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Working Party on Communication Infrastructures and Services Policy

DEVELOPMENTS IN CABLE BROADBAND NETWORKS

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FOREWORD

The Working Party on Communication Infrastructures and Services Policy (CISP) discussed this report at its meeting in December 2009. CISP agreed to forward the document for declassification by the Committee for Information, Computer and Communications Policy (ICCP). The ICCP Committee agreed to make the report public in March 2010.

The report was prepared by Mr. Hyun-Cheol CHUNG of the OECD's Directorate for Science, Technology and Industry. It is published under the responsibility of the Secretary-General of the OECD.

MAIN FINDINGS

The position of cable operators within the pay TV market has changed drastically in recent years. Although video service remains core to the cable industry's business model, cable TV's market share has been dropping significantly with intense competition from direct broadcast satellite services (DBS), Internet protocol Television (IPTV) services, digital terrestrial television services (DTT) and finally from over-the-top (OTT) service providers that supply video over an existing data connection from a third party. Cable still has a strong market position for video, particularly because of its existing relationships with content providers but the market is likely to become more competitive as other substitutable offers become available over a range of media.

A focus on growth has led to a wave of industry consolidation, leaving only one or two major cable operators in most small to medium markets. In Europe, the wave of consolidation is already under way with a single cable operator serving at least 40% of the cable market in every Western European country. The market share is highest in France, Ireland, Spain, Sweden and the United Kingdom where a single cable operator controls more than 70% of each market.

The threat to cable from non-traditional video sources has pushed cable operators to upgrade their networks to support higher bandwidth data services and new video content and applications and the transformation has been rapid. Over the past ten years, cable companies in the OECD have transformed themselves from providers of analogue video services to providers of an array of advanced digital communications services. Most major cable operators have upgraded their networks to support bandwidth-intensive services such as high-definition television and faster broadband Internet access. Much of the growth in cable broadband markets is being driven by growing consumer demand for enhanced video services, competitive pricing strategies and higher data speeds.

In order to achieve bandwidth maximisation and expansion, cable operators, are now considering several options such as recovering bandwidth from switching to digital transmissions, offering switched digital video, upgrading to DOCSIS 3.0 and extending fibre infrastructure ever-closer to end-users. To compete with the incumbent telecommunication firms, cable operators have continued to grow and approach the scale of their telecommunication competitors.

Although all-fibre or all-IP network architecture may be a longer-term reality for cable operators, the cable industry is moving toward greater use of fibre in its last-mile infrastructure. Fibre is required deeper into the network to support new high-speed services and high-definition television programming. The deeper fibre is pushed into the network the smaller the area served by a given amount of bandwidth – leaving more bandwidth potential for each household. Often the idea of extending fibre deeper into the network is referred to as a "fibre deep" strategy.

One of the key areas where cable operators have looked for revenue growth has been voice services. Voice remains the core of many fixed-line operators' revenue streams but competitively priced VoIP services from cable operators are helping cable operators entice customers to drop their fixed PSTN lines and instead take an entire bundle from a cable operator.

Video-on-demand services have also become an important revenue generator for cable companies. Most cable operators in the OECD countries have started supplementing their linear programming packages with VoD libraries in addition to offering basic and premium pay TV channels.

Both cable and telecommunication companies are pursuing multiple-play offers to reduce churn and boost average revenues per user. Customers can also benefit from these offers because they provide the

convenience of a single bill and are often sold at a discount when compared with the price of buying all the services separately. The percentage of subscribers taking triple-play packages is growing and represents a large segment of the subscriber market.

The triple-play packages which are commonly marketed by cable operators include fixed-voice services but the shift away from fixed-line telephony to mobile has led to some cable operators now including mobile voice services within their packages. So far, the majority of these partnerships have had limited success, as new entrants usually struggle to establish a foothold against traditional mobile operators in saturated markets.

While cable companies do provide important infrastructure-based competition there is still asymmetric treatment of different delivery platforms such as DSL and cable in several OECD markets. Today's converging environment means that cable, DSL and FTTH providers have the potential to deliver similar, closely substitutable services to consumers. Yet, in many countries there are differences in the obligations imposed on different platforms which call into question the extent to which technology neutral policies are always followed. In some cases it may be necessary to consider how cable networks could be opened for competition if necessary. Some countries already require or are considering mandating open access to cable networks (*e.g*. Canada, the Netherlands and Denmark).

INTRODUCTION

This paper examines current trends and various bandwidth management strategies for cable operators and also provides information on cable network developments in OECD countries. From the combination of changes in technology and business choices the paper will identify potential challenges and implications of the changing market structure.

In many countries, cable television operators have been the leading suppliers of video services and have enjoyed solid revenue streams from pay-TV subscriptions. In today's marketplace, however, a growing range of alternative platforms exist for the delivery of video services. These include satellite, upgraded telecommunications networks (*e.g.* DSL and fibre-to-the-home, linear and non-linear delivery of video over the Internet and video services over broadband wireless networks). Content providers are also exploring new business models that make direct relationships with consumers instead of relying on broadcasters. Cable operators are responding to these developments by upgrading their networks and expanding into new markets such as voice telephony.

Broadly speaking the entire communications landscape has begun to shift as voice, video and data converge via Internet protocol (IP). Most large telecommunications carriers, cable operators and in some countries wireless operators have launched triple or in some cases, quadruple-play services and this trend is expected to continue.

These services require new bandwidth and this is leading operators to upgrade their networks. As demand for bandwidth increases, operators must decide which technologies and tools to use in order to optimise the existing network bandwidth available on their networks.

In order to achieve bandwidth maximisation and expansion, cable operators are now considering several options such as recovering bandwidth from switching to digital transmissions, offering switched digital video, upgrading to DOCSIS 3.0 and extending fibre infrastructure ever-closer to end-users. To compete with the incumbent telecommunication firms, cable operators have continued to grow and approach the scale of their telecommunication competitors.

This focus on growth has led to a wave of industry consolidation, leaving only one or two major cable operators in most small to medium markets. In Europe, the wave of consolidation is already under way with a single cable operator serving at least 40% of the cable market in every Western European country. The market share is highest in France, Ireland, Spain, Sweden and the United Kingdom, where a single cable operator controls more than 70% of each market.

Multiple-play business models have become the core offers of most operators in the OECD. Both cable and telecommunication companies are pursuing multiple-play offers to increase revenues. The primary goals of offering a multiple-play bundle are both to reduce churn and to win loyalty from existing customers, resulting in the increase in average revenue per user (ARPU). As a result, triple-play penetration continues to grow significantly across the OECD and the majority of large operators are continuing to increase subscribership. Some cable operators have also been entering the mobile market to

take advantage of growth in mobile services, and thus putting themselves in a position to offer quadruple-play services.

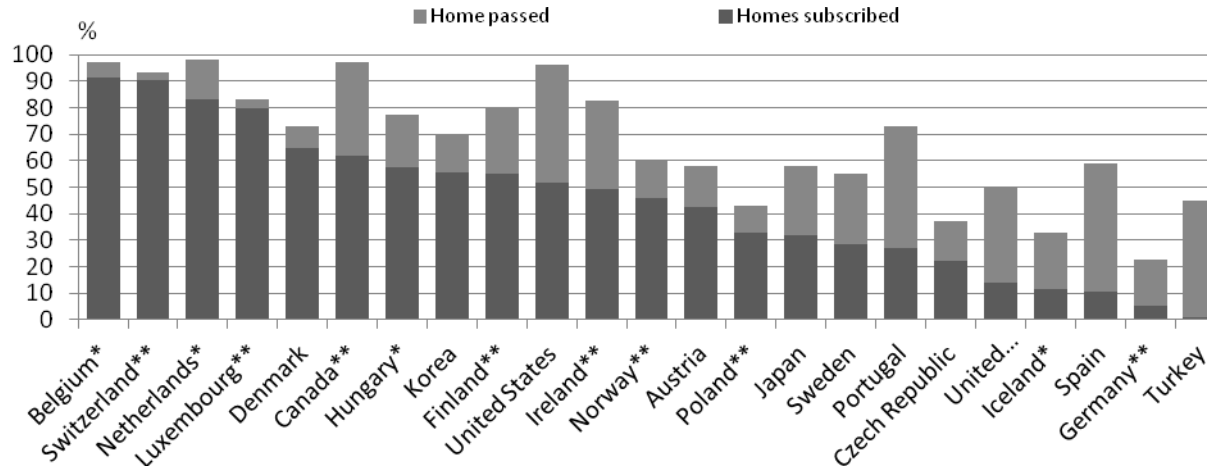
THE CHANGING CABLE LANDSCAPE

State of national cable markets

Cable penetration varies significantly across the OECD. In 2007, a number of countries had very high percentages of television viewers who could have access to television signals via cable. These include Belgium (97.4%), Canada (97.2%), the Netherlands (98%), Switzerland (93%), and the United States (96%). Other countries such as Greece, Iceland and Italy had no significant coverage (see Figure 1).

Four countries (the Netherlands, Belgium, Switzerland and Luxembourg) have been able to achieve a 90% take up rate or better for their cable TV services. At the same time, some other operators have had a more difficult time attracting customers. There are seven countries where less than half of homes passed subscribe to cable: Portugal, Czech Republic, the United Kingdom, Iceland, Spain, Germany and Turkey.

Figure 1. Cable TV: Percentage of homes passed and subscribed, 2007



Note: (*) data for 2006 for 'homes subscribed' and 'homes passed'; (**) data for 2006 for 'homes passed

Cable broadband

The number of broadband subscribers in the OECD reached 267 million in December 2008. Cable networks have the second most-extensive broadband subscriptions, representing 29% of the total broadband connections, while DSL remains the largest platform (60%) and fibre-to-the-home (FTTH) accounts for 10%. Between 2004 and 2008 the percentage of cable connections in total broadband subscribers slightly decreased from 33% in 2004 to 29% in 2008, as shown in Figure 2.

Figure 2. OECD Broadband subscription by technology

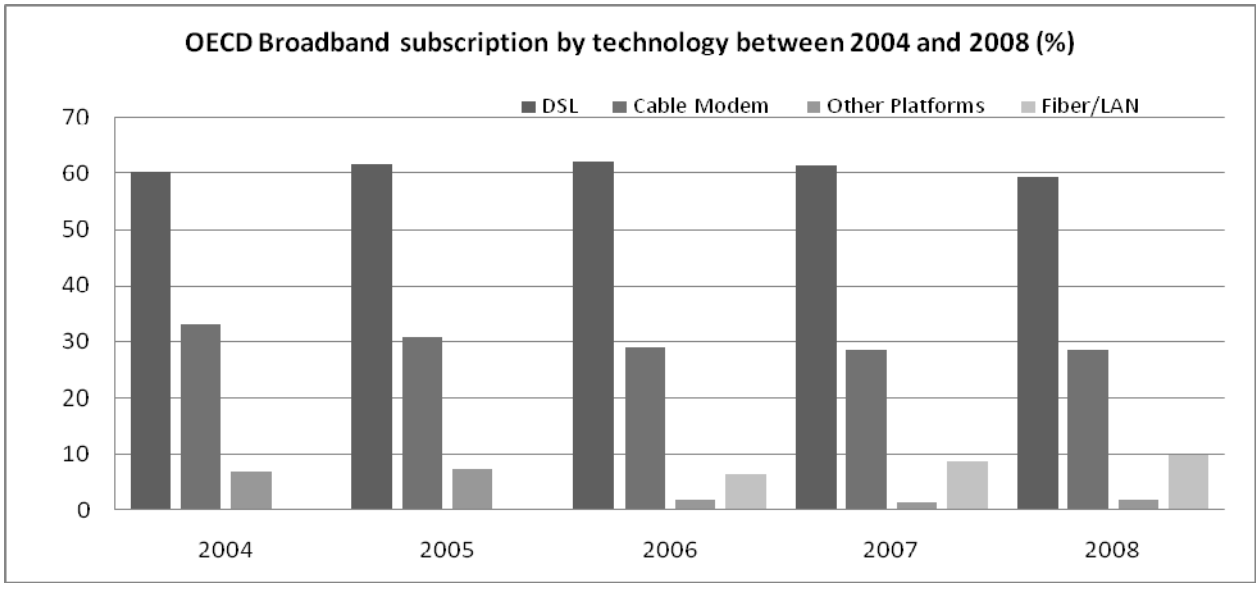


Figure 3 provides a breakdown of broadband subscriptions by technology in December 2008. The share of cable connections in total broadband is shown in Figure 4. Cable broadband coverage is extensive in countries such as Canada, the United States, the Netherlands, Belgium and Korea, but non-existent in others such as Greece, Iceland and Italy. Canada and the United States lead the OECD in cable broadband penetration and other countries have made impressive gains upgrading networks and offering cable broadband services to the majority of homes previously without cable television. The strongest per-capita subscriber growth in cable broadband between 2007 and 2008 was in Luxembourg, Turkey, Germany, Norway, and Hungary. Each country showed strong growth in cable connections among the total broadband connections, with more than a 10% gain in cable connections over the previous year. On the other hand, some countries such as the Slovak Republic, Austria and Denmark saw a decrease in the portion of the total broadband connections due to the relative growth of FTTH (Slovak Republic) and DSL (Austria and Denmark).

