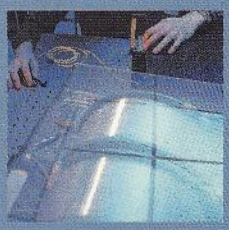
Telstra

new HORIZONS 03

Telstra RESEARCH LABORATORIES

celebrating 80 years of world-leading telecommunications Research & Development



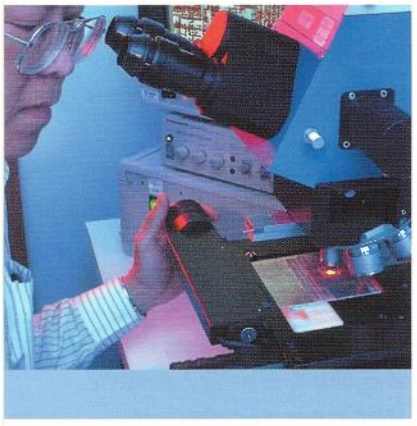
Contents

MissionSTATEMENT

Telstra Research Laboratories aims to deliver sustainable competitive advantage to Telstra by anticipating the impact of technological change on future customer needs and infrastructure requirements.

Telstra Research Laboratories

CELEBRATING 80 YEARS OF RESEARCH AND DEVELOPMENT



Telstra is aware of the role it can play in influencing future technology and is on the lookout for early signs of valuable ideas.

Telstra Research Laboratories (TRL) provides business focused Research and Development (R&D) that underpins Telstra's delivery of new customer value and growth opportunities, and supports Telstra as a telecommunications service provider and network operator. An important part of the role of TRL is the evaluation of new and emerging technologies that contribute to Telstra's technology strategy and positioning. Added to this, TRL expertise provides product innovation and differentiation, the development of techniques and tools for new technology deployment and management, and solutions for complex problems.

Consisting of about 300 staff, TRL is home to many high achievers – around 80 per cent of the researchers have degrees and 30 per cent have high degrees, such as Masters and PhDs. The research environment stimulates people's creativity, allowing them to develop their own talents.

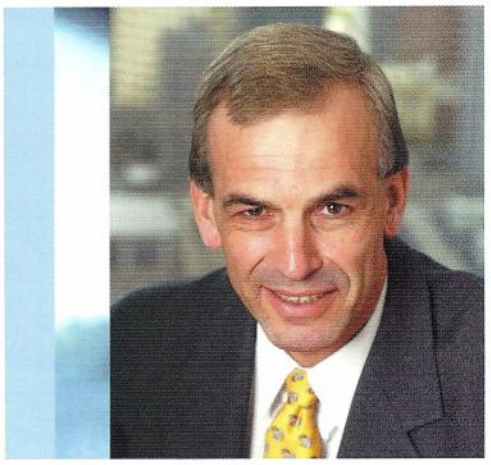
Telstra researchers are a highly skilled group of people who encompass technical skills in the following areas:

- Internet
- Systems Architecture
  network architectures, software architectures, protocol architectures
- Artificial Intelligence
- Web, Internet, multimedia application design
- Human Factors
- Computing
  object computing, distributed computing, network management, computing architectures
- Intelligent Networks
- Switching and Control
- Teletraffic
- Radio
- Transmission systems – optical, cable
- Electromagnetics
- Microelectronics & materials reliability
- Business modelling

Telstra's R&D is a significant part of the company's proud tradition of being a leader in developing today's and tomorrow's technology solutions. It focuses on innovation and commercialisation, as well as capturing visionary ideas for the company.

Making tomorrow's technology simple so it works for you today...

WHATEVER YOUR COMMUNICATION NEEDS MIGHT BE



Dr Hugh Bradlow

Chief Technology Officer
Managing Director, Telstra Research Laboratories

Here at Telstra Research Laboratories (TRL) we have a vision that this company has held for 80 years... to bring you leading edge technology that actually makes a difference to the way in which you communicate and live your life. Making life simpler – taking every day activities for granted to a point where you don't even think about the complexity that sits behind the technology enabling you to do what you need and want to do. This is our goal.

We are proud of our long-standing history in Research & Development (R&D) achievements that have put Australia on the world's technology map.

Seeing beyond the routine – beyond what is possible today – is what excites us at TRL. Taking an idea from seed form and seeing it become a reality for millions is what drives us at TRL.

Paying for parking or buying a drink from a vending machine... even when you don't have coins. (You never have change when you need it!) Band members jamming... even when they are hundreds of kilometres apart from each other. Getting timely, personal, relevant service from a machine by asking it a natural question. Having a conversation with a friend about your favourite TV program during a commercial break by exchanging text messages via your TV screen – or paying your bills online – using your TV rather than a PC. Sitting at home and playing computer games with friends... each in different locations. (This is already becoming the *thing to do* for my younger son and his mates.)

Making technology accessible and useable for all... regardless of location or physical impairment.

These are just some of the visions we have for Australians and, indeed, world users.

We intend to keep Australia on the world map when it comes to telecommunication R&D developments and to achieve what we set out to do, we must be at the forefront of world trends and ride above the often unpredictable technology wave.

Riding on the crest of the technology wave...

In the last five years we have lived through the Internet and the dot com boom and bust. Despite the *tech-wreck*, the technological world today is completely different from even a few years ago. The much vaunted advent of the Internet has seen significant changes to the way people do business, entertain and inform themselves, with more than half of us online, using the Internet daily in our personal and business lives.

There is nothing quite like the communications industry, in terms of the sheer impact it is having on people's lives. When we look back over the past decade, we can only marvel at the way mobile phones and the Internet have transformed the way we live and – as we look forward – there is so much more change to come. The Internet is rapidly becoming broadband enabled, making it possible to do so much more with it, and the mobile phone is becoming data enabled, so not only do we have access to people on the move, but information as well.

Our prediction is that these two technologies – broadband and wireless data – will have the most impact on the online experience for users in the next three years. In our view, people will increasingly see these technologies as obvious and powerful tools in their daily lives. Both will transform the Internet experience in terms of functionality and convenience. We are already beginning to see the effect of the broadband evolution – turning the Internet from an *add on* to people's life, to an integral part of their daily activities. Wireless data is a complementary expansion of that Internet experience onto a mobile environment.

Devices will progressively become IP (Internet Protocol) enabled... cameras, PCs, mobile phones and digital TVs will all be connected. Even now, a photograph taken on a digital camera can be instantly transferred to the Internet via a mobile phone using bluetooth technology – a radio frequency alternative to infra-red available in new mobile phones.

From unbridled hype to rational, sustainable technology...

