Trends in European Telecommunication:

A Status Report of Denmark's Progress in Telecom Reform and Information Infrastructure Development

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A. TELECOM REFORM

INTRODUCTION

The first phase of telecom reform in Europe has been directed toward market liberalisation and the extension of established and new telecom services throughout national economies and societies. New services, e.g., mobile and value-added, have been seen primarily as complementary extensions of traditional telephone services. New regulatory agencies have been seen as potential catalytic agents for promoting liberalisation and the extension of network services. Progress has been measured in terms of benchmark indicators such as number of competitors for different categories of service, market shares, universal service penetration, interconnection and final 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.

However, leading countries like Denmark already are looking beyond the conventional telecom network and services, and its benchmark indicators. They are seeking to develop and apply indicators of progress in a new phase of telecom development, perhaps better labelled as information infrastructure development, i.e., the establishment of a ubiquitous, high speed telecom network, providing access to an ever widening range of services at affordable prices under competitive market conditions.

This new phase of telecom reform requires that the first phase reforms be carried through to completion, while at the same time extending their application to include the major new information infrastructure development objectives. 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. Denmark's commitment to being a leader in implementing information infrastructure objectives is spelled out in the September 1999 government policy document, *The Danes' Admission Ticket to the Network Society,*[2] and expanded upon in other government reports, including *Realigning to a Network Society*,[3] and The National Telecom Agency's *Report on New Access Routes to the Network Society.*[4]

[1] Thanks for research assistance to my staff in the Economics of Infrastructures Chair, TU Delft; and the Center of Tele-Information (CTI), Technical University of Denmark.
[2] Available at www.fsk.dk.
[3] Ministry of Research and Information Technology, 17 January 2000, www.fsk.dk.
[4] The National Telecom Agency, January 2000, www.tst.dk.

The International Discussion Forum reports for 1998 and 1999 focused primarily on documenting progress in the first phase of telecom reform on the basis of benchmark indicators using comparable country data drawn from public information sources. This was supplemented with selective data and analysis on the evolving bandwidth capacity issue that would affect policymakers and regulators in the near future. The 1999 Report documented the forthcoming bandwidth explosion in the international telecom network, and pointed to some of its potential implications.

This year's Report places greater emphasis on information infrastructure and development issues. The Report includes the latest statistical comparisons for the traditional telecom benchmark indicators, but its major challenge is to identify some indicators of progress in information infrastructure development, and to provide a preliminary indication of Denmark's progress in comparison to other leading countries. The primary 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 - UK, Sweden, Finland, Norway, Netherlands, Germany and France. For some indicators, where comparable data for the US and for Canada exists, they are included. Occasionally, where relevant, data for other countries are included.

1. TELECOM MARKETS AND SERVICES

1.1 National Telecom Markets

Table 1.1 shows the relative size of national telecom markets, telecom expenditure per capita and recent growth characteristics. Expenditure per capita is uniformly larger in the smaller countries, although not necessarily increasing any faster in recent years. Norway and Denmark have the largest telecom expenditure per capita, but Finland, Netherlands and France have increased at the fastest rates since 1997. As these countries are all mature markets, generally characterised by declining prices over time, increases in expenditure per capita are likely to be explained by significant consumer responses to price reductions (i.e., price elasticity's of demand greater than one), and/or new services. Whether the higher expenditure per capita in the Nordic countries is due to culture, geography, relative efficiency of their legacy networks, a faster pace of telecom reform or other factors, is an unresolved issue.

Table 1.1 – Size of Telecom Markets (1999)

	Telecom Market Value 1999 (Million Euro)	**Telecom Market Value** 1998 (Million Euro)	**Telecom Expenditure** Per Capita 1999 (Euro)	**Telecom Expenditure** Per Capita 1997 (Euro)	**Growth 1997-99** (%)
DENMARK	4,254	3,886	801	683	17.3
FINLAND	3,839	3,404	744	568	31.0
FRANCE	36,280	32,371	616	478	28.9
GERMANY	53,400	48,605	649	536	21.1
NETHERLANDS	11,572	10,044	736	564	30.5
NORWAY	3,608	3,291	815	683	19.3
SWEDEN	6,935	6,217	781	629	24.2
UK	39,347	35,517	663	555	19.5
EU TOTAL	250,225	221,380	647	512	26.4

Source: EITO 2000

1.2 Universal Service

Since the implementation of new policy orientations for the liberalisation of the telecom sector by the EC in November 1993 (COM (93) 543), different initiatives by the Commission have defined the key elements on universal service policy with respect to scope, methodology and possible funding mechanisms for universal service. Principles for costing and pricing universal service in a competitive environment have also been identified. In March 1996, a second Communication on Universal Service (COM (96) 73) was published to examine issues associated with the scope and affordability of universal service. Different monitoring reports by the Commission since 1998 have begun to assess the scope, level, quality and affordability of universal service.

A generally accepted measure for universal service obligations has been the penetration rate of main telephone lines per 100 inhabitants as shown in Table 1.2. Although all these countries presumably provide a universal service, the main line penetration rates range from a low of 53.3 (Finland), to a high of 70.8 (Norway). 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. Norway's high figure is explained by a significant and growing proportion of ISDN lines, which provide two or more main lines per connection. The US has also seen significant growth in additional lines to households to provide Internet access. Nevertheless the data does suggest that the Nordic countries may have a higher standard of universal service coverage than the larger countries, and the UK in particular. Denmark does not consider universal service a problem and makes no claims, or even calculations of subsidy requirements or costs.

Table 1.2 – Penetration Rate of Main Telephone Lines (main lines per 100 inhabitants)

	1993	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**
CANADA	57.7	59.0	60.0	60.2	61.6	63.4	63.5
DENMARK	59.0	60.0	61.3	61.8	63.6	66.2	68.3
FINLAND	54.5	55.1	55.0	54.9	55.6	55.7	53.3
FRANCE	53.7	54.5	56.3	56.4	57.6	58.1	57.9
GERMANY	45.6	47.7	49.5	53.8	55.0	57.4	58.8
NETHERLANDS	49.9	50.9	51.8	54.3	56.6	59.2	60.6
NORWAY	54.1	55.2	55.8	55.6	56.0	66.1	70.8
SWEDEN	67.8	68.0	68.1	68.2	68.0	68.5	66.5
UK	47.0	48.6	50.2	52.7	54.5	55.5	55.7
USA	57.6	59.8	62.7	64.0	66.0	66.1	66.1

Source: EU Fourth Report on the Implementation of the Telecommunications Regulatory Package, EU Fifth Report on the Implementation of the Telecommunications Regulatory Package; ITU (1998, 1999), NPT, ITU 2000.

For advanced countries such as those being compared here, the traditional universal service indicators are becoming less informative with each passing year because they are affected by the newer services – mobile, ISDN and Internet. These services influence main line

counts without affecting penetration. Revisions to these reporting systems will soon be in order.

1.3 Public Mobile Services

In some countries, e.g. Finland, mobile phones are beginning to substitute for fixed lines. A new service that has been an extension of the fixed network is becoming increasingly integrated with it. Mobile phone penetration is not only an indication of telecom sector expansion, but also of the quality of network coverage in the new environment. The penetration rates for mobile service are exhibited in Table 1.3. The Nordic countries have significantly greater penetration than other countries. Finland continues at the frontier of new developments in mobile.

Table 1.3 – Mobile Subscribers per 100 inhabitants

	1990	**1995**	**June 1999**
CANADA	2.1	8.8	20.0
DENMARK	2.9	15.7	43.7
FINLAND	4.5	19.9	60.7
FRANCE	0.5	2.5	24.3
GERMANY	0.3	4.6	21.2
NETHERLANDS	0.5	3.5	32.0
NORWAY	4.6	22.6	54.7
SWEDEN	5.4	22.8	49.9
UK	1.9	9.8	28.9
US	2.1	11.8	28.3

Source: OECD (May 2000). Cellular Mobile Pricing. Structures and Trends.

2. CONSUMER PRICING

2.1 Public Switched Telephone Network (PSTN): National

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 the costs residential and business users pay for a basket of services including usage charges and fixed charges before the application of any discount plan. These comparisons are valuable for policymakers because they characterise rates used in price regulation, and provide the starting point for comparisons on pricing across countries. PSTN network charges for Denmark have been relatively low compared to the other compared countries, both for business as well as residential users. Among European countries, Denmark ranked second for business users and third for residential users. Sweden leads in both categories.

Table 2.1 – OECD Basket of Total Public Switched Telephone Network Charges (August 1998, US$)[a]

	Business	Residential
CANADA	588	258
DENMARK	627	404
FINLAND	680	498
FRANCE	1141	491
GERMANY	1141	486
NETHERLANDS	681	403
SWEDEN	581	345
UK	966	430
USA	1037	340

Source: OECD, 1999, Communications Outlook, pp. 163-164
[a] Average annual spending, excluding tax.

2.2 PSTN: International Services

Table 2.2 shows the standard international peak rates of incumbent operators in 1998. They provide the starting point against which discount rates can be compared, and give a reasonable indication about the position of Denmark in this market segment. There are two countries that have, rather unexpectedly, extremely high rates in this market – the United States and Canada. This reflects the fact that in these countries most traffic is sold at discount rates, and must call into question the purpose of having tariffed rates at all, as their only apparent function is to obtain regulatory sanction for monopoly prices. France and the Netherlands have the lowest rates. Although all the European countries compared have seen significant rate reductions and are low by broader international standards, Denmark is near the high end of this group. Incumbent operators in other countries in the comparison have been 'reducing' international rates faster than Denmark in recent times. However, as

competition develops, and discount packages are introduced by incumbents, these tariff comparisons become less meaningful as a guide for actual prices. In Denmark, e.g., competitors offer services at prices up to 40% below the Tele Danmark prices.

