UK Broadband Status Summary March 2006

Covering the period October 2005 to end December 2005

A Report for the Department of Trade and Industry

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Contents

Contents **2**
0 Executive summary **3**
1 Introduction **4**
2 Recent developments **5**
2.1 Broadband coverage 6
2.2 Subscribers and market share 6
2.3 Pricing and new product developments 7
2.4 Government and public sector 10
3 Coverage **11**
3.1 Current UK coverage 11
4 Take-up **18**
4.1 Current take-up 18
5 Competition **21**
5.1 Competition between operators 21
5.2 Impact of competition 21
Annex A: Broadband technologies **24**
A1 DSL in general 24
A2 Cable Modems 28
A3 FWA 31
A4 Satellite 35
A5 Other Broadband Access Technologies 37

0 Executive summary

Broadband coverage now reaches 99.8% of UK household population

By the end of December 2005, 99.8% of the UK household population had access to a mass-market broadband technology such as ADSL, cable modem or fixed wireless access (FWA).

This represents a growth of 3.4% since the end of December 2004, when the population coverage had reached 96.4%.

Broadband take-up reaches 9.82m connections and continues to grow

Total broadband connections (ADSL, cable modems, fixed wireless access and satellite) had reached 9.82 million, a growth of 11% in the three months from the end of September 2005.

Growth in infrastructure competition remains static

Non-DSL technologies such as cable modems and FWA will contribute a little to the growth of availability, but more to the development of infrastructure competition on a limited basis in urban and suburban areas.

Competition in the local loop

The Office of the Telecoms Adjudicator (OTA) announced that the total number of unbundled lines was in excess of 210,000 at the end of December 2005, with a run rate of line orders reported to be significantly greater than the 5,000 per week which was reported in November 2005.

1 Introduction

The DTI has commissioned Ovum to provide a series of reports on the current state of the UK broadband market and its likely development over the next ten years.

This report forms the final quarterly update on broadband coverage up to the end of December 2005.

The findings and analysis contained in the report are based on information provided by the major broadband infrastructure providers and additional research, analysis and forecasting carried out by Ovum, building on its comprehensive and continuous research programme.

Chapter 2 contains a summary of recent developments in the broadband market, focusing on the activities of key players.

Chapter 3 provides an analysis of the current state of broadband coverage in the UK, based on data provided by infrastructure players including BT, Kingston Communications, ntl, Telewest, Pipex and UK Broadband.

Chapter 4 contains a summary of the current levels of broadband take-up.

Chapter 5 summarises the key competition issues, building on recent developments outlined in Chapter 2.

Annex A contains a summary of the major current broadband technologies.

2 Recent developments

This chapter summarises the key developments in the UK broadband market arising over the three months from end September 2005 to end December 2005.

Listed below, in chronological order, are some of the key announcements made by broadband operators, service providers and the regulator.

October

- NTL Incorporated and Telewest Global announced a definitive merger agreement under which ntl will acquire Telewest, creating the UK's largest provider of residential broadband and a leading provider of triple play services.
- The European Commission has authorised, under EU state aid rules, a UK broadband project which aims to bridge the “digital divide” between certain areas of England that have ‘fast’ Internet access and those that do not. The initiative will bring broadband communications to the West Midlands, East Midlands and South West England.
- Following successful trials of 8Mbps ADSL broadband, BT announced the next phase for the 8Mbps service. The trial, to begin at the end of November, will involve a wider market – initially 25 exchanges, rising to 53 exchanges as the trial progresses.

November

- Wanadoo became the first of the major ISPs who offer DSL-based broadband to take advantage of local loop unbundling, and launched an 8Mbps broadband service
- Following initial results from a WiMAX trial, Pipex announced in November that it was entering the next phase of development of its wireless broadband offering. Pipex said that the trial network has achieved stable service delivery and drive tests have delivered non-line-of-sight connectivity in excess of 1km from the base station.

December

- The Office of the Telecoms Adjudicator (OTA) announced that the total number of unbundled lines was in excess of 210,000 at the end of December, with a run rate of line orders claimed to be significantly greater than the 5,000 per week which was reported in November.
- The Scottish Executive announced that 378 remote and rural telephone exchange areas have access to broadband, meeting the Executive’s commitment to roll out broadband to every community of the country by the end of 2005.

2.1 Broadband coverage

Broadband is now available to 99.8% of the UK population, having grown from 96.4% in Q4 2004. The observed increase in coverage is largely a result of BT's commitment to provide coverage to 99.6% of households connected to its exchanges by Summer 2005. Having delivered on its commitments, BT is now partnering with local authorities to broadband enable the remaining exchanges. These schemes follow from successful partnerships with local government, such as those seen in Northern Ireland and Scotland, to deliver broadband to rural communities.

Increases in cable coverage have been minor and are largely a result of upgrades of legacy analogue equipment. Large scale deployments of cable are not expected in 2006.

The development of fixed wireless coverage remains uncertain. Pipex announced that it was entering the next phase of development of its wireless broadband offering following initial results from a WiMAX trial. Pipex believes that speeds of up to 8Mbps should be achievable by March 2006, enabling the company to deliver innovative and competitive broadband services to the UK market.

2.2 Subscribers and market share

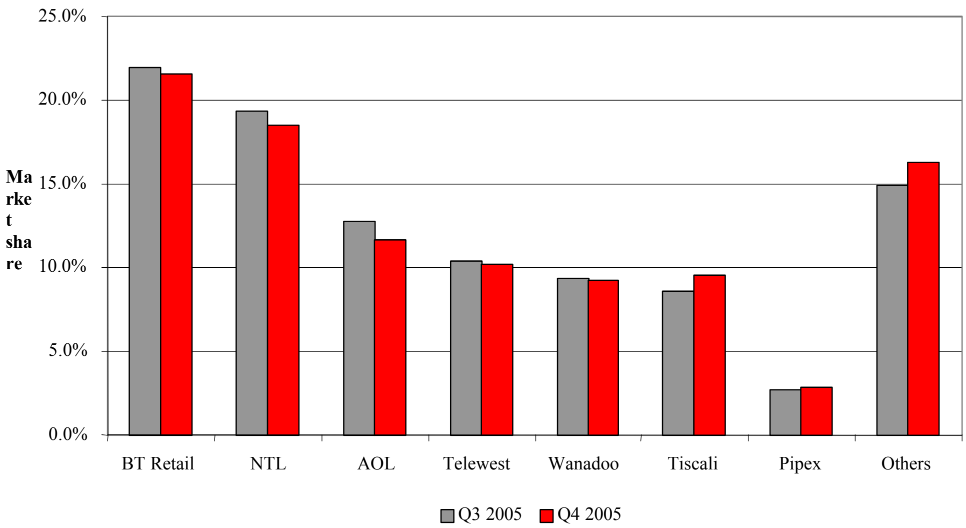
In the quarter ending December 2005, broadband subscribers totalled 9.82 million, marking an 11% increase in new subscriptions over the previous quarter, and 23% since the end of June 2005.

Total BT Wholesale connections increased by 11% to 6.93 million, whilst local loop unbundlers increased their connection base by 72% to 210,000 connections.

Total cable subscriptions at end Q4 2005 were 2.8 million, representing a 7% increase over the previous quarter.

Figure 2.1 shows the market share position of the major broadband service providers at end Q4 2005.

Figure 2.1: Market share of top UK broadband ISPs



Source: Point Topic

2.3 Pricing and new product developments

8Mbps broadband

Wanadoo became the first of the major ISPs who offer DSL-based broadband to take advantage of local loop unbundling and launch an 8Mbps broadband service in November. The service was priced at a promotional rate of £14.99, and will increase to £17.99 after the first six months. Inclusive of the £14.99 monthly fee, for the first six months, is Wireless & Talk - Wanadoo's Voice over Internet Protocol (VoIP) service. Usage is capped at 2GB per month. However an unlimited 8Mbps service is available for £27.99 per month.

Following successful trials of 8Mbps ADSL broadband, BT announced, in October, the next trial phase for the 8Mbps service. The trial, to begin at the end of November, will involve a wider market – initially 25 exchanges, rising to 53 exchanges as the trial progresses. The trial is the next step before an intended commercial launch of higher speed broadband services across the UK by Spring 2006.

WiMAX

Following initial results from a WiMAX trial, Pipex announced in November that it was entering the next phase of development of its wireless broadband offering. Pipex said that the trial network has achieved stable service delivery and drive tests have delivered non-line-of-sight connectivity in excess of 1km from the base station.

The next phase of development will see software and capacity upgrades applied to the trial installation to further understand the performance of the technology and to establish its commercial potential. Pipex believes that speeds of up to 8Mbps should be achievable by March 2006, enabling the company to deliver innovative and competitive broadband services to the UK market.