It has taken 120 years to get the telephone network to a level of reliability and performance that conforms to people's expectations. The challenge now in the online

space is to make the new technology perform at the levels that we have come to expect from the telephone network.

While three years ago the excitement was about the new applications of the technology that users had access to, the priority today is to derive value for users from the applications we have – particularly in terms of the usability and reliability of the technology.

A significant proportion of our work in TRL is focused on improving the performance, reliability and security of networks and enhancing the customer experience. This edition of *New Horizons* describes many of the projects we are undertaking to achieve these goals. For example, this year we feature *IPVIS* – a tool developed by TRL that allows us to build a diagram of an individual customer's virtual private network within the Telstra PIP (Private Internet Protocol) network service. This tool assists us to provide customers with clear and accurate information so that together, we can work out how to respond to issues. And to address the important issue of security for our customers, TRL has created a software tool called a *sniffer* to test the data integrity and secrecy of the wireless LAN environment.

Technology for the people – not for technology sake...

Increasingly, we are finding that the key to delivering superior customer service is the ability to understand customer requirements and ensure that the technology delivered is not only accessible, but just as importantly, useable.

Here at TRL we are proud to maintain a strong focus on the human factors that go into service provision across the technology spectrum. As we introduce mobile data services, we need to understand what network performance is required to deliver a satisfactory customer experience. We have accordingly studied the level of network performance with real users, to determine their Quality of Service requirements for mobile applications. We want to make the customer experience better for all our customers which is why we have established a Centre for Accessibility, with a focus on issues of access to – and use of – the Internet for everyone, regardless of location, age or physical impairment.

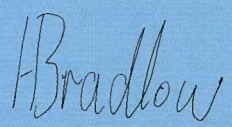
Looking to the future, we also see a range of new applications – based on mobile data, interactive TV and voice technology – which we expect to be attractive to users as the technology becomes available. A new generation of mobile phones using technologies such as Java[1] (J2ME) or BREW[2] will have the ability to update their software *over the air* – making mobile phones behave more like a PC.

These applications, which can be downloaded to the phone *on the fly* as and when they are needed are known as *midlets* and there is an anticipation of many such *midlets* being available for all sorts of purposes. For example, in future, your bank could provide you a midlet that makes checking your current bank balance or transferring money between accounts simpler and intuitive with a few clicks of the mobile phone.

In the world of data technology, it is *game, set and match* to the Internet protocol network technologies. Today, they clearly dominate the world of data networks. As I've mentioned, what we now look forward to is these complex technologies becoming as reliable, secure and as everyday part of our lives as the telephone network is today. With the improvements in network performance and reliability that TRL is pioneering – and with the extension of the Internet via the broadband and wireless data technologies that Telstra is delivering today – we expect to see this vision rapidly become a reality.

In R&D, if you're lucky enough, there is an opportunity to be part of a team that contributes to a world-changing breakthrough. In a recent issue of the scientific journal, *New Scientist*[3], it was predicted that we would see 12 such breakthroughs in 2003 – from space missions that will see robots sent to Mars to explore and help us learn more about this mysterious, red planet to teleporting, or matter transfer. Such visions make R&D truly exciting and we at TRL will continue to play our part on the communication front. As for teleporting in the year 2003, I think it will be some time before we hear anyone say, *beam me up*, unless the script calls for it. This will be one for my children and grand children to get excited about!

I hope you enjoy reading this year's 80-year anniversary edition of *New Horizons* and learning more about the interesting projects our team at TRL has been developing. I am particularly proud of the opportunity to showcase the talented people working at TRL. Over the decades our experts have continued to push the boundaries, ensuring that we have all benefited from an exciting 80 years of R&D achievements.



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1 Registered trademark of Sun Microsystems Inc., a Delaware Corporation.
2 Registered trademark of Qualcomm Incorporated.
3 Issue dated Jan 4, 2003 – Volume 177, No. 2376 – Australian edition.

Evolution of Telecommunications

127 years after Alexander Graham Bell was awarded a U.S. patent for the telephone in 1876, Telstra Research Laboratories celebrates 80 years of significant R&D contributions in the world of telecommunications.

1920's

1923
Australian Post Office established a Research Section with a mission to introduce new technology into the telephone networks to maintain its technical and economic viability.

1940's

1941
Designed and set up a short-wave transmitting station to broadcast to the South Pacific islands and South East Asia. This later became Radio Australia.

1946
Conducted the first experimental studies of VHF mobile services.

1948
Initiated Australia's first fax service, the 'picturegram', between capital cities.

1950's

1962
Commenced first tests of data transmission over the switched analog network at speeds of up to 2,400 bits/sec. This was focused on the NASA space program.

1965
Commenced work on Pulse Code Modulation (PCM) systems for digital transmission of multi-channel systems over inter-exchange copper cable networks. This was the first step in the evolution of the network from analog to digital.

1969
US Department of Defence investigates a networking tool that is to become the Internet.

1970's

1970
Began investigating the use of satellites for mobile services and services to the outback.

1979
Developed a Digital Radio Concentrator System (DRCS) for providing PSTN telephone access to rural communities.

1980's

1981
Experimental optical fibre link installed between two exchanges in Melbourne.

1983
The Internet continues to grow – server names are created for easier use.

First commercial mobile phone user signed in US.

1988
Developed and tested concept for intelligent network architecture to support the first Priority One3 service.

1989
Telecom Australia commences ISDN customer trials and officially launches ISDN in July.

1990's

1991
Pioneered development of a prototype fibre access system to demonstrate passive optical network architecture for laying optical fibre to the home.

1993
Began planning and designing an Experimental Broadband Network, Australia's first large scale trial broadband network based on ATM.

1996
TRL collaborated with Telstra Multimedia to develop Australia's first broadband Internet service – BigPond™ Cable.

1997
Researchers identify the cause of intermittent failures in power supplies that have resulted in major unplanned outages in Telstra's core transmission network to be microscopic 'whiskers' of zinc, invisible to the naked eye, growing on zinc-plated metal cases and sub-racks.

1997
TRL provided novel network architecture design/dimensioning and significant system integration to the successful launch of Telstra's cable modem service on the HFC (Hybrid Fibre Coax) broadband network.

1998
A unique watermarking system is devised for confirming copyright ownership of digital video footage.

1999
Internet Call Waiting product developed allowing users to use a single telephone line to access the Internet, simultaneously receiving a telephone call.

2001
Of the 800 million plus mobile phone subscribers worldwide, 11.5 million are in Australia.

There are around 450 million Internet users worldwide. Australia has 4.2 million Internet subscribers and 10 million Internet users.

2001
Developed a system for detecting and locating faults in Voice on IP services. Developed and commenced commercialisation of Data and Text Mining tools software.