Table 2.2 – International Call Charges, Average of One Minute Peak (US$)

	1998
CANADA	0.94
DENMARK [a]	0.60
FINLAND [b]	0.61
FRANCE	0.37
GERMANY	0.60
NETHERLANDS	0.39
NORWAY	0.52
SWEDEN [c]	0.49
UK [d]	0.52
USA	1.45

Source: OECD (Tariff Comparison Model)
[a] Tele Danmark.
[b] Sonera.
[c] Telia.
[d] BT.

Note: Most USA traffic, and some Canada traffic is provided at discount rates. USA discounts can be as low as 10% of the tariff rate.

2.3 Mobile Services

As it has been rather difficult to compare different countries with respect to their pricing for mobile telecommunication service, the OECD has developed a common methodology for national mobile services.[5] As Table 2.3 shows, the Scandinavian countries continue to enjoy some of the lowest prices for mobile services. Norway, Finland and Denmark have prices significantly lower than the other 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. Recent studies have estimated call termination charges to be 40-70% higher than cost.

[5] At present the personal basket includes 568 calls per annum and the business basket 1169 calls per annum.

Table 2.3 – OECD National Mobile Basket (August 1999, US$ PPP)

	Basket Results		
	Fixed	*Usage*	*Total*
CANADA, BellMobility, All-Out Weekend	567	107	674
CANADA, BellMobility, RealTime 650	613	40	653
DENMARK, TeleMobil, Privat Plus	132	293	425
FINLAND, Sonera, Classic	39	340	379
FRANCE, FT, Reference	193	641	835
FRANCE, FT, Affaire	640	37	677
GERMANY, T-Mobil, ProTel-D1	421	370	791
NETHERLANDS, KPN, Flexibel Premium	261	320	581
NORWAY, Telenor, Primaer	188	196	384
SWEDEN, Telia, Pott	194	494	772
SWEDEN, Telia, Volym	210	390	703
UK, Cellnet, Regular Caller +	438	134	572
UK, Vodafone 20	312	338	650
USA, US West, Advanced 60	396	47	480
USA, Sprint, Spectrum Talk	396	347	443

Source: OECD (forthcoming) Cellular Mobile Pricing Structures and Trends
[a] For February, BellMobility, PCS 250

2.4 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 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 2.4 reflects the OECD basket of leased lines. Tables 2.5 through 2.8 provide comparisons among specific national leased line prices for particular leased line services. Denmark ranks high in all the comparisons and can be

considered a leader in driving leased line pricing reforms. After the period covered in this comparison, TeleDanmark has reduced its prices for national leased lines by 15% (in August 1999), and its international leased line prices by 40% (in April 2000). Yet the enormously wide variations in leased line rates demonstrate there is still a great need for major pricing reforms in most countries.

Table 2.4 – OECD Basket of Leased Line Charges (1.5/2.0 Mbits) (August 1998, US $ PPP × 1000)

	National	International
CANADA	1630	392
DENMARK	1150	206
FINLAND	885	328
FRANCE	2152	551
GERMANY	3149	551
NETHERLANDS	2680	271
NORWAY	1956	190
SWEDEN	1041	232
UK	1857	588
USA	1212	602

Source: OECD (1999) Communications Outlook, pp. 188-189
Note: OECD has calculated the basket for leased lines charges based on the price of the rental charge of 100 leased lines distributed to different distances.

Table 2.5 – National Analogue Leased Line Charges: 2, 50, 200 km

	2 km	50 km	200 km
DENMARK	277	1791	2940
FRANCE	3258	6332	7978
GERMANY	1018	6418	8105
NETHERLANDS	561	2616	3978
SWEDEN	269	1054	1876
UK	805	3645	7241

Table 2.6 – National 64 Kbit/s Leased Line Charges: 2, 50, 200 km

	2 km	50 km	200 km
DENMARK	1186	2700	3849
FRANCE	2773	5378	6685
GERMANY	1104	5415	7071
NETHERLANDS	1688	6344	7705
SWEDEN	2613	3062	3884
UK	2819	5692	7211

Table 2.7 – National 2 Mbit/s Leased Line Charges: 2, 50, 200 km

	2 km	50 km	200 km
DENMARK	2917	18054	29544
FRANCE	13981	46490	43539
GERMANY	5829	29328	43133
NETHERLANDS	9529	34850	48464
SWEDEN	5486	15115	21961
UK	4402	22994	53359

Table 2.8 – International Leased Line Charges to USA

	M.1020	64k	2 Mbit/s
DENMARK	15984	16609	175576
FRANCE	30734	10428	160620
GERMANY	N/A.	32089	N/A.
NETHERLANDS	20148	19331	188355
SWEDEN	27736	27736	318788
UK	42165	36887	343380

Source for Tables 2.5 through 2.8: EU Fifth Report on the Implementation of the Telecommunications Regulatory Package 1999.
Note: All charges are in Euro per year, VAT is excluded.

3. COMPETITION

3.1 Public Fixed Voice Telephony

The dominant strategy for increasing public fixed voice telephony has been to create competitive markets through encouraging entry of new operators.[6] The EU data shown in Table 3.1 indicates the authorisation of many new operators, but with a disproportionately smaller impact on the incumbent's market share.

There seems to be no direct relationship between the decreasing market share of the incumbent operator and the number of new entrants. This is due in part by the fact that many new operators are still sufficiently small as to have little or no impact on market conditions. Although Denmark does not require new entrants to receive authorisation, the reported EU number appears to be significantly understated.

The incumbent market share data appears to be a much better indicator of actual market competition. By this measure, competition is having an impact in most countries in the comparison for international services, in some countries for national long distance, with only a modest impact in the UK for local services. The UK remains the most competitive market. Germany has had the most dramatic increase in competition recently. Denmark ranks high in international service competition and low in national long distance. Although Denmark ranks relatively high in local competition, it cannot be concluded there is effective local service competition in any country yet. Nevertheless, Denmark's ranking on local service competition has been due to the reduction of barriers to entry caused by carrier (pre-) selection, the introduction of number portability, and unbundling the local loop. In all these areas, Denmark has introduced competitive initiatives ahead of the EC deadline. Competition in Denmark's national long distance market tends to run parallel to development in the local services market, rather than with the international services market, as typically happens in larger countries, e.g. Germany.

[6] The EC published in January 1998 a Notice on the status of voice communications on the Internet. The Notice addresses two questions: firstly whether voice telephony over the Internet falls in the category of services which had to be liberalised before 1998, and secondly whether the regulatory provisions for public voice telephony should be applied to voice over the Internet. The notice concludes that given the present techniques used for voice over the Internet, these services cannot be considered as voice telephony service within the meaning of the 90/388/EC Directive. As a consequence, other provisions of the regulatory framework specifically regarding public voice telephony are not applicable to Internet telephony. However, the Commission noted that this assessment will need to be reviewed periodically given the rapid development of the associated techniques.

Table 3.1 – Public Fixed Voice Telephony Operators/Service Providers (August 1999)

		DENMARK	*FINLAND*	*FRANCE*	*GERMANY*	*NETHER-LANDS*	*SWEDEN*	*UK*
Local	Incumbent Market Share (%)[a]	94%	100%	98%	98%	100%	98%	83%
	# of active operators	11	61[b]	8	22	2	22[c]	36
Long Distance	Incumbent Market Share (%)	94%	95%[d]	98%	65%	90%	70%	72%
	# of active operators	11	19	31	47	24	22	26
Inter-national	Incumbent Market Share (%)	64%	89%	98%	65%	70%	63%	54%
	# of active operators	11	14	31	47	24	22	66
Number Portability in Place		Yes	Yes	Yes	Yes	Yes	Yes	Yes

Source: EU (1999) Fifth Report on the Implementation of the Telecommunications Regulatory Package.
[a] For the Netherlands and Germany, figures are from the first period of 1999. For the other countries 1998 figures are presented.
[b] In Finland, 46 regional local operators belong to the Finnet Group.
[c In] Sweden, figure is estimated using the total number of interconnection agreements (in place and under negotiation).
[d] For Finland, figures refer to the combined market share for both Sonera and the Finnet Group.

3.2 Public Mobile Services

Competition in mobile services has increased more rapidly than fixed network services. With each generation of mobile, more competition has been permitted in Denmark and most other countries. The number of operators licensed in the countries being compared is shown in Table 3.2. Here also, a better indication of the significance of competition can be seen from the market share data provided in Table 3.3. Although competition has had a major impact in all the countries, it has been greatest in the UK where BT's market share has been reduced to about one-third of the market and Vodafone is now the leading operator.

With the allocation of frequencies for new (third) generation mobile telecommunication (UMTS) in some countries, however, a new growth market is expected to open up in the next few years. Mobile is then expected to become an effective substitute for fixed line connections for many services and customer groups.

Table 3.2 – Public Mobile Voice Telephony Operators/Service Providers (August 1999)

	Analogue # of Operators	**GSM 900** # of Operators	**DCS 1800** # of Operators
DENMARK	1	2	4
FINLAND	2	4	41[a]
FRANCE	2	12	3
GERMANY	1	2	2
NETHERLANDS	1	5	2
NORWAY	1	2	4
SWEDEN	1	3	4
UK	2	2	2

Source: EU Fifth Report on the Implementation of the Telecommunications Regulatory Package
[a] Includes licenses to regional local operators

Table 3.3 – Public Mobile Voice Telephony Operators/Service Providers *(August 1999*)

	Analogue		**GSM 900**		**DCS 1800**
	Licensed Operators	Incumbent Market Share	Licensed Operators	Incumbent Market Share[1]	Licensed Operators
DENMARK	1	100%	2	46%	4
FINLAND	1	100%	3	62%	35 (32 local)
FRANCE	2	N/A	3	49%	3
GERMANY	1	100%	2	42%	2
NETHERLANDS	1	100%	2	55%	5
NORWAY	1	100%	2	N/A	2
SWEDEN	1	100%	3	47%	4
UK	2	N/A	2	34%[2]	2

Source: Financial Times Mobile Communications
[1] Both for GSM 900 and DCS 1800
[2] Vodaphone is the leading operator. As of January 1999 its market share in the UK was about 37%.