Local loop unbundling

The Telecoms Adjudicator reported that the total number of unbundled lines was in excess of 210,000 at the end of December, with a run rate of line orders claimed to be significantly greater than the 5,000 per week which was reported in November.

It was reported that The Carphone Warehouse was to invest up to £45m over the next three years as part of a major push into broadband and local loop unbundling. The Carphone Warehouse is said to be installing its own kit in 1,000 BT exchanges over the next three years, allowing it to provide broadband services to two thirds of its customer base.

In November, BT decided to introduce a 40% reduction in local loop unbundling (LLU) prices to further stimulate competition in the UK broadband market. The decision is the result of BT's commitment in June to bring the price of LLU charges in line with the wholesale line rental (WLR) offer. The connection charge for new lines to be introduced on 15 December will result in a reduction of £68.43, from £168.38 to £99.95 (excluding VAT). Additionally, shared and fully unbundled products will no longer be subject to minimum-term rental charges, a benefit which could be passed on to end users.

LLU uptake in the UK has historically been slow and Ofcom hopes that the latest price reduction will lead to an increased uptake.

In order to make LLU an attractive option, difficulties with supply must be resolved. According to Ovum research, the UK's LLU growth between Q2 2004 and Q2 2005 was the fifth highest in the EU15, with 276%, but it should be noted that France, which has already unbundled over 2 million lines, had a higher growth rate (326%). This indicates that although LLU growth is showing improvements, the UK is still lagging behind. The OTA was established in 2004 and OpenReach, BT's new Access Service Organisation, as required by Ofcom, is now fully operational. These two organisations should help encourage an increased uptake in LLU in the UK market.

Retail prices

Figure 2.2 provides a summary of several broadband packages available from service providers.

Figure 2.2: Trends in broadband access pricing

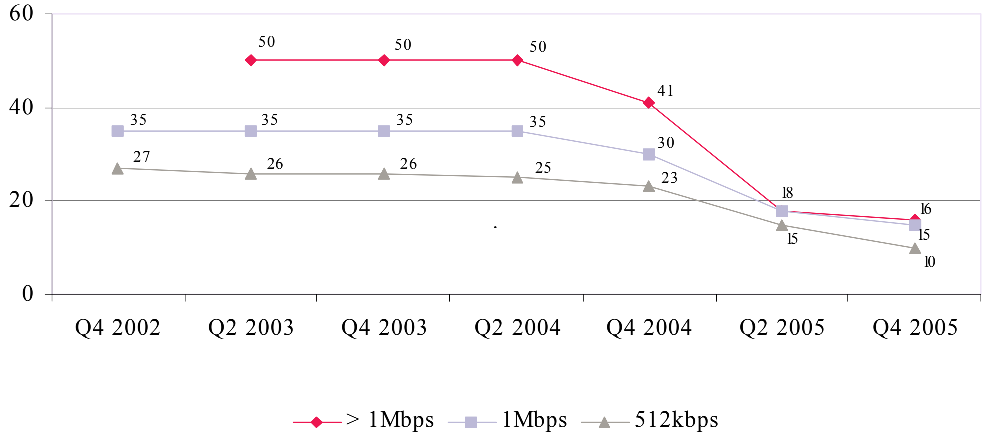
	Dec 04	Mar 05	June 05	Sept 05	Dec 05	Usage caps
Broadband (1Mbps)						
BT	29.99	17.99	17.99	-	-	
ntl	34.99	17.99	17.99	17.99	17.99	Unlimited
Telewest	35.00	19.99	19.99	-	-	
AOL	29.99	24.99	24.99	24.99	17.99	Unlimited
Wanadoo	17.99	17.99	17.99	14.99	14.99	2GB
Tiscali	15.99	15.99	15.99	14.99	14.99	Unlimited
Broadband (2Mbps)						
BT	-	24.99	24.99	17.99	17.99	1GB per day
ntl	-	24.99	24.99	24.99	24.99	Unlimited
Telewest	35.00	35.00	35.00	17.99	17.99	Unlimited
AOL	-	29.99	29.99	29.99	24.99	Unlimited
Wanadoo	-	-	-	17.99	-	2GB
Tiscali	-	-	19.99	17.99	17.99	Unlimited
Broadband (8Mbps)						
Wanadoo	-	-	-	-	17.99	2GB
Broadband (10Mbps)						
Ntl	-	-	-	37.99	34.99	75GB
Telewest	-	-	-	35.00	35.00	

Note: usage caps have been introduced by most providers for some packages, but vary considerably by actual package offered. Hence it is difficult to give a precise comparison.

Source: Operators

There is a noticeable trend towards 2Mbps broadband as the standard offering. While the upward trend is good for the majority, there does however exist a minority who are unable to receive 512kbps and above broadband. The primary reason for this is that the distance of the address from the exchange is too great. Other reasons include the quality of the telephone line being poor, and in some cases the capacity of the line not being sufficient to allow higher speed services. Figure 2.3 illustrates the decline in prices of broadband services since 2002.

Figure 2.3: Broadband prices over time



Source: Ofcom 'The Communications Market', February 2006

2.4 Government and public sector

In December 2005, the Scottish Executive announced that 378 remote and rural telephone exchange areas have access to broadband, meeting the Executive's commitment to roll out broadband to every community of the country by the end of 2005. The Broadband for Scotland's Remote and Rural Areas project has been funded as part of the Executive's £24 million broadband initiative for Scotland. The project also received financial support of up to £5 million from the European Regional Development Fund (ERDF) programme in Scotland. It was run in partnership with Highlands and Islands Enterprise (HIE) and Scottish Enterprise.

The European Commission has authorised, under EU state aid rules, a UK broadband project which aims to bridge the "digital divide" between certain areas of England that have fast Internet access and those that do not. The initiative will bring broadband communications to the West Midlands, East Midlands and South West England.

The Northwest Regional Development Agency (NWDA) showcased Project ACCESS, a £20 million broadband roll-out programme for Cumbria and North Lancashire. Project ACCESS delivers a high capacity wireless broadband network to over 95% of Cumbria and North Lancashire.

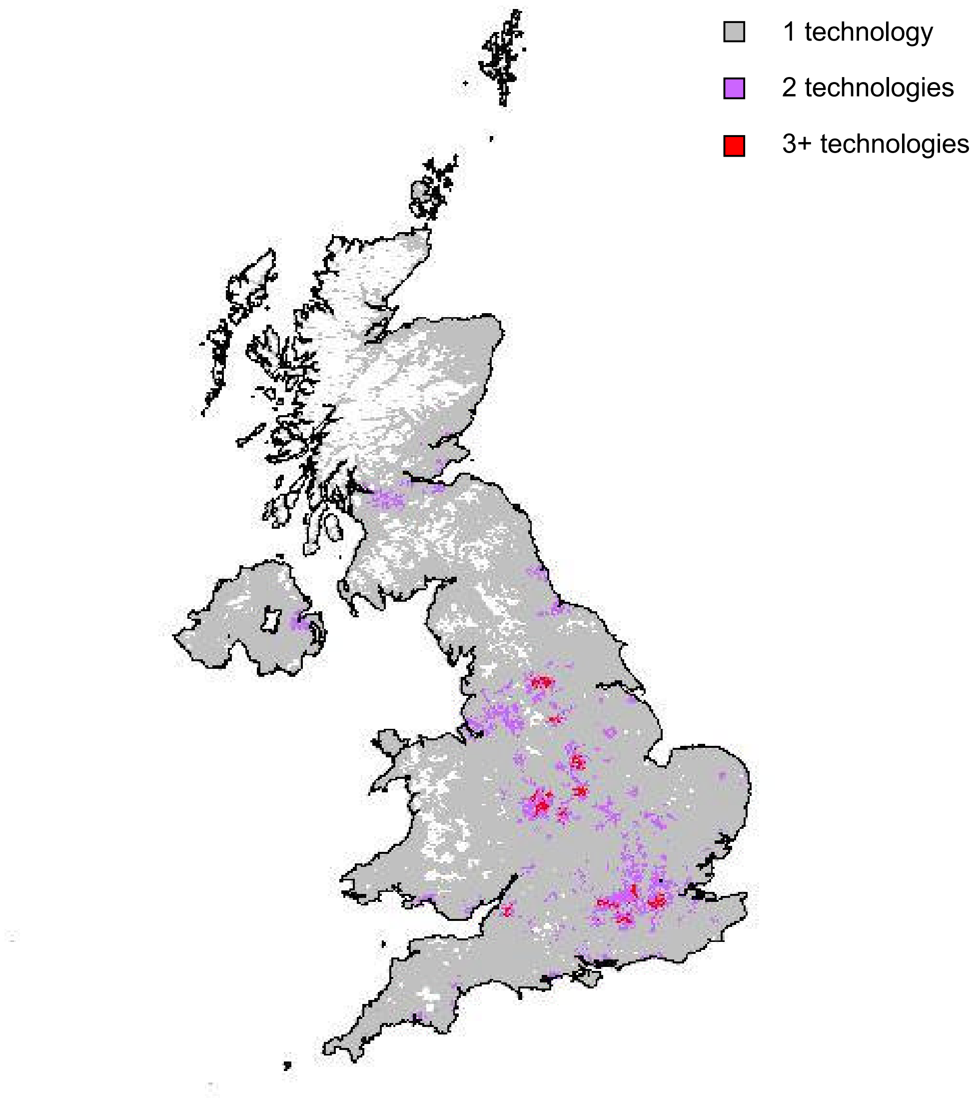
Under a partnership agreement between BT and the South West of England Regional Development Agency (SWRDA), BT announced a timetable for upgrading 19 exchanges, which had previously been considered not economically viable. SWRDA is investing £1.3 million in the upgrade programme in order to benefit nearly 4,000 homes and businesses in the region.

