Chapter 3.7
An Introduction to Optical Access Networks: Technological Overview and Regulatory Issues for Large-Scale Deployment

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ABSTRACT

With the current continuously growing bandwidth demand, it is apparent that conventional broadband access solutions will quickly become bottlenecks in terms of bandwidth provision. In this chapter, the authors analyze the present global challenge for extended bandwidth provision in the scope of the fast developing electronic communications sector, creating a fully converged environment. In particular, first the authors examine several potential options imposed by distinct technologies, as they are currently applied in the marketplace. Then they present a comprehensive review of the emerging optical access solutions, focusing mainly on passive optical network (PON) technologies that promise to efficiently meet the anticipated growth in bandwidth demand and at the same time be economically viable and future-proof from an operator’s perspective, and evaluate their capabilities to the conventional copper-based broadband solutions. They also survey the current deployment efforts and relevant policies in the European Community area, as well as discuss why Europe is lagging with regard to deployment pace when compared to Asia and the USA. Specific and detailed analysis is given for recent developments performed in the European Union, where we identify current trends, potential hurdles and/or difficulties, as well as perspectives for further growth and development.

INTRODUCTION

We are currently witnessing an unprecedented growth in bandwidth demand, mainly driven by the development of advanced broadband multimedia
applications, including video-on-demand (VoD), interactive high-definition digital television (HDTV) and related digital content, multi-party video-conferencing etc, as most of the are offered by the Internet in a converged global environment. These IP-based services are bandwidth intensive and require an underlying network infrastructure that is capable of supporting high-speed data transmission rates (Hellberg, Greene, & Boyes, 2007). Hence, telecom providers are currently focusing on developing new network infrastructures that will constitute future-proof solutions in terms of the anticipated growth in bandwidth demand, but at the same time be economically viable (Chochliouros & Spiliopoulou, 2005).

Most users currently enjoy relatively high speed communication services mostly through DSL (Digital Subscriber Line) access technologies (Starr, Sorbara, Cioffi, & Silverman, 1999). What really fuelled DSL’s deployment is the fact that it allowed network operators to use their already laid copper infrastructure to provide broadband connectivity services to their customers, without actually needing to make large investments in access infrastructure. However, DSL schemes may be considered as not so future-proof solutions, since the aging copper-based infrastructure is rapidly approaching its fundamental speed limits. For example, the most recent DSL variant, VDSL2 (Very high speed DSL, version 2), represents the current state-of-the-art and can theoretically offer up to 100 Mbps symmetric data transfer rates (though much less in real conditions), but only for very small distances (~300 meters). New services will possibly push data rates beyond the capabilities of such networks: for instance a multi-channel HDTV service will pose strong challenges in order to operate efficiently. In addition, the fact that high speed and large distances cannot be achieved simultaneously, results in solutions that are not economically favorable (for example requiring the installation of a large number of new neighborhood nodes). Furthermore, the emerging requirement for capacity symmetry for certain applications or businesses constitutes a significant challenge.

It is evident that these copper-based access networks create a bottleneck in terms of bandwidth and service provision between the operator and the (corporate or residential) end-user. Contrary to that, optical access architectures enable communication via optical fibers that extend all the way from the telecom operator premises to the customer’s home or office (or at least to close proximity), thus eliminating the need for data transfer over telephone wires. Such architectures offer a viable solution to the access network bottleneck problem (Green, 2006), and promise extremely high, symmetrical bandwidth to the end-user (Prat, Balaquer, Gene, Díaz, & Fiquerola, 2002). In addition, they future-proof the operator’s CAPEX investment, as they offer easy and low-cost speed upscale, should such a need arises in the future. While the cost of deploying optical access networks has been prohibitively high in the past (Frigo, Iannone, & Reichmann, 2004), this has been falling steadily, and such networks are now likely to be the dominant broadband access technology within the next decade.

**EXISTING BROADBAND SOLUTIONS AND THE NEED FOR MORE BANDWIDTH**

Today, the most widely deployed broadband access solutions are DSL and Cable TV (CATV) networks. DSL is truly the current “king” of broadband with more than 200 million lines provisioned worldwide as of June 2007 (DSL Forum, 2007), accounting for more than 65% of the total broadband installations. DSL deployment has been a major political issue and priority in many countries that view it as a critical ingredient for their efficient transition into the modern knowledge-based economies and the future competitiveness of their industries. Indeed, DSL is now available in just about all developed