

## Abstract

To account for unprecedented rises in capacity and throughput, network operators are seeking to exploit network components and structures in the most cost-effective way possible. One of the most promising methods to achieve this is the expansion of coherent transmission into currently-unused wideband frequencies, which would permit significant capacity increases. Wideband transmission goes hand-in-hand with simultaneous advances in network structures towards open and multi-vendor approaches, which correspond to increasing levels of network disaggregation.

Practical implementation of wideband transmission is currently hindered by a lack of maturity in both modelling and component technologies: frequency-dependent effects such as stimulated Raman scattering (SRS) and nonlinear interference (NLI) require careful consideration, along with the development of reliable and scalable devices. Creation of an accurate and reliable wideband NLI model that also supports disaggregated architectures is therefore a desirable requirement to handle advancements in network technology, but requires that all wavelengths and fiber spans can be modelled independently, across the entire wideband spectrum.

Within this thesis a wideband and disaggregated NLI model is introduced and subsequently validated using modelling tools that include split-step Fourier method (SSFM) simulations and the open-source GNPY library. A wide variety of disaggregated network configurations are investigated, including non-uniform disaggregated and dispersion-managed network segments, demonstrating full spectral and spatial separability of the NLI. Transmission impairments through an experimental set-up are then evaluated, consisting of propagation through a single fiber span over the L-, C-, S-, and E-bands, amplified with a hybrid Raman pump and bismuth-doped fiber amplifier (BDFA). The intricacies of power optimization, amplification, and the interactions between quality of transmission impairments are then discussed, along with techniques for optimising wideband and disaggregated transmission.