

Case study:
**Measurement and
Monitoring of the Internet**



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The challenge

With the internet becoming an increasingly important tool for both businesses and consumers, ensuring the massive global network operates smoothly is a critical task.

Every day billions of gigabytes of data flow through the complex web of optical cables and switches that span the globe. This rush of digital traffic is putting pressure on the infrastructure and requiring constant investment to keep it operational.

Telecommunications companies are responding to the demand by increasing the capacity and flexibility of their backbone networks. Where 10 gigabit-per-second speeds were once sufficient, now they are rolling out reconfigurable 40 gigabit-per-second optical networks that combine fibre optic cables and optical switches.

While moving to such speeds greatly increases internet capacity, it brings with it management challenges. At speeds of 40 gigabits per second, the pulses of light moving through the cables are at such small timescales that a range of physical challenges come into play.

Imperfections in the fibre can degrade performance, resulting in disrupted traffic.

For example, asymmetry in fibre can result in a polarisation dependent refractive index. This impairment, known as polarisation mode dispersion, distorts the optical pulses by altering the speed of the light of the component polarisation states. Chromatic dispersion can also occur, where different frequency components travel at different speeds which also causes data pulses to spread out and become blurred.

For network operators, the challenge is finding a way to efficiently monitor their high-speed fibre-optic networks, identify problems and predict where breakdowns might occur. They need a way of guaranteeing quality of service for their customers, as the future performance

of the internet depends on it.

The NICTA approach

Because monitoring techniques that work at slower network speeds no longer function as speeds increase, the NICTA team set about creating a different method of analysing the performance of high-speed optical networks.

The Measurement and Management of the Internet (MAMI) project was established to develop new ways to measure the signal-to-noise ratio in optical networks and to detect impairments within the network that could affect performance.

The team took the novel approach of bringing together researchers with two very different sets of skills: optical networking and machine learning. The rationale was that, if they could capture large amounts of data about network performance and then extract meaning from it, an accurate management tool could be created.

The results

The team's first success was the creation of a new-generation optical signal-to-noise ratio (OSNR) monitor that is compatible with optical switches. The OSNR is a measure of the noise introduced by optical as a by-product of their core function, it is a key indicator of system performance.

The NICTA team discovered that, because noise has different polarisation properties when compared with data signals, it's possible to figure out what part of any given transmission is data and what's not.

The team has developed a Polarisation Diversity technique which can cancel out the signal being transmitted through a network. This leaves just the noise which can then be accurately measured.

This somewhat counterintuitive approach has been achieved using inexpensive, off-the-shelf electronic components. A lab prototype is already functioning and

a commercial prototype is expected early next year.

The second success for the team has been the development of a multi-impairment monitor. It is this device which combines the optics and machine learning skills of the researchers.

Essentially the approach taken was to look at network signals in a similar way a cardiologist looks at an ECG of a patient's heart to determine and diagnose any problems.

Impairments in a fibre cable will cause deterioration in signals passing through it, however it can be very difficult to determine which particular impairment is having what effect on a signal.

Standard techniques can detect signal deterioration, however until now there has been no way to extract the effects of individual impairments. This is what the NICTA team has been able to achieve.

Through innovative use of machine learning techniques, the monitoring information is analysed and the effect of individual impairments extracted. So, for example, a network manager can determine whether it's a stress in the fibre or a problem with an optical switch that is causing problems.

This means proactive steps can be taken to remove or minimise any problems and improve the operating efficiency of the network. When that network is the global internet, the flow-on effects can be significant.

Commercialisation opportunities

The prospects for these developments are significant. Network operators are looking for ways to automate the monitoring and management of their networks and this technology can assist them towards that goal.

Commercialisation of the tools could take the form of licensing agreements with network equipment vendors. The technology would be embedded in switches and used by operators as part of their overall network management systems.

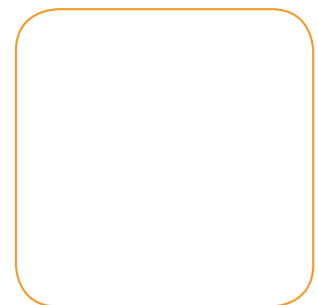
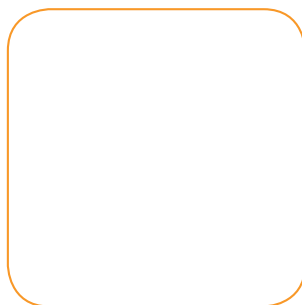
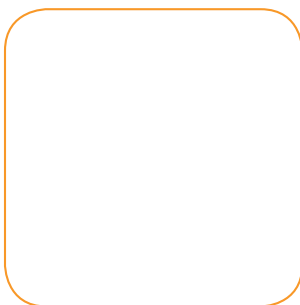
Alternatively, NICTA could partner with a manufacturer and produce network monitoring equipment that could be attached to existing networks, providing significantly improved monitoring and management capabilities.

NICTA is already in discussion with a number of telecommunications carriers and network equipment manufacturers.



Contact Details

Dr. Trevor Anderson
NICTA – Victoria Research Laboratory
Dept. of Electronic and Electrical Engineering
University of Melbourne
Victoria, 0300
Telephone: +61 2 8344 8873
Facsimile: +61 2 8344 6678
Email: trevor.anderson@nicta.com.au
NICTA website: www.nicta.com.au



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