1 shows an overview of all fibre optic capacity laid across the Atlantic, compiled from the FCC International Circuit Status Report with FCC estimates for 2000–2002. AC-1 went into full operation in February 1999 at 40 Gbit/s and was upgraded to 80 Gbit/s at the end of the year. A similar action was performed on the Gemini and TAT-12/13 systems that were upgraded to 30 Gbit/s each. TAT-14 was brought into service in 2000 with 640 Gbit/s. This has brought about a jump in total bandwidth from slightly more than 160 Gbit/s to more than 800 Gbit/s, a 4 fold increase in capacity. Although ambitious plans for additional cables and upgrades that would increase transatlantic capacity by 25 times have been scaled back, and bankruptcy of at least one entrepreneurial venture is possible, one can expect an increase on the order of ten times by 2002, nevertheless an explosion in capacity.

Figure 4.1 Transatlantic submarine cable capacity 1988 - 2003

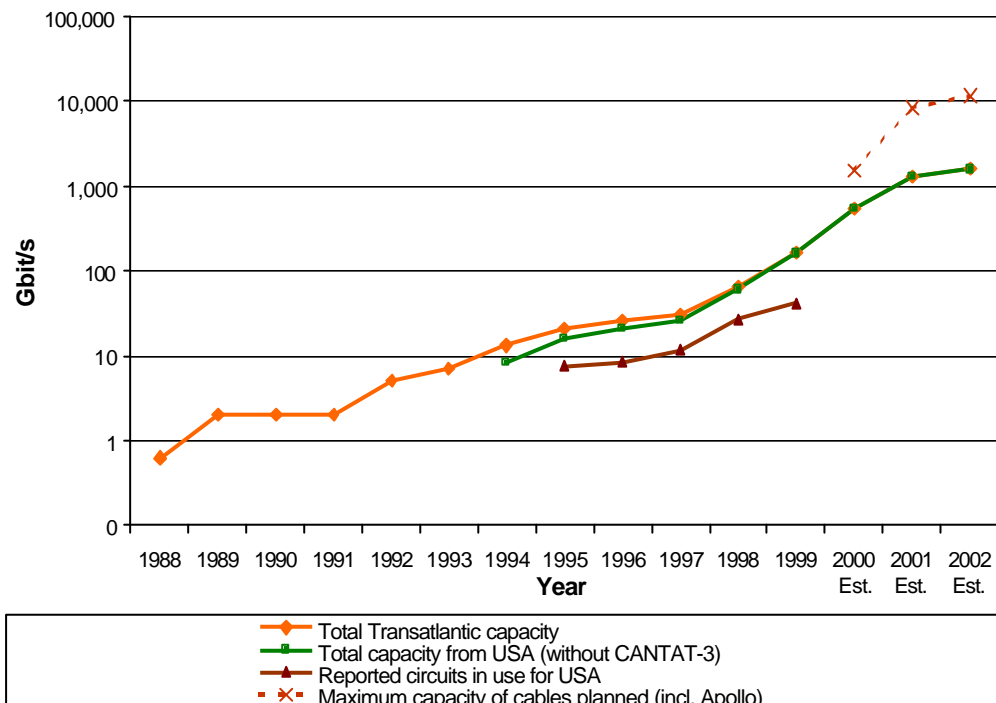
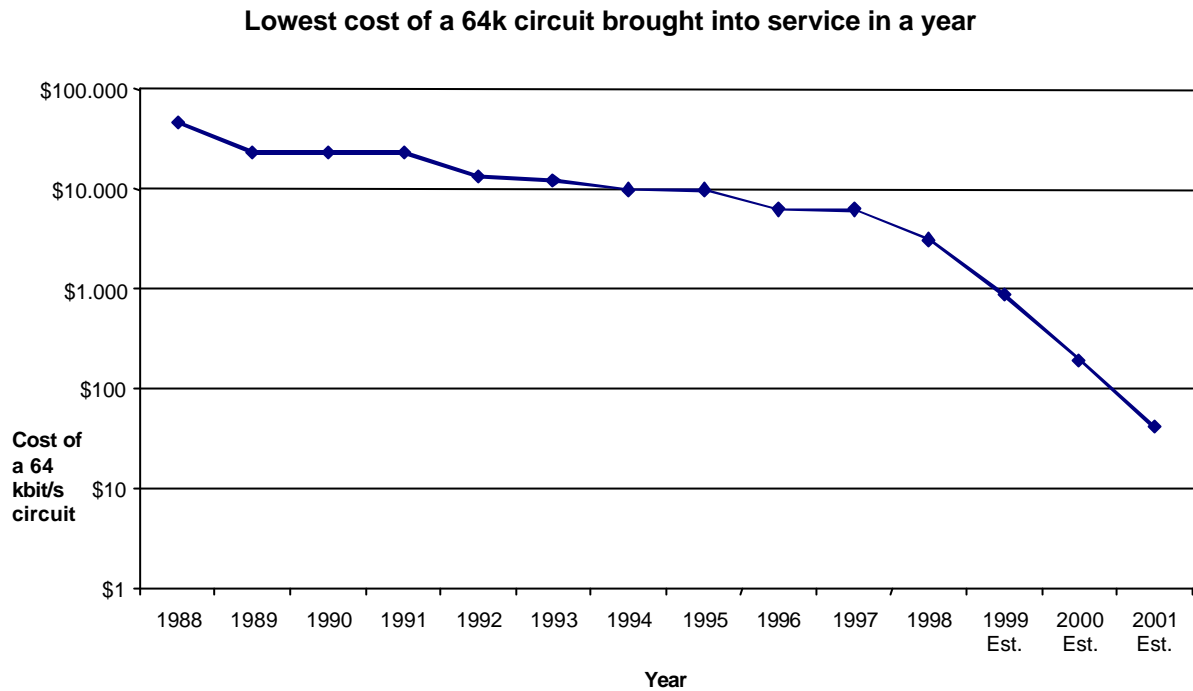


Figure 4.2 shows the current cost curve for the supply of a 64 kbit/s transatlantic circuit, as estimated from FCC data. It shows that the investment required for a transatlantic cable is expected to fall from \$10,000/circuit in 1995 and \$1,000/circuit in 1999 to \$41 per 64 kbit/s circuit, when cables like FLAG Atlantic-1, Hibernia or Level3 become available at their full capacity in 2001. The death of distance is arriving fast.

Figure 4.2 – Cost of newly installed transatlantic circuit capacity is declining.



Source: Based on 1999 FCC International Circuit Status report data

The landing of the TAT-14 sea-cable in Denmark at the end of 2000 has brought direct access to a large supply of transatlantic bandwidth. This may open opportunities for Denmark to position itself for a more active role in the transatlantic Internet economy.

5. NEW ACCESS TECHNOLOGIES

Options and Implementation Horizons

The bottleneck in the development of competition for telecom network services of all kinds is direct access to customers. Unbundling access to local loops permits competitive access opportunities for traditional telecom services, and for higher speed services that can be provided using new technologies applied to existing copper subscriber lines. However, competition for the longer term is centred on alternative "pipes to the home" and the need to supply high speed access for the more sophisticated Internet services being developed.

The time horizons for the development and application of new access technologies depends in part on the pace of technological improvements, and the achievement of reductions in bandwidth unit costs and other technical service parameters relating to security, privacy, intellectual property protection, contracts, etc. And it depends in part on the rate of growth in demand for services that require higher speeds and greater bandwidth. For the near term, new access technologies that are now being made operational in many countries are DSL, upgraded CATV systems and digital TV applications. Fibre to the business is economical in some circumstances, but fibre to the home will require significant cost reductions and demand growth before it becomes competitive.

