Office of the Director of Telecommunications Regulation

ODTR BRIEFING NOTE SERIES

Optical Access

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Foreword

This paper is the fourth to be released in the ODTR's briefing note series[1]. These briefing notes, which are issued as part of our 'Forward-looking Programme', primarily deal with technology developments in the telecommunications sector.

This briefing note concerns optical access, i.e. using optical fibre or wireless optical systems to provide 'last mile' or local loop connections. The high information carrying capacity of optical signals means that optical access constitutes a very high bandwidth alternative to other access technologies such as ADSL over copper, fixed wireless access and satellite connections. Indeed, optical transmission technologies may be a prerequisite for some of the new and emerging bandwidth-intensive applications that are being developed in fields as diverse as education, medicine, research and entertainment.

We need to encourage and facilitate the deployment of broadband access in Ireland, and alongside other technologies optical access is a key element in ensuring that we have the broadband communications infrastructure and services that are critical for our future prosperity. In issuing this Briefing Note, it is my intention to inform and to encourage the industry and other interested parties to consider the prospects for expanding the deployment of optical access in Ireland. I look forward to receiving comments on this and on any other points raised in this Briefing Note.[2]

Etain Doyle.
Director of Telecommunications Regulation.

[1] See ODTR Documents 01/59, 'Technology Developments in Telecommunications', 01/88, 'Next Generation Networks' and 02/16, Wireless Local Area Networks.
[2] Please refer to page 4 for details regarding the submission of comments.

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Comments on this Briefing Note

We welcome any comments or views on this Briefing Note and these should be sent to:

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to arrive on or before 5.30pm on Friday 19th April, 2002.

In submitting comments, respondents are requested to reference the relevant section of this document. Responses will be available for inspection by the public on request. Where elements of any response are deemed confidential, these should be clearly identified and placed in a separate annex to the main document.

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1. Introduction

This briefing note examines optical access and the role it is likely to play in providing broadband telecommunications services in Ireland, and builds on our briefing note on Next Generation Networks[3]. Access is about the 'last mile' to businesses and homes. The paper assumes a basic knowledge of telecommunications transmission technologies, including fibre optics[4] and optical wireless communications[5].

[3] ODTR document 01/88; see also document 01/82
[4] For an introduction to optical technologies see for example: www.sciam.com/2001/0101issue/0101stix.html and www.telecomdirect.pwcglobal.com/telecom/direct:TIH/Telecom_Technology/Information_Technology/ITArt::/Article/iectut021302
[5] ODTR document 01/59

2. What is Optical Access?

The term optical access refers to the provision of local loop or last mile access by optical means, either by fibre optic or wireless optical links and networks. Optical fibre systems work by transmitting light signals carrying information through glass fibre cables using lasers or light emitting diodes. Wireless optical systems (also known as free space optical systems) also work by transmitting light signals, but instead of using glass fibre cables, the signals are transmitted by shining a narrow beam of light through the air between two fixed points. Thus wireless optical systems require line of sight, whereas optical fibre systems do not.

Optical fibre has been used for many years for large capacity leased lines, for example, and wireless optical technology is already being used to a limited degree in Ireland. Optical access is, however, likely to become an increasingly prominent part of the fixed communications infrastructure in the coming years, linking individual homes, blocks of flats, housing estates, offices, company and campus networks, business parks and so on to backbone or local trunk networks[6]. In some situations (e.g. fibre to the kerb[7]), the last few metres to the user might be provided by short-range, high frequency 'wireless tails', (i.e. radio links capable of carrying high speed data).

Optical access is forecast to develop into a multi-billion Euro market in the next five years[8]. It will not however replace other access technologies in the short term, so we can expect to see various mixed models of optical fibre, coaxial and twisted pair copper with or without DSL enhancements, wireless optical, wireless local area networks, satellite and other technologies continue in many situations for some considerable time.

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[6] See "Building a reliable, cost-effective and future-proof fiber optical access network", Ericsson Review No.4, 2001

[7] The term FTTx is commonly used to mean fibre to the x, where x can stand for home, kerb, building, business park, campus, etc.

