Chapter 3
Active Optical Access Networks

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ABSTRACT

In this chapter, active optical access networks (AONs) are examined. AONs are a special type of optical access networks in which the sharing of optical fibers among users is implemented by means of active equipment (as opposed to passive optical networks –PONs– where sharing is achieved by using multiple passive splitters). In active optical access networks, user-side units, known as Optical Network Units (ONUs), are usually grouped in access Synchronous Digital Hierarchy (SDH) rings and fiber-interconnected to a local exchange unit, known as Optical Line Termination (OLT). In AONs (as well as in PONs) the optical fiber (originally used in the trunk network) is introduced in the access domain, namely between the customer and the local exchange. Practically, this means that the huge bandwidth provided by the optical fiber becomes directly available to the normal user. Despite the obvious financial and techno-economical issues related to the massive deployment of optical access networks, the possibilities and challenges created are enormous. This chapter examines the various units and modules composing an active optical access network and presents the basic procedures for implementing such a network.

INTRODUCTION: BACKGROUND

This chapter deals with the active optical access networks, usually referred to as AONs. In this type of optical access networks, sharing of optical fibers among users is implemented by means of active equipment, as opposed to the multiple-passive-splitter approach employed in passive optical networks –PONs– (Venieris, 2007).

Generally speaking, an optical access network can be considered as the optoelectronic infrastructure installed in the access part of the telecom network, that is the part between the subscriber and the local exchange (Figure 1). This infrastructure contains both active equipment, (installed in the customer premises, the local exchange and sometimes in
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Figure 1. An abstract view of an active optical access network

between) and optical fibers used to interconnect the above equipment. This situation should be contrasted to the conventional (copper) access network which is basically passive and merely contains the twisted-pair cable or cables installed between the subscriber and the local exchange.

From the topology point of view, the simplest optical access network would be a “direct-fiber” access network in which each customer would get his/her own pair of fibers (one fiber used for each direction of transmission). Such networks could provide very large bandwidths (nowadays a bandwidth-distance product of 500 Gbps.km is feasible), however they would be very costly due to the amount of fiber and active equipment used. Indeed, “direct-fiber” networks (also referred to as “star-topology” networks) are only deployed in cases where either the service area is small or key-account customers are to be served.

Usually, in optical access networks the “shared-fiber” approach is used which anticipates the sharing of fiber (as well as active equipment) to reduce costs. It is not until the fiber cable gets relatively close to the customer that is split into customer-dedicated pairs of fibers. In active optical access networks, this split is implemented by means of active equipment (as opposed to passive optical access networks where sharing is achieved by using multiple passive splitters).

With the explosive spread of Internet and the increasing demand in data connections and broadband services, as well as the appearance of more and more bandwidth-demanding applications, it is evident that copper-based access solutions (such as DSLs) may soon become inadequate. By exploiting the huge capacity of the optical fiber, optical access networks seem to be the only solution to meet the fast-increasing bandwidth demands.

The idea of using optical fibers in the access part of the telecom network goes back to the early 1990s when the optical fiber had already established itself as the dominant transmission medium for the trunk network. Though the advent and fast spread of copper access technologies (mainly DSLs) in the early 2000s made, at least temporarily, the use of optical access technologies a less obvious choice, it appears now that these two initially competing technologies may be used either in different domains (installation of DSLs might be preferable where fast provision of services is necessary or the deployment of optical cables is costly or problematic) or in a combined manner to optimize bandwidth provided versus cost.

Generally speaking, the basic advantage of optical access networks (PONs or AONs) as compared with other access technologies (copper or wireless) is the huge bandwidth provided by the optical fiber, while their main drawback is the high cost of the active equipment and the need for massive fibre deployment in the access area. Optical access networks can offer bit rates over 1 Gbit/s which make possible the provision of services such as Fast Internet, Video on Demand (VoD) and “triple-play” services.

When referring to optical access networks (either active or passive), the term “Fiber In The Loop” (FITL) is generally used to imply the introduction of fiber-optics either in the whole or in some part of the access network (local loop). Depending on the extent to which the fiber technology covers the local loop (that is, where the electrical-optical interface is put) various alternative and more specific terms can be used. Thus the term “Fiber To The Curb” (FTTC) refers to the arrangement where only the primary part of the access network becomes optical (the optical fiber reaches the outdoor main distribution frame). When optical fibers are deployed up to the build-