Licensing of Fixed Wireless and broadband mobile networks now in process in many countries will open new possibilities. New satellite systems offer medium term possibilities for some users. For the longer term horizon, HIPERACCESS, High Altitude Platform Stations and powerline communication may become possibilities. The unresolved question is whether the competition among the different technologies will tend to supply many pipes to many homes, or one pipe to all homes. Possible options for Denmark and other European countries over the next few years are discussed below.

5.1 ISDN

The first step up from a standard telephone circuit in terms of improving network access speed for residential customers is ISDN, with an equivalent capacity of 2-4 circuits. In some countries ISDN has been available for many years, but its growth was limited by high cost, low demand and relatively few services requiring it. As service offerings have expanded with rapid Internet growth, and demand has increased, some users are going directly to higher capacity DSL, upgraded CaTV or other technology options with higher capacity.

Table 5.1 provides an indication of ISDN penetration in different countries. Penetration in Europe is much greater than North America. The Netherlands, Germany and Denmark have the largest ISDN market penetration. Norway – not listed in this comparison – is also known to have significant ISDN penetration.

Table 5.1 – ISDN Subscription

(x 1000)

| | 1997 | 1999 | Penetration (Bus. + Res.) (1999, %) | Penetration (Residence) (1999, %) |
|-------------|-------|--------|---|---|
| Denmark | 176 | 662 | 12.4 | 9.0 |
| Finland | 116 | 467 | 9.0 | 6.0 |
| France | 2,128 | 3,600 | 6.1 | 2.0 |
| Germany | 734 | 14,218 | 16.2 | 12.0 |
| Netherlands | 810 | 2,280 | 14.1 | 13.0 |
| Sweden | 187 | 645 | 7.3 | 4.0 |
| UK | 1,100 | 3,000 | 4.0 | 4.0 |
| Canada | 451 | 999 | 3.3 | n/a |
| USA | n/a | 2,016 | 0.7 | n/a |

Source: OECD (2001); EITO (2001)

5.2 Digital Subscriber Lines (DSL)

DSL provides an upgrading of the capacity of customers' copper wire connections. It can come in varying sizes, usually from 128 kbits to 2 Mbits, depending on the quality of the copper wire, the distance from the central office, and other factors. If unbundled local loop access is provided, DSL services can be supplied by competitive operators as well as the incumbents. In most countries DSL provides immediate opportunities for enhancing local competition for higher speed access to Internet services. DSL services first became significant in the USA and Canada in 1999. Various European countries began during 2000. Table 5.2 provides recent estimates of early DSL development.

The market for DSL connections in Denmark began to grow faster when the main providers (Tele Danmark, CyberCity and World Online) changed to flat rate pricing during 2000. Table 5.3 provides details on current prices. As of April 2001, it was estimated Denmark had expanded to 45,000 DSL subscriptions.

Table 5.2 - DSL Subscriptions

(Connections per 100 persons, Dec 2000)

| Country | xDSL |
|-------------|------|
| Denmark | 0.49 |
| Finland | 0.29 |
| France | 0.11 |
| Germany | 0.24 |
| Netherlands | 0.09 |
| Norway | 0.01 |
| Sweden | 0.45 |
| UK | 0.05 |
| Canada | 1.53 |
| USA | 0.89 |

Source: Digitoday (online) May 2nd 2001: 'OECD: Norge dårligst I Norden på bredbånd' by Frode Eriksen. http://www.digitoday.no/digi98.nsf/pub/te20010502083313_fse_53786678

Table 5.3 – Prices for ADSL Services in Denmark (DKK)

(May 2001)

| Capacity (KB/s) (down/up) | Tele Danmark | | CyberCity | | Tiscali | |
|------------------------------|--------------|------------------|--------------|-----------|--------------|-----------|
| | Installation | Per month | Installation | Per month | Installation | Per month |
| 256/128 | 995 | 449 ^a | 1995 | 345 | | 295 |
| 256/256 | | | | | 0 | 395 |
| 512/128 | 995 | 549 | | | | 445 |
| 512/512 | | | Free p.t. | 495 | 0 | 595 |
| 1024/256 | 995 | 649 | | 595 | | |
| 1024/512 | | | Free p.t. | 695 | | |
| 2048/512 | | 949 | Free p.t. | 895 | 2000 | 995 |

^a Also as DKK 299 + DKK 0.3/MB

According to Tele Danmark, more than 60% of all PSTN lines have been equipped with ADSL functionally.

5.3 CATV Upgrades

In many countries, the best immediate option for competitive access to higher capacity services is via established cable television (CaTV) operators. In entering the markets for broadband access, CaTV operators in countries with high CaTV penetration rates have a head start over other new access technologies. Table 5.4 provides data on CaTV Internet penetration in the compared countries. Canada, the Netherlands and the US have the greatest penetration at this very early stage of development.

Table 5.4 – Internet Access via Cable Modem
(Connections per 100 persons, Dec 2000)

| Country | Cable Modem |
|-------------|-------------|
| Denmark | 0.56 |
| Finland | 0.29 |
| France | 0.21 |
| Germany | 0.00 |
| Netherlands | 1.58 |
| Norway | 0.34 |
| Sweden | 0.62 |
| UK | 0.03 |
| Canada | 3.01 |
| USA | 1.36 |

Source: Digitoday (online) May 2nd 2001: 'OECD: Norge dårligst I Norden på bredbånd' by Frode Eriksen. http://www.digitoday.no/digi98.nsf/pub/te20010502083313_fse_53786678

The cable TV access market in Denmark consists of two main network providers (Stofa and Tele Danmark) and a multitude of independent cable associations organised under Forenede Danske Antenneanlæg (Danish cable Television Organisation). Stofa supplies 610,000 households with cable TV. Of these, 210,000 households have the possibility to access StofaNet. Access charges are 60 DKK including 60 MB/month + 0.5 DKK per additional MB up to a total of 200 DKK, which is a maximum price (up to 4000 MB though at which point an additional MB is 0.1 DKK). Installation charge is 499 DKK + optional 249 DKK (if one does not install the modem). It is a genuine cable modem with 1 MB up and 384 KB down.

Tele Danmark has two cable solutions K1 and K2 both marketed as WebSpeed. K1 is a hybrid solution, using the cable network as down stream and the telephone network as up stream. Down stream capacity is up to 512 KB. Up stream capacity depends on the telephone subscription. Installation charge is 995 DKK and monthly charge is 98 DKK the first 12 months and 148 DKK per quarter thereafter (use of the telephone network not included). K2 is a genuine cable modem. Installation charge is p.t. 995 DKK (including a modem). Three capacities/access solutions are supplied: 64/64, 149 DKK per month; 256/64, 199 DKK per month; 512/128, 399 DKK per month. All are free of usage charge.

Forenede Danske Antenneanlæg (Danish Cable Television Organisation) is an association of several independent antenna installations, covering about 320.000 households. Several organisation members have already prepared cable network for two-way communication. The typical capacity is 2 MB, and the subscription price around 900 DKK per year. There are no use dependent charges.

The entire cable network covers approximately 1.7 million households. It is estimated that around 500.000 have the possibility to use the network as access to the Internet. Around 10% (50–60,000) of them have installed a cable modem. It is expected that within the next two years almost all the households will have the same opportunity, and it is expected that around 170,000 will have access.