Figure 3. Broadband subscribers per 100 inhabitants, December 2008

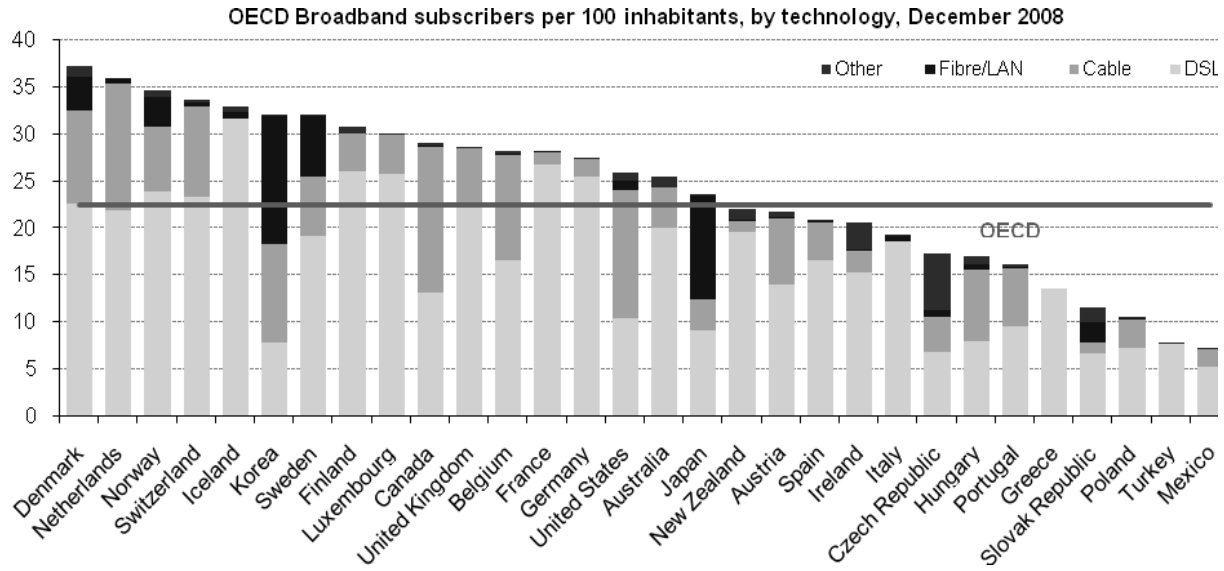


Figure 4. Percentage of cable connections in total broadband, YE 2008

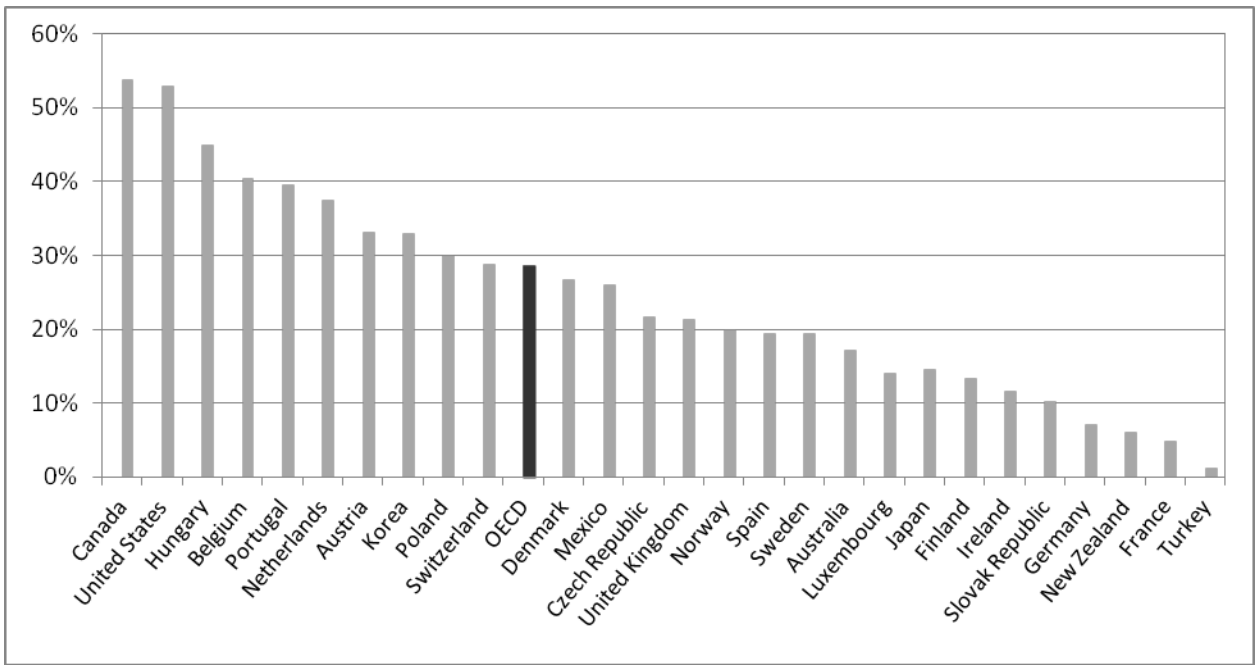


Table 1 provides data on large cable operators across the OECD, including the number of households passed, and the number of subscribers on those networks. Comcast and Time Warner Cable have the largest number of homes passed as well as the largest number of broadband subscribers. A brief summary of national cable markets is presented directly after the table.

Table 1. Selected cable networks in the OECD, 2008

Country	Company	Households passed by cable networks	Cable television subscribers	Cable modem subscribers	Cable telephony subscribers	Cable television subscribers as proportion of households passed (%)	Cable modem subscribers as proportion of households passed (%)**	Cable telephony subscribers as proportion of households passed (%)**
Canada	Shaw	3,540,346	2,248,120	1,565,962	611,931	63.5	44.2	17.3
Canada	Rogers	3,547,000	2,320,000	1,582,000	840,000	65.4	44.6	23.7
Austria	UPC	1,146,500	555,000	433,900	242,100	48.4	37.8	21.1
Ireland	UPC	877,000	537,300	101,900	27,800	61.3	19.9	6.9
Belgium	Telenet	2,768,800	2,402,500	985,300	628,700	86.8	35.6	22.7
Hungary	UPC	1,199,800	856,300	321,500	225,900	71.4	26.8	19.3
Japan	J:COM	12,241,500	2,557,000	1,486,800	1,569,800	20.9	12.1	12.8
Netherlands	UPC	2,740,000	2,044,400	682,500	572,400	74.6	24.9	20.9
Netherlands	Ziggo	4,038,000	3,255,000	1,375,000	809,000	80.6	34.1	20.0
Switzerland	Cablecom	1,867,300	1,556,100	485,500	309,300	83.3	26.0	16.6
Poland	UPC	1,996,700	1,020,500	388,000	147,300	51.1	19.4	7.4
United Kingdom	Virgin Media	12,600,000	3,621,000	3,682,800	4,099,200	28.7	29.2	32.5
Spain	ONO	6,963,000	1,853,000	1,283,000	1,638,000	26.6	18.4	23.5
United States	Time Warner Cable	26,766,000	21,696,000	8,444,000	3,747,000	81.1	31.5	14.0
United States	Comcast	50,600,000	24,200,000	14,900,000	6,500,000	47.8	29.7	13.7
United States	Charter*	11,847,600	8,140,000	2,682,500	959,300	68.7	24.3	10.6
United States	Mediacom	2,854,000	1,961,000	737,000	248,000	68.7	25.8	9.5
United States	Cablevision	4,732,000	3,108,294	2,455,908	1,878,604	65.7	51.9	39.7
Portugal	ZON	2,844,000	1,613,500	479,000	327,100	56.7	16.8	11.5
Germany	Kabel Deutschland	15,293,100	9,013,300	707,500	710,300	58.9	5.9	5.9
Mexico	Megacable	4,152,692	1,482,761	427,190	276,546	35.7	11.7	7.6
France	Numericable	9,400,000	3,500,000	900,000	700,000	37.2	10.3	8.0
Czech Republic	UPC	1,303,200	680,900	312,200	126,800	52.2	26.2	10.7
Slovak Republic	UPC	485,100	291,700	53,100	19,600	60.1	14.7	5.4
Korea	Tbroad	5,116,424	3,457,898	894,312	138,373	67.6	17.5	2.7

Note: (*) data for 2007; (**) for cable modem and telephone services, “households passed” means “two-way homes passed”

Source: Operators.

United States

About 96% of homes in the United States are passed by cable networks and about 95% of homes passed can subscribe to broadband over these networks. This makes the United States the largest cable broadband market in the OECD. At the end of 2008, US cable operators had an estimated 39.8 million residential subscribers (56%) while telecommunications providers counted 29.7 million subscribers (42%).[1] The largest operators in the market are Comcast and Time Warner Cable, which together account for over half of all cable subscriptions. The top six cable operators (Comcast, Time Warner Cable, Cox, Charter, Cablevision, and BrightHouse) accounted for 48% of the total broadband market share in 2008.[2]

Canada

The Canadian broadband market is largely characterised by regionalised competition between the former monopoly telecommunication company and the local cable operator, split about equally between cable modem and DSL subscribers. Cable broadband subscribers have had the overall majority over DSL, but telecommunication operators such as Bell Canada and SaskTel have invested upgraded services that allow them to offer the same services as their cable counterparts. In 2008, around 96% of Canadian households were passed by cable networks and 90% of passed homes could receive cable broadband. The three largest cable operators (Rogers, Shaw Communications and Videotron) hold around 85% of the market between them. Cable-driven broadband competition has made cable operators better positioned in the residential market. As a result, cable operators are typically able to offer more interactive television services such as VoD and higher bandwidth Internet access services. Rogers has upgraded more than 86% of its network and 99% of its network in Ontario to higher bandwidth (860 MHz). Shaw is the largest operator in Western Canada and upgraded parts of its network to DOCSIS 3.0 in early 2009, resulting in the fastest downstream speeds available in Canada at 100 Mbit/s. [3]

United Kingdom

The United Kingdom's cable industry was established to provide infrastructure competition to the fixed-line incumbent BT. In 2007, around 50% of the United Kingdom's households were passed by cable networks with almost all of these being able to receive cable broadband. Cable TV penetration is relatively low (16%) due to extensive terrestrial and satellite broadcast offerings. Virgin Media has around 21% of the residential retail broadband market compared to the incumbent BT which has around 26%.

Netherlands

In the Netherlands, cable companies have broadband connections to nearly one third of Dutch households. The merger of the three largest operators in 2007 leaves the Dutch cable landscape dominated by two main operators: Ziggo accounts for around 65% of the cable broadband market share and UPC Netherlands has about 30%.

Spain

Spanish cable broadband accounts for under a third of total broadband connections and nearly 60% of Spanish homes are passed by cable networks. The recent consolidation has meant that ONO is now the dominant cable operator. ONO recently launched a converged fixed-mobile service and also upgraded its network to DOCSIS 3.0 in response to Telefonica's fibre and VDSL deployments.

Belgium

One of the major developments in the Belgian cable sector was the acquisition of UPC Belgium in 2006 and the acquisition of the digital services and network elements of Interkabel in 2008 by Telenet,

leaving Telenet as the major competitor to the incumbent fixed-line operator Belgacom in the North. From 2006 Tecteo and Brutélé work together to offer services under the same "Voo" brand in the South. Over 95% of Belgian homes are passed by cable networks and cable broadband represented over a third of all broadband connections in Belgium at the end of 2007.

Portugal

Cable broadband connections account for around 40% of total broadband in Portugal. Zon Multimedia is the largest cable operator, which was spun off from incumbent Portugal Telecom,with a 65.6% market share followed by Cabovisao (22.7%) in 2008. Zon has been investing heavily in both fibre and mobile, currently launching the fastest cable broadband services available in the OECD and mobile packages as well.

Switzerland

Switzerland, like the Netherlands and Belgium, has over 90% of households passed by cable television networks. In 2007, Cable broadband connections accounted for just over one third of total broadband subscriptions. The cable broadband landscape in Switzerland is characterised by a number of small regional operators and one dominant national operator, Cablecom. Cablecom was one of the first operators to launch VoIP services in 2003 and offers higher bandwidth (100 Mbit/s) than its competitor on the fixed network, Swisscom.

