Chief Investigator Profiles

MONASH UNIVERSITY
Phone: +61 3 9905 3486
Email: Arthur.lowery@monash.edu.au

Arthur Lowery

Arthur Lowery has worked in academia for 21 years and founded or co-founded two high-tech companies, VPIsystems Inc. (1996) and Ofidium (2008). His early research was in time-domain modelling of semiconductor lasers, enabling the models of the lasers to be combined with models of other optical components to investigate complex photonic circuits. As a researcher in the Australian Photonic CRC, he directed a project to place these models under a graphical user interface. He co-founded Virtual Photonics with Phil Gurney to commercialise this work as the product OPALS. OPALS enjoyed $500k of sales in the first full year of the company. They merged Virtual Photonics with a German start-up, BNeD to form VPI Virtual Photonics in 1998. VPI grew rapidly to become the leader in the Photonic Design Automation field, with products to design lasers, through optical systems and networks, to roll-outs of broad-band networks. More than 1000 papers cite VPItransmissionMaker as their simulation tool. Arthur was elected as IEEE Fellow in 2009: *"for leadership in computer modelling of optical communications systems"* and received the ATSE Clunies Ross award in 2007 for commercialising this work.

In 2004, Arthur Lowery joined Monash University as Professor of Electrical and Computer Systems Engineering, and became Head of the Department in 2007. He developed optical OFDM with Jean Armstrong in 2005 for long-haul transmission systems. Optical OFDM now occupies several sessions at international conferences and is used to implement extremely high spectral-efficiency fibre systems. This and later work forms part of a strong patent portfolio that is being commercialised by Ofidium, which Arthur founded in 2008. Jean Armstrong, Leonore Ryan and Arthur Lowery received the Peter Doherty Award for Innovation from ATSE in 2006 for "Faster Optical Communications".

A key issue with all long-haul communications systems, including OFDM, is fibre nonlinearity, which he tackled in 2007 and has worked on with his student Liang Du (who has since become a CUDOS Research Fellow) since then, proposing opto-electronic and digital computation solutions to break the 'nonlinear Shannon limit' and increase the data capacity or transmission distance of these systems, which is vital for the data demands of broadband networks. Professor Lowery joined CUDOS in 2011 with the goal of incorporating nonlinear optical processing into optical OFDM systems to improve transmission capacity and reach while lowering power consumption.

Key Areas of Research Contribution

- Optical communications systems – design, simulations and prototyping.
- Photonic circuits - design and systems performance.
- Optical Orthogonal Frequency Division Multiplexing (optical OFDM).
- Fiber nonlinearity compensation (the Nonlinear Shannon Limit). Digital and Optical processing of optical signals.
- Bionic Vision.

2011 Achievements

Monash University joined CUDOS in 2011 to collaborate with groups making advanced optical components incorporating linear and nonlinear processing for next-generation long-haul communications systems. These components will increase the capacity of long-haul systems, which is critical if to carry the extra data that will be generated by broadband access networks between cities and continents.

They collaborate closely with researchers at other nodes to build their laboratory's capability and generate early scientific breakthroughs. Monash's laboratory is specifically set up to prototype long-haul optical communications systems, which requires very-high bandwidth electronic waveform generators and receivers, together with 1400-km of optical fibre with periodic amplification. Using this equipment, the group at Monash worked with Jochen Schröder of Sydney University to demonstrate that the Finisar Waveshaper can demultiplex optical OFDM signals. The Waveshaper is already used extensively in commercial telecommunications networks to demultiplex WDM signals, which have a frequency guard-band between each wavelength channel. Optical OFDM signals overlap one another, so the Waveshaper's software has been redesigned to drive its optics to allow this function. A paper demonstrating the demultiplexing of four optical OFDM subcarriers will be presented by Dr Schröder at OFC (Optical Fiber Communications) in Los Angeles in March 2012. This collaboration has also developed new wide-band optical OFDM transmitters, which are required to test the demultiplexer. These have also been used to test digital demultiplexing techniques. This work will be presented by Liang Du.

Dr Mark Pelusi of Sydney University has also visited Monash to help set up the nonlinear processing part of the Terabit/s project. His experience with Highly-Nonlinear Fiber (HNLF) has been invaluable in a recent demonstration of Mid-Span Spectral Inversion (MSSI) for optical OFDM systems: the first time that these technologies have been combined in a laboratory experiment. Mr Md. Monir Morshed joined Monash as a PhD student in 2011 to work on MSSI for OFDM and initially worked on simulating the optimum system. The knowledge that he gained from the simulations was invaluable in obtaining the optimum performance from our experimental system.

A key technology for the implementation of long-haul optical transmission systems is the ability to convert optical signals to electrical signals over extremely high bandwidths, as ultimately all signals are processed by electronic computers. Current long-haul systems demultiplex the wavelength channels then send them to separate receivers. These are limited by the speeds of the electronic receivers and electronic analogue to digital

converters. Multiple channels, or even a Tbit/s 'superchannel' may need to be processed by a single receiver. To pack more data into the fibre's transmission window advanced phase and amplitude modulation formats (such as Quadrature Amplitude Modulation, QAM) combined with polarisation-multiplexing (PolMuX) must be used. These require that the optical phase and polarisation be detected by the receiver, and represented electrically. For this reason, the group at Monash embarked on a program to develop suitable technologies to convert wide-bandwidth optical signals into digital electronic signals. Mr Martin Firus, a Masters student at Monash, completed the initial simulations and submitted an Optics Express manuscript comparing two approaches of optical analogue-to-digital conversion. Mr Firus has recently joined Ericsson to work on the design of the National Broadband Network, but the team at Monash University shall take his work to the experimental stage in 2012.

2011 has been a busy year at Monash. The team purchased a micropositioning station to enable photonic chips to be used in our experiments, developed software to decode new signal formats, built wide-band transmitters for electronic and all-optical OFDM super-channels, and increased their capabilities in nonlinear optics by purchasing and calibrating nonlinear components and commissioning high-power optical amplifiers. The group's aim is to be 'photonic chip ready' so that the next generation of CUDOS chips can be dropped into their experimental systems to demonstrate world-beating optical communications systems technologies.