CUDOS

The Centre for Ultrahigh bandwidth Devices for Optical Systems (CUDOS)

2005 Annual Report

Next Generation Optical Communications Systems

To understand why the CUDOS research program is so important, we need to look at what will be happening in telecommunications over the next five to ten years. The range of services and capabilities provided by modern telecommunications systems are expanding, and will continue to expand, in response to consumer demand. To maximise the profitability of these new services and maintain the competitiveness of existing, more traditional services, carriers like Telstra are investing multi-billion dollar sums in completely revamping their telecommunications infrastructure so that all networks – voice and data – will be based on a single internet protocol (IP) platform. With these new platforms, carriers will provide a wide range of new services based on broadband internet access including internet TV and video telephony.

While carriers are making these massive investments, data from the OECD show that the extent of broadband access is rapidly increasing[1]. In 2000 there were 15 million broadband subscribers in the OECD countries; by mid-2004 the number exceeded 100 million. There is still considerable room for growth; the figure of 100 million represents only about 10 per cent of the total possible subscriber base. However, the rapid growth rate in broadband subscribers of around 70 per cent per year justifies the massive investment in platforms for broadband services that carriers are making.

The clear message then from both the service providers and consumers is that internet traffic, the basis of all the new telecommunications services, is increasing strongly and will underpin an increasing range of business-to-business services and provide communications, information services and entertainment to households.

The fundamental architecture of modern optical communications networks is changing to an internet-style "mesh" where data can be routed along many alternative paths. Mesh networks are reliable, since failure of one "span" in the mesh will not cause global failure. The data is simply re-routed along different spans. They also have high data capacity because of the large number of possible network paths. To fully capitalise on these advantages, the following are required:

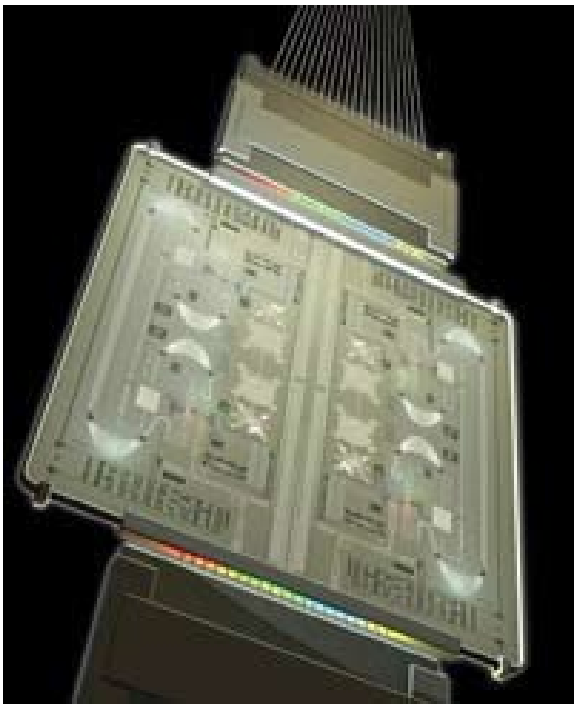
- Real time fault monitoring in the optical domain;
- Rapid equalisation of data transmission along paths of the network, which relies upon:

  – Rapid switching of data from one path to another;

  – Rapid switching of data from one wavelength channel to another as it moves through the network;

  – Optical regeneration – reamplification, reshaping and retiming – of data signals at "node points" throughout the mesh. As the mesh increases in complexity, electronic regeneration becomes increasingly impractical.

Each of these technologies leads towards a picture of future optical networks as complex, dynamic and ultimately programmable entities. The development of "photonic integrated circuits" (PICs) is viewed by most as integral to the realisation of this vision, in much the same way as electronic integrated circuits are integral to the operation of present-day computers. PICs produced using semiconductor foundry techniques similar to today's silicon-based integrated circuits are the only technology able to address the requirements of improved functionality and decreasing transmission costs in next generation optical networks. The development of PICs, and the development of optical functions like regeneration that can ultimately be "encapsulated" in a PIC, are the core of the CUDOS research mission.



A PIC would look little different to an electronic integrated circuit, except that signals are coupled in and out along optical fibres (from www.esa.int/SPECIALS/ GSP/ SEM6AEO3E4E_2.html).

In a report published by the US National Science Foundation in 2005, PICs were identified as one of the key enabling technologies for optical networks of the future[2]. As the workshop report states, "… to improve the transmission capacity, configuration capabilities, and flexibility of networks based on fixed optical fibres, while sharply reducing operational costs, … networks will have "end-to-end dynamic (transparent) optical circuits that can be automatically set up in a matter seconds, rather than today's days or weeks provisioning time." As the report convincingly argues, such flexibility can only be achieved through the development of PICs.

The encouraging developments in the marketplace strengthen the CUDOS mission to develop novel technologies for ultrahigh bandwidth communications technologies, while the recommendations of the NSF workshop validate the research directions of the CUDOS program.

[1] OECD Information Technology Outlook 2004.

[2] NSF Workshop on Mapping a future for Optical Networking and Communications, July 2005.