Investigation of wavelength control schemes in WDM-PONs

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Abstract

Wavelength-division multiplexed passive optical networks (WDM-PONs) are considered as the next step in optical access systems. They provide several advantages over time division multiple access (TDMA) systems (e.g. (X)G-PON) which are available today. WDM-PONs can serve a significant higher sustainable bitrate per user and have a longer unamplified reach. In a WDM-PON, two wavelengths are assigned to each user, one each for upstream and downstream. The different upstream wavelengths from the user (optical networking unit, ONU) to the central office (optical line termination, OLT) need to be controlled within certain limits to allow proper connection and avoid cross talk between different channels. This can be seen as the equivalent to time synchronization in a TDMA system.

Different variants of WDM-PONs have been studied so far. One candidate is a seeded WDM-PON, where the upstream wavelengths for all ONUs are generated at the OLT. The wavelengths are then reflected and modulated with data at the ONUs. As the wavelengths are centrally generated and routed in the remote node through a filter, there is no need for wavelength control at the ONUs. However, the reach of reflective WDM-PONs is limited, mainly due to the interference between the seed signal and the upstream signal, both propagating in the same fiber.

The second candidate is a WDM-PON, in which each ONU is equipped with a tunable laser. As the price of the ONU has to be very low, the tunable laser will neither be equipped with a thermo-electric cooler nor with a wavelength locker. Without these components, environmental changes would lead to unpredictable wavelength changes. Therefore, the wavelength needs to be actively controlled. In this paper we present and compare different wavelength control schemes for WDM-PONs with tunable lasers, all based on components centralized in the access network and shared between all ONUs.