2002
Broadband Internet provides faster access for users.

New Mobile Technologies include GPRS, and potentially 3G GSM and CDMA 2000 1x.

1925
Applied new repeater technology, the vacuum tube, to voice frequency trunk services by installing the first 3-channel carrier system in Australia on the Sydney to Melbourne trunk route.

1930's

1930
Established first frequency standards to provide national time and frequency standards.

1935
Assisted in installing the coaxial submarine cable between Victoria and Tasmania via King Island – at the time the longest in the world. Cable had a bandwidth of 40 kHz (6 channels).

1937
Engineered the first Australian 12 channel VHF (Very High Frequency) radio telephone system between Victoria and Tasmania, a distance of 168 miles, to provide a service while the submarine cable was under repair.

1954
Constructed and installed a 9-channel carrier system for the Victoria to Tasmania coaxial submarine cable in order to increase its capacity from six to 15 channels.

1956
There are 59 million telephones in the US. By June, Australia has 1,814,000 telephones in service.

1956
First public television broadcast in Australia. TRL played a key role by recommending the adoption of the 625 line PAL standard. The recommendation came after years of research, including the development of a video transmission test set in the early 1950's.

1960's

1961
Fully solid state time division multiplexed model telephone exchange developed called SCATS – one of the first in the world.

1971
Commenced investigations into the use of optical fibre for communications.

1972
Demonstrated transmission of analog video signals over optical fibre.

1973
World's first international video conference link between London and Sydney. Dr Martin Cooper sets up the first working prototype of cellular technology in New York.

1973
Designed the first fully electronic exchange to switch live telephone traffic in Australia.

1978
Commenced work in Customer Access Network (CAN). This led to transmission network designs far basic rate ISDN in the CAN.

1983
Assisted in design of microelectronics for the Cochlear ear implant.

1985
Began investigating the use of Asynchronous Transfer Mode (ATM) packet switching to support potential interactive multimedia services.

1985
Developed high-level security system for Electronic Funds Transfer (EFTPOS). Services based on public key cryptography.

1987
ISDN trials begin in US.

GSM mobile technology agreed to be rolled out throughout Europe.

1994
609 million telephone subscribers worldwide.

1994
Carried out field trials of Asymmetric Digital Subscriber Line (ADSL) for delivery of video services to the home over the copper network.

1995
There are around 20 million Internet users worldwide. Australia has 250,000 Internet subscribers.

There are 25 million mobile subscribers in the US and 2.35 million in Australia.

1995
Demonstrated that a proposed 240 kilometre undersea optical fibre can be made repeater free by installing amplifiers at either end of the link. This was the first use of optical amplifiers in Australia.

1999
Researchers use Wave Division Multiplexer optical network design to extend regenerator spacing from 600 km to 1000 km – a world record for this type of fibre technology.

1999
The improved and highly successful Corporate Electronic Directory (developed in 1989) is licensed to external companies for further development and sales to the wider market.

2000's

2000
Mobile Base Station Field Intensity Plotter software demonstrated and sold internationally.

2000
Condor, an expert system developed by TRL over five years, provides call traffic managers with real-time visual representations of call volumes.

2002
HongKong Tel (CSL) uses TRL developed customer behaviour predictive modelling tools to assist in marketing activities.

2002
TRL develops test systems for GPRS data performance.

2002
TRL Artificial Intelligence team wins 2002 KDD Cup for Knowledge Discovery and Data Mining system.

2002
TRL develops commercial version of Lyrebird 1.0 Speech Recognition Application Development Toolkit.

General

GeneralFACT PAGE

...the latest in a series of research activities...

TRL machine learning technologies... innovative techniques to map

graphical objects ...real-market testing environments

for cutting-edge applications

and services...

General

LYREBIRD™ SPEECH APPLICATION DEVELOPMENT TOOL

...it is easy, fast and cost-effective to create natural speech applications with Lyrebird...

TRL develops commercial version of Lyrebird 1.0 Speech Recognition Application Development Kit.

Telstra Research Laboratories (TRL) has successfully completed the initial product release of the Lyrebird Speech Application Development Tool. The Lyrebird tool is a complete, integrated development environment (IDE) for developers to rapidly create and deploy complex and high quality natural language speech applications – using innovative mapping techniques and an integrated graphical environment.

Natural speech applications enable people to interact with a system by speaking naturally. For example, to book a ticket to the cinema, instead of having to navigate through a complex menu structure as you do today, you would be able to phone up and say to a machine: ***"I would like two tickets to see the new James Bond film tonight at the Rivoli at 7.30pm"***.

It is easy, fast and cost-effective to create natural speech applications with Lyrebird through the use of TRL machine learning technologies, innovative techniques to map graphical objects to the VoiceXML speech application scripting standard, and an integrated graphical development environment[4].

Initial benchmark comparison with a speech developer using standard tools[5], showed that Lyrebird achieved a potential 10-fold time saving in the creation of a prototype application, and a potential four-fold time saving in the creation of a complete application.

This initial product is being used by Telstra's Interactive Voice Recognition (IVR) Solutions Group. It is also being evaluated by a number of speech application development companies. The team is working on an updated version of the product.

™ Trademark of Telstra New Wave Pty Limited.

4 Patent applications filed by Telstra New Wave Pty Limited.

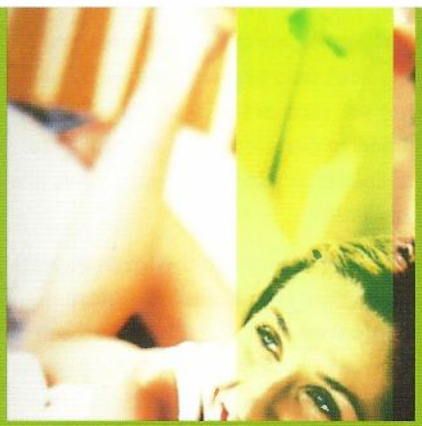
5 This comparison was commissioned by TRL.

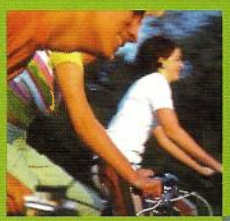
General
SPEECH RECOGNITION

Optimising the usability of speech applications.

As Telstra moves towards implementing more speech services, Telstra Research Laboratories' Human Factors team is investigating what makes a speech application both useful and useable for Telstra customers.

In a new experimental study, using a driving simulation game, participants are tested for comprehension of an auditory message which consists of either recorded human





speech or synthesised speech, to see whether comprehension is degraded when synthesised speech is used. The effect of listening to a message on driving performance is also being studied, as Telstra is keenly interested in the safety issues associated with multi-tasking while driving a car.

