Sarah Dods – Research Interests

My current research interests broadly span changes in the properties of light that is used for communication channels, during the transmission process. To date, this has covered four main areas:

- Optical signal monitoring, which covers techniques to monitor the performance of multiple WDM channels transmitted down a fibre.
- Optical crosstalk, which occurs when unwanted light from another channel arrives at a receiver with the desired channel.
- Polarisation mode dispersion, which occurs when optical fibres are not circularly symmetric, or have asymmetric stresses applied. Both of these cause light in different polarisation states to propagate along the fibres at different speeds. Coupling between the two states, and dynamic changes in stress makes this a very interesting and challenging field for research.
- Improving the performance of high speed WDM transmission systems, by tailoring both the transmitted light via the modulation format; and the transmission system via the dispersion map and amplification scheme.

Optical Signal Monitoring

As optical communication systems evolve from static point-to-point links to dynamic, transparent optical networks, monitoring the performance of proposed and operating links within the network becomes critical. The main drivers behind the need for monitoring are to demonstrate that contractual obligations on BER are being met, to diagnose the location and root cause of faults within the network, to optimize the performance of tuneable elements, and to check proposed connections for dynamic path allocation.

One limitation of many conventional optical signal monitoring techniques is that they only measure the power of the optical signal at the monitor receiver. Although the distribution of this power is directly related to the BER, the optical signal also contains frequency, phase and polarisation information that is discarded. My current research in optical signal monitoring is with Peter Farrell and Kerry Hinton, investigating means to extract more optical information by combining optical signal processing with asynchronous histogram techniques. This class of monitors may have immediate application in today's quasi-static multi-wavelength systems as a diagnostic tool, as well as possible future applications in dispersion compensation and ASONs. Development of the technique requires two aspects to be developed. The first is to determine the best optical elements to use for the most common causes of signal degradation, and to find ways of differentiating between the degradation types in the resulting histograms. The second is to investigate cost-effective ways of implementing the technique.

Optical Crosstalk

Optical crosstalk is one type of signal impairment that becomes increasingly important as communication links become more complex, and channels are added and dropped. The most problematic type of crosstalk is when the signal and interferer are at the same optical wavelength (to within the receiver bandwidth). For a single interferer or for the Gaussian limit of many random interferers, quantifying its effects is straightforward, although it depends on details of optical amplification and the receiver used. However, between these limits the calculation is more complex. My recent work in this area has been with an external colleague, developing simplified but accurate methods of calculating the power penalty from intermediate numbers of interferers. We believe our method will have application in route calculations for ASONs, where the effects of many possible paths with different numbers of interferers may need to be calculated rapidly.

My knowledge of optical crosstalk also feeds directly into optical signal monitoring, as this is one of the possible signal impairments that must be detected and differentiated.

Polarisation Mode Dispersion (PMD)

PMD is a significant problem facing network operators. It is also a particularly bad problem for Australia, as the types of soils here tend to exert more stress on buried cables, causing PMD to become an issue at lower bit rates than many other regions. However, a great deal of weight is being brought to bear on the problem internationally, and we do not currently have a great deal of research infrastructure in this field. It will be difficult for us to compete with large and well-funded facilities overseas that have entire research teams devoted to the topic, and so my research here has concentrated on niche areas.

My current PMD research is through supervision of two student projects. The first is looking at the design of PMD emulators, which artificially create PMD in the laboratory environment. Emulators are necessary tools for studying mitigation of PMD, but need to be carefully designed to model transmission fibres as closely as possible. The second project is looking at the effects of high levels of PMD (more than one bit period). One possible application for this is the use of PMD as a physical-layer data encryption method. Regardless of whether this application turns out to be feasible, the study is leading to deeper understanding of the nature of PMD and investigating the deeper question of whether PMD can be 'undone' by PMD compensators, or whether these devices merely mitigate its effects. This question is particularly important when PMD interacts with other optical phenomena such as non-linear effects

High Speed WDM design

Optimisation of high bit-rate WDM transmission systems is a complex problem, due to the number of variables in the control space. The scope of the problem also makes it difficult to compare results from the literature. The aim of this research, which falls under an ARC grant I hold with Yang Jing Wen, is to use a standardised link to compare a smaller subset of this space. In particular, we are looking at advanced modulation formats. The combination of phase modulators, intensity modulators and optical filters gives a great deal of scope for optimising the transmitted signal, noting that the transmission process itself changes both the spectrum and pulse shape of the signal. We are setting up standardised comparisons of existing modulation formats, and developing new formats to optimise both the optimal spectral characteristics for transmission, and the signal at the receiver.

A final note

The statement above encompasses my current research interests. I have a demonstrated track record of moving into new research areas, and being able to assimilate the necessary background information and climb the learning curve to the point of making contributions in a short space of time. I have found that I enjoy this process, and that it makes me very useful in multidisciplinary teams. I fully envisage this trend to continue in my career, and indeed look forward to broadening my horizons further in the future.