Chapter 6
Converged Fi–Wi Passive Optical Networks and Their Designing Using the HPON Network Configurator

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ABSTRACT
With the emerging mobile 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 to develop valuable converged fiber-wireless access networks for wireless network operators. NG-PON systems present optical access infrastructures to support various applications of many service providers. Hybrid passive optical networks (HPON) present a necessary phase to future PON networks utilizing the optical transmission medium – the optical fiber. For developing hybrid passive optical networks, there exist various architectures and directions. They are specified with emphasis on their basic characteristics. For proposing reliable and survivable architectures, traffic protection schemes must be implemented. For converging Fi-Wi passive optical networks, an integration of optical and wireless technologies into common broadband access network must be considered. Finally, the HPON network configurator as the interactive software tool is introduced.

INTRODUCTION
Emerging applications of advanced end users can be associated with increasing bandwidth demands. Except technological improvements of mobile broadband and broadcast technologies, it is avoidable to consider a reliable support in access networks by appropriate modern and advanced technologies utilizing the fixed transmission medium, above all optical fibers. Optical access networks designed for those applications are called passive optical networks (PON) because only passive optical equipment is located in the remote node (RN). Their main advantages are high reliability, simple maintenance and

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no need of external power supplies. Moreover, present optical infrastructure is transparent to bit rates and modulation formats of optical information signals. Complete passive optical access networks can be upgraded without substantial changes of this fundamental infrastructure. Also, the wavelength division multiplexing (WDM) technique with separated transmission channels assigned to particular subscribers can be implemented into passive optical networks and, by this way, various specific broadband and multimedia services can be provisioned to each end subscriber (Čuchran & Róka, 2006).

The PON network is in its substance a bi-directional point-to-multipoint system that contains passive (optical fibers, passive optical splitters, couplers, connectors) optical elements in a distribution part of the access network and active optical line and network terminals (OLT, ONT) placed in end terminating points of the access network. The key advantage of this PON approach is locating only passive optical components in the optical distribution network (ODN). Optical transmitters and receivers are located inside buildings; other active optical components are not utilized in the outside plant (Figure 1). By this way, total network costs for installing, operating and maintenance of optical network equipment are markedly decreased.

Current standardized PON networks based on the time-division multiple access (TDMA) have evolved as an access solution to provide simplicity and low operational cost. The most effective utilization of the optical transmission medium can be attained using more wavelengths per one fiber by means of WDM technologies. Moreover, scaling up TDMA-PON networks to several tens of gigabits per second of the aggregate capacity is extremely challenging due to the complexity of optical components and burst mode receivers at such high data rates. Therefore, WDM-PON networks are increasingly considered to deliver ultra-high-speed services by enabling service providers to offer a dedicated wavelength straight to a home or business with limitations in terms of scalability and bandwidth granularity.

From a viewpoint of the architecture, we can classify passive optical networks into following classes with basic characteristics (Ramaswami & Sivarajan, 2001), (Róka, 2014):

- **All Fiber**: Passive optical network (AF-PON),
- **Time Division Multiplexing**: Passive optical network (TDM-PON),

*Figure 1. The general PON network architecture*