Chapter 6
Bandwidth Allocation Methods in Passive Optical Access Networks (PONs)

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ABSTRACT

Passive Optical Networks (PONs) are very suitable architectures to face today’s access challenges. This technology shows a very cost saving architecture, it provides a huge amount of bandwidth and efficiently supports Quality of Service (QoS). In PON networks, as all subscribers share the same uplink channel, a medium access control protocol is required to provide a contention method to access the channel. As the performance of Time Division Multiplexing Access (TDMA) protocol is not good enough because traffic nature is heterogeneous, Dynamic Bandwidth Allocation (DBA) algorithms are proposed to overcome the problem. These algorithms are very efficient as they adapt the bandwidth assignment depending on the updated requirements and traffic conditions. Moreover, they should offer QoS by means of both class of service and subscriber differentiation. Long-Reach PONs, which combine the access and the metro network into only one by using 100 km of fibre, is an emergent technology able to reach a large number of far subscribers and to decrease the associated costs.

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EVOLUTION OF THE ACCESS NETWORK: THE FIRST MILE

The access network, also called the first mile or last mile, connects the service provider central offices to residential or business customers. The demanded services are quite different depending on the type of customer. Residential users demand applications related to leisure activities, such as broadband Internet, television or interactive games, whereas companies demand multimedia services for the bidirectional transmission of all kind of information.

In the recent years, the network traffic has been increasing at very high rates, which has caused an important evolution in the transport network. However, the access network has not suffered any important evolution or change. Besides, the new emerging services and the growth of Internet traffic have accentuated the lack of access network capacity. The deployed technology, DSL (Digital Subscriber Line) and coaxial cable, are not able to cover the bandwidth necessary to support these new high demanding services. Up to now, the access network has been associated to the type of delivered information, the pair copper for telephony and the coaxial cable for television. However, from now on the new access network should be unique and should deliver voice data and video under the same platform, which is called “Triple play service”.

Moreover, as Internet traffic has increased highly its presence, operators have deployed different technologies to support such demand. In this way, telephone operators tended to deploy the Digital Subscriber Line (DSL) technology, which uses the same twisted pair as telephony lines and therefore it requires a DSL modem at the customer premises and a Digital Subscriber Line Access Multiplexer (DSLAM) in the central office. The data rate offered by DSL technologies is not enough to support integrated voice, data and video services. Furthermore, the physical area that can be covered by DSL is limited to the distance, which means that it cannot reach every contracted subscriber.

On the other hand, the cable television enterprises integrate data services over their coaxial cable networks. Usually, these architectures combine both fibre and coaxial cable, resulting in a Hybrid Fibre Coaxial (HFC) network, where the fibre reaches the head-end to a curbside optical node, and the coaxial cable covers the rest of the path to the final subscriber. The main problem of this architecture is that each shared node has a limited effective data throughput, which is divided among many homes, each subscriber obtaining a very slow speed during peak hours.

The new emerging services and the insufficient deployed access technologies, help to increase the existing “bottle neck” in the access. Thus, another access technology that could be simple, scalable and capable to transport voice, data and video over the same network is strongly needed. In this way, optical fibre is expected to be the best option to deal with the existing first mile challenges.

The deployment of fibre in the access network is known as FTTX. However the FTTX term can group different categories depending on the portion of fibre included in the access network. Therefore, the most typical FTTX infrastructures are:

- **FTTH**: Fibre To The Home.
- **FTTB**: Fibre To The Business.
- **FTTndu**: Fibre To The multi-tenant building.
- **Deep Fibre**: The fibre ends in one point near the subscriber, and another technology such as copper pair is used to reach the end subscriber. The most important infrastructures are Fibre To the Node (FTTN) and Fibre To the Curb (FTTC).

As fibre is viewed as the most suitable transmission medium in the access network, many
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