3.3 Interconnect Prices

With the Interconnection Directive (97/33/EC) approved by the European Parliament and the Council in June 1997, national regulatory authorities for telecom (NRAs) received an important role in securing adequate interconnection of networks. Different recommendations by the Commission of the European Union followed soon afterwards focusing on cost accounting systems and accounting separation in October 1997 (Part one) and April 1998 (Part two), as well as interconnection prices.

The Commission has been monitoring the way NRAs have been securing adequate interconnection agreements in different EU countries. Since the EU Fourth Report on the Implementation of the Telecommunication Regulatory Package in March 1999, the number of interconnection agreements have been growing in all countries under consideration. Denmark currently has agreements between Tele Danmark and 48 other operators.

However, numbers of interconnect agreements are not necessarily an indication of effective competition. A better picture on progress for interconnection is presented in comparisons of interconnect prices. In order to facilitate further decreases in interconnect pricing the EU Commission has adopted different recommendations defining “recommended price ceilings”, for short distance leased line part circuits of the lengths of up to 5km, corresponding to the “bottleneck” of the incumbent’s local access network, and “best current practice charges” for local interconnection, single transit interconnection and double transit interconnection. As a result, interconnection tariffs for call termination have been decreased in all countries under consideration since October 1997 when the first recommendation on interconnection pricing (C (97) 3148) was decided and initially made public.

Table 3.4 presents the interconnection charges for fixed-to-fixed voice per minute based on a 3-minute call. Denmark ranks in the upper half of the compared countries according to the 1 March 2000, EU data, and moves further up when 1 May 2000 prices are considered. Table 3.5 shows leased line interconnect prices for local metropolitan zone services, and the EC recommended price ceilings. Here also Denmark ranks near the top of the comparisons. A similar picture emerges if the interconnection charges from fixed-to-mobile and mobile-to-mobile are compared across EU countries. Compared to the previous year, rates for interconnection in September 1999 have on average decreased in the countries under consideration. For Denmark, these rates have been below the current best practice in the European Union indicating a lowering of entry barriers related to cost-advantages of incumbent network operators.

Table 3.4 – Interconnect Charges for Fixed-to-fixed Voice, per minute based on a 3-minute call (1 March 2000, EURO cents)

	Local	Single Transit	Double Transit
DENMARK	0.84 (0.75)[1]	1.18 (0.95)[1]	1.80 (1.35)[1]
FINLAND	1.43	1.43	2.63 – 3.28
FRANCE	0.63	1.33	2.01
GERMANY	1.88	1.49 – 1.89	2.28
NETHERLANDS	1.00	1.41	1.70
SWEDEN	0.86-90	1.16 – 21	1.59 – 67
UK	0.54	0.82	1.71

Sources: EC (2000) Interconnect Charges Per Minute, 1 March 2000.
[1]Effective 1 May 2000

Table 3.5 – Leased Line Retail Prices Within Metropolitan Zones (2-5 km), October 1999

	34 Mbit/s	2 Mbit/s	64 kbit/s
DENMARK	744 – 2074	243	99
FINLAND	Case by case	225 – 367	97[1]
FRANCE	5082 – 7215	815 – 995	242 – 277
GERMANY	2582 – 4960	486	92
NETHERLANDS	Case by case	795 – 1489	141 - 274
SWEDEN	2327	441	210
UK	5732 – 5823	560 – 608	250 – 264
EU recommended price ceiling, 24.11.99	1800 – 2600	350	80

Note 1- Price data from 1998
Source: EU Recommendation on Leased Lines Interconnection Pricing, 24 November 1999

Table 3.6 – Unbundled Local Loops: Status and Prices, October 1999

	Status	**Price** (Euro/month)
DENMARK	Implemented	8.23
FINLAND	Implemented	5 – 25
FRANCE	Implemented	NA
GERMANY	Implemented	13.0
NETHERLANDS	Implemented	<15.4
SWEDEN	Implemented	N/A
UK	July 2001	N/A

Source: EU Recommendation on Leased Lines Interconnection Pricing, 24 November 1999

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. The EC issued a Commission Recommendation on 26 April 2000 urging all NRAs to move ahead on the issue and is in the process of developing a directive on the matter. Table 3.6 provides a summary of the status of local loop unbundling in the compared countries and the prices per copper pair, as published by the EC on 24 November.1999. There is a WTO complaint against the delay in the UK.

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 the Danish government policy document, and similar policy statements by the EC and other national governments. The evidence suggests that Denmark and Finland have been the leaders in implementing unbundled access to local loops in preparation for information infrastructure development.

4. ASSESSMENT: TELECOM REFORM

By all the standard indicators, Denmark stands up extremely well in comparison to other 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 near the best in the world, along with the other Nordic countries. Denmark's prices rank almost as well. Overall its leased line prices are the lowest among 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 dropped Denmark's ranking below the median of the compared countries.

With respect to competition, all countries still have a long way to go before their telecom service markets are fully competitive. Mobile and international services show evidence that strong 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 and local services, it is for the moment a follower in national long distance markets - due in part to the small size of the country.

Denmark's performance ranks much higher on prices and market development than it does in the development of competition. When viewed in the context of Denmark's 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 13 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. The most dramatic improvement in performance since last year's report has been by the Netherlands and Germany, which have improved their rankings for several indicators. 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.

Perhaps the key indicators of preparation for information infrastructure development for the next several years are leased line and interconnect prices, and unbundled access to the local loops. These have been key factors helping to explain the world leadership of the US in information infrastructure development and Internet services growth. As Denmark is in a leadership position in all three areas, it is well positioned to build on that in the development of its information infrastructure.

B. INFORMATION INFRASTRUCTURE 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 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 fo 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 Internet development and e-commerce readiness, establishing the conditions for demand to develop; and on steps to establish the upgraded telecom networks needed at international, national and local levels to supply the new services.

5. INTERNET DEVELOPMENTS

Indicators of Internet development cannot be as definitive as traditional telecom indicators, but do provide a basis for general comparisons. Internet hosts and web server sites provide data on services availability. Home PCs and Internet use provide data on acceptance. Internet prices identify access and competitiveness. Internet exchanges show a country's position in the global Internet network.

The significance of the Internet as a service of widespread economic and social importance is demonstrated in the EC's first monitoring report on universal service which addresses the issue of Internet in schools. It requests NRAs to take steps necessary to encourage and permit new as well as dominant/incumbent operators to offer special tariffs to schools. This will involve defining the special category of schools, assessing schools' needs in collaboration with educational and training institutions, indicating the limits of permissible pricing, and dealing with interconnection arrangements, in order that annual flat rate tariffs can be provided. Where special tariffs are provided, however, the Commission notes that they should not serve to distort competition. This is parallel to similar policies in the US and Canada promoting Internet in schools.

5.1 Internet Hosts and Web Server Sites

Tables 5.1 and 5.2 provide data indicating the extent of Internet penetration in the compared countries. It shows that Denmark is following a different pattern of Internet development than most of the other countries. It has far more webserver sites per thousand inhabitants than any other country, but ranks lowest in Internet hosts per site. The number of TLD-hosts (.dk-domain) hosts ranks with the Netherlands and Sweden behind Norway and Finland. The low number of TLD-hosts in the USA is due to the fact that the share of gTLD-hosts is very dominant in the US. 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 5.1 – Internet Hosts per 1000 Inhabitants

	July 1997	April 1999[1]	May 2000[1]	Change 1997-2000
		TLD	TLD	
CANADA[2]	29.0	43.2	N/A	N/A
DENMARK	26.3	59.6	65.7	150%
FINLAND	77.3	91.1	97.8	27%
FRANCE	5.3	9.7	22.0	315%
GERMANY	11.4	18.7	21.1	85%
NETHERLANDS	22.1	43.8	72.4	228%
NORWAY	48.3	76.1	102.5	112%
SWEDEN	33.4	47.7	66.8	100%
UK	15.5	26.0	28.4	83%
USA[2]	35.0	32.6	N/A	N/A

Source: Ripe DNS Hostcount www.ripe.net.
[1] ITU 1999
[2] OECD/ISC www.isc.org.

Table 5.2 – Web Server Sites per 1000 Inhabitants (July 1998)

	Under gTLD[1]	Total
CANADA	4.4	5.2
DENMARK	1.6	8.1
FINLAND	0.5	1.9
FRANCE	0.4	0.7
GERMANY	0.5	2.0
NETHERLANDS[2]	1.0	2.9
NORWAY[2]	0.7	2.4
SWEDEN	2.0	4.8
UK	0.8	3.1
USA	5.2	5.5

Source: OECD (1998)
[1] Generic Top Level Domains: domains that are not under a national domain (like .com, org and .net).
[2] Estimates based on regression of ETO data (end date is October 1998).

5.2 Home PCs and Internet Use

It has been estimated that the present number of people with Internet access in the Nordic countries is 6.2 million (1998), and that this will more than double to 13 million by 2002 (IDC). Table 5.3 suggests that diffusion is increasing rapidly in all the Nordic countries. Finland has the lowest proportion of homes with Internet connectivity, but the highest proportion of regular web-users. In Finland the proportion of regular web users is greater than Internet connectivity, indicating significant access outside the home. In the other countries, less than half the homes with PCs are regular web users.

