Research Statement

I am an Electronics and Communication Engineer post graduated in the field of Optoelectronics and Communication Systems. My M.Tech Thesis was based on Dense Wavelength Division Multiplexing technology. Dense Wavelength Division Multiplexing (DWDM) technology offer unprecedented capability to expand transmission capacity in long-distance telecommunications and increase the flexibility in optical network design. Nonlinear effects in the transmission fiber and amplified spontaneous emission noise limit the performance and therefore dictate the design of long-distance amplified systems, especially those employing Wavelength Division Multiplexing. As for the problems of complexity and long cycle in the DWDM design, part of problems needed to be considered in DWDM link design. The maximum possible transmission distance has been reported to be dependent on various system parameters like number of channels, channel spacing, the allowable power per channel, the amplifier spacing etc. In my project, the hardware implementation of a four lamda point-to-point DWDM link was established. The same model simulated in the simulation software, OPTSIM was utilized for the study of DWDM system to analyze its performance. Simulation software was utilized for the analysis of non-linear effect in DWDM system and power limit employed in DWDM systems. Different performance parameters like bit-error rate (BER), Q-factor, Eye-pattern etc were observed through the simulation software. So a comparison of hardware implementation with that of simulation software was carried out to analyze the performance. Thus an optimized point-to-point DWDM link design, simulation and its performance analysis was carried out effectively.

My research focus is to go deep into the DWDM technology and explore new concepts on DWDM and the impact of non-linear effects in the transmission fiber on the optical link design. The future of DWDM system is Ultra-dense wavelength division multiplexing system (UDWDM). Ultra-Dense Wavelength Division Multiplexing (UDWDM) is the science and technology of packing optical communication channels as closely as physically possible on a single optical fiber or any other optical medium. While the UDWDM concept originated in long-haul fiber-optic communications, it is also expected to be a key enabling technology for future massively parallel computing systems. Currently, much research in optical communications is focused on increasing the bit-rate of individual optical channels from 10 Gb/s to 160 Gb/s. This “high-speed” approach faces serious obstacles due to fiber chromatic dispersion (CD) and polarization-mode dispersion (PMD) since the dispersion penalty scales roughly as square of bit-rate. An alternative equally valid approach for increasing transmission capacity, which however has not received as much attention, is to scale DWDM channel spacing to ultra-dense dimensions of ~ 10 GHz, while keeping the bit rate fixed at 10 Gb/s. This latter approach is known as Ultra-dense WDM (UDWDM). The development of 10 Gb/s UDWDM technology would enable continued advancement in fiber-optic transmission capacity without requiring dramatic upgrades in infrastructure (i.e. new fiber, Raman distributed amplification, per-channel PMD compensation, etc.) . Moreover, 10 Gb/s UDWDM may be the only practical way for Si-based optical interconnects to approach the capacity of optical fiber since Si-based optoelectronic devices are unlikely to ever attain speeds greater than 10 Gb/s.

I would also like to focus on the Non-linear effects in the transmission fiber like Colour-Wave mixing (for example: Four- wave mixing) which is an emerging point of research these days. FWM is a nonlinear process in optical fibers in which generally three signal frequencies combine and produce several mixing products. It originates from the weak dependence of the fiber refractive index on the intensity of the optical wave propagating along the fiber through the third order nonlinear susceptibility. FWM efficiency depends on channel power, channel spacing and fiber dispersion but is independent of the bit rate. FWM efficiency is also a function of signal polarization. In FWM efficiency versus channel spacing for different dispersion values, it can be seen that low dispersion fiber have a higher FWM efficiency than high dispersion fibers and efficiency decreases with increase in channel spacing. High-order harmonic generation (HHG) is a strongly nonlinear process in which the frequency of a fundamental laser is up-converted into its harmonics. Studies of the dynamics of free electron wave-packets in atoms/molecules require ultrashort pulses with temporal duration in the attosecond range. In one of the recent reports, the time-delay-dependence intensity of the phase-matched mixing waves is proposed to provide the evolution information of free electron wave-packets.

I can apply my theoretical and mathematic skills in the development of useful and novel methodologies.