This is the latest in a series of research activities the Human Factors team have undertaken to understand what makes a good speech-based service. Previously, the team worked on the user interface for Telstra Consumer Sales and OnAir Voice Portals and is currently investigating the incorporation of synthesised speech into a Short Messaging Service for fixed phones and identifying potential benefits for Telstra's Directory Assistance Service.

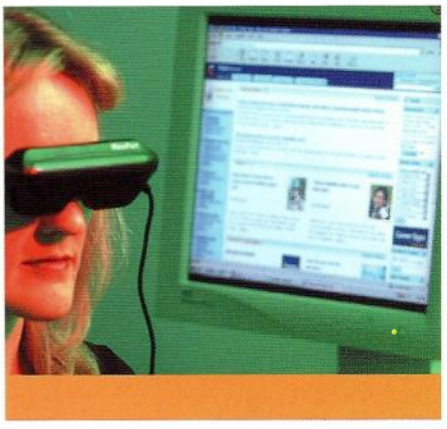
The results of these ongoing studies have led to the development of a set of guidelines, which focus on the user interface for speech applications. The guidelines, *Telstra User Interface Guidelines for Speech Applications (2003)*, are designed to assist Telstra's application developers optimise the usability of new speech services and to pinpoint the best time to incorporate Human Factors methods into the product life cycle.

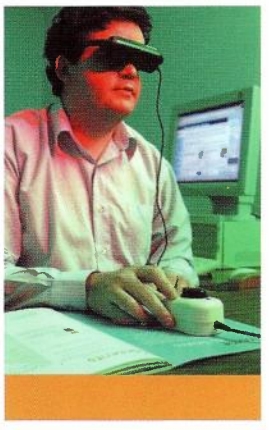
An earlier draft of the guidelines was provided to Standards Australia as an input document for the development of a national standard for speech applications, now in progress.

General

TELSTRA'S CENTRE FOR ACCESSIBILITY – LEADING THE WEB TO ITS FULL POTENTIAL

From a business perspective, web sites that don't have accessibility features risk losing customers.





There is another side to the Internet that many people don't know about. One where blind and vision impaired people can use the Internet. 'Joe' is a 25-year-old university student with no functional vision who is able to use a computer for his studies utilising a screen-reader program called JAWS (Job Access With Speech). In previous years he would have relied on a sighted person to read the materials onto tape in order for him to study. 'Sara', a keen classical music fan, is severely vision impaired and can now independently shop online for CDs using screen-enlarger software.

For many people with disabilities, using the Internet on their own can be an empowering experience.

Chief Executive Officer, Ziggy Switkowski, points out research in the accessibility area is one of Telstra's lesser-known research activities. *"One of the many challenges facing research teams is ensuring that people with disabilities are able to participate fully in the opportunities the new technological world has to offer,"* Dr Switkowski said. *"For over 20 years Telstra has been at the forefront of initiatives that enable people with diverse abilities to access the telephone and today we remain steadfast in our commitment to improving accessibility in the online environment."* [6]

Telstra's Centre for Accessibility is part of the Human Factors Group of the Telstra Research Laboratories and was established in May 2001 as a key part of this commitment. Nearly 19 per cent of the Australian population has some kind of disability[7] and according to Dr Rob Pedlow, Centre Leader, it's the personal stories like Sara's that are truly rewarding.

The approach to accessibility is to make the Internet work for all people, including people who are blind, vision impaired, deaf, sound impaired, people with limited use of their hands and arms, people with no fingers, and people with motor and cognitive disabilities. Various adaptive technologies enable a variety of people to use the Internet – such as Joe's screen-reader which is a piece of software that uses a speech synthesiser to read out the information – to access online information.

Studies have also found that the number and severity of limitations tend to increase as people age, for example changes in vision, hearing, memory, or motor function. And according to participants in independent research studies, aging-related conditions can be accommodated on the Web by the same accessibility solutions used to accommodate people with disabilities.[8]

Currently, the Centre for Accessibility is developing W3C[9] (world wide web consortium) accessibility standards for Telstra's own Web pages. Telstra's Mathew Mirabella is a member of the W3C Web Content Accessibility Guidelines Working Group – an international group with members from many corporations and universities. This has enabled the Centre to input into the internationally recognised standards and specifications body for the emerging Internet.

For more information on the Accessibility Centre's continuing activities, as well as an opportunity to look at a Web site that conforms to W3C guidelines, visit: **www.telstra.com.au/accessibility**

6 Extract from Telstra media release *(Telstra opens new technology showcase)* dated 24 Oct 2001.

7 Australian Bureau of Statistics, 1998 data.

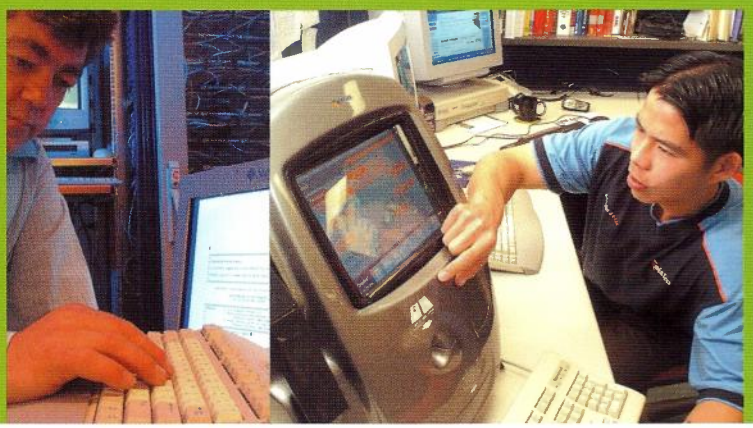
8 Source: Australian Bureau of Statistics, 1998 data.

9 Registered trademark of Massachusetts Institute of Technology, a Massachusetts Corporation.

General

THE LAUNCESTON BROADBAND PROJECT

A real-market, testing environment for cutting-edge broadband applications and services.



The Launceston Broadband Project (LBP) is a joint initiative between Telstra and the Commonwealth Government which provides $30 million in funding over five years in order to establish a real-market testing environment for broadband applications and services.

The trial group is comprised of Launceston residents and small business owners who are ADSL subscribers. In addition to the trial customer base, the Project encompasses a Telstra R&D laboratory based in Launceston (called 'B-eLab') and a business development fund provided by the Commonwealth Government to seed the creation of new broadband and online applications by Tasmanian companies.