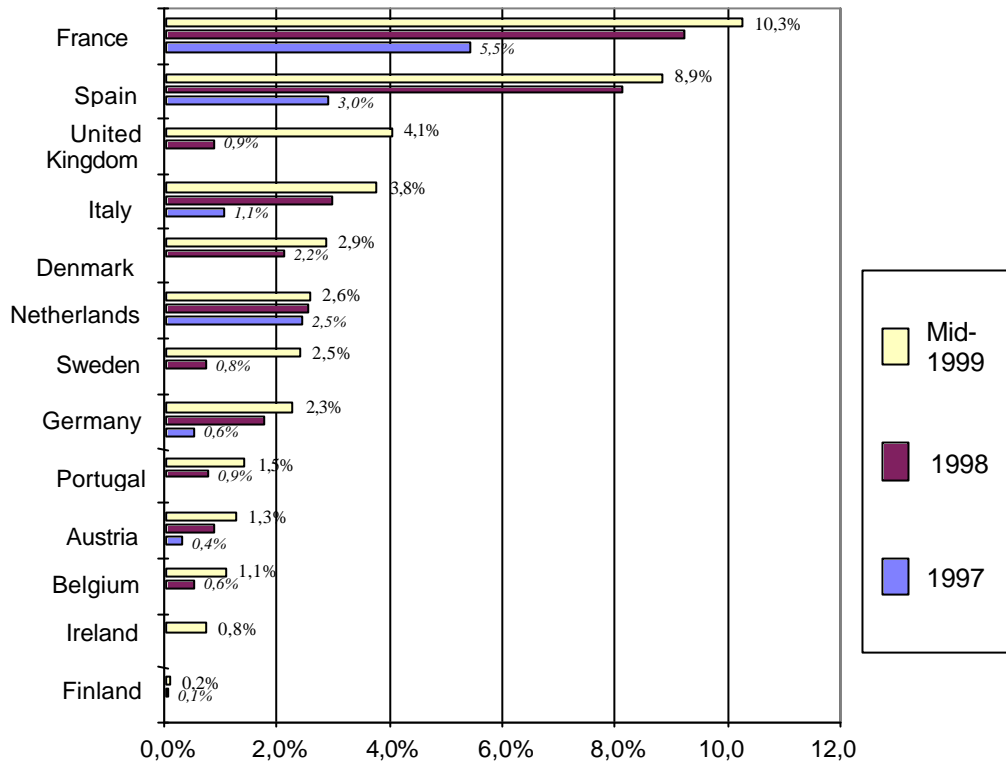
5.4 Digital TV

As Digital TV opens for transmission of data services in addition to the traditional audio and video services, it is one the new high capacity access routes, and because of its coverage and ease of use, a potentially promising one. The new data services can be related to the TV programs or they can be non-TV-related services. The program related data services consist of background information related to the programs including, e.g., sale of books, CDs and other merchandise. The non-TV-related services can be any data services, such as access to the Internet, data cast, etc.

Digital TV can be distributed using cable, satellite and terrestrial networks. In the last few years the number of digital TV subscribers has increased rapidly and digital TV is now promoted vigorously as interactive, I-TV. France has led the way in global I-TV development, but the service is now available in satellite and cable networks in many countries. Regarding terrestrial networks the USA, the UK and Sweden are among the first countries to implement these services.

Figure 5.1 shows the ratio of digital TV subscribers for all distribution forms to total TV-households in selected European countries. Denmark ranks fourth with a 2.9% penetration. In the US the penetration rate in 1999 was about the same as the European leader, France (10%).

Figure 5.1



Source: IDATE, Development of Digital Television in the European Union – Reference Report 1999, Montpellier, 1999

The main difference between traditional telecom networks and TV-networks is that the first are two-way or communicative and the second are one-way or distributional. The lack of a 'built-in' return channel is a weakness in the development of interactive services. The solution has been to use the telecom network as the return channel, which can be built into the systems. There is, however, no standard solution for this, and the complexity and the cost of implementing the return path in the terrestrial and satellite networks, at least at the current technological development, makes such integration unfeasible. Another problem is the capacity available per user as the distributive networks are designed for transmission of the same content to many users. Among different distribution platforms, cable networks are technologically better positioned to integrate the return path inside the network and to optimise the networks to keep the capacity per user on a reasonable level.

5.5 Fibre to the Home

It has been estimated that more than 25 million miles of fiber-optic cable had been laid by the end of 2000, and there will be a 500-fold increase in capacity by 2003. But very little of it will be laid to residential homes. Fibre is now the dominant technology in international and national networks, and the concentrated central core of larger cities. It is increasingly being used to construct fibre rings in local networks in metropolitan areas, and provides direct connections to large firms. For smaller cities and towns, SMEs and residences, to be served by fibre economically they have to be located on the path of fibre links in the larger networks.

The interest in fibre arises from its enormous, and increasing, bandwidth carrying capacity and its rapidly declining unit cost as the technology continuously improves. (Some fibre fans

claim Moore's Law now applies.) One can project that at some future time, the growth in demand for high bandwidth services to the home and the decline in fibre costs will make fibre to the home not only the economical choice, but the only choice as DSL, upgraded CaTV cables and new mobile networks would not be able to handle the bandwidth demand. But so far the vast majority of demand can be satisfied on existing networks, and whatever reductions in fibre cost take place, they cannot replace the 70% of the local loop cost associated with installation, e.g. digging ditches. For the immediate future, it will still be very difficult for fibre to compete with already installed copper and coaxial cable. Even the most optimistic telecom operators are not planning to get any closer to the home than "fibre to the curb", and only that in special circumstances.

There is increasing interest by city and town governments in establishing local fibre networks, as important both to retaining and attracting business for the local community economy and supporting major public institutions, e.g., schools. In the USA and Canada, several cities and towns have constructed backbone fibre distribution networks, or are planning to do so. But they are not planning to extend them to homes or even neighbourhoods outside the central core. A committee of the Government of Toronto (five million) recommended such a project to the city council. Other cities are considering special underground ducts to house the cables of competing operators. Some condominium and apartment blocks are establishing internal fibre wiring and connections to the curb as a means of making fibre connections more attractive. It has been suggested that this principle might be extended to residences as a matter of policy.

These approaches would all make fibre to the home more feasible for the operators, but more expensive for residential users. This could promote development for some while restricting it for others and make a universal service more difficult to achieve. It would also bias the competition among alternative "pipes" to the home in favour of a technology that, if it wins, may well end up a monopoly because of its enormous bandwidth and infinitesimal marginal cost.

Stockholm based Bredbandsbolaget is believed to be the leading fibre company in Europe in a very small market with few active players. The firm was started in 1998 for the development of a Fibre to the Home (FttH) service by utilising Local Area Network switching gear that is installed in the basements of apartment blocks. These switches are interconnected by fibre optic cable, while the last 100 meters is realised by installing 4-pair copper data-cabling. With the LAN-switch based design Bredbandsbolaget launched in 2000 a 10/100 Mbit/s Internet access services with a guarantee of 1 Mbit/s at a price of circa \$25 per month. This low price is based on the very large scale production of LAN-switches for the general business community and the high amount of dark fibre available in particular in the Stockholm area from municipality owned StokAB.

Bredbandsbolaget announced in 2000 it is expanding its operation area under the name Bredband.com to all Nordic countries and the Benelux area. Its goal is to wire one million homes by end 2002. The total number of connected apartments at January 31st, 2001 by Bredband was 103,000, mostly in the Stockholm area. Bredband has sold its service to about 25% of the homes connected. In February 2001 Bredband announced it had to reduce its network expansion, and raise the monthly fee, due to the high capital amounts involved and tightening capital market.

5.6 Fixed Wireless Access

Fixed Wireless Access (FWA) has attracted serious interest as an efficient way to stimulate competition in the local loop by creating an alternative infrastructure. The US had an early

start by granting licenses in 1998 and US companies are active on this area over most of Europe. Licenses for FWA have been awarded in Finland, Germany, Norway, Portugal Spain, Switzerland and the UK. In Denmark seven licenses were awarded in December 2000.

However the FWA markets in many European countries have turned sour during 2000. The auction in the Netherlands for point-to-multipoint microwave links, slated for March 2000, has been deferred and the UK auction, held in November 2000, failed to gain bids on the lots for a substantive number of areas. In addition, the major European players, many of them founded and financed by US FWA entrepreneurs, faltered or did not start their network build outs. Formus (Callino), Teligent and Winstar are under bankruptcy protection, and UPC terminated its Swiss and Spanish wireless venture. Firstmark withdrew from the UK bidding. Most FWA operators now concentrate on data communications services, filling a niche market rather than attempting to provide any serious local loop alternative for fixed voice telephony service.