Table 5.3 – Diffusion of Home PCs and Internet Use, 1999

	Proportion with PC	Internet connectivity	Regular web-users
DENMARK	52 (65[1])	31 (45[1])	22
FINLAND	49	28	31
NORWAY	57 (67[2])	29 (36[2])	24
SWEDEN	58	42	29

Source: Regeringens proposition, Sweden, 2000, Danish Ministry for Research and Information Technology
[1] Data is from 2000
[2] Data is from late 1999

5.3 Internet Pricing

In the current phase of the Internet, most consumers still use dial-up connection via modems and telephone lines to access the Internet. As Table 5.4. 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 5.4 illustrates Denmark's favourable comparison with the other countries under consideration, and ranks fourth after Finland, Sweden and the UK with respect to low access rates.

Table 5.4 – 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.

5.4 Internet Exchanges: Nodes in the Global Network

Table 5.5 Overview of Selected Internet Exchanges (IX) in Various Countries, 1999-2000

	Total number of IXs in country[3]	(Biggest) IX	Location	Number of connected ISPs	Estimated daily traffic (Mbps)
BELGIUM	2	BNIX	Brussels	35[1]	60[1]
CANADA	4	QIX (RISQ)	Montreal	6[3]	32[3]
DENMARK	1	DIX	Lyngby	23[1]	–
FINLAND	1	FICIX	Helsinki	10[6]	32
FRANCE	6	SFINX	Paris	40[5]	–
GERMANY	7	DE-CIX	Frankfurt	60[4]	–
ITALY	3	NAP Nautilus	Rome	12[3]	1
NETHERLANDS	7	AMS-IX	Amsterdam	90[1]	400[3]
SWEDEN	3	KTHNOC(D-GIX)	Stockholm	31[1]	–
UK	12	LINX	London	100[2]	741[3]
USA	93	MAE-East	Washington, DC	116[3]	2000[3]
USA	93	Ameritech	Chicago	107[1]	1633[1]
USA	93	MAE-West	San Jose, CA	76[3]	–
USA	93	SIX	Seattle	30[1]	53[1]

Sources: www.ep.net; TeleGeography (2000), *Hubs and Spokes*
Notes:
[1] Data from May 2000;
[2] Data from March 2000;
[3] Data from October 1999;
[4] Data from April 2000;
[5] Data from May 1999;
[6] Data from December 1999.

Table 5.5. presents some data on public national access points (NAPs) and private peering points[7], i.e. major intersections on the Internet, where large amounts of data traffic converge. They allow ISPs to save bandwidth – particularly outside the US where aggregating regional traffic can effectively allow ISPs to replace international bandwidth with less costly local capacity. Public NAPs and private peering points are not centrally managed, and no single entity has the economic incentive to facilitate problem resolution, to optimise peering, or to bring about centralised routing administration.

[7] Private peering comparable to interconnection agreements.

The presence and status of Internet exchanges (IX) can be taken as a proxy for the activity of national ISPs and for the (in)dependence of regional networks (e.g., Europe) from the US backbone system. In other words, the more ISPs are connected to one central national exchange point, the better the situation for data throughput in that country. Table 5.5. suggests that there is a growing number of IXs in Europe and Asia, indicating an increasing percentage of traffic that stays in the respective regions. Denmark's rankings as the eighth country on the list suggests significant Internet traffic development.

Most IXs are geared towards national ISPs. The exceptions in Europe are LINX (UK) and AMS-IX (NL). These two exchanges also have the highest growth figures, both in terms of the amount of data exchanged and the number of participating ISPs. A plausible scenario is the rise of one central European clearing service. DE-CIX could be a third candidate – the overall share of Germany in global Internet traffic has risen significantly during recent years. At this moment, though, LINX is still by far Europe's largest exchange point with a very international orientation (16 out of the 100 partners are from non-UK countries).

The lack of publicly available statistical data on Internet peering, traffic levels and traffic growth in a number of countries creates difficulties for regulators to assess dominant market power on the Internet. The most prominent 1998 example of these difficulties has been the EU evaluation of the MCI – Worldcom merger leading to the enforced sale of the US Internet backbone of MCI to Cable & Wireless. This is likely to be a future issue both for telecom regulators and competition authorities.

6. E-COMMERCE READINESS

6.1 E-commerce and 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 so-called “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.

Another protocol is SET (secure electronic transactions) designed by MasterCard and Visa to facilitate financial transactions over the Internet. SET-systems are much larger and hence much slower than SSL-systems. They also require more bureaucratic formalities. SET is still in development and not yet widely available. Up to this moment the success of SET has been very modest. The Danish banks have tried to push the SET-standard but as yet it has failed to take off. The exclusion of SET figures does not seem to affect the general validity of this analysis.

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 huge differences between the various systems (for example, SSL requiring less bandwidth than SET).

Table 6.1 shows that the US is by far the leader with regard to the number of secure servers and its recent growth continues to be higher than most other countries. In January 2000, growth of the density of SSL-servers (# per million inhabitants) has accelerated in the US, Canada and Denmark. Growth in other countries has remained more or less constant.

Table 6.1 – Number of SSL-based Servers per million Inhabitants and Growth Rates, September 1996 – April 2000

	September 1997	February 1999	Growth	April 2000	Growth
CANADA	18.1	49.5	173%	100.7	103%
DENMARK	2.1	13.8	557%	47.3	243%
FINLAND	3.9	24.8	536%	57.8	133%
FRANCE	1.1	7.6	591%	18.9	149%
GERMANY	1.8	13.2	633%	37.4	183%
NETHERLANDS	4.8	15.5	223%	32.1	107%
NORWAY	5.2	22.7	337%	52.7	132%
SWEDEN	6.0	33.6	460%	77.5	131%
UK	6.0	21.3	255%	59.1	177%
USA	27.6	89.9	226%	193.8	116%

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

Table 6.2 – Number of SSL-based servers as a share of world total (%), September 1996 – April 2000

	September 1997	July 1998	February 1999	January 2000	April 2000
CANADA	5.7	4.5	4.6	4.0	4.2
DENMARK	0.1	0.2	0.2	0.3	0.3
FINLAND	0.2	0.3	0.4	0.4	0.4
FRANCE	0.7	1.1	1.3	1.6	1.5
GERMANY	1.5	2.4	3.2	4.2	4.1
NETHERLANDS	0.8	0.6	0.7	0.7	0.7
NORWAY	0.2	0,3	0.3	0.3	0.3
SWEDEN	0.5	0.7	0.9	1.0	0.9
UK	3.6	3.5	3.7	4.8	4.7
USA	77.0	71.7	73.0	69.6	70.7

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

Table 6.2 shows the relative share of a country in the world-wide number of SSL-servers. The continuous growth of Germany is the most striking recent trend.

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 huge 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 6.3. 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 6.3 – 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.

6.2 E-commerce in Nordic Countries

According to the Economist Intelligence Unit the Nordic countries are amongst the top 15 countries for business environment rankings and connectivity ratings. USA is ranked first followed by Sweden, Finland and Norway. Denmark is ranked 12th in this study (2000, www.ebusinessforum.com), but is forecast to catch up with the other Nordic countries as national schemes for digital communication (2000) and legislation on digital signature (May

2000) are put into effect. Table 6.4 provides a recent estimate of Internet-based e-commerce. It suggests that Sweden has made the fastest start in e-commerce activity in its very earliest stages.

Table 6.4 – Internet-based E-commerce, 1998 (x 1000 persons)

	Population	Internet connections	Users of Internet	Persons who have traded	Internet e-commerce turnover (mill ECU)
DENMARK	5200	1700	1500	250	20
FINLAND	5100	1600	1100	200	20
NORWAY	4500	1600	1400	250	22
SWEDEN	8700	3600	3100	950	200

Source: Teldok, 2000 & www.naring.regeringen.se

General Population

Access

Access to both PCs and the Internet is quite high in the Nordic countries, which relates to high penetration rates at home, at work and at schools. Table 6.4 documents the diffusion of home PCs, connectivity and web usage. Looking at the trend in the Denmark data, it is noteworthy that growth between 1999 and 2000 was very high. The number of persons with PC and Internet access at home has grown to 65% and 45% from 52% and 31% in 1999. The total access-rate for PCs and Internet at home, work and school has grown to 77% and 65% respectively.

E-commerce Activities

Various reports provide indications on how people actually use the Internet. These reports however have different structures and methodologies and thus can only be compared with considerable caution. The data is summarised in Table 6.5. Research on Internet use in Denmark in April 2000 shows what the Danish population uses the Internet for e-mail (46%), information search (28%), news (20%), and chat (6%). Further e-commerce in the form of transactions is a relatively small but growing activity as 7% have ordered items, 6% have performed electronic payment, whereas 16% use net-banking.

Table 6.5 – Internet-based Activities by Population

	e-mail	Information	News	Chat	Games
DENMARK	46%	28%	20%	6%	–
FINLAND	74%	58%	52%	18%	17%
SWEDEN	49%	56%	21%	8%	–

Similar research on Sweden from 1998 shows that their activities on the Internet related to information search (56%), e-mail (49%), news (21%), and chatting (8%). E-commerce was quite diffused as 11% had performed some form of e-commerce. Net-banking on the other hand had only been used by 7%. Findings from Finland 1999 show that whenever the Finns use Internet they apply e-mail (74%), acquire news (58%), search other information (52%), chat (18%), and play games (17%). No data has been found on the Norwegian behaviour.

A recent IDC report (2000) concludes that B2C e-commerce is thriving in the Nordic countries. They are the leading countries in Europe. Sweden has the highest proportion of shoppers, whereas the value of the purchased items is the highest in Denmark.