Hungary

Cable broadband connections in Hungary account for around 45% of total broadband connections. Around 77% of Hungarian households are passed by cable networks. UPC Hungary is the largest cable operator with a 34% market share for broadband. UPC offers a fast downstream speed of up to 120 Mbit/s. Its cable networks are 97% upgraded to two-way capability and 71% of homes passed are served by a network with a bandwidth of at least 750 MHz.

Japan

Japan had roughly 58% of homes passed by cable networks in 2007. Cable broadband market share remains at 13.6% of Japan's total 28.3 million subscribers. J:COM is the leading cable operator in Japan and has been particularly aggressive in developing its digital television offers: it offered 21 HD channels in 2008 and added 9 HD channels[4] as of September 2009. In terms of broadband speeds, J:COM is one of the world leaders, offering 160 Mbit/s in limited areas and 42 Mbit/s or 12 Mbit/s elsewhere, depending on the location.[5]

Korea

Cable broadband connections account for around 33% of total broadband connections in Korea. While cable retains a strong foothold in the broadband market, most operators continue to use cable broadband as just one of the technologies deployed by operators. For example, SK Broadband has a total of 3.74 million subscribers, but only 1.63 million (about 43%) of these are connected via cable broadband lines, while around 1.9 million subscribers (50%) are connected by fibre (Apartment LAN and FTTH), and 0.21 million using DSL (5.7%) as of June 2009.

Germany

While Germany remains the largest cable market in Europe, the penetration of cable television is much lower than in most other European countries. Around 53% of German households are passed by

cable television networks. Cable broadband connections accounted for 7.1 % of total broadband connections in 2008. The German cable market has a unique feature – a separation of licensing and ownership between the cable backbone network and the lines connection individual subscribers.[6] The historic business model of most operators was to act as signal distributors rather than having direct relationships with customers. Some have claimed that this has hampered the development of the cable broadband market.[7] Kabel Deutschland (KDG) is the largest cable operator, owning six of the former nine Deutsch Telekom cable systems and serving about 10.4 million customers.

Austria

Around 58% of Austrian households are passed by cable networks. UPC Austria is the largest cable operator, followed by Liwest and Salzburg Cable. Beside these three operators, there are over 230 cable networks that operate in geographic areas exclusively. Austrian cable broadband accounts for 35% of total broadband connections and cable operators have acted as first movers offering bandwidth of up to 100 Mbit/s by utilising EuroDOCSIS 3.0.

Increased video competition

In most OECD countries, the position of cable operators within the pay TV market has changed drastically in recent years. Although video service remains core to the cable industry's business model, cable TV's market share has been dropping significantly with intense competition from direct broadcast satellite services (DBS), Internet protocol Television (IPTV) services, digital terrestrial television services (DTT) and finally from over-the-top (OTT) service providers that supply video over an existing data connection from a third party. Cable still has a strong market position for video, particularly because of its existing relationships with content providers, but the market is likely to become more competitive as other substitutable offers become available over a range of media. Over-the-top video substitution is expected to continue growing as more content owners decide to sell directly to the public.

Digital Terrestrial Television (DTT)

Digital Terrestrial Television (DTT) represents the upgrade path for traditional analogue television. The upgrade to terrestrial broadcasting in digital format has helped terrestrial broadcasters match the picture quality of video available on digital cable networks. As a result, DTT services are increasingly a less-expensive option for high quality video in areas where the distribution networks have been upgraded. In some areas the growth in DTT has been particularly high.

In the United Kingdom, Ofcom data shows that most recent growth in the number of multi-channel households has come from free digital terrestrial television. The UK's digital terrestrial television service, called "Freeview" has grown from 1.2 million households receiving it as their main household service at the end of 2002 to almost 10 million at the end of 2007.[8] In France, free DTT also has grown steadily, reaching 22% of the population in 2007 compared with 10% in 2006.

Growth in Europe for DTT has been particularly strong. In 2007, there were several countries which had achieved adoption rates of 20% or more: Italy (24%), France (29.8%), the United Kingdom (36.6%) and Spain (54%).[9]

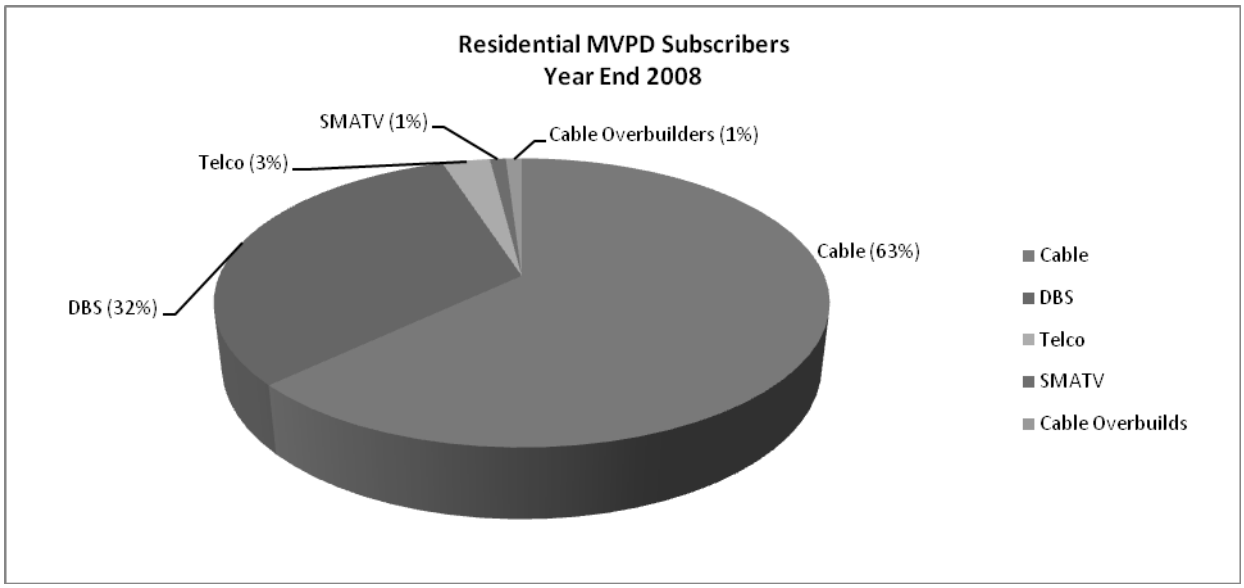
Combination receivers which support DTT over-the-air transmissions and IPTV content delivered over a data network are now available in some markets. Some argue that telecommunications operators which offer these dual receivers can largely replicate basic cable offerings in markets.[10]

There are some areas where DTT services are limited compared to cable. For example, DTT does not support newer video-on-demand services which are increasingly available on other platforms.

Satellite

Data from the NCTA (National Cable and Telecommunications Association), the cable industry body in the United States, shows that cable's share of the multi-channel video market has dropped to 63.5% in 2008 from 68.2% in 2006, while the market share of satellite-based operators grew from 29.2% in 2006 to 32% over the same period (see Figure 5).[11] Ofcom in the United Kingdom published a report on pay TV which provides strong evidence of satellite providers' dominance in the market. It shows that there has been continuing strong growth in the total number of subscribers to Sky, but not in the total number of cable customers. For example, in 1999 the numbers of pay TV subscribers on Sky and on cable were broadly similar, 3.5 million and 3.0 million respectively. By the second quarter of 2007, there were many more subscribers on Sky (8.1 million compared to 3.4 million on cable).[12]

Figure 5. Residential MVPD Subscribers, 2008



Note: MVPD stands for Multi-channel Video Programming Distributor

Source: NCTA

Internet Protocol Television (IPTV)

Traditional telecommunication providers have introduced a new wave of competition within the video market as they begin providing IPTV services. Facing declining revenues for fixed-telephony, incumbent and competitive operators across the OECD began entering the video programming distribution market with IPTV services. IPTV is usually offered by telecommunications operators as part of a triple-play strategy and video is either delivered in a linear (broadcast style) and/or as a non-linear service with VoD offerings in broadcast quality to a television.[13] Some DSL providers found it difficult to acquire content but most have been able to expand their offerings to the point they are commercially competitive with cable. Telecommunication operators also are using new services such as catch-up TV services and multi-television viewing to attract subscribers.

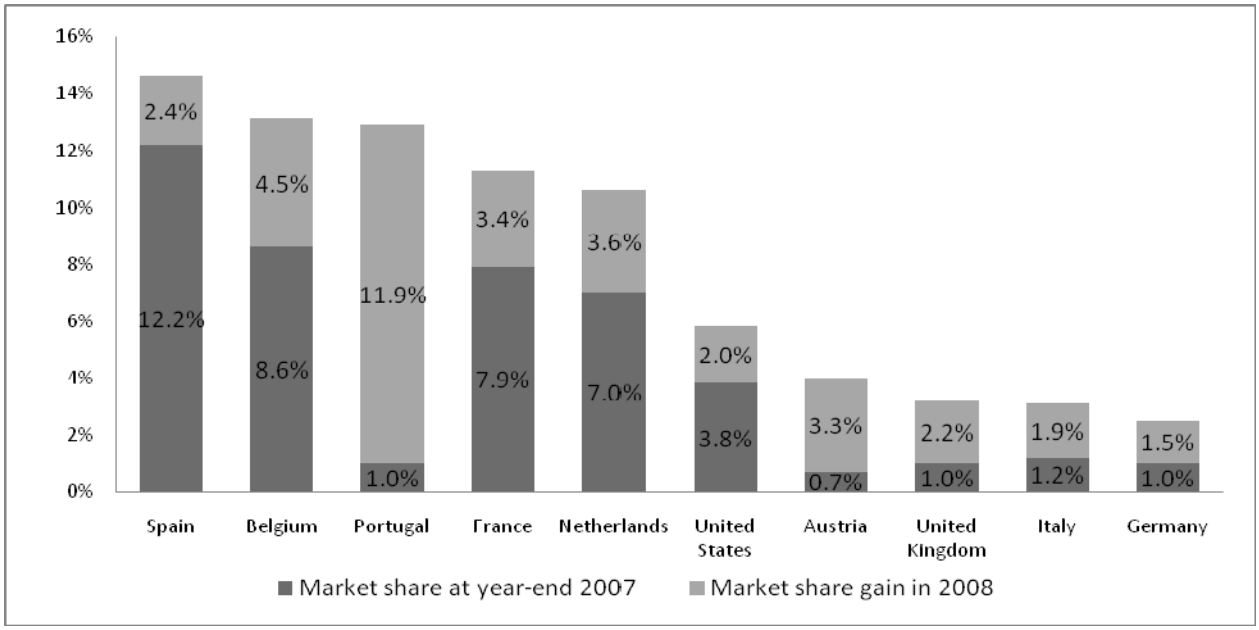
Telecommunication firms have been largely successful at entering video markets and slowing some of the losses from their fixed line businesses. For example, a market research suggests that four incumbent operators (Portugal Telecom, Telecom Austria, TeliaSonera and KPN) have been very aggressive with their IPTV services throughout 2007, which has led to a significant slowdown of line losses; slowing them by nearly 50% or more between 2007 and 2008.[14]

In the Unites States, Verizon had 1.9 million FiOS TV customers at year-end 2008, while AT&T had more than one million U-Verse lines in service, having added 264 000 homes in the last quarter of 2008.[15] France, which is among the leaders in the OECD providing IPTV service, had 7.3 million IPTV over DSL subscribers at the end of 2008, compared to latest figures for the United Kingdom and Germany of 554 000 and 973 000 subscribers respectively.[16]

Figure 6 shows that traditional telecommunication firms in countries such as Portugal, Belgium, France and the Netherlands are making considerable gains in their respective pay TV markets. The traditional telecommunication's market share gain of 12% in Portugal and roughly 4% in other countries shows the competitive threat for cable providers.

Furthermore, the moves of traditional telecommunication operators to acquire broadcast capability via satellite or digital television operators (*e.g.* France Telecom's acquisition of Canal Digital) helps position them more strongly within an already competitive pay TV market.[17]

Figure 6. Telecommunication operators market share growth for pay TV, 2007-2008



Source: Arthur D. Little, Exane BNP Paribas.

Over-the-top television (OTT)

In many ways satellite and IPTV adhere to familiar models of video distribution where an infrastructure provider aggregates content and distributes it to end users based on a subscription model. The transmission medium changes but the delivery model remains the same.

Internet television[18] and "over-the-top" (OTT) video services represent a new paradigm for television content delivery because the content is no longer tied to the infrastructure provider who carries it. Internet television and OTT are video services where subscribers access video content over the public Internet from various content providers and the video is delivered over existing Internet connections. The potential of such services is enormous because an Internet subscriber's video options are no longer tied to the choices of an aggregator. Over-the-top services include Internet video streaming, downloading and distribution of movies, television shows and other video programming.

