Final Year Projects – 2018

Photonic Systems Group, Tyndall National Institute

Cleitus Antony and Paul Townsend
Email: cleitus.antony@tyndall.ie; *paul.townsend@tyndall.ie*

Theme: Next Generation Fibre to the Home: 25Gb/s and beyond

Over the recent years, fibre optic cable, once used only for long-haul communications, has been extended all the way to end user's premises to enable the delivery of ever faster broadband communication. The most efficient architecture to implement this last leg of the optical communication network (or optical access) is a passive optical network (PON) based on optical power splitting and sharing of the main trunk fibre. PON technology has been evolving for the last 25 years with increasing bit-rates to meet the exponentially rising bandwidth demand. The latest in the series, 100GPON, is expected to be standardized by 2019 and will meet the increasing demands of home bandwidth, including cloud services, 4K HDTV, and will also support backhaul for 5G mobile stations. The new 100G system will have to be able to re-use the fibre and splitters infrastructures deployed by previous generation of PONs and at the same time target much higher bit-rates, split ratio and reach. Traditionally this has been compensated for by increasing transmitter laser power, but this is now becoming increasingly difficult due to cost and technical reasons so one effective solution is to boost the received power using **optical amplification**.

Project 1: Raman amplification for next generation optical access networks (12-week)

Our recent work has shown that Raman amplification is a promising candidate for optical access network applications. Raman amplifiers providing gain over a 100-nm spectrum (1520 to 1620 nm) have been in commercial use in long-haul applications since 2004. However, the design constraints differ in the implementation of Raman amplifiers for the passive optical network scenario in the O-band (1260nm – 1360nm).

In this project, the student will

(a) Understand the basics of optical communication system.
(b) Study the principle of distributed Raman amplification in optical fibre.
(c) Experimental characterisation of broadband Raman gain.
(d) Investigate the nonlinear interaction when multiple wavelength signals are transmitted through the Raman amplified optical fibre. The purpose of this study is the figure out the optimum wavelength spacing between the 4 channels of the upstream transmission (see figure 1).
(e) Numerical modelling to reshape the gain spectrum using multiple pump wavelengths.

Project 2: Time-resolved full-field (amplitude and phase) optical waveform measurement for transmitter characterisation (12-week or 6-week)

Time and Wavelength Division Multiplexing (25Gb/s x 4 wavelengths) will be adopted in the next generation optical access system. This means that the **transmitter** will be allowed to emit data at **25Gb/s** every 125μs typically, and only for a **short duration**. This imposes stringent requirements on the transmitter's ability to tune to a specific optical frequency early in the burst and also to have frequency drift (<50GHz) during the data transmission. This is very challenging requirement for directly modulated lasers that are currently being developed for such systems. Directly modulated lasers suffer from frequency drift due to thermal effects within the duration of the burst and as well as optical frequency fluctuations due to data modulation: a change in carrier density directly affects the refractive index of the chip.

To characterise such directly modulated lasers, we need advanced systems capable of measuring accurately **very fast optical frequency changes** and to **track the frequency drift during bursts.** The student will experimentally implement and compare the performance of two measurement techniques:

(a) Frequency discriminator technique which employs programmable optical filter to convert frequency fluctuations to amplitude fluctuations before detection.
(b) Heterodyne detection method where the time-resolved full-field (amplitude and frequency) fluctuation of the input signal is extracted from the beating of the input signal with a strong local reference laser.

Application : Next generation optical access networks supporting multiple services (business, residential & mobile backhaul)