[8] M. Engstrom, Chairman's remarks, at "Optical Access Networks – developing strategies for successfully implementing fibre in the last mile", 3rd & 4th October 2001; London

3. Advantages and drawbacks

Compared to other communication technologies, optical technology has the most to offer in terms of information-carrying capacity, and hence the variation and number of services that can be provided. Fibre to the home (FTTH) for instance is capable of carrying a variety of communications and entertainment services, including telephony, high-speed Internet access, broadcast cable television, and interactive, two-way video-based services. All of these services can in principle be provided over a passive optical distribution network via a single optical fibre to the home. In addition, an FTTH solution based on for example wavelength division multiplexing (WDM)[9] would allow for additional flexibility and adaptability to support additional future services.

Single optical fibres are already capable of carrying information at tens or hundreds of Gigabits per second, and it is forecast[10] that by 2003 this will have risen to 10 Terabits per second[11]. To put these data rates into perspective, a good quality single digital television channel requires about 8 to 10 Megabits (million bits) per second, and transmission of holographic images for some next generation applications, in for example entertainment, training and research, might require tens of Gigabits per second.

The performance to cost ratio for optical communications has been increasing exponentially, (c.f. the development of low cost computing), and optical technology advances are taking place on many fronts. For example, tunable lasers will help carriers more effectively manage optical networks, enabling reductions in time in provisioning bandwidth and in delivering services.

One of the drawbacks to fibre-based optical access is the need to lay cables. Generally, rights of way and digging are major cost elements and can pose problems in deploying any type of cable and fibre infrastructure. However, new digging and ducting techniques (e.g. through sewers and other pipes) are helping to reduce cable-laying costs, and it may be possible to avoid digging by using overhead cabling in some instances.

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[9] Wavelength division multiplexing is a technology that enables single fibre-optic strands to carry multiple wavelengths of light, with each wavelength channel carrying digital data at high bit-rates.
[10] www.bt.com/bttj/tomorrow/index.htm
[11] A Gigabit is a thousand million bits and a Terabit is a million million bits

3.1 Optical wireless

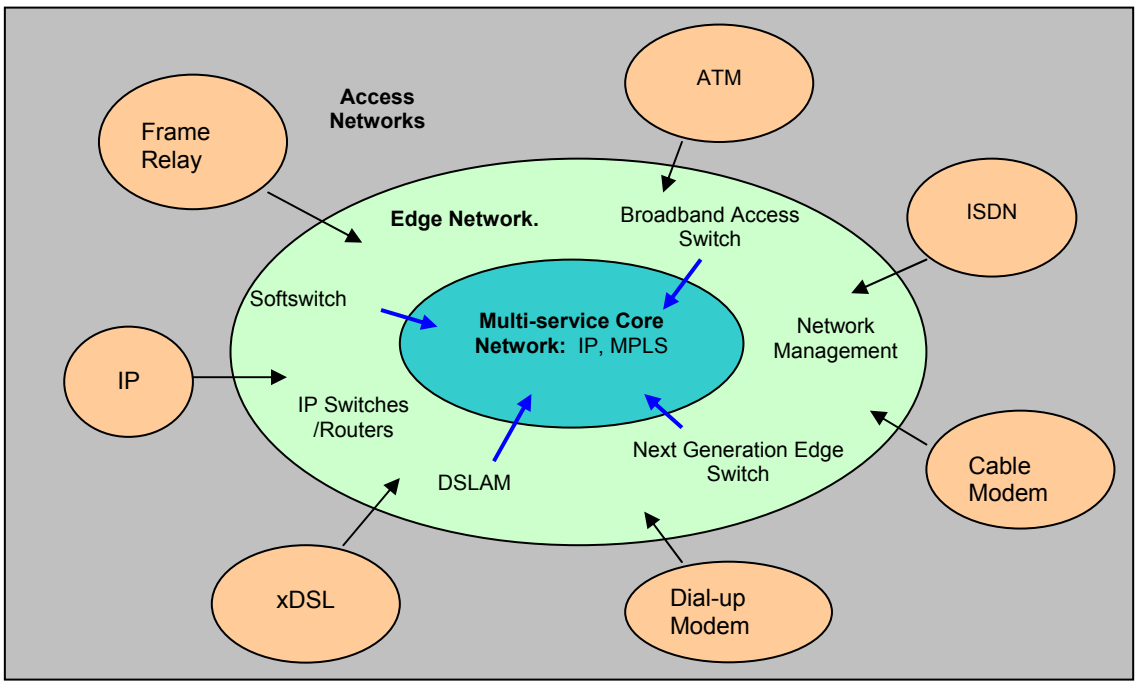
In some situations where there is line of sight the use of wireless optical links rather than fibre can overcome these difficulties. Wireless optical is increasingly seen as having a significant role to play in many situations, given its low roll-out costs compared to optical fibre and short installation times. It is sometimes regarded as a temporary solution while planning and rights of way problems are overcome, and as a way of inexpensively conducting market trials for new broadband applications.