3 Coverage

3.1 Current UK coverage

Figure 3.1 shows the level of coverage of mass-market broadband technologies in the UK at end of December 2005 (Q4 2005).

Figure 3.1: Terrestrial broadband coverage of the UK at Q4 2005



Source: Ovum, BT, Kingston Communications, ntl, PCCW, Pipex, Telewest

At the end of December, 99.8% of the UK population (households) had access to a terrestrial mass-market broadband solution.

Figure 3.2 shows that ADSL is the dominant terrestrial broadband technology, providing access to 99.7% of households. Cable modem and FWA are the two other most significant providers of broadband, offering services to 48.2% and 11.2% of households respectively.

Figure 3.2: Proportion of households covered by broadband technology, Q4 2005

Technology	**Population coverage (%) Q4 2005**	**Population coverage (%) Q3 2005**
ADSL	99.7%	99.6%
Cable modem	48.2%	48.1%
FWA	11.2%	11.2%
Satellite	100%	100%
Total	99.8% (excluding satellite)	99.7% (excluding satellite)

Source: Ovum

Figure 3.3 presents a regional breakdown of broadband service availability during Q4 2005.

Figure 3.3: Proportion of households covered by broadband technology by geographical region in Q4 2005

	DSL	**Cable**	**FWA**	**Total**
East Midlands	99.9%	54.8%	20.8%	99.9%
East of England	99.9%	49.4%	0.3%	99.9%
London	100.0%	55.1%	36.6%	100.0%
North East	99.9%	48.9%	0.0%	99.9%
North West	99.9%	54.7%	3.4%	99.9%
Northern Ireland	99.4%	32.5%	0.0%	99.5%
Scotland	99.5%	42.0%	0.0%	99.5%
South East	99.6%	45.6%	7.4%	99.7%
South West	99.5%	40.2%	12.1%	99.7%
Wales	99.3%	25.1%	0.0%	99.3%
West Midlands	99.7%	63.0%	22.2%	99.7%
Yorkshire and Humberside	99.9%	42.6%	13.8%	99.9%
Total	*99.7%*	*48.2%*	*11.2%*	*99.8%*

Source: Ovum

Figure 3.4 breaks out broadband availability by rurality. The total column illustrates the percentage of households which have access to at least one broadband service.

Figure 3.4: Household coverage by mass-market broadband by area type, Q4 2005

	DSL	**Cable**	**FWA**	**Total**
Urban	99.9%	62.9%	15.9%	99.9%
Suburban	99.8%	36.6%	5.4%	99.9%
Rural	99.2%	7.4%	1.0%	99.2%

Source: Ovum

Current DSL coverage

Total UK DSL coverage, as of December 2005, was calculated to cover over 99.7% of the UK household population.

Figure 3.5 shows the coverage of DSL by postcodes across the UK.

Figure 3.5: DSL coverage in the UK, Q4 2005

Source: Ovum, BT, Kingston Communications

Current cable modem coverage

Cable modem based services are restricted to within a cable operator's network reach. For the UK, it is estimated that 48% of households are passed by broadband enabled cable networks, based on the postcode data provided by cable network operators[1].

Figure 3.6: Cable modem coverage in the UK, Q4 2005

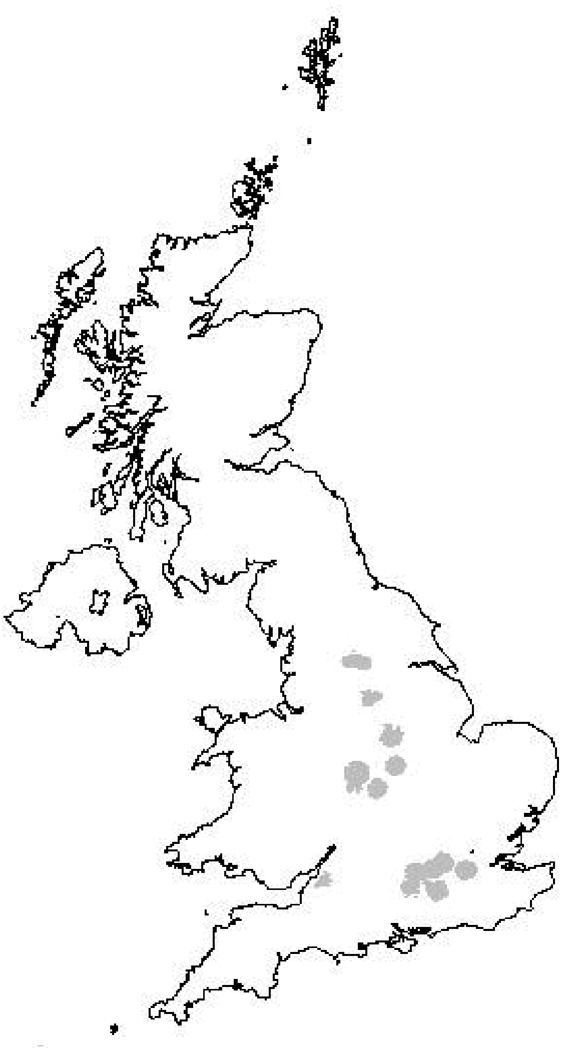
Source: Ovum, ntl, Telewest, Isle of Wight Cable

[1] ntl and Telewest

Current FWA coverage

Figure 3.7 shows the coverage provided by FWA networks. Coverage by fixed wireless terminals has remained static and remains at 11% of the UK household population.

Figure 3.7: FWA coverage in the UK, Q4 2005



Source: Ovum, PCCW, Pipex

FWA coverage is limited to a small number of regions across England. Over 45% of the current FWA residential population coverage is spread across London and the

South East. The Midlands area constitutes around 30% of the total coverage. The South West and Yorkshire and Humber each have around 10% population coverage, with the remainder being spread across the North West and East of England.

In addition to the two main FWA providers in the UK, Pipex and PCCW-owned Broadband UK, there are a number of other providers.

Telabria and Libera are wireless operators who are looking to expand through deploying WiMAX technology in order to serve businesses. Telabria intends to roll out WiMAX in the South East of England while Libera, from its base in Bristol, intends to roll WiMAX out to cover 75% of businesses over the next two years.

There exists a number of smaller providers who target areas, in particular villages, where ADSL blackspots exist. Langreen is an example of such a provider, Langreen currently serves over 50 communities across the UK. Langreen is partnering with local bodies to bring their expertise to blackspot areas in order to deliver broadband. However, the small nature of ADSL blackspots and their often rural location means that not all are being addressed. Consequently, there remains pockets of the population who are missing out on the broadband revolution.

Current satellite coverage

Broadband satellite coverage in the UK nears 100% (there are occasional satellite shadows) and can be considered ubiquitous. However, in the UK at least, it remains essentially a niche service with its main benefit being ultimate reach where no other technology can. There exists significant drawbacks that have inhibited the mass-market adoption of satellite to date, they include:

- the rapid roll out of DSL broadband has dampened much of the demand that may have existed
- the economics for providing point-to-point services have yet to be proven and remain doubtful in areas where terrestrial alternatives exist
- even at the speed of light, it takes approximately 0.3 seconds for a signal to travel from a ground station to a geostationary satellite and back to Earth again. This unavoidable latency is a serious disadvantage for some real-time broadband applications such as video conferencing.

4 Take-up

Mass market broadband take-up is currently in the phase of fastest growth in the UK as technology availability, consumer awareness, applications and content availability, pricing and affordability are coming together as strong forces driving demand.