There have also been analyses on the socio-economic background for Internet-use. Data collected on the Nordic countries show that high-income groups use Internet much more than low- and medium-income groups. On average a high-income group has a double frequency compared to the medium group. This tendency and gap is highest in Sweden (36 compared to 70%) and lowest in Norway (24 compared to 30%) (IDC, 1998). Other trends show that the age-groups under 50 are much more frequent users than older age groups.

Drivers and Barriers

The drivers for home Internet use relate to enhanced access of services and mailing, but also the ability to perform tele-work. Almost 40% of Swedish Internet-users get connected at home in order to work overtime. The users of Internet in Denmark in 2000 indicate that they are confident with information searches and using e-mail (90%), but are less confident with submitting personal information (30%).

Business Sector

In the Nordic countries almost all firms have computers and most have Internet access. Internet-based e-commerce measured in turnover is by far the most developed in Sweden, as shown in Table 6.6. It has been attributed by some experts to the long traditions of mail-ordering. Denmark on the other hand has high proportions of e-commerce between businesses that are related to VAN-based connectivity; almost half of all Danish firms apply EDI. Whereas a major portion of Danish B2B e-commerce is situated outside Internet connectivity, about 90% of Swedish B2B e-commerce is Internet-based. The Nordic countries are far ahead of the average for Western Europe.

Table 6.6 – Transactions in E-commerce (1998) (turnover per person, US$)

	B2C E-commerce	B2B E-commerce	Total E-commerce
DENMARK	6.94	18.75	25.69
FINLAND	10.61	16.85	27.46
SWEDEN	11.47	18.14	29.61
WESTERN EUROPE	4.86	9.8	14.66

Source: IDC, 1999.

Access
Table 6.7 shows Sweden and Denmark with the highest Internet connectivity among companies.

Table 6.7 – Company's Connectivity to Internet

	Computers	Internet Access	Homepages
DENMARK	97%	85%	69%
FINLAND	–	60%	28%
NORWAY	–	66%	–
SWEDEN	99%	93%	74%

Source: Forskningsministeriet, www.fsk.dk & Teldok, www.teldok.framfab.se & IDC 2000.

E-commerce Activities
E-commerce may be viewed from different perspectives e.g. through the narrow approach where only transaction related activities like ordering, digital delivery and payments are included in e-commerce. The other extreme is the widest possible, which assumes that any activity performed by a firm is done for commercial purposes and hence e-commerce is everything a business does on electronic platforms. The following data on the Nordic countries includes both transactions and other commercial uses of Internet.

Table 6.8 – Internet-based Activities for Firms

	Marketing	Business information	Information search	Recruitment	Electronic procurement	Received orders via homepage
DENMARK	63%	74%	90%	37%	39%	22%
FINLAND	–	48%	63%	–	–	9%

Source: Forskningsministeriet, www.fsk.dk

Danish firms (1999) use the Internet for marketing (63%), communication with suppliers (74%), information search (90%), and communication with public sector (54%). Over half the Danish firms (2000) have engaged in some kind of Internet-based e-commerce (54%) as ordering (39%), recruitment (37%), receive orders (22%), receive digital services/products (49%), and electronic payments (36%). The Finnish firms use Internet for information acquisition (63%), and contact info (48%). In 1998 only 9% of Finnish firms had received orders online. EDI has also become diffused in Finland where a third of all firms applied it in 1999. In comparison 8% of Norwegian firms had engaged in b2c e-commerce and 13% in electronic payments by 1999.

Motivation and Barriers
The drivers for applying Internet and e-commerce solutions by firms are quite similar in all the Nordic countries. Most state that market access leading to new customers and the fear of losing customers as prime drivers together with opportunities to provide new services. A secondary motivation is cost considerations.

Constraints to information technology use relate to frequent software updates and security, but also to shortage of skilled personnel, and potential loss of working hours. Barriers related directly to e-commerce trading also include costs of internal readjustments, uncertainty in contracting and payments, and that "goods are not suited for e-commerce".

Impact of E-commerce on Businesses
Little evidence has been collected to illustrate impact on businesses. Some reports have indicators for the integration of Internet and e-commerce in work processes expressed in amount of workplaces with PCs and Internet-access. Employees in Danish businesses have 68% and 54% access rates in 2000, and use searches (33%) and mail/calendar (56%). 42% have received IT-training on the job.

Other indicators for e-commerce include turnover of e-commerce compared to conventional trading. Findings in Norway suggest that 8% of businesses in 1999 doing e-commerce had turnover from e-commerce exceeding 25% of total turnover. About 40% of the businesses had turnover between 1% and 2% of total turnover. 11% of Danish firms (1999) had turnover over 1% from the Internet, and 11% had turnover over 1% from orders received through EDI.

Public Administration

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, applying electronic services, making electronic procurements, providing tele-work etc. Some of these issues have been covered in analyses of the public sectors in the Nordic countries.

Access
The public sector PC and Internet access in Denmark is high as almost 100% of administrative personnel have PCs, Internet-access and e-mail account. Figures are comparable for the other Nordic countries.

Public E-commerce Services
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 a third of all municipalities. Over 30% perform e-procurement, which is either Internet or EDI-based. A successful Internet-based self-service facility provided by a central institution is the individual tax-registration. This facility was introduced in 1998–1999 and in 1999 there were 70,000 Internet-based requests for the tax forms. At the same time there were 230,000 requests through the self-service telephone, which has been provided for a much longer period. Table 6.9 summarises the Internet-based availability of public services in Denmark.

Table 6.9 – 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"

As Table 6.10 shows, in Sweden there is a higher proportion of public home pages as 100% of central institutions and 98% of all local municipalities have such an Internet-interface. One of their successful services is their national employment office, which has 50–70,000 electronic visitors daily. The Norwegians have a smaller proportion of public institutions with home pages at 74% of central and 31% of local municipalities (1998).

Table 6.10 – Homepages in Public Sector

	Central Administration	Local Municipalities
DENMARK	100%	71%
NORWAY	74%	31%
SWEDEN	100%	98%

7. THE TRANSATLANTIC LINKAGE

7.1 The Changing Structure of Transatlantic Traffic

1998 was the first year of full liberalisation of the telecom market in Europe and it also was the year that the demand for International Leased (Private) Lines by Internet Service Providers became very visible in the statistics. Table 7.1 shows that for Sweden, the Netherlands, the UK and to a lesser extent Germany the main use has shifted from voice telephony to private lines. For Denmark, Finland, Norway and France the major use is still for voice telephony. Canada has an even distribution between circuits used for voice and private lines.

More remarkable is that the total number of active circuits from the USA to the UK neared the number of active circuits from the USA to Canada, while the Netherlands counted more active circuits than France and Sweden neared Germany. The low number of active circuits to the USA for Denmark, Finland and Norway underlines the position of Sweden and its capital Stockholm as the major international telecommunications traffic hub for the Nordic countries. This also highlights the influence of the large Internet Exchange in Sweden on demand for circuits to the USA. This pattern is also visible, but to a lesser extent, for the Netherlands and the UK.

Table 7.1 – International Connections to the US in 64 kbps circuits

	1998 Combined Cable & Satellite					
	Telephony	**Private Line**	**Other Serv.**	**Active Ckts**	**Idle**	**Telephony/ Active Ckts**
CANADA	54909	53330	630	108869	121633	50.4%
DENMARK	586	203	1	790	566	74.2%
FINLAND	276	202	1	479	210	57.6%
FRANCE	4389	4626	31	7046	5138	62.3%
GERMANY	5595	7364	33	12992	11377	43.1%
NETHERLANDS	2087	6129	9	8225	15115	25.4%
NORWAY	472	103	1	576	98	81.9%
SWEDEN	2673	9460	127	12260	2054	21.8%
UK	25444	75828	2978	104250	110025	24.4%

Source: FCC International Bureau, 1999 Report on International Circuit Status Data.

A review on the proportion of circuits used for voice telephony for the 1995–1998 period shows that the 1998 liberalisation has lead to a shift to voice circuit use for France and Germany. In Germany it was mainly due to a decrease in private line use and in France by a strong increase in voice telephony. In the UK and the Netherlands the balance shifted further to private line use, while Sweden saw equal growth in circuits used for private lines and for voice telephony. The shift away from voice telephony is still happening at a very moderate

tempo for Denmark, Norway and Finland. As Internet demand continues to grow, leased (private) line traffic can be expected to increase in parallel.

Table 7.2 – Percentage of Active Circuits in Use for Telephony Service on Links to the US

	1998 Telephony/ Active Ckts	1997 Telephony/ Active Ckts	1996 Telephony/ Active Ckts	1995 Telephony/ Active Ckts
CANADA	50%	53%	56%	85%
DENMARK	74%	80%	81%	94%
FINLAND	58%	71%	82%	73%
FRANCE	62%	47%	49%	73%
GERMANY	43%	39%	45%	68%
NETHERLANDS	25%	36%	35%	64%
NORWAY	82%	80%	80%	97%
SWEDEN	22%	22%	37%	97%
UK	24%	44%	40%	53%

Source: Based on Table 5, FCC 1999 Report on International Circuit Status Data

7.2 The Transatlantic Capacity Explosion

Up to 1998 the largest cables on the transatlantic routes were the CANTAT-3 from Canada to the UK and Denmark (1994, 5 Gbit/s capacity) and the TAT-12/13 cable system to the UK and France (1995, 5 Gbit/s upgraded to 10 Gbit/s in 1996). These cables provided more than 50% of transatlantic capacity in the period from 1995 until the end of 1997.