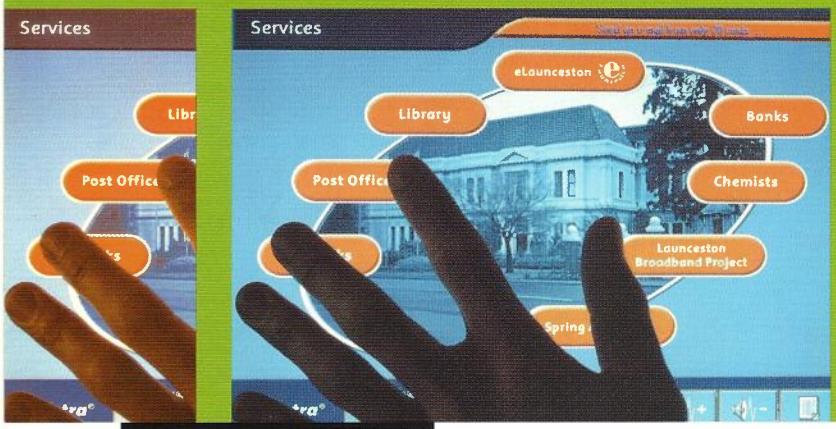
Trial members in Launceston are the first in Australia to assess certain in-development and proof-of-concept online applications, specifically developed as part of this initiative.

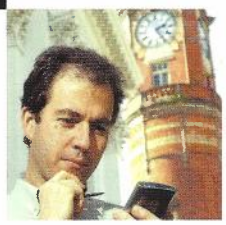
The project enjoys excellent support from local government, the community and the IT industry.

General

THE LAUNCESTON BROADBAND PROJECT

The new technology environment will effectively open our networks and platforms to the IT industry...





Pervasive Computing

One area of development generating considerable interest is what is known as *pervasive computing*. This is the expansion of computing technology into the personal device market. The continued acceptance and use of mobile phones, PDAs (Personal Digital Assistants) and handheld computers has stimulated a merging of personal device technologies, bringing expanded computing opportunities to the greater community.

The B-eLab has a focus on broadband applications and services, set against the characteristics of pervasive devices. In this environment, it is important to efficiently create and deploy applications across a wide range of devices, without the burden of developing specifically to each.

Sun Microsystem's Sun ONE is a middleware platform that addresses the needs of managing and configuring such devices, integrating seamlessly both desktop computers and non-traditional devices. Sun ONE will form the basis of Telstra's common online technology platform, Telstra.One.

Telstra's CEO, Ziggy Switkowski has said that: *"The new technology environment will effectively open our networks and platforms to the IT industry for the development and hosting of the customer applications of the future. Together with Sun, we will aim to fast track the development of compelling customer applications and services, driving the take up of wireless and broadband in the markets we serve. We expect this to be a tremendous boost to technology innovation in Australia."* [10]

The B-eLab's primary interest in Sun ONE is as a development platform to evaluate applications across various devices in combination with broadband ADSL, wireless gateways (e.g. 802.11b) and mobile networking technologies (e.g. GSM, GPRS, Bluetooth).

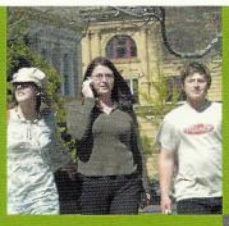
Combining these into a seamless Wide Area Network is a challenging undertaking. Delivering seamless connectivity and content across multiple network and device combinations is a significant challenge.

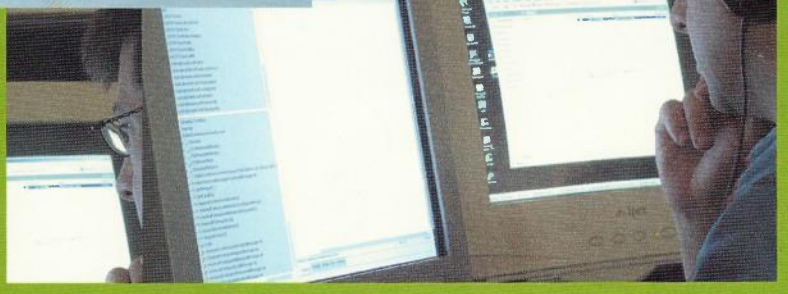
10 Extract from Telstra media release *(Telstra's leadership keeps Australia at technology forefront)* dated 29 July 2002.

Bringing us all together; the eLaunceston Community Portal

With its specific focus on the Launceston community, eLaunceston provides an ideal environment in which to explore the impact of localised content on the immediate community. The portal, along with Telstra's hosting infrastructure and experience, aims to provide great value to the community – an essential goal of the consultative group drawn from local stakeholders.

Local management of the portal affords greater exposure to everyday Internet usage and user preference, boosting our understanding of customer demands, and informing and influencing strategic planning.





...eLaunceston provides an ideal environment in which to explore the impact of localised content on the immediate community...

Telstra Develops Additional Feature to be used with Microsoft[11] Outlook

A recent survey of Telstra's top customers[12] showed nearly 70 per cent are actively using Microsoft Outlook as a business management tool.

Outlook's organisational features have been adopted by many businesses to schedule and control meetings and to simplify the timing and notification processes. Telstra ConferLink® extends Outlook's capabilities to allow users to schedule, participate in and manage telephone conferencing, all from within Outlook, and in the manner they've grown accustomed to. With ConferLink, meeting managers can call each participant into the meeting, see who is online at all times and control the course of the teleconference using familiar Outlook functions. Once the meeting has finished, ConferLink emails a report with meeting statistics, such as attendance and duration.

The product is currently being trialed internally at Telstra in cooperation with our Launceston Broadband Project consultative group. It is just one example of how existing technologies can be developed and used to facilitate efficiency in the workplace.

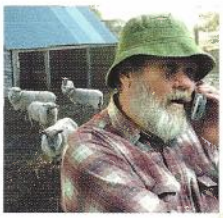
11 Registered trademark of Microsoft Corporation, a Washington corporation.
12 Survey commissioned by (TRL).
® Registered trademark of Telstra Corporation Limited.

Network

...opening up the possibility of a whole range

of interactive applications

Network FACT PAGE



ABOUT TELSTRA'S NETWORK[13]

Consists of 3.1 million kilometres of telecommunications fibre.

Manages around 30 million calls across the network every day

Around 130,000 customer service enquiries are managed each day (equates to over 47 million per year).

Over 9 million business & residential lines in operation.

Over 10 million, basic access lines in service (including more than 1 million domestic wholesale customers).

Over 850,000 directory assistance calls per day.

Telstra established a Regional Networks Taskforce – with a value of $187 million – to improve the reliability of rural telephone services.

1,290 rural exchange upgrade programs completed.