Besides the conventional FWA, a new type of semi-fixed FWA has sprung up based on Wireless LAN technology. Jippii deploys a Wireless LAN based public Internet access network service in Helsinki, and Telia provides a similar service in Stockholm. Both operators are utilising the new Wireless LAN standard technology that operates in the license free Industrial, Scientific and Medical band of 2.4 GHz for their outdoor coverage.

Wireless LANs are set up as an indoor public service in airports, hotels and convention centres and outdoor on larger company and university campuses. Wireless LAN technology is also sold with dedicated directional antenna's and operated in a number of European countries by start-up operators as a cheap alternative for microwave FWA to the Internet. They are able to reach out the several km in line-of-sight and provide 3 Mbit/s symmetric access for the service users.

5.7 Broadband Mobile Services

Second and third generation (3G) mobile networks are generally seen as playing a more significant role in future telecom markets than FWA. The licensing of additional competitors in second generation mobile in some countries, including Denmark, is expanding competition in existing mobile markets that will both extend the limits of these markets and speed up the competitive overlap with fixed networks. Denmark licensed additional 2G networks (GSM900/DCS 1800) in January 2001. The role of 2G mobile is enhanced by the introduction of new technologies such as HSCSD (High-Speed Circuit-Switched Data), GPRS (General packet Radio System) and EDGE (Enhanced Data GSM Environment). These "2½ G" technologies will provide bit rates between 4 and 40 times as fast as 2G. The rollout of HSCD and GPRS began in Europe during 2000.

3G networks are expected to be able to provide Internet access at speeds up to 2 Mbits, and open a new competitive alternative "pipe" to the person. In addition, 3G systems will offer the capability of a clear technical and operational separation between network operators and service providers. All the compared countries examined in this report have, or will be issuing four to six 3G licenses in 2001. Denmark has announced that it will auction four 3G mobile licenses on 5 September 2001.

The financial fallout from the enormous auction prices paid in the UK and Germany, and significant but lesser amounts in other countries, and the return to reality of stock prices in the sector, is having a major impact on 3G network rollout plans in many countries. Current

expectations suggest a 2-4 year time horizon for network development and service deployment.

5.8 Satellites

New satellite technologies will play a significant role in future telecom networks, but whether they will be capable of providing a competitive “pipe” to the home for high speed Internet services is at present a speculative question. Direct broadcast satellites have taken a small, but significant share of the television market in some countries, and this could expand. But the primary role of satellites has been in international and some national (for large countries) networks as a transmission vehicle for a variety of telecom services, with a comparative advantage in television transmission.

Digital TV could open possibilities with the development of advanced technologies for LEO and MEO satellites. But the current expectation is that the Teledesic satellite plan, which focuses on high speed access to Internet services, will connect primarily to local operators, not to homes. As a competitor supplying an alternative “pipe” to the home for high speed access to Internet services, the satellite option remains speculative and long term, and with a comparative advantage only for a small and specialised portion of the market.

6. INTERNET DEVELOPMENT

Indicators of Internet development cannot be as definitive as traditional telecom indicators, but do provide a basis for general comparisons. Internet hosts provide a general indication of services availability. Internet connectivity provides an indication of coverage. Internet prices identify access and competitiveness. The market share of Incumbent Institutions in the ISP market provides another indicator of competitiveness.

6.1 Internet Hosts and Connectivity

Table 6.1 provides data indicating the extent of Internet development in the compared countries. Data on Internet hosts indicates the US is significantly ahead, with Finland, Canada and Sweden in the second tier. However, Internet hosts is not necessarily a very precise indicator. Other data suggest that Denmark and the UK have a relatively high number of web server sites per host.

Whereas Internet hosts is an indicator from the supply side, Internet connectivity is an indicator from the demand side. On this measure the UK is the leader. Penetration is growing rapidly in all countries, although it is apparent that France and Germany started later than the other countries. In Denmark, Internet connectivity grew from 45% to 68% between 2000 and 2001.

It should be noted that the penetration data in Table 6.1 reflects the percentage of people who have Internet access. The Nielsen / Net Ratings' Global Internet Trends Report of June 2001 estimates that actual services to homes in the USA is at 50%, and in Europe at 25%. Given the rapid growth rates in all the countries compared here, comparative rankings at any moment in time are not likely to be indicative of long-term comparative rankings.

Table 6.1 – Internet Hosts and Connectivity

| | July 1997 | June 2001 ^a | Hosts per 1000 inhabitants (June 2001) ^a | Internet Connectivity June 2001(%) |
|-------------|-----------|------------------------|---|------------------------------------|
| Denmark | 138 | 502 | 94.4 | 68 |
| Finland | 350 | 1,007 | 194.7 | 62 |
| France | 308 | 1,590 | 26.9 | 19 |
| Germany | 823 | 4,034 | 49.2 | 42 |
| Netherlands | 341 | 1,875 | 118.6 | 71 |
| Norway | 180 | 589 | 132.0 | |
| Sweden | 310 | 1,533 | 173.1 | 74 |
| UK | 924 | 4,185 | 70.3 | 79 |
| EU | 3,828 | 14,052 | n/a | |
| Canada | 912 | 5,697 | 186.8 | |
| USA | 15,131 | 79,231 | 290.4 | |

Source: OECD; Netsizer (<http://www.netsizer.com>)

^a Taken directly from Netsizer (other values from OECD Outlook 2001, which are also taken from Netsizer)

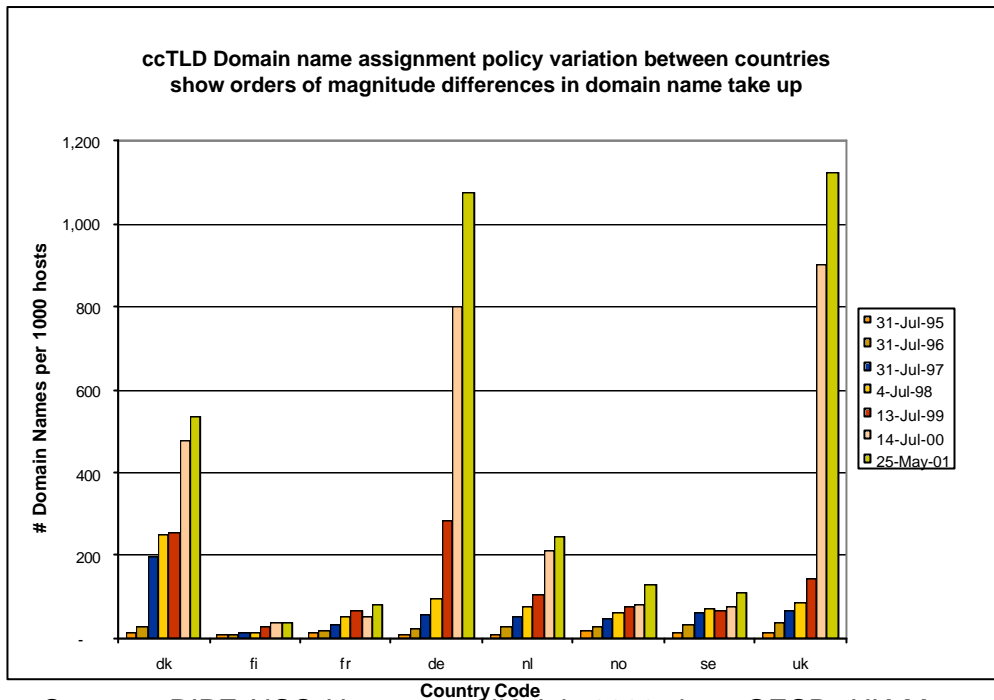
6.2 – Domain Name Registrations

Figure 6.1 shows the strong differences among the various countries when the number of active⁴ assigned *country code TLD* domain names are compared with the number of Internet hosts installed under the same ccTLD. The differences are better explained by the variation in ccTLD domain name assignment policy than by other gauges (such as internet penetration level).