4.1 Current take-up

Latest figures (end September 2005) indicate that total residential broadband connections (ADSL, cable modems, fixed wireless access and satellite) had reached 7.8 million at the end of September 2005[2], a penetration of 30% of UK households. Business broadband connections totalled just over 1 million.

DSL growth in the three months to September 30 was 12% while cable modem growth was 9%[3]. FWA and satellite growth were both limited during the quarter.

BT Wholesale connections increased by over 1.3 million during the six month period since the previous report. This represents slower growth than that experienced in the six months to March 2005, where net additions increased by almost two million. Connections to an unbundled exchange increased from 41,000 in Q1 to 122,000 in Q3.

Figure 4.1 summarises estimates[4] of the current level of broadband connections by residential and business customers, by broadband technology.

Figure 4.1: Broadband connections, Q4 2005

	ADSL	*Cable modem*	*FWA*	*Satellite*	*Total*
Residential	6,076,101	2,578,379	2,636	1,332	8,658,448
Business	1,107,899	51,921	5,701	2,004	1,167,525
Total	**7,184,000**	**2,630,300**	**8,337**	**3,336**	**9,825,973**

Source: Ovum, Point Topic

[2] Point Topic

[3] Point Topic and operators' reports. During the research process for the new quarterly statistics report, we commonly also return to past quarters with the aim of synchronising earlier estimates with official sources. Some restatements were thus necessary for this quarter compared to Q3 2005. Some of the historical statistics will be different from those published in earlier reports. Generally, preference should be given to the numbers in the most recent report - this report.

[4] Estimates are based on Ovum analysis, using operator data where available

Current DSL take up

In the six month period to December 2005, the DSL market in the UK grew by almost 26% to reach over 7.2 million lines. There are signs that the growth rate is beginning to slow as the market approaches maturity stage.

Approximately 32% of DSL lines are retailed by BT, with the remainder provided by ISPs through wholesale DSL (predominantly from BT Wholesale).

Figure 4.2 shows how DSL connections are concentrated.

Figure 4.2: ADSL connections, and penetration of potential total within the residential and business sectors, Q4 2005

	Residential	*Business*	*Total*
Urban	4,530,738	737,663	5,268,401
	28%	91%	
Suburban	986,657	193,743	1,180,401
	20%	80%	
Rural	558,706	176,493	735,198
	13%	55%	
Total	**6,076,101**	**1,107,899**	**7,184,000**

Note: businesses may have more than 1 broadband line

Source: Ovum

Current cable modem take-up

At end December 2005, total residential cable modem connections were approximately 2.6 million. Broken down, ntl had over 1.6 million broadband subscribers while Telewest had close to one million subscribers.

Figure 4.3 shows the current take-up of cable modems at end December 2005.

Figure 4.3: Cable modem subscribers and penetration, Q4 2005

	Residential	*Business*	*Total*
Urban	2,216,495	43,421	2,259,916
	14%	5%	
Suburban	305,928	7,706	313,634
	6%	3%	
Rural	55,956	794	56,750
	1%	0%	
Total	**2,578,379**	**51,921**	**2,630,300**

Note: businesses may have more than 1 broadband line

Source: Ovum

Current FWA take-up

Currently there are two major players operating in the UK: Pipex and PCCW, through its UK Broadband business. There are a number of other smaller players operating in unlicensed bands.

Neither operator publicises subscriber figures. Current estimates suggest there are approximately 8,000 FWA subscribers.

FWA has stumbled slightly this year as both Pipex and PCCW considered the market in light of the rapid deployment of DSL in rural areas and the role of WiMAX.

Current satellite take up

We estimate that there are currently over 3,000 2-way broadband satellite subscribers.

5 Competition

The competitive environment for broadband in the UK continued to develop quickly over the last Quarter of 2005.

ISPs have continued on the path of offering higher speeds for a lower cost. For example, Ofcom observed in its 2005 Communication Market Report that a 512kbps connection typically cost £27 per month at the end of 2002. By the end of 2005, operators were offering a 1Mbps connection from £14.99 a month, with the average cost down to £16.50 from £27 a year ago.

5.1 Competition between operators

NTL Incorporated and Telewest Global announced a definitive merger agreement under which ntl will acquire Telewest, creating the UK's largest provider of residential broadband and a leading provider of triple play services.

Wanadoo became the first of the major ISPs who offer DSL-based broadband to take advantage of local loop unbundling, and launched an 8Mbps broadband service.

Following successful trials of 8Mbps ADSL broadband, BT announced the next phase for the 8Mbps service. The trial, to begin at the end of November, will involve a wider market – initially 25 exchanges, rising to 53 exchanges as the trial progresses.

The Office of the Telecommunications Adjudicator (OTA) announced that the number of unbundled lines at the end of December 2005 was in excess of 210,000, with a run rate of line orders significantly greater than the 5,000 per week which was reported in November 2005.

5.2 Impact of competition

Price

The UK currently remains ranked 4th in the price index table, see Figure 5.1. The only ISP in the UK to make any changes to its pricing of broadband in the last quarter of 2005 was AOL who reduced the price of their 1Mbps service significantly from £24.99 to £17.99.

The price index is calculated as the price of the top 5 retail ISPs, weighted by market share. Prices used are for mainstream residential products and include connection fees amortised over a three-year period and are adjusted for purchasing power parity (PPP).[5] In order to give a value between 0 and 1 for this index a PPP price of

[5] Prices are converted from local currency to USD using the exchange rate from the same time as the PPP factors to ensure consistency.

USD200 or less (per year) is allocated a score of 1, with a PPP price of USD800 or more allocated 0. A linear scale is used between these points.

Figure 5.1: Price Index at Q4 2005

	Q4 2005	**G7 rank Q4 2005**	**Q3 2005**	**G7 rank Q3 2005**	**Q1 2005**	**G7 rank Q1 2005**
Japan	0.97	1	0.98	1	0.98	1
France	0.86	2	0.85	2	0.94	2
Canada	0.79	3	0.80	3	0.77	3
UK	**0.77**	**4**	**0.76**	**4**	**0.72**	**4**
Ireland	0.75		0.75		0.67	
Italy	0.71	5	0.70	5	0.50	6
Australia	0.69		0.69		0.63	
Sweden	0.64		0.65		0.63	
US	0.63	6	0.62	6	0.62	5
South Korea	0.53		0.54		0.53	
Germany	0.44	7	0.46	7	0.41	7

Source: Ovum

Customer choice

At the end of December 2005, 99.8% of the UK population (households) had access to a terrestrial mass-market broadband solution. This represents an increase of 2% on coverage estimates in the Q1 2005 report. The observed increase in coverage is largely a result of BT's commitment to provide coverage to 99.6% of households connected to its exchanges by Summer 2005. Having delivered on its commitments, BT is now partnering with local authorities to broadband enable the remaining exchanges. These schemes follow from successful partnerships with local government, such as those seen in Northern Ireland and Scotland, to deliver broadband to rural communities.

Access to two or more mass-market broadband solutions remained unchanged over the Q4 2005 period - 45% of the UK household population had a choice of two terrestrial broadband technologies, and 7% had a choice of three technologies.

Increases in cable coverage have been minor and are largely a result of upgrades of legacy analogue equipment. Further large scale deployments of cable are not expected in 2006.

The development of fixed wireless coverage remains uncertain. Pipex announced that it was entering the next phase of development of its wireless broadband offering following initial results from a WiMAX trial. Pipex believes that speeds of up to 8Mbps should be achievable by March 2006, enabling the company to deliver innovative and competitive broadband services to the UK market.

We have calculated an availability index which is a measure of the percentage of the population with access to a terrestrial broadband solution (naturally a value between 0 and 1).