13 Excerpts from Telstra's Annual Review 2002, for the year ended 30 June 2002.

Network

INTERACTIVE TV

Interactive TV opens up the possibility of a whole range of interactive applications – from paying bills to participating in quiz shows.

Broadcasting of Digital TV has already started in Australia. Satellite-delivered TV has been digital for some time, and cable TV can be expected to be digital from 2004. Digital TV allows greater quality pictures and many more channels. With the provision of a suitable return path it also allows other data to be sent both to and from the digital Set-Top Unit (STU).

This opens up the possibility of a whole range of interactive applications. Many of these may be connected with the television programs, such as participation in quiz shows or instantly purchasing items as they are advertised. Other interactive applications will function entirely in their own right.

Such a system opens the possibility of new services by which customers could control the Telstra services to which they subscribe. They could also request new services, pay their bills, access their email or send and receive messages.

The television environment allows for much richer presentation of information than a voice system does over the telephone, but several unique constraints apply. The TV screen resolution is much lower than that of a PC, the memory and processing power of an STU is much less than that of a PC and most importantly, an STU remote control cannot easily be used to issue complex and lengthy commands. Telstra Research Laboratories (TRL) is applying both its technical and human factors expertise to these problems.

Although interactive TV is in its infancy in Australia, TRL is experimenting with prototype systems and has already had services running in the laboratory for exchanging SMS messages with mobile phones, accessing chat sessions on telstra.com® and displaying information from the telstra.com website – all correctly formatted for best presentation on the TV screen.

Much of the work undertaken at TRL has involved achieving an understanding of the different ways people relate to and use their television sets. TRL's Human Factors teams have studied the nature of the human/TV interface, including work on application look and feel, development of a style guide to ensure consistency between applications, and focus group studies to obtain real data on real users under tightly controlled conditions.

® Registered trademark of Telstra Corporation Limited.

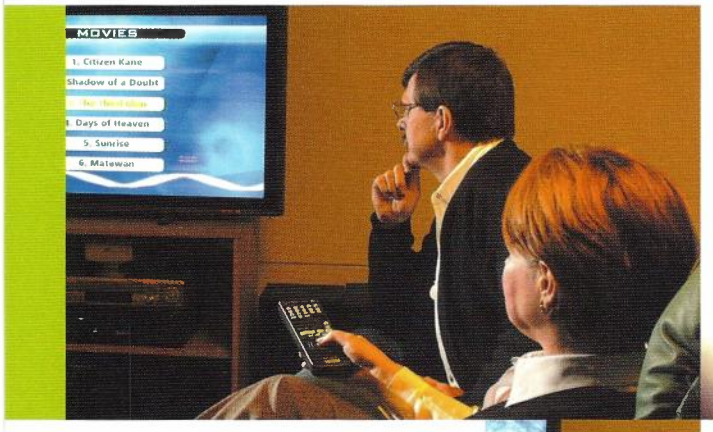
Network

VIDEO ON DEMAND

Progressing video on demand.

The concept of receiving videos on demand through the network is not new. However for years now it has been a source of frustration for both users and potential providers and so the concept has not become a reality. Telstra Research Laboratories (TRL) has been actively involved in the development of the video on demand concept and has solved, in past years, a number of the impeding technical problems.

TRL has developed sophisticated cost models which allow Telstra to assess options based on a variety of different network environments, different devices in the home and different video qualities. These developments are constantly reviewed on the basis of new technologies, new commercial products and new techniques that may make the commercial implementation of *Video on Demand* services possible. These include techniques that will allow management of digital rights to protect against piracy and ensure legitimate distribution of the content.



These models will help Telstra determine when the commercial environment is right, and position it to quickly respond and provide the infrastructure to support the heavy demands that this service will place on the networks, as well as keeping the price to the customer to a minimum.

TRL is also identifying all the potential service opportunities in this area, including retail and wholesale business, home consumers, and industries such as the hospitality industry.

...identifying all the potential service opportunities...

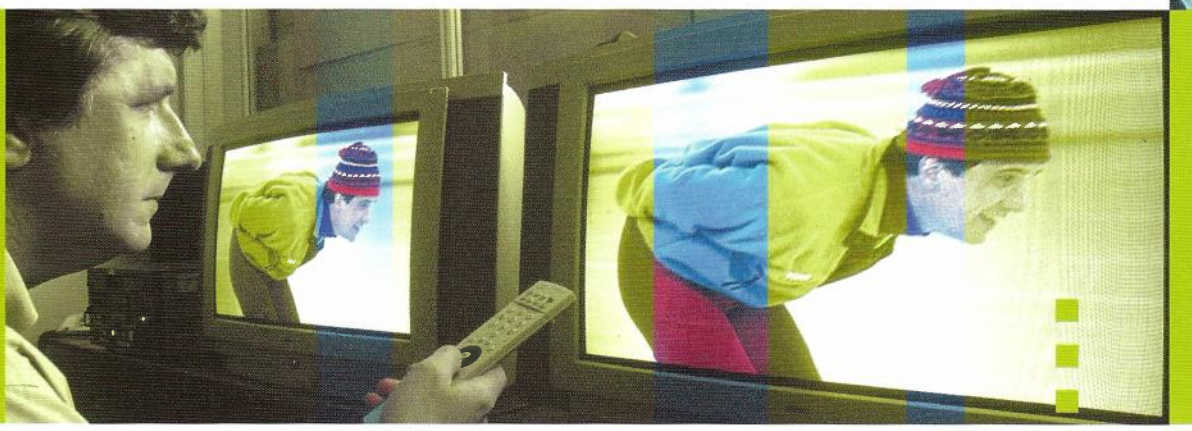
Network

QUALITY DIGITAL PICTURES AND AUDIO

Researching advances in compression and streaming technologies to greatly improve picture quality.

There is an increasing demand for quality digital audio and video signals to be made available over networks. The user's perception of the value of audio/visual services will be greatly influenced by the signal quality. This is why Telstra Research Laboratories (TRL) is using its knowledge and experience in the digital representation of image, video and audio, to constantly monitor and test advances in the field.

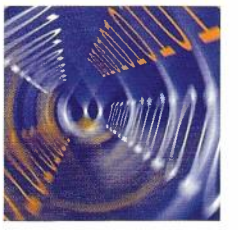
TRL tests many different types of picture with a range of different types of compression methods, both proprietary and based on international standards like MPEG-2 and MPEG-4. Greater quality might be achieved at a given bit rate or the rate might be reduced while still maintaining a given quality.