The still very strict rules in Finland and France on domain name eligibility and assignment are exemplary. Denmark has introduced far more liberal rules on whom can register what domain name. A similar shift to a very limited set of name assignment rules and wide eligibility as in Denmark has been made during recent years in Germany, the UK and to a lesser extent in the Netherlands.

⁴ An active name is a domain name that could be found by a search of the domain name tree on the Internet. Registrations of names that are not implemented on the Net are not counted by RIPE. In some countries these speculation and false implementation names add another 25% domain name registrations.

Figure 6.1 – Domain name take-up



Sources: RIPE NCC Hostcount; UK July-2000 data, OECD; UK May 2001 data Netsizer and Netnames domain name stats

Table 6.2 shows the differences in registrations under generic TLD's like .com, .net and .org and the ccTLD's for July 2000. Denmark, Germany, the Netherlands and the UK have more registrations in their ccTLD's than under gTLDs. The data demonstrates that the United Kingdom, Denmark and the Netherlands attained a higher number of domain names per capita than the United States in July 2000.

Table 6.2 – Domain name registrations under top-level domains

July 2000

| | Number of gTLDs | Number of ccTLDs | Total | gTLDs per 1000 inhabitants | ccTLDs per 1000 inhabitants | Total domains per 1000 inhabitants |
|-------------|-----------------|------------------|------------|----------------------------|-----------------------------|------------------------------------|
| Denmark | 49,775 | 206,454 | 256,229 | 9.4 | 38.8 | 48.2 |
| Finland | 45,650 | 17,603 | 63,253 | 8.8 | 3.4 | 12.2 |
| France | 445,825 | 89,097 | 534,922 | 7.5 | 1.5 | 9.1 |
| Germany | 455,125 | 1,732,994 | 2,188,119 | 5.5 | 21.1 | 26.7 |
| Netherlands | 216,900 | 399,411 | 616,311 | 13.7 | 25.3 | 39.0 |
| Norway | 72,050 | 45,541 | 117,591 | 16.1 | 10.2 | 26.4 |
| Sweden | 146,125 | 45,241 | 191,366 | 16.5 | 5.1 | 21.6 |
| UK | 1,121,850 | 1,938,740 | 3,060,590 | 18.9 | 32.6 | 51.4 |
| Canada | 678,275 | 93,330 | 771,605 | 22.2 | 3.1 | 25.3 |
| USA | 10,120,208 | 6,468 | 10,126,676 | 37.1 | 0.02 | 37.1 |

Source: OECD Communications Outlook 2001 based on data of Matthew Zook

6.3 Internet Pricing

In the current phase of Internet development, most consumers still use dial-up connection via modems and telephone lines to access the Internet. As Table 6.3 shows, these Internet access charges vary widely across countries, and in some countries PSTN charges account for most of the cost of access. The OECD has developed a methodology to compare the diverse pricing mechanisms across countries. In its Internet access basket, the OECD included PSTN fixed and usage charges, as well as ISP charges, for 20 hours at off-peak times using discounted PSTN rates. Table 6.3 illustrates Denmark's favourable comparison with the other countries under consideration.

Table 6.3 – OECD Internet Access Basket for 20 Hours at Off-peak Times Using Discounted PSTN rates, 2000 (US\$ PPP, incl. VAT)

| | PSTN fixed charge | PSTN usage charge (discounted) | ISP charge | Total |
|--------------|-------------------|--------------------------------|------------|-------|
| Canada | 20.61 | 0.00 | 15.22 | 35.83 |
| Denmark | 12.35 | 12.58 | 4.27 | 29.20 |
| Finland | 11.40 | 5.53 | 6.95 | 23.88 |
| France | 11.19 | 0.00 | 22.81 | 34.00 |
| Germany | 11.94 | 17.32 | 9.58 | 38.84 |
| Netherlands | 18.13 | 14.65 | 0.00 | 32.78 |
| Norway | 14.52 | 12.61 | 8.95 | 36.09 |
| Sweden | 10.14 | 12.11 | 2.32 | 24.57 |
| UK | 12.72 | 0.00 | 12.59 | 25.31 |
| USA | 14.29 | 2.33 | 16.45 | 33.07 |
| OECD average | 13.49 | 11.97 | 10.67 | 36.14 |

Source: OECD, www.oecd.org/dsti/sti/it/cm/

Note: PSTN fixed charges include monthly rental fee and additional monthly charges related to discount plans, if applicable. The basket includes 20 one-hour calls. Off peak is taken at 20h00. In Canada, France and UK, ISP and PSTN usage charges are bundled and included under the ISP charge.

6.4 ISP Market Structure

Table 6.4 provides data on the market share of incumbent's subsidiaries in ISP market. Incumbent domination is greatest in Finland and the Netherlands, and least in the UK. If barriers to entry are minimised in this market, incumbent's should not be expected to dominate the market, although they can be expected to be significant players.

Table 6.4 – Market Share of Incumbent's Subsidiaries acting as ISP, 2000

| | Market Share (%) |
|-------------|------------------|
| Denmark | 40 |
| Finland | 53 |
| France | 39 |
| Germany | 44 |
| Netherlands | 50 |
| Sweden | 29 |
| UK | 9 |

Source: EC 6th Report.

7. Network Society Development: Applications

7.1 E-commerce Readiness

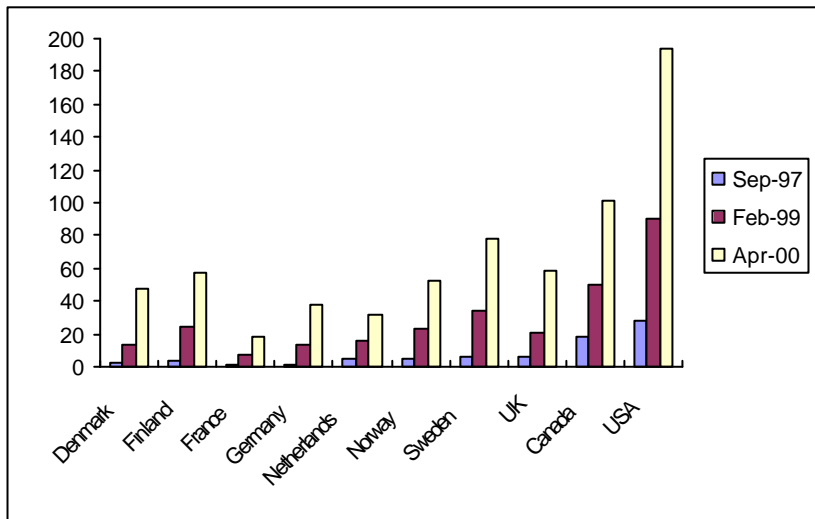
Secure Servers

Given the current lack of common definitions for surveys, the measurement of e-commerce poses serious problems. One useful measure is the number of “secure servers”, which are considered essential to the conduct of e-commerce. A current standard is the use of SSL (secure socket layer), a protocol developed by Netscape for encrypted transmission over TCP/IP networks. It sets up a secure end-to-end link over which http or any other application protocol can operate. The most common application of SSL is https for SSL-encrypted http. Any security system consumes relatively large amounts of bandwidth because of the multiple checks that are being performed (generating chunks of data that go back and forth) but there are large differences between the various systems.

Figure 7.1 shows that the US and Canada are the leaders with regard to the number of secure servers, but growth rates are greater than 100% per annum in all of the compared countries at this early stage of development. Denmark ranks in the mid-range of the countries compared.

Figure 7.1 – Number of SSL-based Servers per million Inhabitants

September 1996 – April 2000



Source: OECD (2000); Netcraft (2000).