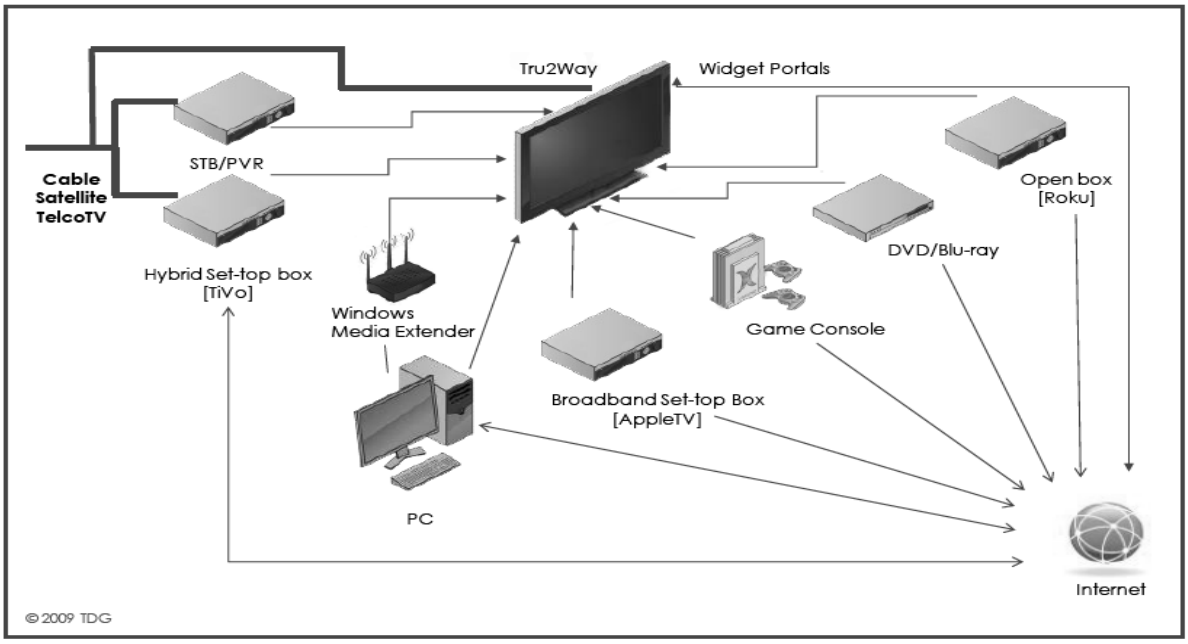
Anecdotal evidence suggests that these services are beginning to encroach on other forms of television viewing as the amount of publically available content grows and as residential broadband speeds increase to support ever-higher quality video.

Some market analyses point towards video being the fastest growing segment of all Internet traffic and the trend will be more likely to continue. A study from comScore illustrates that nearly 178 million Internet users in the United States watched 33.2 billion online videos in December 2009. Google sites attracted 135 million unique views during that month, followed by Yahoo! sites with 59.8 million views, Fox Interactive Media with 56.8 million views and CBS Interactive with 47.9 million views.[19] The percentage of online population who streamed video in 2008 is significant in countries such as the United States (80%), the United Kingdom (84%), France (79%), and Germany (77%).[20]

OTT services are still in their early stages but the popularity of YouTube for short video clips and Hulu for full episodes of popular television programming indicates that consumers are willing to consume video programming delivered over the Internet. The extent to which consumers are willing to substitute OTT services for subscriptions to traditional pay television services remains to be seen.

Netflix gives its subscribers access to thousands of movies and TV shows that were previously only available on DVD, allowing them to access content on computers as well as a number of devices connected to the TV. YouTube recently introduced its online rental services with five films, all from independent filmmakers. Other content providers such as NBC, Disney and Viacom make some of their television programmes available for streaming directly from their own websites. The programming is commonly offered over the Internet with a delay after the programming has been shown on the traditional television network. With the rapid uptake of online video and developments in web-enabled video platforms such as Roku box,[21] Internet-ready TVs and game consoles, some companies have begun looking beyond the PC and instead delivering online video directly to the television, bypassing cable operators. Figure 7 illustrates that the traditional pay TV set-top box is no longer the only way to deliver video content to the television. A growing number of content providers do not only provide existing cable television programmes online, but also deliver Internet exclusive content and bonus material directly to the television. In general, OTT video business models are based either on an advertising-supported service offering professionally produced content (*e.g.* Hulu), or on subscription-based services (*e.g.* Netflix). Obtaining distribution rights to programming remains one of the biggest challenges facing OTT video providers.

Figure 7. Multi-source and multi-path video



Source: TDG

OTT is still a nascent video market but it will likely be an increasingly important source of video content. Such new models of video distribution could eventually pose a challenge for traditional content distribution platforms as well as the ISPs which provide IPTV following traditional cable TV distribution models. There are a number of key avenues for future research which emerge from the growth of Internet television and OTT services.

1. What will be the impact on free-to-air television as advertising spending increasingly moves to the Internet and Internet-supplied video?

2. Will the importance and necessity of broadcast spectrum decrease as broadband connectivity expands and OTT video services become available?

3. What would be the benefits and drawbacks of public television shifting to an OTT model?

4. What quality of broadband service would be required to ensure sufficiently high-quality video delivery over the Internet?

5. Could existing regulations applied to traditional broadcasting and cable systems be relaxed if OTT service availability and take-up reach a certain threshold?

6. Are markets sufficiently competitive or are regulatory provisions in place to ensure that existing operators do not negatively shape competitive video traffic on their networks?

Shifting revenues amid a changing market structure

Video markets are indeed evolving as the previous section highlighted. Some of these changes can be captured by examining the breakdown of cable revenues to see the importance of different business segments. Table 2 shows how total cable revenue in the European Union rose to EUR 17.9 billion in 2007

from EUR 8 billion in 2000. However, the share of pay TV business in total revenues, which was regarded as the traditional core business of cable companies decreased from 76% of revenues in 2000 to 58 % in 2007. In contrast, the emerging component of Internet access grew from 3% of revenues in 2000 to 23% in 2007.

Table 2. Total cable revenues, 2000 and 2007

EUR billions

	2000	2007
Television	€6.14	€10.51
Telephone	€1.61	€3.18
Internet	€0.27	€4.20
Total	€8.02	€17.90

Source: Cable Europe.

The competition from new video providers can be illustrated by subscribership growth in the United States in 2009. For the pay TV market in the United States, DBS providers (DirecTV and Dish) acquired net subscribers of 250 000 and two major telecommunication operators (AT&T and Verizon) added net subscribers of 548 000 during the first half of 2009, while the top ten cable operators added only 25 000 net subscribers.

A breakdown of individual operator revenues over time helps highlight higher growth areas and the relative sizes of revenue sources. Table 3 provides the breakdown on cable revenues for several operators between 2007 and 2008. Internet and phone service revenues grew more quickly than video revenues for Comcast, Liberty Global and Rogers between 2007 and 2008.

Table 3. Cable revenues of selected operators

Millions of local currency, 2007-2008

		2007	2008	% change 2007 to 2008
Comcast	Video	USD 17,686	USD 18,849	6.6%
	High-speed Internet	USD 6,402	USD 7,225	12.9%
	Phone	USD1,766	USD 2,649	50%
Liberty Global[22]	Video	USD 4,332	USD 4,953	14.3%
	High-speed Internet	USD 2,067	USD 2,497	20.8%
	Phone	USD 1,166	USD 1,402	20.3%
Rogers	Video	CAD 1,540	CAD 1,669	8%
	High-speed Internet	CAD 608	CAD 695	14%
	Phone	CAD 455	CAD 514	13%

Source: Operator annual reports.

Market consolidation

Smaller cable companies have found it difficult to compete with larger telecommunication firms which often have a national footprint. This has led to a wave of industry consolidation in the cable industry which has left most markets with 1 or 2 large cable operators in small to medium-size markets.[23] Data from industry body Cable Europe illustrates that the wave of consolidation in the cable industry is already under way with a single cable operator serving at least 40% of the cable market in every Western European

country. The consolidation has been even more profound in France, Ireland, Spain, Sweden and the United Kingdom where a single cable operator controls more than 70% of each market.[24]

In just one year, the number of cable operators in Europe shrank 30% from 9 610 at the end of 2007 to 6 722 in 2008, mainly due to the market consolidation in countries such as Germany and Belgium. As a result, previously fragmented cable markets such as France (Numericable), Spain (ONO) and the United Kingdom (Virgin Media) are dominated by a single player. The previously fragmented Dutch market was transformed into two major cable operators (Ziggo and UPC Netherlands) through the gradual merger of Casema, Multikabel and @home. Recently Liberty Global, the parent company of UPC Broadband, has signed a share purchase agreement with Unity media, the second largest cable operator in Germany, to acquire 100% of the shares.[25] Examples of such consolidation across the OECD countries are presented in Table 4.

Table 4. Cable industry consolidation

2002-2008

Date	Country	Event	Notes
November, 2002	United States	AT&T Broadband acquired by Comcast	Comcast became the largest cable operator in the United States
March, 2003	Germany	Six regional cable networks acquired by investor group merged to form Kabel Deutschland	Kabel Deutschland became Germany's largest cable operator
July, 2004	France	UPC acquired Noos	UPC-Noos became the largest cable operator in France
March, 2005	France	NC Numericable acquired France Télécom Câble's activities following its acquisition by Cinven/Altice	Numericable became the second-largest cable operator in France
June, 2005	Germany	Ish acquired by Iesy	Iesy consolidated its position as a regional operator
September, 2005	Japan	J:Com acquired all the shares of Odakyu Cable Vision	J:Com consolidated its position as Japan's largest cable operator
November, 2005	Spain	Ono acquired Auna	Ono consolidated its position as the largest cable operator in Spain
November, 2005	Japan	J:Com acquired majority stake in Cable Television Vision	
December, 2005	Germany	Tele Columbus merged with Iesy to form Unity Media	Unity Media became one of the largest cable operators in Germany
December, 2005	Ireland	NTL Ireland sold to Chorus, which is part of UPC	Chorus NTL became one of the largest cable operator in Ireland
January, 2006	Japan	J:Com acquired majority stake in Rokko Cable Vision	
January, 2006	Korea	Hanaro Telecom acquired Thrunet	Hanaro Telecom became the largest cable operator in Korea
April, 2006	Belgium	Voo formed from merger of ALE-Télédis and Brutele	First steps towards creation of one major cable operator in Wallonia (French-speaking part of Belgium)
June, 2006	France	UPC-Noos acquired by Cinven/Altice	The combined entity, Numericable, became the only cable operator in France
July, 2006	United Kingdom	NTL merged with Telewest	NTL (now Virgin Media, following takeover of Virgin Mobile) now has over 90% of the UK cable market
July, 2006	United States	Adelphia acquired by Comcast and Time Warner Cable	Comcast and Time Warner Cable consolidated their positions as the two major cable operators in the United States.
September, 2006	Japan	J:Com acquired majority stake in Cable Net Shimonoseki	
September, 2006	Japan	J:Com acquired majority stake in Cable West	
January, 2007	Czech Republic	Karneval acquired by UPC	UPC became the largest cable operator in the Czech Republic

February, 2007	Netherlands	Ziggo formed from merger of Casema, Multikabel and @Home	Ziggo became the largest cable operator in the Netherlands
November, 2007	Japan	J:Com became the largest shareholder in Kyoto Cable Communications	
January, 2008	Japan	J:Com merged consolidated subsidiaries J:Com Kansai with Cable West and Hokosetsu Cable Net	
March, 2008	Korea	SK acquired Hanaro Telecom	The combined entity, SK Broadband became the largest cable operator in Korea
October, 2008	Belgium	Telenet acquired Interkabel	Telenet consolidated its position as Belgium's largest cable operator
November, 2008	Portugal	ZON completed the acquisition of four regional cable companies including Bragatel	Zon consolidated its position as Portugal's largest cable operator

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Source: Operators, ABIresearch (2008).

One of the key concerns with the recent merger activity is how it will affect competition in the market for pay TV, particularly because increasing firm size can lead to less competition and can create market power which can result in pricing above competitive levels.[26] The U.S. regulator FCC adopted an order in 2007 establishing a 30% cap on horizontal ownership which limits the number of households one company can serve. Recently a federal appeals court ruled in favour of Comcast's and the cable industry's request for the elimination of these ownership limits. While it is still premature to judge how the market will respond, a press report suggests that this could lead to future consolidation across all platforms of the pay TV market.[27]

Cable introducing new services (broadband, VoIP)

The threat to cable from non-traditional video sources has pushed cable operators to upgrade their networks to support higher bandwidth data services and new video content and applications. The transformation has been rapid. Over the past ten years, cable companies in the OECD have transformed themselves from providers of analogue video services to providers of an array of advanced digital communications services. Most major cable operators have upgraded their networks to support bandwidth-intensive services such as high-definition television and faster broadband Internet access. Much of the growth in cable broadband markets is being driven by growing consumer demand for enhanced video services, competitive pricing strategies and higher data speeds.