1998 was the year when entrepreneurs landed transatlantic cables outside the traditional system where incumbents laid their TAT-cables by pooling their resources and risks. At the end of 1997 the first of the two Gemini cables laid by Worldcom and Cable & Wireless to the UK was brought into service at 5 Gbit/s. The second part of the cable system was completed in spring 1998 with an initial capacity of 10 Gbit/s. The TAT-12/13 pair was upgraded in 1998 for a second time to 20 Gbit/s to meet the fast rising demand. Finally in 1998 Atlantic Crossing-1 was laid by a new upstart company, Global Crossing, to the UK, the Netherlands and Germany adding initially 20 Gbit/s of capacity landing into the UK.

The combined effect of this large amount of new transatlantic capacity and the liberalisation in 1998 has not been a sudden oversupply of capacity. According to the FCC 1999 report on International Circuit Status Data the full percentage of US transatlantic cable capacity declined only from 45.3% to 43.9%. Thus nearly all new capacity was immediately taken into use.

Figure 7.1 shows an overview of all fiber optic capacity laid across the Atlantic, compiled from the FCC 1999 International Circuit Status Report with the FCC estimates for 1999–2001. AC-1 went into full operation in February 1999 at 40 Gbit/s and has been upgraded to

80 Gbit/s at the end of that year. A similar action was performed on the Gemini and TAT-12/13 systems that upgraded to 30 Gbit/s each.

The first cable that is expected to be brought into service after AC-1 is TAT-14, slated for mid-2000 with 640 Gbit/s. This means a jump in total bandwidth from slightly more than 160 Gbit/s to more than 800 Gbit/s, a near 400% increase. Although ambitious plans for additional cables and upgrades that would increase transatlantic capacity by 25 times have been scaled back, one can expect an increase on the order of ten times by 2002.

Figure 7.1 – Supply of transatlantic circuit capacity is accelerating

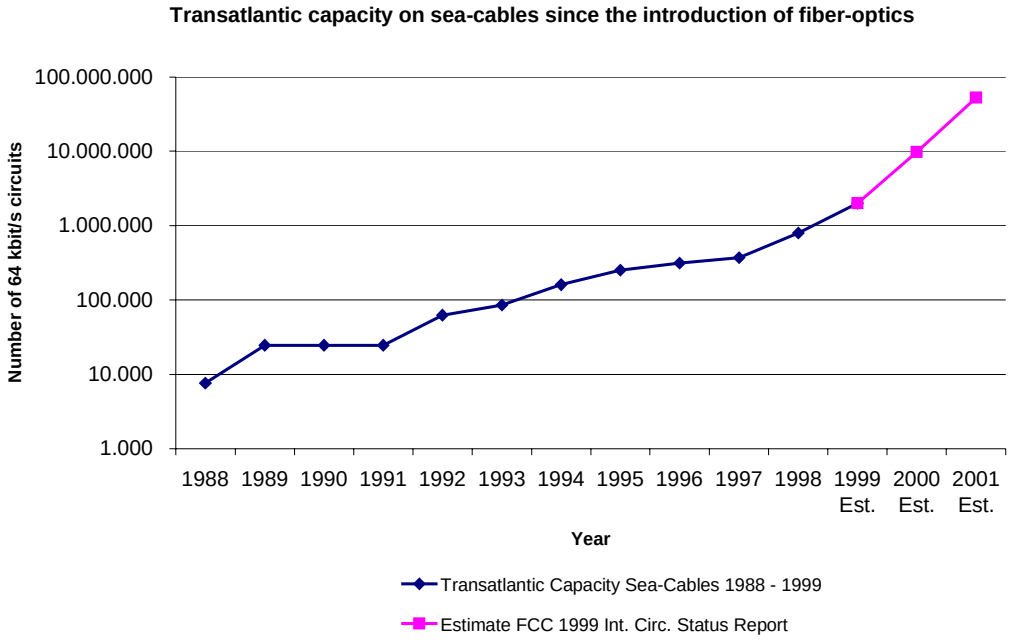
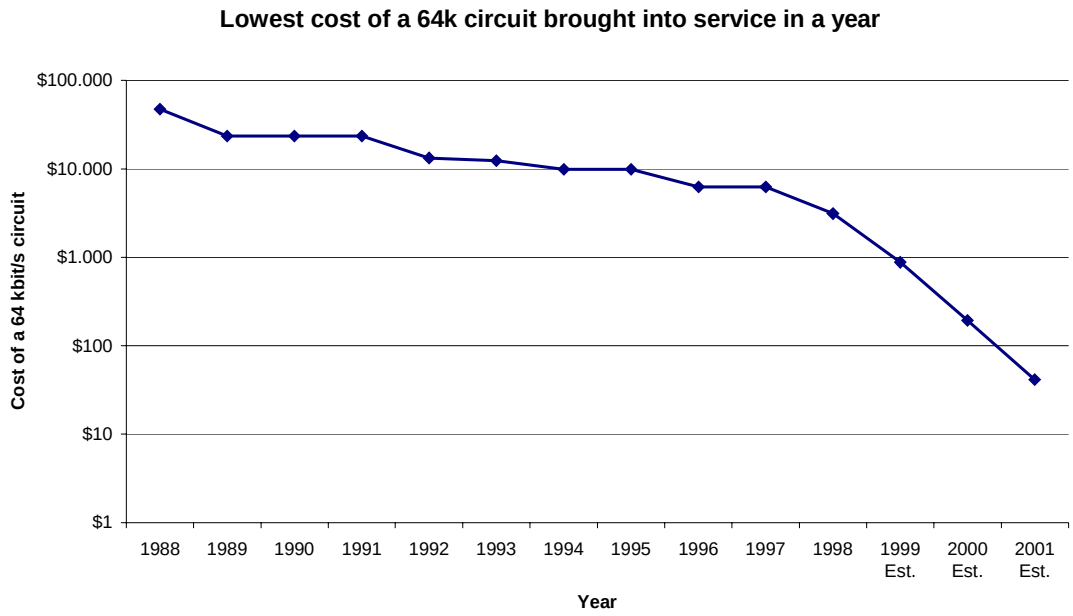


Figure 7.2 shows the current cost curve for the supply of a 64 kbit/s transatlantic circuit, as estimated from FCC data. It shows that the investment required for a transatlantic cable falls to $41 per 64 kbit/s circuit, when cables like FLAG Atlantic-1, Hibernia or Level3 become available at their full capacity in 2001. The death of distance is arriving fast.

Figure 7.2 – **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 will bring 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.

8. NATIONAL NETWORK INVESTMENT

As the convergence of telecom, computing and media proceeds, increased attention is focused on the capacity of national telecom network, 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. Most Internet traffic between European countries still travels via the USA. Yet in recent years, investment rates by national incumbent operators have been declining in some countries. 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.

8.1 Investment per Subscriber Line in Fixed Networks

Investment trends in local networks are shown in Table 8.1 and 8.2 For most countries average investment per year per subscriber line is increasing, reflecting the increasing need for upgrading and expanding capacity. 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 subscriber line in Denmark has been among the lowest among the compared countries during the past decade, but jumped dramatically in 1998 to the highest by a long way. Even for the most technologically advanced national networks, this may be the beginning of a period of major investment in upgrading local networks for the Internet bandwidth economy.

Table 8.1 – Investment per Year per Subscriber Line in Fixed Networks (US$)

	1988 – 1990	1991 – 1993	1994 – 1996	1997	1998
OECD Average	226.94	244.93	261.98	283.65	237
DENMARK	171.92	138.88	172.64	200.90	374
FINLAND	260.01	186.12	224.42	291.04	316
FRANCE	168.81	202.14	190.22	190.63	170
GERMANY	313.01	443.59	301.80	264.21	189
NETHERLANDS	170.74	212.55	187.16	168.58	184
NORWAY	241.07	212.93	245.54	287.83	288
UK	195.04	142.76	165.16	316.81	232
USA	176.17	181.48	236.19	302.63	135

Source: OECD, ITU 1999
NOTE: 1998 is from ITU World Development Report: Telecom Investment per main line and may not be directly comparable with OECD data.

Table 8.2 – Public Telecommunication Investment per capita (in US$)

	Average 1988-90	Average 1991-93	Average 1994-96	1997	1998
CANADA	127	117	95	134	133
DENMARK	96	81	106	128	247
FINLAND	135	101	124	162	175
FRANCE	81	106	106	110	97
GERMANY	118	197	156	145	107
NETHERLANDS	77	104	98	95	104
NORWAY	118	113	139	180	179
SWEDEN	127	134	136	109	86
UK	84	65	84	171	127
USA	93	100	141	200	90

Source: OECD 1999, ITU 1999

9. NEW ACCESS TECHNOLOGIES

9.1 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 centered on alternative "pipes to the home" and the need to supply higher 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 advanced 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 in an area supplying all the needed services. Possible options for Denmark over the next few years are discussed below.

9.2 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. Table 9.1 provides a DSL development summary for the last quarter of 1999 and the first quarter of 2000. Although the number of lines is still relatively small, the growth rate is very high. Current estimates are that 50-60% of US subscribers could be served by DSL. The incumbent operators are focusing on residential users, while the competitive companies are targeting business users, including SMEs. The incumbents serve 75% of the customers, but the percentage of revenues will be less than that.

Table 9.1 – DSL Deployment Summary: USA and Canada

Service Provider	Lines in Services (000)		Residential %	Equipped COs	
	(1999) Fourth quarter	(2000) First quarter		(1999) Fourth quarter	(2000) First quarter
ILECs-US	386	563	84	2,042	3,843
CLECs-US	111	179	22	4,475	5,619
IXCs-US	7	13	39	380	2,504
Total US	504	755	69	6,897	11,966
ILECs-Canada	95	128	88	435	518

Source: Telechoice, www.xdsl.com

In Europe the rollout of DSL began later than in the USA, due to the slower development of competition in local network services, and particularly in unbundling access to the local loop. In leading countries, following experimental programs in 1999, significant rollout is beginning in 2000. This includes Denmark and all the countries to which it is being compared in this report.