Figure 5.2: Availability Index at Q4 2005

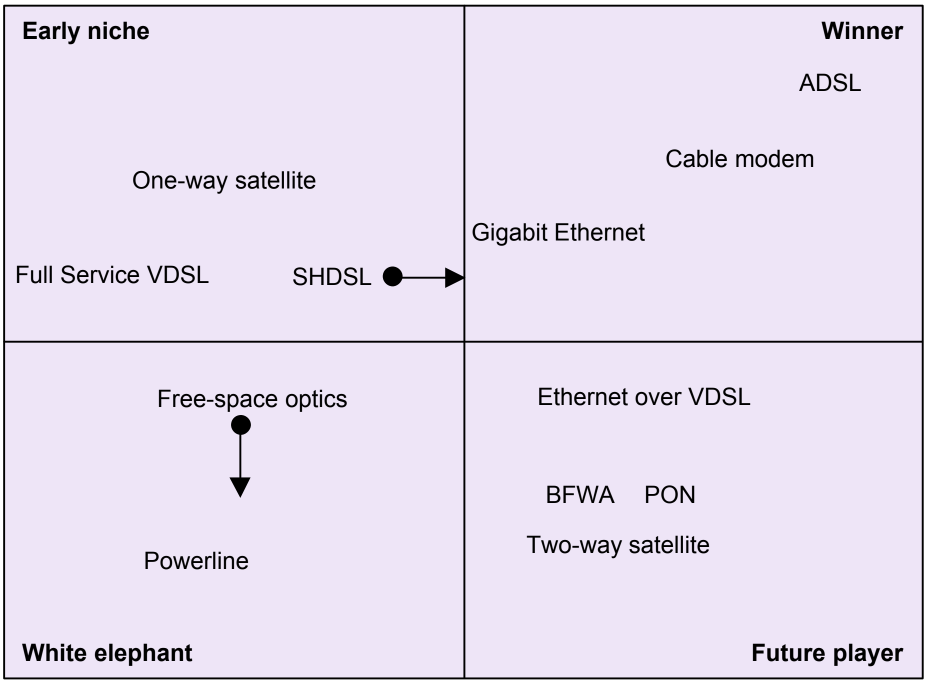
	Q4 2005	**G7 rank Q4 2005**	**Q3 2005**	**G7 rank Q3 2005**	**Q1 2005**	**G7 rank Q1 2005**
UK	**1.00 (0.998)**	**1**	**1.00 (0.997)**	**1**	**0.98**	**1**
South Korea	0.97		0.97		0.97	
Japan	0.96	2	0.96	2	0.95	2
France	0.95	3	0.95	3	0.90	3=
US	0.94	4	0.94	4	0.89	6
Germany	0.91	5	0.91	5	0.90	3=
Sweden	0.90		0.90		0.90	
Italy	0.90	6	0.90	6	0.90	3=
Canada	0.89	7	0.89	7	0.86	7
Australia	0.85		0.85		0.80	
Ireland	0.85		0.81		0.74	

Source: Ovum

Annex A: Broadband technologies

Figure A1 shows the access technology landscape as we see it today. This is a snapshot of the market and we expect technologies to move around the grid as time progresses. The arrows show how we expect some technologies to move in the medium term. For further details of each technology please refer to the individual documents within this series.

Figure A1 **Broadband access technology landscape**



Source: Ovum

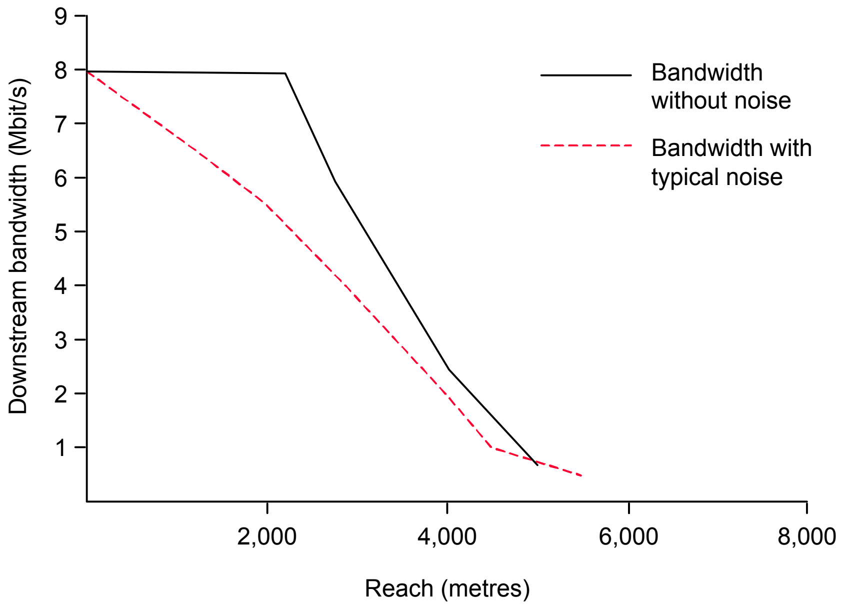
Note: PON stands for Passive Optical Network

A1 DSL in general

DSL has a distinct advantage over other fixed access network technologies, as it enables the incumbent operator to re-use its investment in its copper infrastructure, which, at least in more developed countries, is already deployed to cover a high percentage of the population. For a typical incumbent operator, the access network can account for approximately 70% of its network costs, and it is therefore important to make this investment work as hard as possible. DSL is also important for competitive operators, as it allows them, either through local loop unbundling or wholesale access, to gain access to broadband markets without having to deploy their own local access network.

However, DSL is not the perfect broadband technology, as there is a trade-off between reach and bandwidth. The decline of bandwidth with the length of the copper local loop is shown in Figure A2 for the most popular DSL technology, ADSL.

Figure A2 **ADSL – reach versus bandwidth**



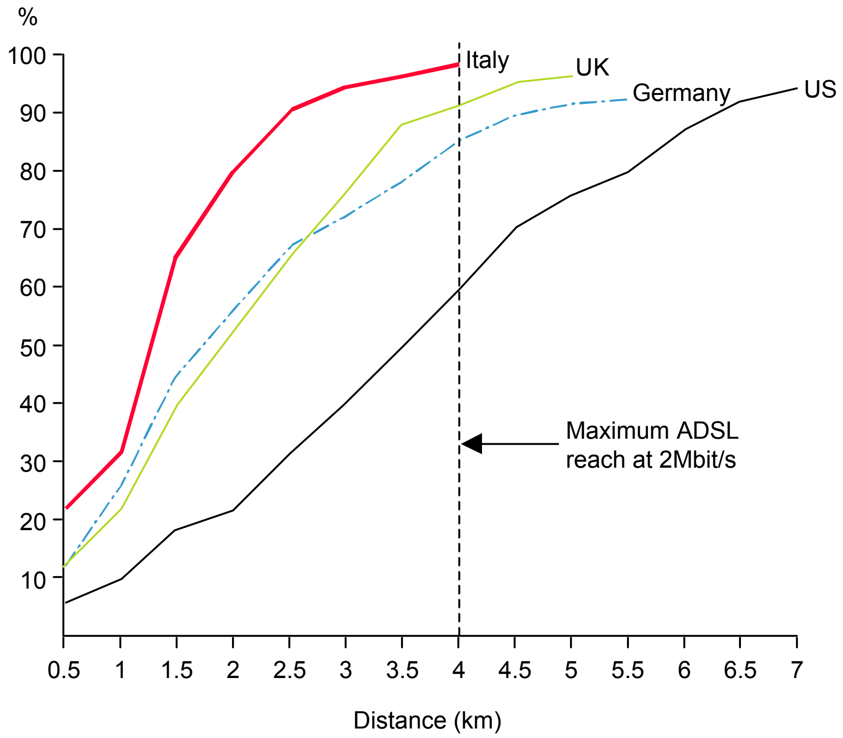
Note: these figures are for 0.5mm copper wiring. Reach depends on the size, age and quality of the wiring used

Source: Fujitsu

The practical implications of this trade-off vary between countries and regions. Different countries have different average local loop lengths, as shown in *Figure A3*. The proportion of customers within the range of 2Mbps ADSL services can vary from as little as 60% in the US to more than 90% in countries such as the UK and Italy, although in practice this simple picture is complicated by other factors.

Naturally, within countries, longer loops tend to be in rural areas and the outer suburbs, so there is a particular problem in providing broadband services by DSL in these areas.

Figure A3 **Local loop lengths in Europe and the US**



Source: IEEE Communications

Overview

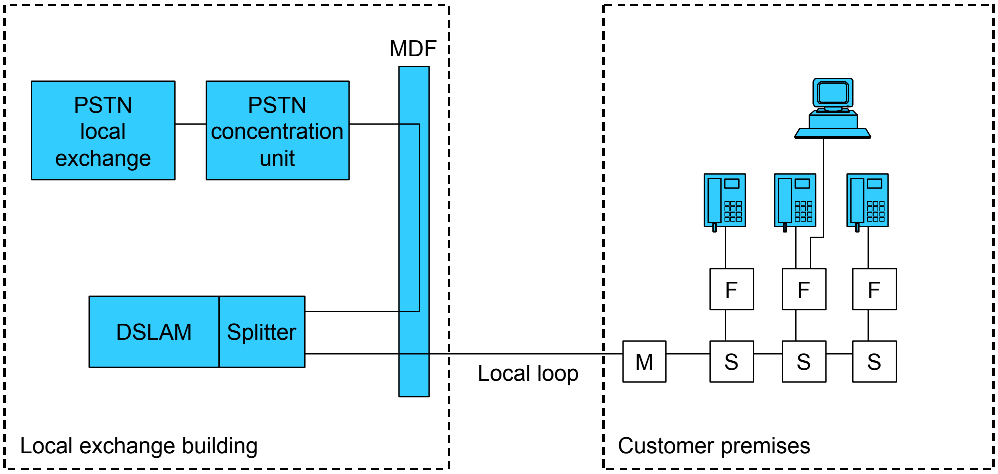
ADSL is an asymmetric broadband access technology that was specifically designed for the residential market. However, due to the lack of any other cheap broadband solution in this bandwidth range, ADSL is also proving reasonably popular in the SME market. Being asymmetric, it is ideal for any broadband service where the majority of the traffic flows in the downstream direction – which of course includes high-speed Internet access. So far, high-speed Internet access has been the main service offered by operators, and this is currently where the customer demand lies.