Personal video recorders (PVR) and video on demand (VoD)

Cable companies began as video platforms which broadcasted video content to all subscribers. The one-to-many distribution model is very efficient for delivering the same, high-bandwidth content to subscribers in a linear fashion and meant that cable (and satellite) operators were best positioned to introduce high-definition (HD) television programming to subscribers in a cost-effective manner.

The drawback of this one-to-many distribution model was that it was limited to linear viewing – meaning subscribers had to watch the programmes at the time they were broadcast. Cable operators have been innovative at shifting the way people can watch television by allowing users to (time shift) their viewing though the use of personal video recorders (PVR) and by introducing video-on-demand (VoD) content which is streamed directly from the cable operator to the end user whenever it is requested.

A number of cable operators are now offering more HDTV programming choices and provide PVR[28] services, which allow customers to select, record and store programs and play them at any convenient time.[29] Some operators such as Cablevision in the United States are also deploying time-shifted TV (network DVR) capabilities into the infrastructure, reducing some of the reliance on PVRs.

There is increasing demand for high-definition content as more people buy HD-compatible televisions. This is leading many operators to add more HD channels to their line-ups. Operators in North America, in particular, are finding that the number of HD channels and HD VoD titles are key elements consumers consider when selecting operators.

The pay-TV market is very competitive in many countries and this has led to similar products or bundles of services from various competitors. As a result, most cable operators in OECD countries have started supplementing their linear programming packages with VoD libraries in addition to offering basic and premium pay TV channels.[30] In most cases, cable operators offer VoD services that typically feature content such as movies, sports and television series with various business models including subscription VoD (SVOD), transactional VoD (pay as you watch) and Catch up TV (watching previously broadcasted programmes).[31]

Telecommunication firms have also been very active in this area with most satellite and IPTV providers offering similar services to compete with cable providers. These services include VoD, HD broadcast programming, Personal Video Recorders (PVR), digital terrestrial TV (DTT) tuners. In the United States, DirecTV (a DBS provider) offers extensive HD programming[32] and exclusive sport content (*e.g.* NFL Sunday Ticket) to its 17.6 million subscribers. [33] Recently the United States telecommunication firm Verizon increased its VoD services to more than 18 000 titles per month including more than 2 400 HD programs a month.[34] In France, the competitive ADSL/FTTH provider Free offers more than 300 channels, VoD services and provides a "TV to PC" service, which allows TV programmes to be streamed into any PC connected to the Internet.[35] Finally, some competition is from over-the-top providers such as the iTunes store.

Voice services

One of the key areas where cable operators have looked for revenue growth has been voice services. These services remain the core of many fixed-line operators' revenue streams but competitively priced VoIP services from cable operators are helping cable operators entice customers to drop their fixed PSTN lines and instead take an entire bundle from a cable operator.

In 2008, some estimates put the total number of residential Voice over Internet Protocol[36] (VoIP) subscribers at 106 million worldwide. NTT, France Telecom[37] and Comcast took the lead as the world's largest VoIP service providers. Thanks to the cost savings that VoIP provides, the VoIP market had healthy growth of 33% to USD 30.8 billion in 2008.[38] Cable operators have been successful in gaining the significant market shares, despite initially trailing over-the-top voice providers such as Skype and Vonage. The success of cable companies in the voice market is largely due to their bundled packages. [39] In many cases, operators provide access to voice services for free or for a relatively low incremental cost as an add-on to existing cable broadband service and adjust their revenue focus to fixed-to-mobile and international calls. Cable operators have been able to attract subscribers who would otherwise have been required to pay a fixed line charge to an incumbent telecommunication operator.

While all data are not available, the OECD *Communications Outlook 2009* shows that the total number of cable voice phone subscribers reached 23.8 million at the end of 2007.[40] Across the OECD area, the United States took the lead with 8.3 million subscribers, followed by the United Kingdom (4.1 million), and Spain (2.3 million) in 2007.

Portuguese cable operators increased their VoIP customer base from 1 521 to 249 431 subscribers between 2001 and 2007. During the same period, cable operators in the Netherlands increased their VoIP subscriber base from 160 thousand to 1.2 million while operators in the United States went from 6 million to 23.8 million over the same time frame.[41]

Bundles

Cable operators introduced voice services as a way to better compete with fixed-line providers and build revenues but these voice services are rarely offered on a stand-alone basis. They are mainly sold as bundled packages.

Both cable and telecommunication companies are pursuing multiple-play offers to maintain a competitive edge.[42] The primary goals of offering a multiple-play bundle are both to reduce churn and to win loyalty from the existing customers, resulting in the increased average revenue per user. Customers can also benefit from these offers because they provide the convenience of a single bill and are often sold at a discount when compared with the price of buying all the services separately. The percentage of subscribers taking triple-play packages is growing and represents a large part of the market (see Table 5). Virgin Media has 56% of its subscribers on a triple-play package while other operators are in the 20-35% range.

Table 5 Penetration of bundling by selected operators

2008

	Single-play	Double-play	Triple-play
Time Warner Cable	45.8%	32.9%	21.3%
Virgin Media	16%	28%	56%
ONO	20.5%	45.4%	34.1%
Telenet	56%	22%	22%
UPC Netherlands	65%	9%	26%
Zon Multimedia	24%	53%	23%
J:Com	47%	28%	25%

Source: Regulator filings by operators.

Triple-play customers are typically more profitable than double-play or single-play customers and most marketing is aimed at encouraging customers to take multiple services at a lower price than each standalone product on a combined basis.[43] Therefore, marketing and pricing strategies vary from appealing to user habits to offering quite simple *à la carte* menus. For instance, customers of Virgin Media and UPC Netherlands can build their own bundles out of a range of choices or choose a popular bundle with double, triple or quadruple-play offerings. Table 6 shows the approach Virgin Media has taken to simplify each of the stand-alone offers into three "size" categories, which can then be mixed and matched.

Table 6. Virgin Media (UK): Triple play bundles

Broadband	TV	Phone
Size L (up to 10 Mbit/s)	Size M+ (over 65 digital TV channels)	Size M (unlimited weekend UK landline calls)
Size XL (up to 20 Mbit/s)	Size L (over 100 digital TV channels)	Size L (unlimited evening and weekend UK landline calls)
Size XXL (up to 50 Mbit/s)	Size XL (over 165 digital TV channels)	Size XL (unlimited anytime UK landline calls)

Source: Virgin Media.

Mobile

The triple-play packages which are commonly marketed by cable operators include fixed-voice services. The shift away from fixed-line telephony to mobile has led to some cable operators now including mobile voice services within their packages.

Several operators such as Rogers Communications (Canada), Virgin Media (the United Kingdom), Kabel Deutschland (Germany) and Telenet (Belgium) started to offer quadruple-play bundles several years ago. These packages are more common when an operator such as Rogers also has a wireless/mobile division. In other cases cable providers have been broadening their service offerings by partnering with existing mobile operators or becoming mobile virtual network operators (MVNO) themselves.

Traditional fixed line operators were among the earliest to include mobile services because they usually have mobile subsidiaries. Rogers Communications is one of the few cable operators to have had mobile operations from the beginning, founding its mobile subsidiary back in 1985. A few have acquired mobile capabilities through acquisitions, such as Virgin Media's acquisition of Virgin Mobile in the United Kingdom. The Spanish operator ONO began MVNO operations in the local market in September 2009. For most, however, the preferred path is the formation of a partnership with an established mobile operator.

So far, the majority of these partnerships have had limited success, as new entrants usually struggle to establish a foothold against traditional mobile operators in saturated markets. For example a joint venture between major cable operators in the United States and the mobile provider Sprint/Nextel was unsuccessful. In Belgium, Telenet's mobile offering via an MVNO had only attracted 56 000 mobile subscribers in 2007, representing just over 3% of its cable subscriber base. Nevertheless, the driving force of wireless communications within the telecommunications sector means that cable operators remain attracted to the possibility of gaining incremental revenue and leveraging the mobile as an additional screen for their video content.

Cross-integration of services

In support of their bundled services strategy, cable operators continue to introduce features that operate across two or more of their services. For example, Time Warner Cable provides its customers a Caller ID on TV feature that displays incoming call information on the customer's television set. Shaw has continued the deployment of digital simulcast, a technology where all analogue channels are converted into a digital signal and simulcast to over 80% of homes passed. This technology allows for the deployment of a low priced digital cable terminal. The terminal permits access to all digital features including the on-screen programming guide, VoD and pay-per-view (PPV) movies.

A number of large cable operators have also embraced "Tru2way"[44], an effort to create a common platform for set-top box applications, regardless of the box's operator system, which has hindered application development in the past.

Another interesting development is the "TV Everywhere" concept which would authenticate users to watch programmes they have already paid for as part of their cable subscription on various websites over the Internet. For example, a cable subscriber with access to the TV Everywhere platform would be able to visit the website of a content provider and watch over-the-top video as long as that content was also paid for in the subscribers existing cable subscription. Comcast is now conducting a technology trial for the new TV Everywhere service (On Demand Online) and plans to launch the new service nationwide by the end of 2009.

It is unclear what impact services such as TV Everywhere will have on content distribution but it could open up a wide range of other business models. By offering cable TV programming on-demand on the Internet, cable operators can gain leverage to differentiate themselves from DBS and IPTV providers. Rogers Communications in Canada also launched online on-demand services with 15 network partners with no additional charges to its subscribers in November 2009.

The next challenge coupled with the provision of TV Everywhere that some cable operators are facing might be how to integrate Web services and introduce targeted advertising into their platforms. The growth of more personalised content consumption such as VoD gives operators the opportunity to leverage targeted advertising.

As the Internet video providers increase their competitive market presence, cable companies may be forced to consider breaking up the big bundles of channels they now carry that consumers buy and instead begin offering individual channels or smaller groups of channels on an *à la carte* basis.

Operators upgrading their networks (DOCSIS, etc)

Cable networks were originally introduced as a means of retransmitting terrestrial broadcasting services to households in remote and rural areas where people could not obtain those services directly. Prior to the mid-1990s, the cable industry operated coaxial cable systems, which connected the cable company's video programming equipment located at the cable head-end to all subscribers using coaxial cable. The first cable networks were unidirectional only because the only service delivered was television, there was no need to develop a two-way communications network.[45]

The growth of residential Internet access in the 1990s drove the cable industry to invest in technologies which provided higher capacity and allowed for the provision of Internet access. The primary purpose of these investments was to convert cable systems to digital hybrid-fibre-coax (HFC) systems and the first cable modems were symmetrical devices with downstream speeds of only a few Mbit/s.[46] Upgrades from unidirectional networks for analogue TV to bidirectional networks allowed operators to provide broadband, voice services, as well as digital TV. Most cable operators in the OECD have enhanced the quality and capacity of their network infrastructure through significant capital investments.[47] These investments have enabled cable operators to leverage their existing networks and expand service offerings to include digital programming, faster Internet, video-on-demand (VoD), high-definition television (HDTV), personal video recorders (PVR), and telephony.

Cable operators' need for additional bandwidth to deliver an increasingly differentiated service offering has spurred large HFC networks upgrades across the OECD. As consumer demand grows for more HDTV programming, on-demand choices and high-speed data, cable operators need more bandwidth to meet these needs. Given that bandwidth is a main driver of enabling operators to expand new services,

cable operators have continued to optimise the existing network bandwidth and to increase the total amount of capacity available on their networks. Faced with growing competition for data services, cable operators have invested in broadband capacity using the industry standard "data over cable service interface specification" (DOCSIS), which can provide downstream data services of up to 160 Mbit/s. These headline speeds are similar to those offered by many FTTH providers in the OECD.

Cable operators in the OECD areas are mainly pursuing three key upgrade strategies.

1. Reclaiming existing bandwidth by moving from analogue to digital broadcasting

2. Limiting the amount of channels sent simultaneously to subscribers by introducing switched digital video (SDV) services. SDV transmits only the requested television signals to households instead of broadcasting all channels to all subscribers. Several operators have moved in this direction (*e.g.* Time Warner Cable and Rogers).

3. Expanding bandwidth on the network by upgrading to 1 GHz networks (*e.g.* Cox Communications).

Cable operators are being selective about how and where to invest in their networks and capabilities. Some investments are targeting the network while others focus on improving equipment at the user's premise. For example, some operators are investing in digital terminal adaptors which convert new digital TV signals back to analogue signals for use with older televisions.