Understanding the delivered quality of a signal is a complex process. The quality of a received video signal after compression and decompression depends very much on its origins and what is in the picture. Things like the amount of fast motion, the depth of fine detail, the amount of noise and the source of the original – either film or TV camera – are all factors that influence the quality of the picture in the compression/decompression process.

The network carriage, including any packet loss or congestion, also has an effect on a received video or audio service. Network performance can be characterised and directly related to the experience a customer may have when streaming audio or video content.

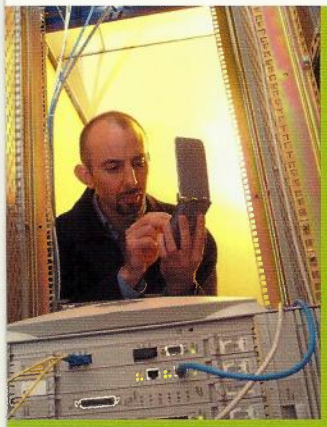
TRL assists to dimension Telstra's networks in such a way that they can support future services as necessary without having expensive, unused capacity. TRL also advises when new services can become technically or economically possible – enabled by advances in compression and streaming technologies.



Network

CUSTOMER SERVICE MANAGEMENT

Helping to ensure that customer requirements are met by Telstra's IP networks.



Telecommunications are a fundamental part of modern businesses. As integrated networks and applications become more complex, Telstra Research Laboratories (TRL) is using its expertise in systems and service management to help ensure that IP (Internet Protocol) solutions not only support a business but evolve with it. Service Management helps ensure the provision of the best networks that reflect current and future business priorities.

TRL is developing innovative ways to enhance the way Service Management is provided for IP networks. To better understand what customers need, TRL works closely with market researchers, product managers and customer representatives.

TRL not only aims to ensure that new products or systems are the best, but also, that the designs incorporate the increasingly complex needs of customers. TRL helps write customer requirements, evaluates new services from both technical and customer viewpoints, and is also able to help trial particularly complex customer solutions.

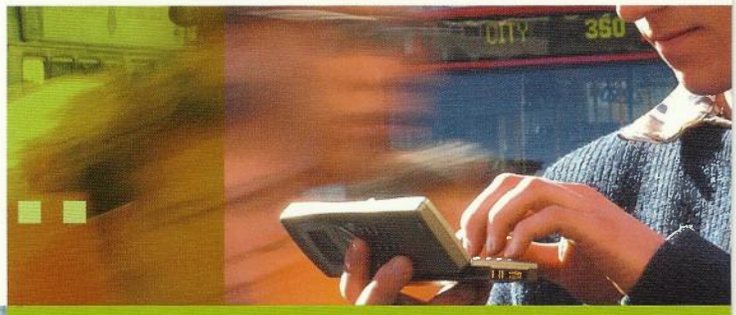
A new and exciting component of TRL's commitment to excellence in Customer Service Management is the IP Solutions Evaluation Centre. The Centre is a facility that combines TRL's expertise, the Telstra Private IP network including a variety of access technologies, such as ATM (Asynchronous Transfer Mode) and GPRS (Generalised Packed Radio Service), hosted applications such as mail, and demonstration and trial facilities in both Melbourne and Sydney.

The IP Solutions Evaluation Centre offers both key areas of Telstra and customer representatives the opportunity to truly experience Telstra's complex IP products and services, and understand how best to apply them to meet our customers' varied business needs.

Network

QUALITY OF SERVICE

Investigating Quality of Service (QoS) from a customer perspective.



As new wireless data technologies emerge, Telstra has to make increasingly complex and important technology decisions about which technologies it should deploy to meet emerging and anticipated customer requirements. Telstra Research Laboratories (TRL) has measured and begun to quantify customer expectations in terms of the network performance required to provide a satisfactory experience. This enables efficient configuration of wireless networks and optimises Telstra's ability to provide end-to-end technology solutions to the Australian community.

TRL has investigated QoS from a customer perspective. By presenting customers with typical experiences expected from current and future wireless networks, and requesting subjective ratings for each condition, thresholds of customer satisfaction may be identified.

These thresholds can be mapped to the particular levels of network parameters required to satisfy customers, providing the basis for efficient network configuration now – and in the future. As applications expected to run over these networks place different demands on network resources, threshold identification is specific to an application.

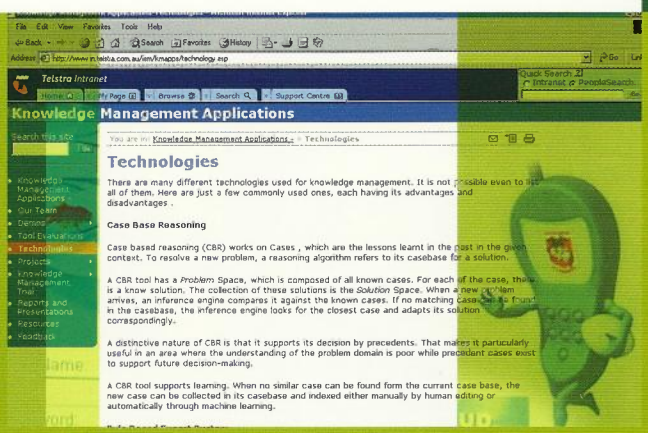
This benefits both Telstra and our customers. It enables efficient and cost-effective configuration of the wireless networks required to run these applications, in turn allowing the service quality required by customers at the lowest possible price.

The innovative nature of this research combines specialist user-centred and engineering expertise. This helps ensure that customers receive cost-effective technology solutions as we head from the world of GSM (Global System for Mobile Communications) and GPRS (General Packet Radio Service) to 3G networks and beyond.

Network

SOFTWARE QUALITY

Moving to the forefront of software integrity through a model approach to software management.



Software costs usually make up at least 80 per cent of the cost of telecommunications equipment, with systems comprising from many hundreds of thousands, to millions of lines of code. Due to the complexity of the software, it is often the subtle bugs in software rather than any hardware problems that have the potential to cause large-scale service outages.

The cost of using such flawed software is not only in the expense of diagnosis and repair, but also in the damage to customer relationships from the resultant service interruptions.

The telecommunications industry worldwide has recognised the need for improved software quality and has been developing standard processes and metrics that stipulate how the supplier should measure and analyse the performance of the software during development and post delivery and how change control should be managed.

Telstra Research Laboratories (TRL) is actively assisting Telstra in moving to the forefront of contemporary practice in software management – developing the ability to assess the quality of the software being purchased and influencing the quality of this software during production.