ADSL operators are now increasingly focusing on the development of new broadband services that will generate additional revenue streams. Today, most ADSL tariffs are based on a flat rate, offering unlimited Internet access for a fixed monthly charge. This simple service has succeeded in attracting customers, but does not allow operators to increase the revenues per user, which they now need to do.

Network architecture

On the whole, ADSL is thought of as an exchange-based solution. The basic architecture is shown in *FigureA4*.

Figure A4 **ADSL system implementation (exchange-based, with microfilters)**



M = master socket

S = extension socket

F = filter

MDF = main distribution frame

Source: Ovum

The installation of ADSL on a line leaves the traditional PSTN equipment for the delivery of PSTN voice services largely unchanged, which is a big advantage. All the local loops at an exchange terminate at a main distribution frame (MDF), which cross-connects each local loop to the corresponding copper pair from the PSTN concentration unit. When a customer orders ADSL, their local loop is diverted and plugged through to a DSL access multiplexer (DSLAM) via a splitter. The splitter separates out the ADSL and voice signals electronically. The voice channel is routed back through the MDF to the concentration unit, and the data signal is routed through the DSLAM to the backhaul data network. This re-routing of the local loop has to be done manually and can add significantly to costs, delays and errors in setting up DSL services.

The voice and data signals also need to be distinguished at the customer's premises. In the original architecture for ADSL, this is done by another splitter at the point of entry to the premises, which in effect divides the home network into separate voice and data parts. The problem with this is that installing such a splitter is a job for a telecoms engineer, making it very difficult to provide ADSL profitably, and at an acceptable price for the consumer mass market.

The solution has been not to split the home network at all, but to use microfilters instead. A microfilter is a low-cost device that filters out the high-frequency broadband signal on a DSL line. It is installed by plugging it into a phone jack and then plugging the telephone lead into the back of it – something customers can easily do for themselves. The microfilter protects the phone from interference due to use of the line for ADSL. The ADSL modem is plugged into the same shared home network and itself filters out the low-frequency voice signals to forward just the broadband data to and from the user's computer.

This microfilter-based approach is what has made user self-installation of ADSL possible. Self-installation is now virtually universal for consumer ADSL services and in each country where it has been introduced, it has stimulated rapid growth in DSL numbers at a much more attractive cost from the operator's point of view.

ADSL is the most successful broadband access technology today. In terms of subscriber numbers, it crept ahead of cable modems in late 2001. We predict that ADSL's advantage over its main competitors will continue to increase over the next five years.

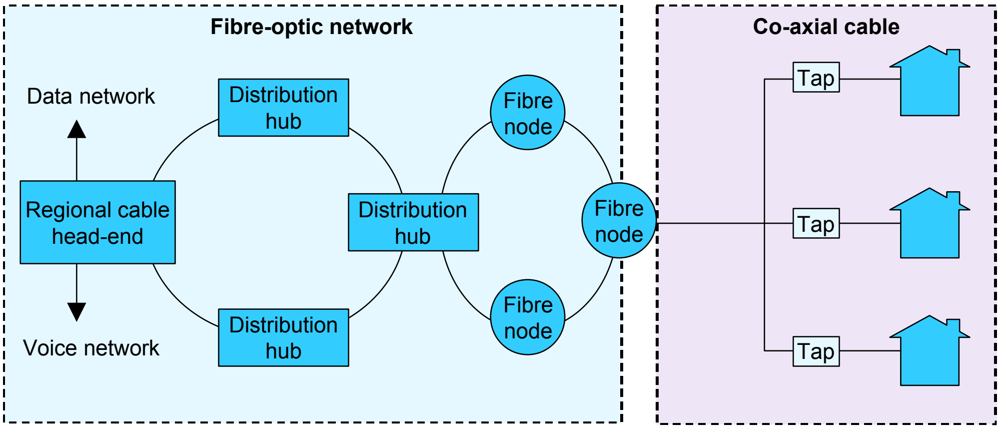
A2 Cable Modems

TV to Internet

Cable networks were originally deployed for the delivery of broadcast TV services. To make sure that standard TV sets could be used, the operators simply recreated the analogue TV signals on the co-axial cable. As the only service delivered was TV, there was no need to develop a two-way communications network, and thus the first cable networks were one-way only.

To deliver both TV and high-speed Internet access, and to support two-way communication, the newer cable networks use a hybrid fibre co-axial architecture, shown in *Figure A5*. Most older networks are in the process of being upgraded to this standard as well.

Figure A5 **Hybrid fibre co-ax cable architecture**



Source: Ovum

Cable and voice

To enable voice services over the cable connection, the network has to be further upgraded for the delivery of voice-over-IP. This means significant additional investment in telephony infrastructure. Operators need softswitch and gateway components and users need to be connected through DOCSIS 1.1 equipment. Deploying triple play may become inextricably linked to multimedia upgrades in the HFC network and a replacement programme for user CPE.

In the UK and Spain, this upgrade has been unnecessary as the operators have deployed combined HFC and twisted copper pair access networks, with voice services carried over the copper pair. However, as this is not a true multimedia solution, operators will need to upgrade over time as multimedia applications become more significant.

US and Europe: PacketCable and IP Cablecom

The Cable Labs-initiated PacketCable project was launched to define a method of carrying multimedia traffic, with varying levels of QoS, over cable infrastructure. Other objectives include support for VoIP network management, provisioning, security and billing. DOCSIS 1.1 was chosen as the technical starting point because of its enhanced QoS features.

In Europe, ETSI has developed additional standards for the European cable industry under the banner of IP Cablecom. Although these – for the most part – follow PacketCable closely, the need for a development path that includes existing circuit-switched telephony equipment is stronger in Europe. Many European cable companies have deployed telephone service using conventional voice switching and separate voice pairs.

VoIP

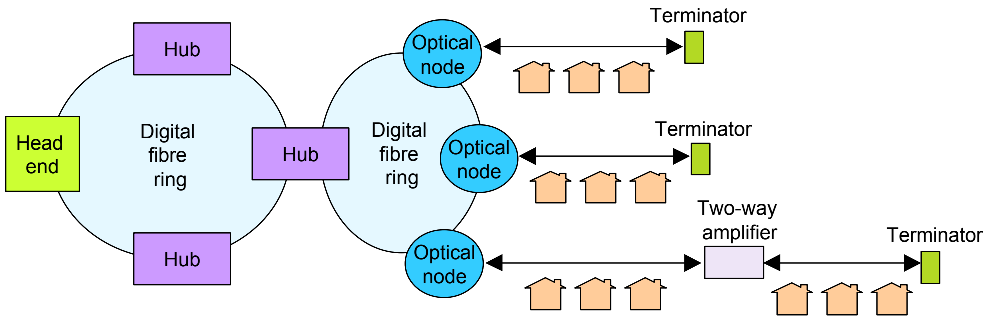
PacketCable was designed with the goal of absolute parity of voice services between cable and the PSTN. At the time that the PacketCable standards were developed, Internet usage was less and VoIP quality was much poorer than it is today.

VoIP quality is now very high, providing that network latency is sufficiently low. In any event, users' expectations of a phone service have decreased. Cellular phones offer a lower quality call – lower than VoIP – and are widely used. Against this background occasional periods of reduced quality have become acceptable within a phone service. This means that operators looking to move into voice do not necessarily have to go down the more costly PacketCable route as it is viable to launch a second-line voice service much more cheaply.

Providing QoS and voice – deep fibre architecture

In order to move beyond Internet services that can only provide a low guaranteed rate, in addition to voice-enabling the network, operators are carrying out deeper upgrades. For example, in the US, the need to have an extremely reliable backbone for telephony coupled with expansion of channels and offering of business services has led cable companies to push out fibre ring architecture deeper into the network, as shown in *Figure A6*.