The market for ADSL-connections in Denmark has recently been invigorated, in that the main providers (Tele Danmark, CyberCity and World Online) have changed to flat rate pricing. Customers pay a monthly subscription fee depending on the capacity of the connection and installantion, but are not charged for the use. Table 9.2 provides details.

Table 9.2 – Prices for ADSL Services in Denmark (DKK)

Capacity (KB/s) (down/up)	Tele Danmark		CyberCity		World Online	
	Installation	Per month	Installation	Per month	Installation	Per month
256/128	995	399				
256/256					0	395
512/128	995	599				
512/512			1995	595	2000	595
1024/256	995	1199				
1024/512			1995	795		
2048/512			1995	995	2000	995

According to Tele Danmark, approximately 50% of the network was enlarged with ADSL-functionality in May 2000. Tele Danmark plans that 60% of all PSTN lines shall be equipped with ADSL at the end of 2000. As Denmark provides unbundled access to the local loop, this gives competitors the opportunity to provide ADLS services, and could provide a major

stimulus to competition in the local services market. CyberCity and World Online are currently upgrading their networks. No figures subscriptions have been released.

9.3 CATV Upgrades

Europe

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 with other new access technologies. In the USA, AT&T has purchased TCI, the largest US cable operator as part of a major commitment to provide higher speed access to the home for all telecom services. It is currently in the midst of a very expensive upgrading investment.

Table 9.3 provides data on CaTV penetration in the compared countries. Denmark ranks quite high. Yet, competitive access to Internet services over CaTV cable does not appear to have developed significantly in Europe.

Table 9.3 – Total Cable TV Subscribers

	CaTV subscribers ('000) (1999)	**CaTV subscriber per household** (%) (1998)	**Homes passed per 100 households** (%)
DENMARK	1,316[a]	56.0 [b]	68.0
FINLAND	842[a]	41.0 [b]	52.0
FRANCE	2,700	10.5	N/A
GERMANY	19,900	44.0	N/A
NETHERLANDS	6,200	91.0	95.0
NORWAY	775[a]	41.0	N/A
SWEDEN	1,960[a]	53.0	65.0
UK	2,990	10.0	N/A

Source: EITO 2000, ESIS 1999, VECAI 2000 (for the Netherlands)
[a] For 1998 only.
[b] For 1997 only

Table 9.4 shows actual and estimated cable modem shipments to the compared countries for 1998–2000. The Netherlands is the largest market for cable modems, where first commercial deployments began in 1995. The total installed base in the Netherlands at 1999 is about 100,000 units. This gives the Netherlands a cable modem penetration rate per residence of 1.6%, more or less equivalent to the USA, which is estimated at 1.8%. Shipments to the Nordic countries are growing at a slower pace, and are below Western European average. IDC forecasts that this pattern to continue into 2003.

One reason for the slow growth is that the technology is not always living up to expectations. It is estimated that about half the modems shipped are effectively narrowband modems (up to 115 kbit/s per user). Even the high speed cable modems deployed by most cable operators throughout the world are turning out to be effectively providing a narrowband like service with download bit rates at peak hour of 200 kbit/s.

Table 9.4 – Cable Modem Shipments, 1998-2000.

	1998	**1999** (estimated)	**2000** (estimated)
DENMARK	5.5	8.2	14.5
FINLAND	1.8	5.2	9.6
FRANCE	16.4	31.9	104.7
GERMANY	4.6	12.5	42.6
NETHERLANDS	29.8	49.5	104.9
NORWAY	2.0	4.7	11.8
SWEDEN	2.1	9.0	24.8
UK	0.3	25.9	63.3

Source: International Data Corporation, August 1999.

The regulatory discussion in the United States and some countries in Europe (the Netherlands and Sweden) has been about the provision of open access rules to stimulate a variety of services from Internet Service Providers (ISPs), and the implications for investment incentives for incumbent cable operators, and ensuring low switching costs for subscribers among alternative service suppliers.

Denmark

The cable TV market 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
Stofa offers Internet access via the cable network to households and companies, under the brand name StofaNet. The service is available to households and companies localised in areas in which Stofa has established a cable network. StofaNet offers a 512-KB access to the Internet in both directions. Private customers pay for the installation (which includes various hard- and software) and the current payment is composed of a quarterly payment and a price per minute/bit.

The installation price is 299 DKK and there are three levels of subscription, as shown in Table 9.5.

Table 9.5 – Stofa Subscription Prices

	Quarterly charge	Use dependent charge
Surfer	199	0.19 per minute
Basis	349	0.10 per minute
Mega	698 (incl. 300 MB)	0.25 per extra MB

Tele Danmark
Tele Danmark's cable network has approximately 825,000 subscribers. Tele Danmark offer their subscribers use of the network as the down stream access (capacity 512 KB) in connection with using the PSTN network as the up stream access. Prices for installation including cable modem are 1995 DKK *and* a quarterly charge of 294 DKK. At the time of introduction the expected penetration rate of 5% seems to have been overly optimistic. Tele Danmark seem to have had problems establishing the specified capacity.

In early 2000 Tele Danmark announced that it would offer a service that only uses the cable network, building out the network with a return path. The capacity will be 512 KB. It is expected that the first customers will be connected in spring 2000 (starting in Ålborg and Århus). The network will be expanded in accordance with demand.

FDA
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.

9.4 Digital TV

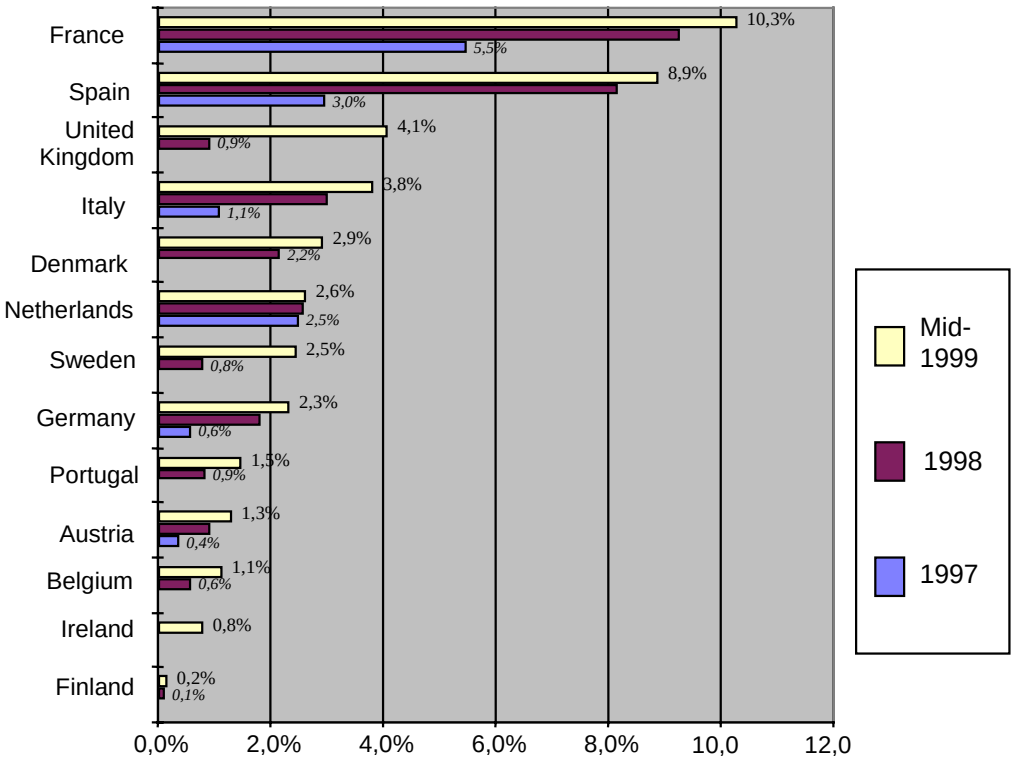
As Digital TV opens for transmission of data services in addition to the traditional audio and video services, it is one the new high capacity access routes, and because of its coverage and ease of use, a potentially promising one. The new data services can be related to the TV programs or they can be non-TV-related services. The program related data (PRD) services consist, e.g., 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, whereas a decision on this is still pending in Denmark, but likely to be taken soon.

Figure 9.1 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 9.1



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 best positioned to integrate the return path inside the network and to optimize the networks to keep the capacity per user on a reasonable level.

The emerging interactive services are adapted to the environment in which the services are offered. I-TV services – especially on the terrestrial and satellite platforms – will have other characteristics than services on, e.g., a local area network with a symmetric 10 Mbit/s capacity. The challenge is to develop services that utilize the characteristics of the distributive broadcasting networks, i.e., not to transfer the concepts developed for high capacity and symmetrical networks. Examples of interactive services offered on the broadcasting networks without using a return path at all are:

- Transmission of data in a repetitive form. For example, the *Financial Times* can be broadcast in intervals to set-top-boxes. Attached to the data, the selection icon can be downloaded to the boxes and the user can choose to access the data by clicking on the icon. This is an example on an interactive service without return path. This example is identical to tele-text in the analog world.
- Transmission of film or other entertainment program in regular intervals on different channels. This service is known as Near Video On Demand and offers the user a possibility for 'pseudo interactivity'.
- Transmission of, e.g., a Java applet to the boxes that communicates with the user. A simple example is to send an applet that based on some input parameters tell people their optimal weight. The applet can communicate with the user, ask lots of questions, gather the necessary data from the user and calculate the optimum weight without any need for return channel.
- Another example will be to download computer games to the boxes and give the users the feeling of using interactive services.