Technical problems were encountered with some of the early wireless optical systems. For example, reliability problems were encountered under adverse weather conditions such as heavy rain or dense fog. The technology has developed in recent years and most problems can be readily overcome by careful network design, (e.g. limiting the range of the link, implementing redundant paths and using reliable and resilient transmission protocols)[12].

[12] See footnote 4; see also http://www.redherring.com/insider/2002/0308/2033.html

4. Market Development

At present, high capacity edge and core networks are often connected to high capacity business networks[13], local area networks and other end user equipment by relatively low capacity access links or networks. (Figure 1 illustrates the architecture for 'next generation networks'.) This creates what is often referred to as 'the local access bottleneck', analogous to two fat pipes connected by a drinking straw. At present, optical access technologies are, in the main, being used to serve large business users, (e.g. in leased circuits above 2Mbps).



ATM: Asynchronous Transfer Mode
ISDN: Integrated Services Digital Network
IP: Internet Protocol
MPLS: Multi Protocol Label Switching
DSLAM: DSL Access Module
DSL: Digital Subscriber Line.

Figure 1 – Next generation network architecture.

However, there are various examples of deployment of optical fibre in the local loop to smaller businesses and homes. These range from purely commercial projects to

[13] Deploying ATM, IP, Frame Relay, etc.

subsidised or government-funded schemes. For example, in several parts of Hamburg, HanseNet has built optical access networks to serve homes and offices, whereby each fibre connected building is equipped with a Gigabit Ethernet switch and each customer can use a capacity of 10Mbps[14]. In Canada, over 26 Quebec school boards representing more than 1000 schools are planning to deploy or have already deployed dark fibre networks interconnecting their schools[15].

While most users do not yet need the very high access data rates offered by optical technologies, some existing businesses, universities and other leading-edge users are already requiring them. As more high data rate applications are developed, tested and deployed by early adopters in Ireland and around the world, so demand for these and similar applications will increase.

The availability of broadband capacity, especially for local access, is an important factor affecting the development of new information technologies and services, including new software applications. For example flow control algorithms are being employed to control data traffic from one machine to another. Faster networks would lessen or do away with the need for these.

Furthermore, it is well recognised that software and application developers tend to emerge or locate where leading edge infrastructure is available for them to test and bring to market their products and services. This is highly significant for Ireland, given the success to date of its software sector, and the economic contributions it already makes here. As Irish IT and software companies look to participate in the development of next generation applications, so the availability of optical networks all the way from the user to international backbone networks is likely to become a critical success factor. This is important to enable IT and software companies to provide new information and communication based services to the wider Irish economy and society, and to enable Ireland's IT sector to move up the value chain.

[14] Establishing Broadband Services and Optical Access Networks in Hamburg, Dr. Volker von Essen, HanseNet Telekommunikation GmbH, at Optical Access Network Conference, (EF International), London, October 2001.
[15] See for example: http://www.canarie.ca/advnet/canet3/fibre.html

5. Conclusion

Optical fibre has been used for many years for large capacity leased lines and wireless optical technology is already being used to a limited degree in Ireland. It is vital that we have leading-edge telecommunications networks so that users can access modern information and communication services, and in order that next generation applications can be developed and deployed here. Expanding the deployment of optical access is therefore likely to be an important issue in the future development of the telecommunications market in Ireland.

Given the important and wider role optical access will probably come to play over the next five years, it is important that the ODTR develops a full understanding of how, where and when it may impact on the development of the Irish telecommunications market. The ODTR would welcome comments from interested parties to inform our work programme on the development of broadband in Ireland, including a review of the possible technologies, market issues and experience in other countries.