Figure A6 **Deep fibre architecture**



Source: Ovum

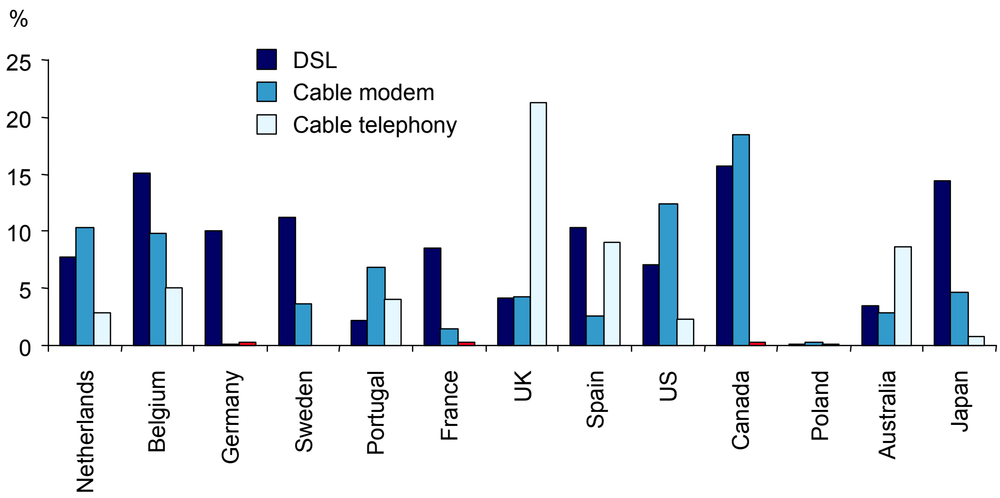
The architecture also removes amplifiers from the segments, making them entirely passive and hence more reliable. The number of homes per node generally needs to be reduced to 250 or fewer if passive segments are used.

On the whole, cable modems have been a success. However, ADSL has now overtaken cable modems in terms of worldwide subscribers, and its lead will increase. This is due to the following factors:

- availability of cable modems differs greatly between countries, depending on the extent of the local cable TV networks
- not all networks are upgraded to support cable modem
- operators have limited investment resources

Figure A7 shows the varying penetration of cable modem penetration compared to DSL and the existence of cable telephony (or not) in key markets.

Figure 3 **Cable modem, DSL and cable telephony penetration, end of 2002**



Source: Ovum

A3 FWA

Overview

Fixed wireless access (FWA) could be described as the most complicated of all fixed access technologies. At the last count, we listed more than ten acronyms for technologies in this area. The vice president of a telecommunications company once told Ovum that he would consider using FWA, if only he knew what it did! With the division between what is mobile and what is fixed blurring, this is getting even worse.

The basic facts of FWA

FWA bypasses the local loop by using radio technology to connect the customer to the exchange. Any issues related to local loop unbundling, digging optical fibre ducts and so on can therefore be ignored.

FWA services are allocated bands in the radio frequency spectrum. For example, mobile services usually operate in the 800–1,000MHz or 1,700–to 2,000MHz frequency bands. FWA services generally use higher frequency bands, with allocations somewhere in the range of 2.4GHz up to more than 40GHz. (Hertz, or Hz, is the unit of frequency and 1Hz is one cycle per second, so FWA signals are carried on radio waves with frequencies from 2.4 billion to 40 billion cycles per second.)

Essentially, the higher the frequency band the system works in, the greater the bandwidth available. However, as the frequency increases, so the range and the ability to receive signals that are not in the direct line of sight decreases. Less range means more base stations to cover the same area, and the line-of-sight requirement means lower penetration of the area covered, or installing even more base or repeater stations to fill the gaps.

Some parts of the spectrum are licensed and some are not. Licences can be expensive and carry strict conditions, but non-licensed spectrum can be 'noisy' and therefore susceptible to interference.

Most equipment can work at a range of different frequencies and so can be modified to suit different frequency allocations in different countries. This can even include mobile spectrum if it is not currently being used for mobile services.

Depending on the frequency and modulation scheme being used, radio service distances can range from 1 kilometre to 35 kilometres, and bandwidths can range from 64kbps to hundreds of Mbps.

Unlicensed bands (2.4GHz to 5GHz)

The lowest-frequency FWA bands, in the 2.4GHz and 5GHz regions, can be used without a licence in most countries. They are often known as the ISM (industrial, scientific and medical) bands and a huge variety of devices generate signals in this range, from microwave ovens to garage-door controls. They are now becoming increasingly important for low-cost fixed wireless services, and also as the frequency bands used by wireless LAN services.

With the agreement of the IEEE standard 802.11a/b, wireless LAN hotspots are being installed in thousands of locations. The UK has approximately 50% of the hotspots in Europe. The concept of a 'hotspot' is to have a small area, such as an airport lounge or a cafe, where people can access the Internet directly from a laptop computer using a very local radio signal.

Alternatively, independent operators can use this spectrum, using different signalling technology, for true broadband FWA – up to 1Mbps (burst) over 6 kilometres. Wireless ISPs have been using these frequencies to serve small groups of customers in the US and Latin America for some years, but up until now this has been rare in other parts of the world.

IEEE 802.16a/WiMAX

The advantage of 802.11 over other FWA technologies is that it is a standardised technology. This allows interoperability between equipment as well as economies of scale, which enables low equipment prices. However, 802.11 is not ideally suited for use in local access, albeit that some operators are using for just that. However, a third standard, 802.16, has been developed to have the same advantages as 802.11 but be better suited for use in the access network.

802.16, otherwise know as WiMAX, covers the frequency bands in the range between 2GHz and 11GHz. This flexibility and frequency range allows operators to tune into the frequency plan of its home country whilst allowing bandwidths of just under 100Mbps per sector.

Supporters of the technology claim it is not dependent on line of sight, but this will not be the case at frequencies over 3GHz in practical deployments.

3.5GHz

The 3.5GHz band shares the same technical characteristics as the 2.4GHz and 5GHz bands, but it is a licensed band in most countries. Most technologies that work in this area can also work in the 2.4GHz and 5GHz bands.

Early 3.5GHz systems concentrated on narrowband ‘wireless local loop’ type services – generally voice only. Ionica in the UK was a prime example. This is because at 3.5GHz, bandwidth is limited, and to reduce equipment costs, point-to-multipoint architectures are required. Therefore, to capture a large customer base, the bandwidth that is available must be shared out thinly. As voice requires only 64kbps (assuming no encryption), voice only over FWA seemed logical from a technology point of view. Unfortunately, the business case did not work and companies such as Ionica have disappeared.

However, new technologies have now been developed that enable operators to deliver broadband FWA with both voice and data (bursting at Megabit rates) to customers using the 3.5GHz band. At the same time, using the 3.5GHz band has benefits because it allows reasonably wide-area coverage. Although technically 3.5GHz is less dependent on line-of-sight access than higher frequency systems, in practice it must be considered as a line-of-sight technology.

MMDS (2.5–2.7GHz)

Multipoint multichannel distribution service (MMDS) was originally designed to induce competition in the US cable TV market. The initial systems therefore transported data only in the downstream direction, and so could not be classed as a true communication medium. However, the frequency plan has now been upgraded to allow communication in both directions.

Apart from the fact that they use slightly different frequencies, there is no fundamental difference between MMDS in North America and 3.5GHz FWA in the rest of the world. The reason for the use of different frequencies was that the 2.5–2.7GHz frequency bands had already been assigned for other purposes in Western Europe and Latin America.

LMDS (over 20GHz)

Local multipoint distribution service (LMDS) is the term generally used in the US; in the rest of the world these bands are more often known by their frequency (26GHz and so on). LMDS was designed to be the radio world's answer to broadband access. Operating above 20GHz, LMDS can deliver bandwidths in the region of 150Mbps and above. Unlike MMDS, LMDS was designed from the start for two-way communications and was intended to be a true competitor to xDSL and even fibre-optic access.

Although there was a rush of interest in licensing and launching services in these bands at the time of the telecoms boom, the actual results have been disappointing. The costs proved too high, and the technical difficulties too great, to support viable services at frequencies over 20GHz. There are only a handful of end users of these services today, and these are generally on a trial basis. The most promising applications for the time being are probably in backhaul for mobile base stations.

Trials have been carried out with systems working at over 40GHz. One possible application is to provide infill for broadcast TV coverage in mountainous regions. The range at 40GHz is very short, but such services may be well adapted to cover a narrow mountain valley, for example.