Even when the return path is available the interactive services must be implemented with the limited upstream capacity in mind (and limited down stream capacity per user) and the one-to-many characteristic of the broadcasting network.

9.5 Fibre to the Home

It has been estimated that 23 million miles of fiber-optic cable had been laid by the end of 1998, and there will be a 500-fold increase by 2002. 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 bandwith 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 bandwith 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) recently 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 bandwith and infinitessimal marginal cost.

The largest fibre to the home development is in Bermuda. There have been some developments in Singapore and Hong Kong. Service is provided in some neighbourhoods in Stockholm, Toronto, Ottawa, Palo Alto and a few other cities, as well as for campus networks in some universities, including at Twente, NL. Stockholm based Bredbandsbolaget is believed to be the leading fibre company in Europe in a very small market with few active players.

9.6 Fixed Wireless Access

Fixed Wireless Access (FWA) is attracting increasing interest as an efficient way to stimulate competition in the local loop by creating an alternative infrastructure. FWA is considered a cost-effective technology for new market entrants without a local (copper) network. The FWA operator is independent of the incumbent's network and its service roll-out schedule.

The US had an early start by granting licenses in 1998 and US companies are active on this area over most of Europe. So far licenses for FWA has been awarded in a so-called beauty contest process in Finland, Germany, Norway, Portugal and Spain, whereas Switzerland has used auctions and UK plans to do so. In Denmark a beauty contest process has been started and eight licenses are foreseen to be granted. Table 9.6 summarizes the rollout of FWA in Europe.

Table 9.6 shows that Denmark, along with most of the countries being compared in this report is moving more deliberately than Finland, Ireland and Germany, the countries that licensed FWA first.

Virtually all fixed wireless operators concentrate first on the traditional telephone services, although with plans to offer higher speed services later. So far, fixed wireless in developed countries has proven to be a service filling a market niche rather than providing comprehensive competition for local telephone services. It is too early to tell how far it might grow as a competitor for basic telephony and higher speed services.

Table 9.6 – Fixed Wireless Access Roll-out Across Europe

Country Awarded licences	Total number	Licences Granted	Allocation Method	Bandwidth
FINLAND	57 metropolitan licences	Spring 1999		3.5 GHz, 10,5 GHz, 26 GHz, 38 GHz
GERMANY	622 local licences	August 1999	Beauty contest	3,5 GHz, 26 GHz
IRELAND	4 national licences	September 1999	Beauty contest	26 GHz
LUXEMBOURG		January 1999	Auction	3.5 GHz, 26 GHz
PORTUGAL	11 regional licences	Granted	Beauty contest	3.5 GHz, 26 GHz, 28 GHz
SPAIN	3 national, 3 regional licences	March 2000	Beauty contest	3.5 GHz, 26 GHz
Licences in progress / forthcoming				
AUSTRIA	7 regional licences	Due late 2000	Auction	26 GHz
BELGIUM	Undetermined	No	Undetermined	26 GHz, 40 GHz
DENMARK	8 national licences	Due December 2000	Beauty contest	3.5 GHz, 26 GHz
FRANCE	2 national, 44 regional licences	Due July 2000	Beauty contest	3.5 GHz, 26 GHz
GREECE	Undetermined	In progress	Undetermined	Undetermined
ITALY	Undetermined	No	Undetermined	26 GHz
NETHERLANDS	5 national licences	Due Summer 2000	Auction 26 GHz	2.6 GHz, 3.5 GHz
NORWAY	6 national licences	Granted March 2000	Beauty contest	26 GHz, 38 GHz, 40 GHz
SWEDEN	Undetermined	In progress	Undetermined	Undetermined
SWITZERLAND	3 national licences, 45 regional licences	March 2000	Auction	3.5 GHz, 26 GHz
UK	3/4, including at least one national licence	Due Summer 2000	Auction	28 GHz

Source: Telecom Markets/IDATE

9.7 Advanced 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 has started a process for licensing additional 2G networks (GSM900/DCS 1800) by January 2001. The role of 2G mobile is expected to be enhanced by the introduction of new technologies 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 has started,but is waiting for terminals. The rollout of GPRS is generally expected 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. Table 9.7 summarizes the 3G rollout schedule for most European countries.

Table 9.7 – Europe's 3G Mobile: The Current Situation

	Number of Licences	Allocation Mode	Expected Allocation Date
AUSTRIA	4 – 6	Auction	3Q00
BELGIUM	4	Beauty contest	12/2000
DENMARK	4	Beauty contest	09/2000
FINLAND	4	Beauty contest	allocated
FRANCE	4	Beauty contest	1Q01
GERMANY	4 – 6	Auction	07/2000
GREECE	3	Undecided	undecided
IRELAND	3	Beauty contest	undecided
ITALY	5	Beauty contest	08/2000
LUXEMBOURG	4	Beauty contest	early 2001
NORWAY	4	Beauty contest	3Q00
NETHERLANDS	5	Auction	07/2000
PORTUGAL	4	Beauty contest	1Q01
SPAIN	4	Beauty contest	allocated 03/2000
SWEDEN	4	Beauty contest	11/2000
UK	5	Auction	allocated 04/2000

Source: IDATE, 2000

All the compared countries examined in this report have, or will be issuing four to six 3G licenses in 2000 or 2001. As 3G networks will allow the served market to extend beyond national borders more than previous mobile systems, the Finland, Spain and UK licensees may realize some competitive advantage from early licensing. However, given the enormous amounts bid for the UK license, competitors licensed in beauty contests may have a significant cost advantage over those licensed through auctions.

The UK 3G auction has stimulated considerable interest among politicians and finance ministers in "beauty contest" countries, including Denmark, about the possibility of using auctions for 3G licensing. Mixed models, along the lines of the French plan, may involve high fee payments for the beauty contest winners, thus bringing the two systems closer together in terms of payments to national governments for 3G licenses.

9.8 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. In Denmark, one of the new competitive operators, Tele2, formerly provided voice service access by satellite, but has now stopped the service.

Digital TV, discussed in section 9.4 above, 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 specialized portion of the market.

10. INFORMATION INFRASTRUCTURE ASSESSMENT

Comparative assessments of progress in information infrastructure development are much more difficult than for telecom reform because of the absence 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 Internet growth and e-commerce preparation, 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 this year, 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. Recent government policy changes relating to digital signatures and related issues should be a stimulus to e-commerce growth in many countries.

The coming explosion in transatlantic bandwidth capacity within the next few years 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 are well positioned to take advantage of this opportunity. With respect to national network investment, Denmark moved from being a relatively low investment country to the highest in Europe on a per capita basis in 1998, driven primarily by the deployment of new mobile networks.

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 the Nordic, and other, 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 still have to be made operational. 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 to drive the competitive process forward for quite a few years yet.

11. 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 steps taken 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 telecom reform process. The available information documents that Denmark is a leader in telecom reform, but like all countries, has specific areas of comparative strengths and limitations. Denmark has been a leader in opening its markets and minimising barriers to entry, e.g., licensing, interconnection, and more recently local loop unbundling. Competition has progressed most rapidly in mobile and international services. National and local services remain overwhelmingly dominated by the incumbent, but the limited penetration of the local service market by new competitors (6%) still ranks Denmark high by international comparison, where all countries have had difficulty introducing competition.

Nevertheless, Denmark, like all other countries, still has a way to go before its markets are effectively competitive. For this reason, continued priority attention to interconnection and access prices and conditions will be necessary. Although Denmark's interconnection prices are at, or better than the EU best practice standard, they are only about average for the leading countries with which it compares itself. Moreover the trend of interconnection prices is down in almost every country, especially in those countries where cost-based pricing has been implemented. This would justify moving ahead on the establishment of cost-based interconnection prices as rapidly as possible. A more proactive approach by the regulator may be necessary to reduce, if not completely overcome, existing limitations on market participation.

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 in 2001. 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.

The data on e-commerce readiness indicates that Denmark, along with its Nordic neighbours, is leading, and is likely to continue to lead European development, especially when measured in terms of per person participation. As with the development of the basic telecom services, the revenue per person is markedly higher in the Nordic countries. When considered in light of their generally lower prices, this portends a more rapid integration of telecom-based services into the economic and social lives of the people in the Nordic countries. For the development of future Internet services, national policy and regulation must be aware of this characteristic which could provide an accelerator to growth.

An issue not covered in this report because of the lack of European data, but which is becoming increasingly important for policymakers and regulators, is the tendency for Internet development to widen, rather than narrow, economic divisions in society between the "haves and have nots", the rich and poor, the educated and the less educated, the connected and

the disconnected – what the Danes refer to as “A” and “B” classes of citizenship. This has been documented in the US by a series of reports by the NTIA on the “digital divide”, and has attracted the concern of the FCC Chairman on how regulation might help to overcome it. It applies to communities, income groups, cultural and racial groups, and individuals.

At least in its early stages of development, the market benefits those who are best positioned to take advantage of the Internet opportunities. It is still an open question as to how universal and ubiquitous the market driven high speed Internet will become, and what policymakers and regulators can or should do to accelerate competitive forces and supplement them where necessary. Many local communities in several countries are investing in rollouts of higher capacity networks because they have concluded market development is likely to be too slow and/or incomplete. The Swedish government has committed to establishing a national broadband network linking communities.

A universal service policy with respect to the rollout of higher speed Internet access must pay particular attention to the speed and priorities of development. For some communities, delayed development may mean no development, and no community. This issue will be a challenge of increasing importance for policymakers and regulators over the next several years.