Australian Government: Department of Innovation, Industry, Science and Research (Oct. 2009)

https://grants.innovation.gov.au/SciencePrize/Pages/Doc.aspx?name=previous_winners/PM2009Sullivan.htm

2009 Prime Minister's Prizes for Science

John O'Sullivan
How astronomy freed the computer from its chains

Nearly a billion people use John O'Sullivan's invention every day. When you use a WiFi network - at home, in the office or at the airport - you are using patented technology born of the work of John and his CSIRO colleagues.

They created a technology that made the wireless LAN fast and robust. And their solution came from John's efforts to hear the faint radio whispers of exploding black holes.

Today John is working on technology that will allow us to look back almost to the beginning of time itself.

For his achievements in astronomy and wireless technologies John O'Sullivan receives the 2009 Prime Minister's Prize for Science.

In 1977 John O'Sullivan co-wrote a paper about the use of a set of mathematical equations known as Fourier transforms to sharpen optical telescope images distorted by the atmosphere. The paper is short and, like John O'Sullivan, somewhat humble. It builds on first principles of physics, but brings together a broad view joining radio and optics. And the paper is seminal. It explains the techniques known as adaptive optics and proves why they work.

What's truly remarkable is that the consequences of that paper are now at work in millions of homes, airports, cafés, offices, hotels and universities across the world. They have cut the cables that tied computers to the desk and turned laptops into ubiquitous social and business tools.

The wireless LAN story is a textbook example of how blue sky research can lead to the most practical of outcomes. It also explains how John O'Sullivan, an engineer from the esoteric world of radio astronomy, joined the world of commerce with Rupert Murdoch and Cisco before returning to his roots.

"John is unusual in that he likes to work things out from first principles," says CSIRO Fellow and former Australia Telescope director, Ron Ekers. "He's not comfortable with just reading answers to problems in books. He has the engineer's push to build things and make things work, but he also thinks like a physicist about the basic properties of matter and electromagnetic radiation. That's a really rare and wonderful combination."

As an undergraduate at the University of Sydney, John did a dual degree in physics and electrical engineering, and then went on to a PhD in radio astronomy. After completing his doctorate, he set off in 1974 to work for a year on the Westerbork radio telescope in The Netherlands. Nine years and two children later, during which time he became head of the group responsible for the development and maintenance of the Westerbork's receiver systems, he was lured back to Australia as head of the Signal Processing Group in the CSIROs Division of Radiophysics.

Amongst John's many research interests was the search for radio waves from exploding black holes- predicted in 1974 by Stephen Hawking. John didn't find them, but the techniques he and his collaborators developed to clean up intergalactic radio wave distortion eventually found expression as the technology in the wireless LAN.

Fourier transforms were the key to his work. They were essential for the new Australia Telescope at Narrabri, constructed for Australia's bicentennial. To simplify and speed up the transform task he worked with Austek Microsystems to create a computer chip to do the processing for him.

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By 1990 CSIRO was looking for ways to commercialise its capability in radio physics. "We realised that our skills with antennas, signal processing, and radio design might allow us to cut the network cable that linked every office computer," John says. "From the beginning we set out to match the speed of the best wired networks of the time."

But reflections got in the way. In the confines of buildings and rooms, radio waves bounce off many surfaces, so that a transmission arrives at a receiver followed by a series of echoes. This leads to a fuzzy, ambiguous signal, akin 'ghosting' on a television.

Through his long associated with radio astronomy, Ekers says, O'Sullivan was equipped with at least three tools to bring to bear on the problem-knowledge that a solution lay somewhere among the many signal processing techniques astronomers were already using, an ability to conceive of what electromagnetic waves look like under Fourier transformation, and an understanding that it was possible to design a chip that could be fitted into a computer to undertake the necessary processing. "He already knew how to approach the problem, and he knew that it would work."

Using the same techniques he'd applied to astronomy, John and his team realised they could send the information over many different frequencies and recombine the signal at the receiver.