E-Readiness Rankings

The Economist Intelligence Unit / Pyramid Research unit develops E-Readiness assessments of 60 countries. The rankings for 2000 and 2001 are listed in Table 7.1.

Table 7.1 – EIU/Pyramid Research e-readiness rankings

| | May 2001 | | May 2000 | |
|-------------|-------------------|------|-------------------|------|
| | E-readiness score | Rank | E-readiness score | Rank |
| Denmark | 7.70 | 9 | 8.2 | 12 |
| Finland | 7.83 | 8 | 8.6 | 3 |
| France | 7.26 | 15 | 8.1 | 14 |
| Germany | 7.51 | 13 | 8.2 | 13 |
| Netherlands | 7.69 | 10 | 8.4 | 5 |
| Norway | 8.07 | 5 | 8.5 | 4 |
| Sweden | 7.98 | 6 | 8.6 | 2 |
| UK | 8.10 | 3 | 8.4 | 6 |
| Canada | 8.09 | 4 | 8.3 | 7 |
| US | 8.73 | 1 | 8.8 | 1 |

Source: The Economist Intelligence Unit

The factors (both of a quantitative and qualitative nature) included in the index are in six categories: connectivity (30%); general business environment (20%); e-commerce consumer and business adoption (20%); legal and regulatory environment (15%); supporting e-services (10%); social and cultural infrastructure (5%).

All the compared countries are ranked significantly high. The US is well ahead of the others, with France lagging. For the other countries the significant changes in rankings between 2000 and 2001 suggest there are only marginal differences among them. However given Denmark's general higher rankings on related indicators, the reasons for Denmark's ranking might be worthy of further investigation.

7.2 E-Commerce Activity

The specific use of e-commerce varies widely from country to country. In some countries, such as Denmark, EDI has been the base for a relatively high ranking in the business-to-business (B2B) sector. In others, such as Sweden, e-commerce is almost entirely TCP/IP-based. The balance between B2B and business-to-consumer (B2C) also shows large differences. In Denmark, the success of B2C has been much less pronounced than B2B. Overall, the *total* turnover of e-commerce per capita does not differ a lot among the Nordic countries, with the exception of Sweden that has a slightly higher position.

There is a very strong relationship between the turnover figures reported in a paper by Falch & Henten (*Telecommunications Policy* 24:5, 2000) and the number of SSL-servers in those countries ($R^2=0.99$). Based on this regression the (1998) original figures were updated and the totals were calculated for a selected set of other countries and presented in Table 7.2. The estimates for the turnover per capita give a general indication for the volume of e-commerce within a national economy and across countries.

Table 7.2 – Estimates for Total (B2B and B2C) E-commerce Turnover per capita, July 1998 and April 2000

| | July 1998 | | April 2000 | |
|-------------|--|---|--|---|
| | Secure servers (SSL) per million inhabitants | Estimated turnover E-commerce per capita (\$) | Secure servers (SSL) per million inhabitants | Estimated turnover E-commerce per capita (\$) |
| Canada | 29.6 | 1.500 | 100.7 | 2.551 |
| Denmark | 8.2 | 1.183 | 47.3 | 1.761 |
| Finland | 12.8 | 1.251 | 57.8 | 1.916 |
| France | 3.7 | 1.116 | 18.9 | 1.341 |
| Germany | 5.9 | 1.149 | 37.4 | 1.615 |
| Netherlands | 7.9 | 1.178 | 32.1 | 1.536 |
| Norway | 12.4 | 1.245 | 52.7 | 1.841 |
| Sweden | 16.1 | 1.300 | 77.5 | 2.208 |
| UK | 11.9 | 1.238 | 59.1 | 1.936 |
| USA | 53.2 | 1.849 | 193.8 | 3.929 |

Source: OECD (2000); Netcraft (2000); Falch & Henten, (2000), "Digital Denmark: From Information Society to Network Society," *Telecommunications Policy* 24:5.

At the consumer level B2C penetration has barely begun. Table 7.3 provides an estimate of transaction values and percentage of retail sales. Although Sweden has a distinct lead in these statistics, at this early stage of market development, it can mean little more than a good starting position. This conclusion is supported by the data on e-commerce user profiles in Table 7.4.

Table 7.3 – B2C E commerce in selected OECD Countries

| | Value of transactions 1999, US\$ million | Value of transactions growth rate 1998-99 | Penetration rate, % of retail sales |
|-------------|--|---|--|
| Denmark | 46 | 220 | 0.20 |
| Finland | 51 | 160 | 0.22 |
| France | 345 | 215 | 0.14 |
| Germany | 1,199 | 200 | 0.30 |
| Netherlands | 182 | 210 | 0.34 |
| Norway | 61 | 200 | 0.26 |
| Sweden | 232 | 170 | 0.68 |
| UK | 1040 | 280 | 0.37 |
| USA | 24170 | 195 | 0.48 |
| Canada | 774 | 166 | 0.26 |

Source: <http://www.ebusinessforum.com/>

Table 7.4 – E-Commerce User Profiles

October 2000, %.

| | <i>“Rarely”</i> | <i>“Occasionally”</i> | <i>“Regularly”</i> | <i>Index</i> |
|-------------|-----------------|-----------------------|--------------------|--------------|
| Denmark | 27 | 12 | 4 | 603 |
| Finland | 22 | 11 | 2 | 474 |
| France | 8 | 10 | 1 | 282 |
| Germany | 17 | 17 | 5 | 723 |
| Netherlands | 14 | 13 | 7 | 795 |
| Sweden | 25 | 16 | 6 | 840 |
| UK | 11 | 22 | 9 | 1101 |

Source: Eurobarometer (2000); TU Delft (2001)

7.3 E-Government

Measurement of the public sector relationship to e-commerce has multiple facets. The public sector has importance in providing national strategies for e-commerce, providing the legal framework for transactions, shaping and promoting market development through effective regulation, applying electronic services, making electronic procurements, providing tele-work etc. It must also invest to upgrade its own networks and services for electronic access and delivery. Table 7.5 shows current levels of public IT expenditures. Denmark, Sweden and Finland are spending the most per capita, and France and Germany the least. This correlates well with many other indicators on the pace of information infrastructure and network society development.

Table 7.6 provides information on access rates for government websites. Finland, The Netherlands and Denmark rank highest. Given their rankings on other indicators, Sweden has unexpectedly low, and France unexpectedly high access rates.

Finland's *Citizen Network Form Service* is regarded as a global standard in e-Government. It makes it possible not just to find and complete forms but sign them and send them over the net (the lack of a digital signature is holding back similar services in many other countries). Even data sharing to offer pre-completed forms is possible (e.g., automated census and pre-completed tax return based on data shared from other organisations). The Finnish smart national ID card is intended to make a range of further e-services available to citizens.

Table 7.5 – Public IT spending

2000/2001 (Euro)

| | Totals (million) | Per capita |
|-------------|------------------|------------|
| Denmark | 1,686 | 317 |
| Finland | 1,324 | 256 |
| France | 9,160 | 155 |
| Germany | 12,720 | 155 |
| Netherlands | 3,051 | 193 |
| Norway | 955 | 214 |
| Sweden | 2,418 | 273 |
| UK | 11,960 | 201 |
| EU | N/a | 122 |

Most of the public content on the web is limited to general information. On-line interaction is still confined to few areas, with tax services ahead (ESDIS, 2000). However, the popularity of the government web sites seems to be based more on specific cultural variables (note France's high access rate) than on the actual content.

