Chapter 12

Broadband NG–PON Networks and Their Designing Using the HPON Network Configurator

Rastislav Róka
FEI STU Bratislava, Slovakia

ABSTRACT

With the emerging applications and needs of ever increasing bandwidth, it is anticipated that the Next-Generation Passive Optical Network (NG-PON) with much higher bandwidth is a natural path forward to satisfy these demands and for network operators to develop valuable access networks. NG-PON systems present optical access infrastructures to support various applications of many service providers. Therefore, some general requirements for NG-PON networks are characterized and specified. Hybrid Passive Optical Networks (HPON) present a necessary phase of the future transition between PON classes with TDM or WDM multiplexing techniques utilized on the optical transmission medium – the optical fiber. Therefore, some specific requirements for HPON networks are characterized and presented. For developing hybrid passive optical networks, there exist various architectures and directions. They are also specified with emphasis on their basic characteristics and distinctions. Finally, the HPON network configurator as the interactive software tool is introduced in this chapter. Its main aim is helping users, professional workers, network operators and system analysts to design, configure, analyze, and compare various variations of possible hybrid passive optical networks. Some of the executed analysis is presented in detail.

INTRODUCTION

Demands for modernizing advanced applications and new multimedia broadband Internet services to both residential and business customers imply that the broadband access network will be faced with the challenge of transmitting an increasing volume of dynamic data-centric traffic with higher bit rates (up to a few Gbit/s). Although a huge capital cost were invested in creating of metallic (homogeneous lines or coaxial cables) or wireless infrastructures together with signal transmitting technologies, market demands for very broadband transmission paths are still expanding. At the

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same time, wireless communication networks represent a rapidly growing market whereby new standards enable higher capacity, reliability and a larger number of supported users. Metallic access solutions (Digital Subscriber Lines, Power Line Communications or Hybrid Fiber-Coax) as well as emerging Worldwide Interoperability for Microwave Access and Long Term Evolution wireless technologies are realizable with severe limitations in both network reach and offered bandwidth per user. Such constraints can be indisputably solved by the necessity of Fiber-To-The-x architectures.

Common key advantages of FTTx architectures are a reliable and safety transmission medium (the optical fiber), a reachability of remote communities compared with other access technologies, a flexibility of signal transmission rates up to Gbit/s directly to particular residences, a scalability of system components, a utilization of passive optical components only, a local power supply and a low energy consumption, a possibility for implementations of various WDM technologies (Čuchran & Róka, 2006). As can be seen, a broad mix of services for full-filling of customer requirements is provided by diverse topologies and infrastructures in the access network. However, there exist three extensive problems – a low throughput, a service variety and a traffic irregularity. Therefore, current solutions do not seem to adequately address the stringent requirements identified regarding next generation passive optical access networks. Thus, the convergence of optical, metallic and wireless networks (Figure 1) is also a crucial requirement which will enable boosting network penetration and correspondingly justify operational expenditures and capital expenditures for the broadband access network.

One of the prominent technologies for offering the FTTH architecture is the passive optical network (PON). Architectures of optical access networks must be simple – from a viewpoint of service provisioning for subscribers. It means that passive architectures with no switching and control elements in the optical distribution network (ODN) are preferable against active ones. Moreover, optical network terminals (ONT) on the subscriber side must be simple, cheap and high reliable. These conditions separate out utilization of sophisticated optical lasers and other complex optical components in common ONT equipment. Optical ONT components must be also able working in the environment without any temperature control. The optical line terminal (OLT) on the central office side can be more sophisticated because it is located in the temperature controlled environment and costs are amortized between several connected end subscribers.

Emerging applications of advanced end users can be associated with increasing bandwidth demands. Except technological improvements of mobile broadband and broadcast technologies, it is unavoidable to consider a reliable support in access

Figure 1. Connectivity options for the next generation passive optical access network architecture