Within a year, in 1992, CSIRO applied for an Australian patent and the long process of prototyping, trialling, and then commercialising and defending the technology and the patent, began.

The US patent came in 1996. The solution was so successful, that IEEE, the global standards body, wrote it into one of its standards for wireless networking, 802.11a. It is now part of two subsequent standards, 802.11g and n. But it took until April 2009 to agree on licensing terms with the makers of wireless computers.

Meanwhile, John joined News Limited in 1995 as their global technology director, guiding the roll out of satellite, pay and digital television. And in 1999 he started a consulting role and became the chief technical officer with Radiata Communications - a CSIRO/Macquarie University spin-off company that commercialised a chip using the wireless LAN patent. When Radiata was taken over by Cisco Systems for about A$500 million in early 2001, he then led their wireless LAN chip team.

But after this decade - long excursion into industry, John O'Sullivan is now back doing what he loves best - solving complex problems at the interface between astronomy and engineering. He is working on the design of the Australian Square Kilometre Array Pathfinder telescope - a step towards the giant Square Kilometre Array which will be able to look back 13 billion years - almost to the Big Bang itself.

Meanwhile the wireless LAN technology continues to change the world. It's built into the next generation of mobile phones and is set to transform how we interact with our cars and homes.

Related Sites

- http://www.csiro.au/science/wireless-LANs.html
- http://www.ska.gov.au

Qualifications

1974 Doctor of Philosophy (Electrical Engineering), Sydney University
1969 Sydney University Sports Blue (Hockey)
1969 Bachelor of Engineering, H1, University Medal, Sydney University
1967 Bachelor of Science, Sydney University

Career highlights, awards, fellowships and grants

2009 CSIRO Chairmans Medal
2005 - present Systems Engineer, CSIRO Australia Telescope National Facility
2004 - 2006 Lead Signal Processing Architect, G2 Microsystems
2001 - 2004 Director IC Systems Engineering, Cisco Systems

1999 - 2001 Vice President Systems Engineering, Radiata Communications
1995 - 2000 Director Technology, News Ltd
1989 - 1995 Deputy Chief of Division, CSIRO Radiophysics
2000 CSIRO Medal for development and application of fast Fourier transform technology
1983 - 1989 Head of Signal Processing Group, CSIRO Radiophysics
1974 - 1983 Head of Receiver Group, Netherlands Foundation for Radio Astronomy (now ASTRON)

Research highlights

- Achieved an eight-fold increase of the bandwidth processing capacity of the Westerbork Radio Telescope as project leader for the digital continuum backend receiver
- Participated in a series of innovative experiments to detect exploding black holes and other short time astronomical events
- Developed an intellectual underpinning for adaptive optics in light telescopes and redundant baseline interferometer in radio telescopes
- With Austek Microsystems created a fast Fourier transform computer chip. This VLSI chip consisted of 160,000 transistors and performed real time transforms at rates up to 2.5 Msamples/s.
- Influential role in the system design for the Australia Telescope
- Led a CSIRO team comprising Graham Daniels, John Deane, Diethelm Ostry, Terry Percival who together invented a patented technology that uses fast Fourier transform and other techniques to enable fast, robust wireless networking in the home and office.
- Led the system design for the worlds first 802.11a (WiFi) chipset developed by Radiata Networks
- Over 40 scientific and technical papers at numerous industry conferences
- Granted 12 patents in the area of special purpose FFT processors, Wireless LANs and antennas

Memberships

- Member of the Institute of Electrical and Electronics Engineers and Institute of Engineers Australia
- Member of international review committee for information and communications technologies in CSIRO
- Member of Australian Square Kilometre Array Consultative Committee
- Chair of the Mathematics, Information and Communication Sciences Expert Advisory Committee, Convenor ICT Appraisal committee, 2004 CRC selection round.
- Optical Society of America
- Board Director AAPT, Taggle Systems