Table 7.6 – Access Rates for Government Web Sites

(in %)

| | |
|-------------|-----|
| Denmark | 19 |
| Finland | 21 |
| France | 18 |
| Germany | 10 |
| Netherlands | 21 |
| Norway | N/A |
| Sweden | 11 |
| UK | 11 |
| EU | 15 |

Source: EC/ISDG (2001)

One way of measuring public sector e-commerce readiness relates to the proportion of home pages at different institutions, and the accessibility of 24-hour services. In Denmark, there are high proportions of home pages for the central institutions at all levels (100% for national and 71% for local municipalities, 2000), but it is much smaller for their associated branches (less than 20%). Some of the electronic services provided by local municipalities in Denmark include e-forms, which are provided by more than a third of all municipalities. Over 30% perform e-procurement, which is either Internet or EDI-based. Table 7.7 summarises the Internet-based availability of public services in Denmark.

Table 7.7 – Internet-based Public Services, Denmark

| Service | Availability |
|---|---------------------|
| Service information (Opening hours, legislation, etc.) | 95% |
| Leaflets for download | 68% |
| News | 84% |
| Self service data processing | 61% |
| Interactive dialogue (e-mail) | 72% |

Source: www.si.dk (2000) "Digital Communication in the Public Sector"

ASSESSMENT: INFORMATION INFRASTRUCTURE AND NETWORK SOCIETY DEVELOPMENT

Comparative assessments of progress in information infrastructure development are much more difficult than for telecom reform because of the paucity of directly comparable data, or even agreed upon indicators of comparison, for a development process that is still in its earliest stages. Rankings mean less, and may be extremely transitory. What is more important is whether the necessary activities are underway to guide and stimulate information infrastructure development.

With respect to information infrastructure and information society development, the US and Canada started earlier than Europe and are further along the growth curve. Denmark and the other Nordic countries are leading Europe by most indicators, and are moving ahead rapidly to facilitate further growth. Finland has the highest penetration. Sweden is the Internet hub of the Nordic region. With the landing of the TAT-14 transatlantic fibre cable in Denmark in 2000, opportunities for Denmark to play a more active role in the evolution of the Internet may be presented.

Similarly, the Nordic countries are moving ahead at a leadership pace in e-commerce readiness, again with Sweden and Finland as the front runners by most indicators. In Sweden and Denmark in particular, the public sector has been a major driver of growth through its administrative and purchasing activities. Government policy changes relating to digital signatures and related issues should be a stimulus to e-commerce growth in many countries, including Denmark. The current explosion in transatlantic bandwidth capacity will provide a major stimulus for the integration of European and North American e-commerce activity, and could open new opportunities for European firms in North American markets. The Nordic countries, the Netherlands and the UK are well positioned to take advantage of this opportunity.

It is still very early in the process of deploying new local access technologies. The primary driver of Internet growth at this stage is additional subscribers to the currently most popular services, email and web site access, which can be supplied economically on narrowband and enhanced narrowband networks. It appears that the fastest growing access technology in most European countries is ISDN. DSL and upgraded CaTV access still have technical, economic and market development challenges to overcome if they are to be capable of providing ubiquitous services, and the 3G mobile initiatives are not likely to be operational for several years. Effective competition in local markets is still primarily a gleam in the eyes of economists, policymakers and regulators. The available information suggests there will be a need for proactive regulation for the foreseeable future, both to drive the competitive process forward and to shape and promote information infrastructure and network society development.

Table 8.1 shows the rankings of an Information Society Index that attempts to weight assessments of preparedness for information or network society development in four areas, computing, Internet, telecom/broadcasting and societal capacity. Denmark ranks very high at 5th, and again finds itself in direct competition with the other Nordic countries for the international leadership positions.

Table 8.1 – Information Society Index 2001

| | Score | Rank |
|-------------|-------|------|
| Sweden | 6,496 | 1 |
| Norway | 6,112 | 2 |
| Finland | 5,953 | 3 |
| USA | 5,850 | 4 |
| Denmark | 5,837 | 5 |
| UK | 5,662 | 6 |
| Netherlands | 5,238 | 10 |
| Canada | 5,126 | 12 |
| Germany | 4,937 | 13 |
| France | 4,104 | 21 |

Source: IDC (<http://www.idc.com>)

8. CONCLUSIONS

Denmark has set a high standard for its telecom reform process – to offer consumers the “best and cheapest” services. It has established itself as a leader in Europe and internationally and compares itself not to the average EU standard, but rather to international best practice. This report has drawn some comparisons of the progress in Denmark with a selected group of countries that are its competitors for international best practice rankings, or are otherwise important for comparison.

In interpreting the comparative information, it must be kept in mind that the data is not complete and captures only a partial picture of a rapidly changing industry and an evolving process of telecom reform and information infrastructure development for network societies. The available information documents that Denmark is a leader in most aspects of telecom reform, but like all countries, has specific areas of comparative strengths and limitations. Denmark is notable as a leader in opening its markets and minimising barriers to entry, e.g., licensing, interconnection, leased line prices and local loop unbundling. Actual competition has progressed most rapidly in mobile and international services. National and local services remain dominated by the incumbent.

Nevertheless, Denmark, like all other countries, still has a way to go before its markets are effectively competitive. Experience so far with the early deployment of alternative higher speed access via DSL, coaxial cable (CaTV), fibre cable, 3G mobile and other possibilities suggests that significant local competition using different technologies is still more on the longer, rather than the shorter term radar. Although Denmark’s interconnection prices are at, or better than the EU best practice standard, continued priority attention to interconnection and access prices and conditions, and the further development of competition in the various network services markets will be necessary.

For the future it is important that NRAs and policymakers in Denmark and other countries prepare themselves for the Internet economy, and a major acceleration in the speed of integration of national and international networks. The activities and priorities of leading NRAs will increasingly shift from issues of traditional telecom reform to issues associated with the continuing rollout of the information infrastructure as the foundation for the development of network societies. NRAs will need to be active in monitoring and guiding this process if the ambitious objectives of government policy in Denmark and other countries are to be achieved.

ANNEX – SUPPORTING TABLES FOR FIGURES

Figure 1.1 – Telecom Market Development

(million EUR)

| | 1999 | 2000 | 2001 (est.) | Revenue per capita (2001) | Revenue per telecom path ^a (1999) | CAGR (1998-2001) (%) |
|-------------|---------|---------|-------------|---------------------------|--|----------------------|
| Denmark | 4,362 | 4,778 | 5,190 | 976 | 696 | 9,0 |
| Finland | 3,939 | 4,196 | 4,461 | 863 | 634 | 8,6 |
| France | 36,533 | 42,107 | 46,751 | 791 | 667 | 12,9 |
| Germany | 53,515 | 59,368 | 65,964 | 804 | 746 | 10,6 |
| Netherlands | 11,662 | 13,656 | 15,162 | 959 | 711 | 14,2 |
| Norway | 3,753 | 3,996 | 4,424 | 991 | 637 | 9,2 |
| Sweden | 7,019 | 8,482 | 9,081 | 1,025 | 603 | 12,8 |
| UK | 40,637 | 47,113 | 52,745 | 886 | 707 | 12,6 |
| Canada | 19,325 | n/a | n/a | n/a | 720 | n/a |
| US | 254,333 | 270,356 | 286,848 | 1,051 | 1,149 | 6,3 |

Source: EITO (2001); OECD (2001)

^a Fixed plus wireless.