Mesh

Mesh FWA uses the same frequencies as LMDS (but could be deployed at any frequency), but is a completely new access solution in terms of its architecture. A mesh system is fundamentally a multipoint-to-multipoint access solution. This means that a customer's receiver is also a transmitter, and paths are formed by hopping from one customer to another. By spreading receivers around a city, the issues of short reach and low penetration can be resolved.

The technical problems are challenging, such as those related to routing to achieve efficient coverage, but mesh systems could eventually provide the means to make LMDS a cost-effective and attractive broadband solution.

Wireless point-to-point

FWA solutions are generally point-to-multipoint, sometimes known as PMP. That is, a single central hub sends to, and receives from, a number of FWA users. The alternative of point-to-point (PTP) is used mainly for trunk connections within the backhaul network or to connect large business customers when an optical fibre connection is either impossible or not economically viable. An alternative use is for backup when there is only one fixed-line access into a building.

These systems are usually fully SDH-capable to provide carrier class of service, and are generally very expensive.

Outlook for FWA

It is fair to say that broadband FWA has not seen much success, and many analysts see it as a complete failure. We believe the failures are mainly due to the following problems:

- although licences are not required for all FWA bands, larger operators prefer to use licensed spectrum as it provides better quality. However, in many countries the licences have been expensive and are restrictive in their use
- in some countries (especially in Europe), many regulators forced the operators to achieve a certain geographic coverage in a specified amount of time. This led to operators deploying expensive network equipment in areas where there was little or no demand
- some business cases were just plain wrong. Deploying broadband FWA in large cities, where heavy competition already exists, was always going to be tough
- the downturn in the telecoms market caused much-needed investment to dry up
- differing frequency plans and licences around the world have hindered economies of scale, and therefore equipment is still expensive.

However, we do not believe that the broadband FWA market is dead. It still has potential in countries or areas where other forms of broadband access are not available. Some broadband FWA technologies could also be used in heavily populated areas to provide a cheap but low-quality connection for Internet access.

Changes in regulations and licensing procedures, together with great advances in technology, mean that there is light at the end of the tunnel for BFWA. WiMAX is also bringing equipment costs down and allowing self-installation for the very first time – both will improve BFWA's chances of some success in the future as a niche market product.

Broadband FWA will never be as large as ADSL or cable modems, but we believe that it does serve a certain need in the access market. Fixed-line technologies will never be able to reach every customer in every part of the world, and this is where FWA comes in. FWA will have more success in developing countries, where fixed-line infrastructure is poorly developed.

A4 Satellite

The history of satellite telecommunications, since the launch of the first civilian communications satellite, Telstar, in 1962, is one of missed opportunities and isolated spectacular successes that have been matched, in recent years, by spectacular failures. Over the last 40 years, satellite's relationship with terrestrial telecommunications has wavered between being a pre-cursor, a competitor and a complementary service.

Some fundamental strengths of satellite are consistent:

- satellite is an ideal wide-area point-to-multipoint delivery mechanism. This is central to the success of satellite broadcasting. It has also allowed very small aperture terminal (VSAT) services to achieve some success, particularly in North America, even in areas where terrestrial alternatives are available. VSATs are moderately-sized dishes that make it economical to provide communication services via satellite to widely spread business locations
- satellites provide coverage in areas that may be economically marginal for terrestrial technologies. A single geostationary satellite can see as much as 42% of the earth's surface
- in principle, a satellite network can be deployed in a fraction of the time it might take to implement its terrestrial equivalent.

Set against these advantages are some significant drawbacks of satellite solutions that have inhibited their mass-market adoption to date:

- line-of-sight is required between the user and the satellite
- the economics for providing point-to-point services have yet to be proven and remain doubtful in areas where terrestrial alternatives exist
- networks are only as flexible as the ground segment allows; adjustments to the space segment are impossible after launch
- even at the speed of light, it takes approximately 0.3 seconds for a signal to travel from a ground station to a geostationary satellite and back to Earth again. This unavoidable latency is a serious disadvantage for some realtime broadband applications such as video conferencing
- launch and in-orbit failures are unpredictable.

One-way satellite systems

Most current satellite Internet access traffic is from hybrid access, whereby the user connects to the Internet via a normal phone line but downloads via satellite to a small dish (similar to a satellite TV receive-only antenna). The technology takes advantage of the asymmetric nature of most Internet usage, with narrowband browsing combined with satellite's strength in wide-area broadband distribution services.

Two-way satellite systems

Two-way satellite systems are gaining ground rapidly. As precursors of future Ka-band systems, two-way Ku- and C-band services already account for almost as much revenue as the hybrid services.

Satlynx, a joint venture launched in June 2002 between Gilat Satellite Networks, SES Astra and Alcatel, offers two-way satellite packages that are re-sold by a number of carriers to extend their broadband services. Services based on this platform typically offer uplink speeds of up to 150kbps and downlink speeds up to 8Mbps. A proprietary protocol is used for the uplink, with the downlink using the DVB standard.

Practical transmission rates for these services vary widely – an inherent issue with satellite systems that are based on shared transponder capacity, because the ratio of user demand to available capacity changes rapidly as the system grows. The uplink speed seen by a user at peak times may drop to 50kbps, although the massive downlink capacity of a satellite transponder means that downlink congestion is less likely to be an issue.

VSAT and corporate services

All of these systems have developed out of traditional VSAT technology. Such systems were originally designed for distribution of data from a central hub to multiple receive-only terminals, such as at car dealerships. In these markets in North America, the one-to-many advantages of satellite systems have ensured that VSATs have held their own even where terrestrial networks are available. They have evolved to two-way networks with progressively smaller and cheaper remote terminal equipment and faster transmission speeds. For the most part, however, their cost and complexity limits their market to large or medium-sized corporations. Generally, equipment and airtime are bundled into a monthly rental spread over approximately three years.

The latest VSAT systems can offer faster download rates than are available from hybrid and two-way consumer services. For example, Gilat's Broadband Interactive system provides DVB-based downlink services at speeds from 2Mbps to 38Mbps (which can then be shared among multiple user PCs).

Future development with Ka-band

Now that the first broadband Ka-band systems are becoming available, we expect them to overtake existing VSAT, hybrid and two-way systems. The services planned represent a massive leap forwards from those available today, with 2Mbps uplinking by individual users and download rates of between 10Mbps and 100Mbps. User terminals are planned to cost under $1,000 (with a target of $500), but this is a circular equation, dependent on the achievement of mass-volume production.

A5 Other Broadband Access Technologies

Ethernet over VDSL

Ethernet over VDSL is currently a proprietary technology using Ethernet at the layer 2 rather than ATM. It is cheaper than full service VDSL, but due to the lack of standards is not deemed to be 'carrier class'. Therefore, this technology is currently being deployed in Gigabit Ethernet networks within the MTU buildings. As the technology is standardised, street deployments will be possible. With the technology being Ethernet-based, we see it as the next step on from ADSL2+ (which we believe will eventually also be mainly deployed as an Ethernet solution), and therefore is a future winner, eventually taking the place of full service VDSL.

SHDSL

Symmetrical high-speed DSL (SHDSL) fills a need in a certain niche market. It is the only ATM-based DSL technology that can currently provide a true leased line replacement service, and the only standardised DSL technology that supports pair bonding. Therefore, even though SHDSL has not taken off in the way everybody first thought, we believe it still has a place to play in the broadband future and will therefore eventually move out of the 'early niche' section and into the future winners.

Gigabit Ethernet

Although Gigabit Ethernet is still a young technology we believe it has already booked its place in the broadband future. As well as providing direct services, this technology will eventually replace SDH in the metro space. However, obstacles to its deployment still exist today. The main ones are immature technology solutions and the high cost of deploying optical fibre into the access network. Currently, its main successes are in the multi-tenant unit (MTU) and large corporate LAN interconnect markets.

Powerline communications (PLC)

Powerline technology is unlikely to be a mass-market success in the broadband access market and will find it challenging to compete effectively with DSL, cable modems or broadband fixed wireless access for two main reasons:

- Interference to wireless and other systems remains a major problem. In Europe, measuring and setting standards for this interference remains part of an ongoing debate on how to manage the problem while recognising in principle at least the potential of PLC for providing broadband access. A four-year EU-assisted project is underway to help to solve this problem but we do not expect any major breakthroughs.
- Difficulties in scaling up solutions based on PLC technology scale. A large number of nodes at sub-station transformers need to be powerline-equipped to provide any decent level of broadband availability in an area which negatively impacts the business case for deployment.

PLC may find opportunities inside the customer's premises. As home networks start to take off, using the existing electricity infrastructure could be attractive to homeowners. However, wired Ethernet and 802.11 wireless LAN (WiFi) are cheaper solutions, and are expected to dominate home networking.