One key strategy for upgrading cable networks has been to install new 1 GHz technologies in conjunction with extending fibre closer to the premises. A "fibre–deep" architecture extends optical fibre to nodes in the network that are within a few hundred metres of the subscriber's home allowing much faster data speeds and, at the same time, reducing the need for amplifiers and power supplies in the network.

In other situations, operators can take advantage of fibre-optic networks extended even deeper into the network – all the way to the premises. Technologies such as radio frequencies over glass (RFoG) allow cable operators to build access infrastructure that will potentially tap the 30 THz of current theoretical carrying capacity of fibre directly to the premises. In many cases, RFoG has a significant operational advantage over HFC because optical transmission has lower power requirements and fewer active components within the network. Some have suggested that while it is difficult to predict whether or not cable operators will extend fibre all the way to users in the near future, there could be some co-integration of fibre and cable standards in the future.

The advertised speeds of cable broadband connections are typically faster than DSL connections in most countries but telecommunication firms have made significant investments in network upgrades to match or surpass cable's advertised speeds. Moreover, a number of incumbent telecommunication operators have fibre-to-the-home (FTTH) networks in the planning or rollout stages, thus enabling them to provide very fast download speeds of 100 Mbit/s or greater.

Cable operators have begun installing fibre closer to end users and using the newest iteration of the cable standard, DOCSIS 3.0 to compete with the fibre offers of competitive operators.[48] By 2008, cable's average advertised speed of 15 Mbit/s is more than double that of two years before. Currently major cable operators have begun offering broadband services at speeds of at least 50 Mbit/s or greater, using DOCSIS 3.0 (see Table 7). For comparison, many fibre providers now offer downstream speeds of 100 Mbit/s.

The cable operators with the fastest advertised speeds over their cable infrastructure are Portugal, Japan, the Netherlands, Poland, and the Slovak Republic. The fastest advertised speed by a cable operator

is 200 Mbit/s by ZON in Portugal.[49] The top advertised download speeds of ZON increased from 18 Mbit/s to 200 Mbit/s within the space of one year. It is also interesting to note that cable top speeds in the two countries dominated by cable broadband subscriptions, Canada and the United States, are a little bit slower than the advertised speeds in countries dominated by DSL providers.

Table 7. Top advertised cable broadband speeds, October 2009

Operator	Country	Fastest advertised download speed
ZON Multimedia	Portugal	204,800
J:COM	Japan	163,840
UPC	Hungary	122,880
UPC	Netherlands	122,880
UPC	Poland	122,880
UPC	Slovak Republic	122,880
Welho	Finland	112,640
UPC	Austria	102,400
Shaw	Canada	102,400
UPC	Czech Republic	102,400
Numericable	France	102,400
Kabel BW	Germany	102,400
C & M	Korea	102,400
LG Powercom	Korea	102,400
SK Broadband	Korea	102,400
Tbroad	Korea	102,400
Cablecom	Switzerland	102,400
Cablevision	United States	102.400
Charter	United States	61,440
Rogers	Canada	51,200
Virgin Media	United Kingdom	51,200
Stofa	Denmark	51,200
Get	Norway	51,200
Videotron	Canada	51,200
Ono	Spain	51,200
Com Hem AB	Sweden	51,200
Comcast	United States	51,200
Time Warner	United States	51.200
Numericable	Luxembourg	30,720
Elisa	Finland	30,720
Kabel Deutschland	Germany	30,720
Telenet	Belgium	25,600
TelstraClear	New Zealand	25,600
Ziggo	Netherlands	25,600
Optus	Australia	20,480
UPC Ireland	Ireland	20,480
TV Cabo	Portugal	20,480
Turksat/Uydunet	Turkey	20,480
Cegecom	Luxembourg	18,432
Megacable	Mexico	10,240
Cablevision	Mexico	1,536

With regard to top upload speeds, most operators provide upstream services at speeds of 10 Mbit/s or less due to the constraints in upstream bandwidth. Exceptionally, some metropolitan customers of ZON multimedia currently enjoy ultra-fast upload speeds of 1 Gbit/s and two operators in Korea (SK Broadband and LG Powercom) plan to deliver upstream speeds of 100 Mbit/s with bonding of four upstream channels at the end of 2009.

Pricing for cable broadband varies widely from country to country, with considerable differences between the lowest and highest prices. For example, ZON multimedia in Portugal currently offers two kinds of cable broadband services ("net cabo" and "net wideband") based on the technology applied and price for the highest bandwidth, "ZON fibra 200", is EUR 99.90 per month, while price for the second lowest bandwidth, "ZON classic", is about EUR 34.90 a month.[50] Some of this pricing variation is being driven by a wider range of packages and broadband speeds on offer. Some operators such as Rogers Communications, Welho, Optus and Cablecom still offer entry-level, low-speed (less than 1 Mbit/s) services for a relatively low price. With the deployment of wideband technology, however, cable companies are now also offering more premium services, which have increased the range of offers by each operator.

Furthermore, competition from telecommunications operators' deployment of FTTx, in particular fibre-to-the-home, has further accelerated network bandwidth enhancements. As a result, most cable networks in the OECD countries have been upgraded to provide advanced services. A number of operators such as Comcast (United States), Numericable (France), ONO (Spain), Comhem (Sweden), J:COM (Japan) and Welho (Finland) upgraded their networks by installing fibre to neighbourhood aggregation points and then using DOCSIS 3.0 to offer much faster download speeds to customers over the remaining short distance of coaxial cable.[51]

Since bandwidth is a main driver of enabling cable operators to expand new services, cable operators continue to assess the evolution of network infrastructure. As demand for bandwidth increases, operators must decide on which technologies and tools to use in order to optimise the existing network bandwidth or to increase the total number of capacity available on their networks.[52] Cable operators are currently considering several options to optimise bandwidth. These include:[53]

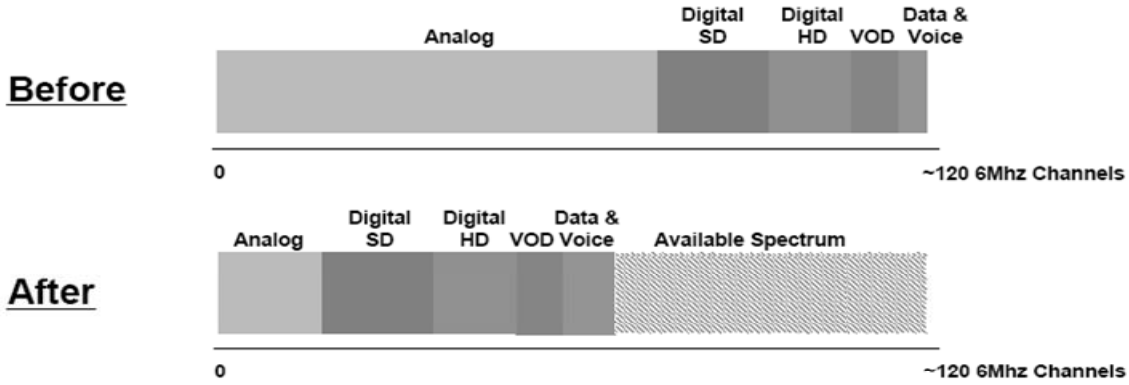
- Analogue reclamation (shift from analogue to digital signals)
- MPEG-4 Advanced Video Coding (compression)
- Switched Digital Video (streaming only requested channels)
- DOCSIS 3.0 (upgrade of the standard)
- "Fibre Deep" (Fibre deeper to nodes in neighbourhoods)
- RF over Glass (Sending cable television signals over fibre-to-the-home infrastructure)

Bandwidth reclamation through migration to digital services

The terrestrial television networks in some OECD countries have completed the transition from analogue to digital signals. These include Luxembourg and the Netherlands in 2006, Finland, Sweden and Switzerland in 2007, and the United States and Denmark in 2009. Coupled with these developments, some cable operators have completed the digital switchover or are still migrating from legacy analogue services to digital services. In looking at capacity allocation, an analogue TV channel typically occupies a 6 MHz (8 MHz in Europe) slot in a cable system. A typical system would therefore allocate about 360 MHz for 60

analogue channels. A typical cable system has a total of 750 MHz of capacity using HFC so the 60 analogue TV channels would occupy nearly half of the network's total capacity. Switching to digital signals significantly reduces the amount of bandwidth required for each channel which can then be used for other services such as data or video on demand (see Figure 7).[54]

Figure 8. Bandwidth reclamation through digital migration



Source: Comcast.

MPEG-4 Advanced Video Coding

Another way to maximise bandwidth is by using greater compression on the signals. Moving from the older MPEG-2 standard to the newer MPEG-4 encoding, cable operators can reduce their bandwidth requirements by up to 75%, thus enabling them to deliver more HD programming. Although the solution does not result in a broader spectrum for video, it allows operators to squeeze more TV channels into each 6 MHz (8 MHz in Europe) channel band.

MPEG-4 advanced video coding (MPEG-4 AVC or H.264) is the latest, broadly accepted video compression standard and can achieve significant improvements in rate-distortion efficiency compared with existing standards. The upgrade to MPEG-4 does require substantial investment in infrastructure, particularly new encoders and set-top boxes for consumers.

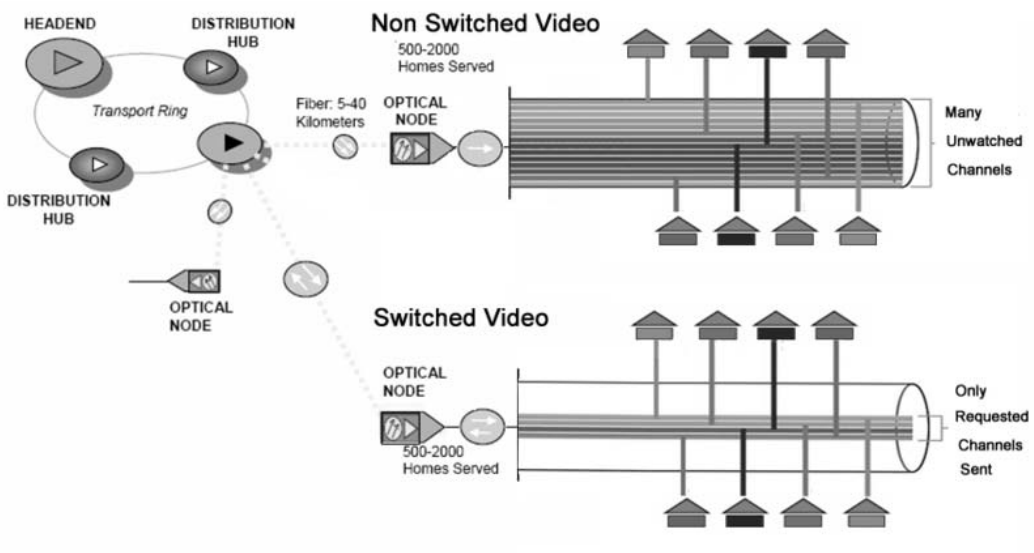
Switched Digital Video (SDV)

Some cable operators such as Time Warner Cable, Cox Communications in the United States and Rogers in Canada have made significant efforts to maximise the efficient uses of their bandwidth by introducing new ways to minimise unnecessary video transmissions on the network. By using switched digital video (SDV), operators can stream only the channels which are currently being requested on the network to homes, saving bandwidth which can then be used for other services.[55] In SDV systems, channels that are less frequently viewed can be designated as switched services. They are not broadcast throughout the cable network. Instead, they are placed onto the cable plant only if at least one set-top box is tuned to that service. In essence, SDV frees up more bandwidth on existing systems by only delivering a single programme a customer wants to watch at a given time.

The primary benefit of SDV is bandwidth savings. SDV allows cable operators to offer a set of services to their customers using only a fraction of the bandwidth needed to broadcast those channels to all subscribers. By streaming only those channels that are actually being watched, cable operators can not only consume less bandwidth compared to traditional broadcast, but add a set of new channels onto existing

plant.[56] Another advantage of using SDV is that it makes more efficient use of network bandwidth without requiring major network upgrades such as the move from 850 MHz to 1 GHz infrastructure.[57] Figure 8 illustrates how SDV can reduce spectrum and bandwidth requirements in the network. Time Warner Cable has deployed switched digital video as an alternative to upgrading its 750 MHz HFC plant, while Cox Communications is using switched digital video and upgrading network equipment to 1 GHz technologies.[58]

Figure 9. SDV Diagram



Source: Wikipedia, http://commons.wikimedia.org/wiki/File:Cable_Switched_video_Network_Diagram.png

One of the drawbacks of SDV is that it only economises downstream video. There is no expansion of upstream connections and with the expected increase in interactive services on cable networks, expansion of the upstream spectrum and bandwidth will likely be needed.