Figure 1.2 - Penetration Rate of Main Telephone Lines and Mobile Subscriptions
(communication channels per 100 inhabitants)

| | Fixed | | | Mobile | | | Telecom access paths per 100 inhabitants |
|-------------|-------|------|----------------|--------|-------------------|-------|--|
| | 1995 | 1999 | cagr (1995-99) | 1997 | 2000 | cagr | 1999 |
| Denmark | 61.1 | 68.4 | 2.90 | 27.5 | 60.2 | 29.5 | 117.8 |
| Finland | 55.5 | 55.1 | -0.20 | 45.6 | 69.6 | 15.0 | 120.2 |
| France | 56.1 | 57.8 | 0.70 | 9.8 | 42.5 | 62.3 | 92.7 |
| Germany | 51.4 | 58.8 | 3.40 | 9.9 | 44.1 | 63.7 | 87.4 |
| Netherlands | 52.5 | 60.8 | 3.70 | 10.8 | 56.9 | 73.0 | 103.7 |
| Norway | 56.8 | 70.5 | 5.60 | 38.4 | 61.5 ^b | 26.60 | 132.0 |
| Sweden | 68.7 | 73.8 | 1.80 | 35.8 | 66.6 | 22.7 | 131.3 |
| UK | 50.4 | 56.5 | 2.90 | 14.3 | 53.4 | 54.5 | 96.6 |
| Canada | 59.8 | 65.5 | 2.30 | 14.1 | 22.7 ^b | 26.90 | 88.1 |
| USA | 45.7 | 52.8 | 3.70 | 20.4 | 31.5 ^b | 24.30 | 81.1 |

(communication channels per 100 inhabitants)

Source: OECD (2001); FT Mobile Communications (2000)

^b 1999 data.

Figure 2.1 (a) – Annual Leased Line Rentals
for 64 Kbit/s line (Euro, excl. VAT)

| | 2 km | 50 km | 200 km - standard | 200 km - lowest discount |
|-------------|-------|-------|-------------------|--------------------------|
| Denmark | 1,190 | 2,560 | 3,130 | 2,450 |
| France | 2,770 | 5,280 | 6,520 | 5,470 |
| Germany | 1,080 | 5,120 | 6,260 | 5,150 |
| Netherlands | 3,010 | 6,340 | 7,560 | 6,040 |
| Sweden | 2,690 | 2,720 | 3,650 | n/a |
| UK | 3,120 | 6,400 | 7,830 | 6,040 |
| USA/Canada | 1,290 | 3,520 | 10,170 | 7,550 |
| EU | 2,200 | 5,000 | 6,500 | |

Source: EU 6th Report on the Implementation of the Telecommunications Regulatory Package (2000/2001)

Figure 2.1 (b) – Annual Leased Line Rentals
for 2 Mbit/s line (Euro, excl. VAT)

| | 2 km | 50 km | 200 km - standard | 200 km - lowest discount |
|-------------|--------|--------|-------------------|--------------------------|
| Denmark | 2,140 | 11,160 | 16,740 | 12,660 |
| France | 8,570 | 25,120 | 42,790 | 29,120 |
| Finland | 2,860 | 8,370 | 11,160 | 8,860 |
| Germany | 4,290 | 16,740 | 26,050 | 17,100 |
| Netherlands | 15,710 | 33,490 | 48,370 | 36,720 |
| Sweden | 4,640 | 9,770 | 14,880 | n/a |
| UK | 5,000 | 25,120 | 52,090 | 39,260 |
| USA/CA | 3,210 | 13,950 | 44,650 | 27,860 |
| EU | 8,200 | 26,900 | 44,400 | |

Source: EU 6th Report on the Implementation of the Telecommunications Regulatory Package (2000/2001)

Figure 2.1 (c) – Annual Leased Line Rentals

for 34 Mbit/s line (Euro, excl. VAT)

| | 2 km | 50 km | 200 km |
|------------|--------|---------|---------|
| Denmark | 7,500 | 64,170 | 190,910 |
| France | 52,500 | 215,830 | 354,550 |
| Germany | 20,000 | 140,000 | 181,820 |
| Sweden | 21,250 | 58,330 | 90,910 |
| UK | 53,750 | 163,330 | 327,270 |
| USA/Canada | 45,000 | 81,670 | 163,640 |

Source: EU 6th Report on the Implementation of the Telecommunications Regulatory Package (2000/2001)

Figure 3.1 – Market Share Incumbents in Public Fixed Voice Telephony

| | Local ^a | | Long-distance ^b | | International | |
|-------------|--------------------|-------|----------------------------|-------------------|---------------|------|
| | 1998 | 1999 | 1998 | 1999 | 1998 | 1999 |
| Denmark | 99.1 | 99.7 | 90.0 | n/a | 64.0 | 56.3 |
| Finland | 99.5 | 99.7 | 37.0 | 37.9 | 54.7 | 51.5 |
| France | 100.0 | 100.0 | 95.0 | 80.0 | 85.0 | 72.9 |
| Germany | 99.5 | 99.0 | 70.0 ^c | 60.0 ^c | 70.0 | 60.0 |
| Netherlands | 99.9 | 99.9 | 89.0 | 84.0 | 90.0 | 85.0 |
| Norway | 100.0 | 99.6 | 98.0 | 88.0 ^d | n/a | 73.0 |
| Sweden | 99.0 | 99.0 | 83.0 ^e | 86.0 ^e | 68.0 | 62.0 |
| UK | 85.7 | 84.6 | 69.3 | 66.6 | 48.4 | 45.4 |
| Canada | n/a | 71.0 | 73.9 | 72.1 | 64.0 | 43.0 |
| USA | 97.0 | 94.6 | 38.7 | 37.1 | n/a | n/a |

Source: OECD (2001)

^a Percentage of access lines

^b Share of switched minutes

^c New entrants share of total national call minutes was 5.9% in 1998 and 18,2% in 1999.

^d On July 1 1999 the long-distance charge zones were eliminated.

^e Based on revenue shares

Figure 3.2 – Mobile Telecommunications Revenue Share

| | # of effective operators | Share of dominant operator |
|-------------|--------------------------|----------------------------|
| Denmark | 4 | 48 |
| Finland | 3 | 63 |
| France | 3 | 48 |
| Germany | 4 | 40 |
| Netherlands | 5 | 48 |
| Norway | 2 | 73 |
| Sweden | 3 | 52 |
| UK | 4 | 30 |
| Canada | >6 | 32 |
| USA | >6 | 13 |

Source: LIRNE.NET Estimates

Figure 3.3 – Interconnect Charges for Fixed-to-fixed Voice

Per Minute (Euro cents)

| | Local (0.50-0.90) ^a | | Single Transit (0.80-1.50) ^a | | Double Transit (1.50-1.80) ^a | |
|-------------|-----------------------------------|-----------------------------|--|-----------------------------|--|-----------------------------|
| | April 2001 | Change, 1998-2001 (%) | April 2001 | Change, 1998-2001 (%) | April 2001 | Change, 1998-2001 (%) |
| Denmark | 0.68 | -34 | 0.95 | -47 | 1.35 | -39 |
| Finland | 1.45 | -3 | 1.45 | 4 | 2.65 | -4 |
| France | 0.60 | -20 | 1.25 | -28 | 1.85 | -26 |
| Germany | 0.90 | -10 | 1.50 | -13 | 2.30 | -11 |
| Netherlands | 0.85 | -31 | 1.45 | 4 | 1.70 | -17 |
| Sweden | 0.93 | -21 | 1.25 | -28 | 1.70 | -29 |
| UK | 0.63 | -4 | 0.90 | -25 | 1.80 | 6 |

Source: ONPCOM01-14

^a 'Best current practice' for 2000 between brackets.

Figure 7.1 – Number of SSL-based Servers per million Inhabitants

September 1996 – April 2000

| | September 1997 | February 1999 | April 2000 |
|-------------|---------------------------|--------------------------|-------------------|
| Canada | 18.1 | 49.5 | 100.7 |
| Denmark | 2.1 | 13.8 | 47.3 |
| Finland | 3.9 | 24.8 | 57.8 |
| France | 1.1 | 7.6 | 18.9 |
| Germany | 1.8 | 13.2 | 37.4 |
| Netherlands | 4.8 | 15.5 | 32.1 |
| Norway | 5.2 | 22.7 | 52.7 |
| Sweden | 6.0 | 33.6 | 77.5 |
| UK | 6.0 | 21.3 | 59.1 |
| USA | 27.6 | 89.9 | 193.8 |

Source: OECD (2000); Netcraft (2000).