Data Over Cable Services Interface Specification (DOCSIS) 3.0

Initially DOCSIS was introduced to address the challenges created by emerging broadband demand. Developed by CableLabs in collaboration with a number of cable equipment vendors, DOCSIS defines the communications and operational support interface requirements for a data over cable system. The DOCSIS initiative was originally launched in 1997 to ensure the interoperability of cable modems, but since evolved to provide additional capabilities and functionality.[59] The successive versions of the DOCSIS specification are provided in Box 1.

Box 1. DOCSIS Versions

DOCSIS 1.0 defines basic broadband Internet connectivity for cable modems, enabling operators to purchase interoperable equipment from multiple vendors to drive down prices

DOCSIS 1.1 provides improved operational flexibility, security and quality of service features, allowing the cable operator to offer guarantees on data rates and service delivery

DOCSIS 2.0 was developed in response to increased demand for symmetric services such as IP telephony and increased upstream throughput to 30 Mbit/s of capacity

DOCSIS 3.0, the most recent version of the specification, provides a number of enhancements, most notably, channel bonding and support for IPv6 and support for IPTV. Channel bonding provides the flexible way to increase downstream speeds to a minimum of 160 Mbit/s and upstream throughput up to a minimum rate of 120 Mbit/s

DOCSIS 3.0 is the latest version of its technology and includes a channel bonding technique that enables data throughput of at least 100 Mbit/s. Channel bonding is a technique that allows operators to combine multiple 6 or 8 MHz physical RF channels into a single logical channel. The current specification supports bonding of up to four channels, providing up to 160 Mbit/s downstream, channel bonding has the potential to deliver speeds of up to 1 Gbit/s. With DOCSIS 3.0, cable operators are now able to offer one of the fastest download speeds, as well as to be better positioned to cope with increased network traffic driven by bandwidth intensive applications such as video streaming. Table 8 highlights the maximum upstream and downstream speeds for the different versions of DOCSIS as well as EuroDOCSIS.

Table 8. Maximum usable speeds for DOCSIS/EuroDOCSIS

Version	Downstream	Upstream
DOCSIS 1.0	38 Mbit/s	9 Mbit/s
EuroDOCSIS 1.0	50 Mbit/s	9 Mbit/s
DOCSIS 2.0	38 Mbit/s	27 Mbit/s
EuroDOCSIS 2.0	50 Mbit/s	27 Mbit/s
DOCSIS 3.0 (4 channel)	152 Mbit/s	108 Mbit/s
EuroDOCSIS 3.0 (4 channel)	200 Mbit/s	108 Mbit/s
DOCSIS 3.0 (8 channel)	304 Mbit/s	108 Mbit/s
EuroDOCSIS 3.0 (8 channel)	400 Mbit/s	108 Mbit/s

Source: Cablelabs, Cable Europe Labs.

Cable operators in the OECD are upgrading their existing networks with next generation technology and/or are currently deploying DOCSIS 3.0. In the United States, all five major operators, Comcast, Time Warner Cable, Cox, Cablevision and Charter, began offering faster broadband services using DOCSIS 3.0 at their core markets, in particular where immediate, tangible telecommunications operators threats exist (*e.g.* Verizon and AT&T's significant expansion of fibre optic networks).[60] In Europe, recently most UPC broadband companies (*e.g.* UPC Netherlands, UPC Poland) have completed their network upgrades and are now offering much faster broadband services at speeds of 100 Mbit/s or above.

The most interesting initiative of DOCSIS 3.0 might be the recent launch of a 200 Mbit/s service by the Portuguese cable operator ZON multimedia. With ZON's launch, Portugal will be the first country in Europe to provide such high-speed broadband services to its residential customers. Table 9 provides the information on the current status of DOCSIS 3.0 deployment in the OECD areas.

Table 9. DOCSIS 3.0 Deployment

Country	Operator	Top downstream speeds (upstream)	Upgraded since
Austria	UPC Austria	102 Mbit/s (10 Mbit/s)	Jun-09
Belgium	Telenet	25 Mbit/s (1.25 Mbit/s)	on commercial trial
Japan	J:COM	160 Mbit/s (10 Mbit/s)	Dec-07
Netherlands	Ziggo	120 Mbit/s (10 Mbit/s)	Apr-09
Netherlands	UPC Netherland	120 Mbit/s (10 Mbit/s)	Sep-09
United States	Comcast	50 Mbit/s (10 Mbit/s)	Oct-08
United States	Time Warner Cable	50 Mbit/s (n/a)	Sep-09
United States	Cox	50 Mbit/s (n/a)	Apr-09
United States	Cablevision	101 Mbit/s (n/a)	Apr-09
United States	Charter	60 Mbit/s (n/a)	Feb-09
Canada	Rogers Cable	50 Mbit/s (2 Mbit/s)	Aug-09
Canada	Cogeco	50 Mbit/s (1.5 Mbit/s)	mid-09
Canada	Videotron	50 Mbit/s (1 Mbit/s)	Feb-08
Canada	Shaw	100 Mbit/s (5 Mbis/s)	Feb-09
Finland	Welho	110 Mbit/s (5 Mbit/s)	n/a
Spain	ONO	50 Mbit/s (3 Mbit/s)	Oct-08
France	Numericable	100 Mbit/s (n/a)	2008
Portugal	Cabovisao SA	30 Mbit/s (n/a)	Jul-09
Portugal	ZON Multimedia	200 Mbit/s (1 Gbit/s)	Oct-09
U.K.	Virgin Media	50 Mbit/s (1.5 Mbit/s)	Dec-08
Korea	LG Powercom	100 Mbit/s (10 Mbit/s)	n/a
Korea	SK Broadband	100 Mbit/s (10 Mbit/s)	n/a
Poland	UPC Poland	120 Mbit/s (10 Mbit/s)	Sep-09
Germany	Kabel BW	100 Mbit/s (2.5 Mbit/s)	n/a
Norway	Get	50 Mbit/s (n/a)	n/a
Denmark	Yousee	50 Mbit/s (4 Mbit/s)	n/a
Hungary	UPC Hungary	120 Mbit/s (10 Mbit/s)	Aug-09
Switzerland	Cablecom	100 Mbit/s (7 Mbit/s)	Jun-09
Slovak Republic	UPC Slovakia	120 Mbit/s (10 Mbit/s)	n/a
Czech Republic	UPC Czech	100 Mbit/s (10 Mbit/s)	n/a

Extending fibre

Although all-fibre or all-IP network architecture may be a longer-term reality for cable operators the cable industry is moving toward greater use of fibre in its last-mile infrastructure. Fibre is required deeper into the network to support new high-speed services and high-definition television programming. The deeper fibre is pushed into the network the smaller the area served by a given amount of bandwidth – leaving more bandwidth potential for each household. Often the idea of extending fibre deeper into the network is referred to as a "fibre deep" strategy. In Canada, the cable operator Videotron is currently deploying a fibre deep architecture that reduces the number of homes connected to a given node.[61] Typically, fibre deep architecture extends optical fibre to nodes in the network that are within a few hundred metres of subscriber's home and reduces the need for amplifiers and power suppliers required on the network. Therefore it is sometimes referred to "N+0" because there are no amplifiers cascading from

node, while other operators use "N+2" or "N+3" architecture, referring to the number of amplifiers necessary to deliver a quality signal.

While fibre deep strategies can be built to minimise fibre investment, this architecture also interoperates with all existing traditional HFC components such as installed set-top boxes and DOCSIS cable modems.[62] Some equipment manufacturers such as Aurora Networks claim that a fibre deep architecture in a cable system passing 20 000 homes would only cost about 20% more than a traditional HFC upgrade, but it has the potential to reduce operational costs significantly (see Table 10).[63]

Table 10. Cable network upgrades: Hybrid Fibre Coax vs. "Fibre deep"

	Power supplies	RF amplifiers	Optical nodes	Actives per mile	Cascaded RF amplifiers	Power cost (10 years)	Maintenance cost (10 years)
Traditional HFC	55	1,100	33	>5	5	$564,710	$871,500
Fibre Deep	20	0	200	~1	0	$278,373	$229,500

Source: Aurora Networks.

Radio Frequency over Glass (RFoG)

Although DOCSIS technology delivers a four to eight times increase in bandwidth, it does not increase total network capacity. Rather, it manages existing bandwidth more efficiently between subscribers through bonding of downstream channels. Any increase in total bandwidth requires additional network investments.

Recently a standard called "radio frequency over glass" or (RFoG)[64] has emerged as an HFC and FTTP bridging architecture for cable operators. It allows cable operators to build access infrastructure that will potentially tap the 30 THz theoretical carrying capacity of networks which eventually will extend fibre all the way to end users. In many cases, RFoG has a significant operational advantage over HFC because optical transmission has limited power requirements and minimises active electronic parts.[65] For example, standard PONs (Passive Optical Networks) provide a reach of up to 20 kilometres using unpowered components, whereas HFC networks require RF amplifiers approximately every 1 000 feet to maintain signal quality. Ultimately, some of the core technologies and processes the cable industry has developed for DOCSIS and PacketCable Multimedia will be merged with FTTH standards like GPON (Gigabit Passive Optical Network) to create powerful new solutions for subscribers.

Extending reach

Although some cable companies offer more than 90% coverage within their footprints, others suffer from limited reach, as homes passed by their network miss a substantial proportion of the population. For most, building out their own networks to increase their coverage is expensive. Therefore, some operators are offering various services through local loop unbundling. For example, the cable operator Virgin Media in the United Kingdom has cable coverage of about half the population. Virgin Media also offers various services through BT's DSL infrastructure to those living outside of its cable networks. UPC Austria acquired the DSL operator Inode in March 2006, enabling it to target subscribers beyond the 30% of households covered by its cable network with broadband and telephony services. Another example of extending reach is the various acquisitions of local PSTN networks by Polish cable operator Multimedia Polska between 2001 and 2003. Multimedia Polska delivers triple-play services to its PSTN subscribers and is the first operator in Poland to launch IPTV, ahead of Telekomunikacja Polska, the incumbent telecommunications operator.[66]

Other cable operators have extended their reach in the video market by using alternative technologies including satellite and the fixed-wireless technology MMDS (Multichannel Multipoint Distribution Service). Pan-European cable operator UPC broadband uses both satellite and MMDS to complement its cable service in certain markets. MMDS is used in Ireland; satellite is used in the Czech Republic and Hungary while both satellite and MMDS are being offered in the Slovak Republic. Altogether, these technologies account for 6% of the operator's pay TV subscriber base. Canadian cable operator Shaw Communications recently acquired Cancom, which includes satellite operator Star Choice in 2000. As of November 2007, Star Choice accounted for 28% of Shaw's pay TV subscribers, but a much higher 52% of its DTV subscribers.

Historically, the small and medium-sized business market has remained out of cable's reach and is generally underserved. Cable's lack of physical reach is still an obstacle to providing business services on a universal scale.[67] As cable's penetration of its residential customer base has nearly reached saturation and faces fierce competition from satellite and IPTV, however, some operators have been trying hard to capture the last frontier of new cable revenue. Time Warner Cable is offering "Business Class" product, a combination of business communications tools including broadband access, dedicated access over fiber and services such as Web hosting, remote data storage and managed security. Cox emphasises voice services that support everyday business needs including personal accessibility, telecommuting and extension dialling between locations.

REGULATORY ISSUES

Cable operators are often bound by regulations relating to content, coverage and franchises.[68] In many cases, cable operators are required to carry national broadcast services on their platform as well as any local terrestrial broadcast programmes. For example, the US Communications Act and the FCC's programme access rules limit the ability of affiliated programmers to offer exclusive programming arrangements to cable operators.[69]

Cable operators in the United States are also subject to general cable franchise requirements from franchising authorities at the state or local level.[70]

Other regulatory issues include the role of regulators in determining if operators have significant market power. For example, as part of the implementation of the EU Regulatory Framework, each Member State's National Regulatory Authority (NRA), is required to analyse certain markets to determine if any operator or service provider has significant market power.

Another key regulatory issue which has emerged in some OECD countries regarding cable networks is how much control operators will be given to manage traffic flows on their networks. Recently some regulators (the FCC and the CRTC) have introduced new measures on the network management practices, requiring cable operators to inform consumers of traffic shaping practices in advance of changes to their policies.[71]

The level of competition in the television market will continue to be an important focus for regulators. Overall, cable industries continue to play a critical role in stimulating competition both in

pricing and new service offerings in markets where they are present. For example, voice markets received a boost of competition when cable operators began offering voice services to compete with incumbent telecommunication firms.

While cable companies do provide important infrastructure-based competition there is still asymmetric treatment of different delivery platforms such as DSL and cable in several OECD markets.[72] Today's converging environment means that cable, DSL and FTTH providers have the potential to deliver similar, closely substitutable services to consumers. In some cases it may be necessary to consider how cable networks could be opened for competition if necessary. Some countries already require or are considering mandating open access to cable networks (*e.g.* Canada, the Netherlands and Denmark).[73]

NOTES

[1] FCC, "High-Speed Services for Internet Access: Status as of December 31, 2008", February 2010, p. 11, http://hraunfoss.fcc.gov/edocs_public/attachmatch/DOC-296239A1.pdf.

[2] Evie Haskell, "The Inside-Out Year – Winners, Losers & Changing Tides," The Bridge, April 2009.

[3] The Canadian Radio-television and Telecommunications Commission (CRTC) reported that cable operators had 55% of residential high-speed Internet access subscribers at the end of 2008, compared to 39.5% for the former monopoly telephone companies.

[4] J:COM, "Outline of Q3 FY 2009," www.jcom.co.jp/ir_en/financial/review.html.

[5] OVUM, "Cable modem benchmark," May 2008, p.40.

[6] OECD, "Broadband and Telephony Services Over Cable Television Networks," 2003. P.33.

[7] Dan Maldoom, Richard A.D. Marsden, J. Gregory Sidak, Hal J. Singer (2005), pp.152-153.

[8] Ofcom, "Pay TV market review", Annex 8 to pay TV investigation consultation, p. 4.

[9] See http://mavise.obs.coe.int.

[10] See http://www.totaltele.com/view.aspx?ID=443655.

[11] NCTA, "Comments of the National Cable & Telecommunications Association" before the Federal Communications Commission with regard to annual assessment of the status of competition in the market for the delivery of video programming (MB Docket No. 07-269), May 2009.

[12] Ofcom, "Pay TV market overview, Annex 8 to pay TV market investigation consultation," December 2007.

[13] OECD (2009), *Communications Outlook 2009*, p. 195., OECD, Paris

[14] Arther D. Little, Exane BNP Paribas, "Reviving the fixed line," February 2009, p.20.

[15] As a result, Verizon and AT&T are now the 8th and 10th largest video providers in the United States, while cable operators (Comcast, Time Warner Cable, Cox, Cablevision and Charter) are now five of the top ten residential phone companies in the United States.

[16] Light Reading, "Telecom Market Spotlight: Europe," www.lightreading.com/document.asp?doc_id=182293&.

[17] Market analysis shows that there were 21.8 million IPTV subscribers globally at the end of 2008, of which nearly 10.4 million were in Western Europe. France alone accounts for more than a quarter of the world's IPTV customer base, with 5.7 million subscribers, http://www.lightreading.com/document.asp?doc_id=174235.

[18] The term Internet TV generally describes the delivery of TV programming over the Internet, typically to personal computers as streamed or downloadable video content. Internet TV is a topic now being addressed by the European DVB Project for potential standardisation.

[19] ComScore, Press release, "U.S. online market continues to ascent as Americans watch 33 billion videos in December," http://www.comscore.com/Press_Events/Press_Releases/2010/2/U.S._Online_Video_Market_Continues_Ascent_as_Americans_Watch_33_Billion_Videos_in_December

[20] The Progress and Freedom Foundation, "Media Metrics: The True Story of the Modern Media Marketplace, 2009, p. 65; ComScore, "(Re)introducing online video, and online video measurement: U.K, France and Germany," 2009.

[21] Roku box is a device that allows consumers to stream video from Netflix, Amazon.com and other websites directly to consumers' television.

[22] Liberty Global operates cable broadband networks in 14 countries, principally in Europe (11 countries), Japan, Chile and Australia.

[23] Market capitalisation (often Market Cap) is a measurement of the size of business enterprise equal to the share price times the number of shares outstanding of a public company. Comcast, the leading cableoperator in the United States. has a market cap of about USD 32 billion, while AT&T and Verizon have market cap of USD 154 bn, and USD 87 bn, respectively.

[24] Cable Europe, Cable Facts & Figures, www.cableeurope.eu/uploads/images/FF-YE2008/FF_YE2008_all.pdf.

[25] See http://online.wsj.com/article/SB10001424052748703683804574532091854629728.html.

[26] Sangho Seo, "Cable consolidation and deployment of advanced broadband service," VOL. 9 NO. 6 2007, pp. 57-69, Emerald Group Publishing Limited.

[27] *Wall Street Journal*, "Comcast Could Tie Up More Cable Nationwide", http://online.wsj.com/article/SB125251261621296039.html.

[28] Some cable operators (*e.g,* Rogers and Time Warner Cable) offer dual tuner.

[29] Leitchtman Research Group, market research firm, estimates that over 90% of all TV viewing in the United States today remains "traditional" live-linear TV, while time shifting of TV has grown in recent years.

[30] However, market analysis shows that VoD is still relatively unknown by consumers in the United States. and VoD occupies only 3% of weekly video minutes viewed.

[31] It is often referred to as "Start Over, " which features time-shifted technology that allows customers to restart a programme already in progress.

[32] DirecTV currently offers 130 HD channels and is expected to expand to 200 HD channels by the end of 2009.

[33] For example, NFL Sunday Ticket subscribers can view a mix-channel with up to 8 games on one screen while the NFL supercast service lets customers access the game and interactive statistics on line through a PC or laptop.

[34] Verizon also added new HD on-demand contents from HBO, Cinemax, Startz Entertainment and The Movie Channel, along with an additional 140 hours of movies on-demand from Encore.

[35] OECD (2007), "IPTV: Market Developments and Regulatory Treatment," p.12., OECD, Paris.

[36] VoIP is a technology for communicating using "Internet Protocol" instead of using analogue phone line.

[37] By the end of 2008, France Telecom was the largest VoIP service provider in Europe, followed by Illiad, SFR, BT and United Internet in Denmark, http://www.telegeography.com/product-info/euro_voip/downloads/euro-voip-exec-summary.pdf.

[38] Infonetics, "VoIP and UC Services and Subscribers," http://www.infonetics.com/pr/2009/2h08-voip-UC-market-research-highlights.asp.

[39] VoIP markets shifted over the last several years with most new growth coming from subscriptions where voice is bundled with broadband Internet access from cable or DSL providers.

[40] The total subscriber represents the sum of 16 countries: Austria, Belgium, Canada, Germany, Ireland, Italy, Japan, Luxembourg, the Netherlands, New Zealand, Portugal, Spain, Sweden, Switzerland, the United Kingdom and the United States.

[41] OECD (2005), *Communications Outlook 2009*, OECD, Paris.

[42] IDATE, "Bundles and Range Strategies: The Case of Telecom Operators," http://mpra.ub.uni-muenchen.de/3550/1/MPRA_paper_3550.pdf.

[43] Philippa Biggs and Tim Kelly, "Broadband pricing strategies," VOL. 8 NO. 6 2006, p. 5, Emerald Group Publishing Limited.

[44] Tru2way is a digital cable technology developed by CableLabs that is designed to built directly into TVs, eliminating the need for a set-top box. Initially six major operators have committed to deploying Tru2way by 1 July, 2009 but failed to meet the deadline.

[45] The channel capacity of these systems was limited by the spectrum capacity of the coaxial cable, which was generally not more than 750MHz, and the substantial size of the spectrum used by each analogue channel (6 MHz or 8 MHz). The hypothetical maximum of these systems was approximately 120 channels, but most systems provided fewer channels.

[46] Cable broadband Internet access requires a cable modem at the customer's premises and a cable modem termination system at a cable operator facility, typically a cable television head end.

[47] For example, The US cable industry invested heavily over the last 10 to 15 years to transform itself from a one-way analog video provider to a provider of multiple services over a two-way digital broadband platform capable of providing voice, video and high-speed data services; investment was at least USD 10 billion in each of the last ten years. Total investment during this period was USD 129 billion.

[48] In Europe, 11.2 million homes were passed by fibre at the end of 2008, and there were 1 661 895 fibre-to-the-home/building (FTTH/FTTB) subscribers. French cable company, Numericable, whose high-speed network passes 3.4 million homes; and municipalities and power companies, which still account for 58.5% of all of Europe's FTTH/B projects.

[49] Zon Multimedia now offers four speeds of packages (50 Mbit/s, 100 Mbit/s, 200 Mbit/s and 1 Gbit/s) utilising multiple network configurations. While a 1 Gbit/s package is delivered via FTTH, the three other speeds are served using EuroDOCSIS 3.0.

[50] Both "Zon Fibra 200"and "Zon Classic"are bundled offers that include fixed telephone, broadband and TV.

[51] OECD (2009), *Communications Outlook 2009*, p. 106., OECD, Paris.

[52] ABIresearch, "Cable operators' service, network, and transformation trends," p. 26.

[53] Pike & Fischer, "Bandwidth Optimization and Expansion Market and Technology Assessment," http://www.broadbandadvisoryservices.com/researchReportsBriefsInd.asp?repId=698.

[54] It is often referred to as the digital dividend.

[55] Briefly speaking, switched video is a network scheme for distributing digital video via a cable. In a switched video system, the unwanted channels do not need to be sent and SDV frees up more bandwidth on existing systems by only delivering a single channel to the television at a time.

[56] CISCO, "The Economics of Switched Digital Video," http://www.cisco.com/go/sdv.

[57] Motorola, "Using Bandwidth More Efficiently with Switched Digital Video," http://www.motorola.com/staticfiles/Business/_Documents/static%20files/Switched%20Digital%20Video%20June%202008%20537340-001-c.pdf.

[58] Cox opted to go to SDV first in some of Cox systems where it was facing fierce competition and in other systems it has opted to go to 1 GHz plant and deploy SDV later.

[59] Several documents discussing DOCSIS technology are:

- microtune.com/pdf/Whitepapers/Microtune_Making_DOCSIS_3_0_a_Reality.pdf,
- http://microtune.com/pdf/Whitepapers/cable_whitepaper_bandwidth.pdf,
- www.advanced-television.com/PDF/E_0508_P14,15,16,18,19(2).pdf,
- www.ftthcouncil.org/en/knowledge-center/white-papers/2008/docsis-30-and-ftth-the-essential-differences.

[60] Cable & Satellite International, "DOCSIS 3.0: progress report," http://www.cable-satellite.com/pdf/features/may-jun_09/18.pdf.

[61] See www.lightreading.com/document.asp?doc_id=159499&site=cdn.

[62] Key articles are found at http://business.motorola.com/ultrabroadbandsolutions/pdf/ScreenPlays_Article-Surging_Use_of_Fibre_Opens_New_Cable_Migration_Paths.pdf, http://documents.exfo.com/appnotes/anote202-ang.pdf.

[63] See www.aurora.com/site/applications.an?li=a-fd.

[64] It is sometimes referred to as 'Cable PON' (Passive Optical Network).

[65] Several documents and articles discussing RFoG are found at: www.lightwaveonline.com/featured-articles/RFoG-plus-PON--Enabling-cables-all-IP-future-64581082.html, www.cedmagazine.com/Article-RFoG-cable-rural-opportunity-090109.aspx, www.cable-satellite.com/pdf/features/may-jun_09/6.pdf, 20Deliver%20DOCSIS%20and%20GPON%20Services%20over%20Fibre.pdf.

[66] ABIresearch, "Cable Operators' Service, Network, and Transformation Trends," 2008, pp. 14-15.

[67] In addition, cable's shared network characteristics make it difficult for operators using currently deployed cable broadband technology to guarantee the consistently high speeds and other advanced features that some business customers require.

[68] According to the new FCC rules, after transition in 2009, cable operators must continue making local stations viewable by all subscribers until 2012.

[69] After the FCC has extended the exclusivity restrictions through October 2012, the cable industry has challenged this FCC action in Federal court.

[70] OECD (2007), "IPTV: Market Developments and Regulatory Treatment," p.35., OECD, Paris

[71] The FCC ordered cable operators to disclose certain information about the network management practices to the FCC and to cease the practices at issue by 31 December, 2008, which is now challenged in Federal court. Recently Canadian regulator CRTC introduced a new Internet traffic management practices framework for ISPs. The Commission is also requiring ISPs to inform consumers of their practices.

[72] Dan Maldoom, Richard A.D. Marsden, J. Gregory Sidak, Hal J. Singer, "Broadband in Europe," pp. 143.

[73] In the Netherlands, regulator OPTA ruled that some cable operators have significant market power and must open their networks to third parties. It is the first time that cable companies have been forced to do so in Europe. Tele 2 quickly announced it planned to use the regulation to offer analogue television over cable in the Netherlands, http://www.totaltele.com/view.aspx?ID=443655.