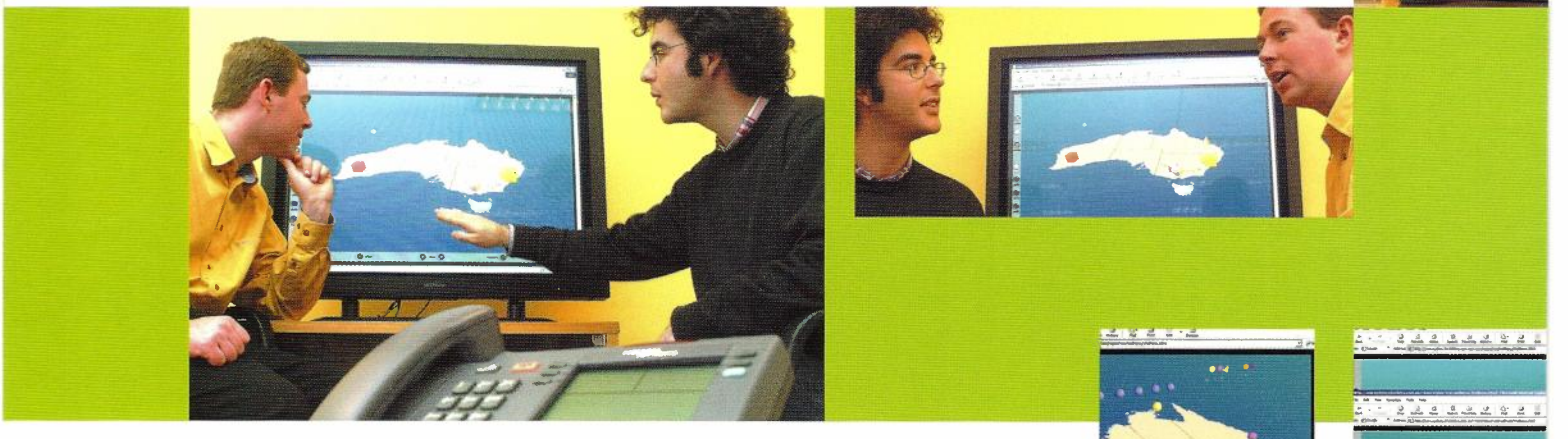
TRL is also assisting parts of Telstra to develop processes to handle the whole range of software acquisitions. The key process improvement model championed by TRL is the Capability Maturity Model – Integration (CMMI), which covers virtually all aspects of software and systems development and acquisition.

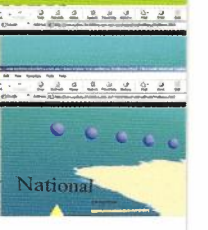
The telecommunications industry worldwide has recognised the need for improved software quality...

Network

VIRTUAL OPERATIONS ENVIRONMENT

Applying advanced technologies to create a meaningful virtual environment where people can discuss and view complex network data.





Telstra has created an operations organisation capable of managing the complexities of all the IT and network infrastructure used to deliver service to our customers. Telstra uses volumes of data with complex relationships to comprehend the state of its network and hosting technologies. Making sense of that data is a challenge that Telstra operations staff face every day.

The Virtual Operations Environment project is working to produce tools and systems that will transform the available raw data into rich and meaningful visualisations that will be easy to interpret. These visualisations represent complex data sets in ways that highlight information important to the operator and more subtly represent data of lesser importance.

The advanced technologies include technology originally designed for Virtual Reality applications. Interactivity is incorporated into the visualisations to allow multiple operators to *enter* a virtual space so they can communicate with each other and share a view of data, even over remote distances.

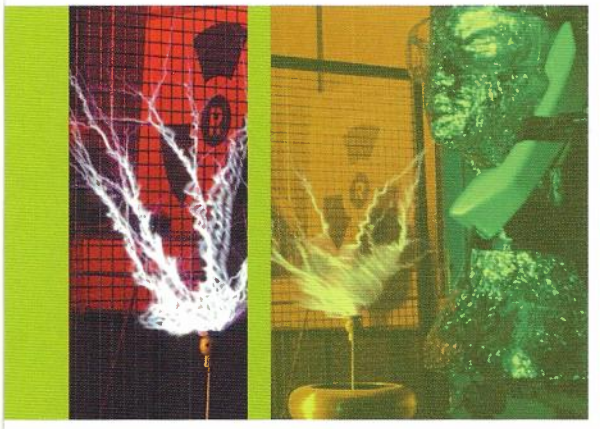
Network

FAILURE ANALYSIS

Fault finding at the microelectronic and board levels plays an invaluable role in resolving difficult hardware problems.

Operational problems with equipment can be costly, complex and hard to identify. Often it is hard to ascertain whether or not the equipment is at fault, or even if the fault can be adequately resolved.

Telstra Research Laboratories' (TRL's) failure analysis group specialises in fault finding at the microelectronic (individual chip) and board levels, and plays an invaluable role in resolving difficult hardware problems.



Failures often result from the harsh environments in which equipment is used. Payphones are an example of a product that experiences a hard life in the field. As an outdoor, remotely located unit, the payphone must contend with lightning, temperature variations and vandalism. TRL has provided many solutions to past and current problems with payphones, the most recent ranging from lightning damage to fraud schemes.

Another example of a reliability problem tackled by TRL is the phenomenon of zinc whisker growth from electroplated surfaces near electronic equipment. This phenomenon has become the scourge of the electronics industry. When these virtually invisible conductive filaments grow, break off and become airborne, they can impact on sensitive electronic circuitry resulting in equipment outages – with no apparent cause.

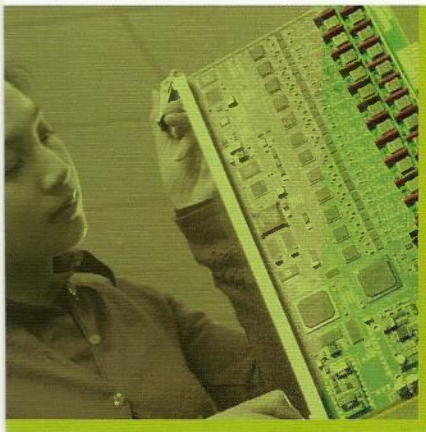
TRL has been providing risk assessments and recommendations to private industry as well as to other groups within Telstra and has designed, developed and patented an airborne whisker detector to aid investigations into equipment outages.

An outdoor, remotely located unit, the payphone must contend with lightning, temperature variations and vandalism...

Network

SPECTRUM MANAGEMENT

The Spectral Compatibility Tool assesses spectrum management requirements of DSL systems under development in order to minimise cross talk interference.



Telstra Research Laboratories has developed a Spectral Compatibility Tool that can be used to assess the spectrum management requirements of new DSL (Digital Subscriber Line) systems under development against the requirements of the Australian Communications Industry Forum (ACIF) Code C559.

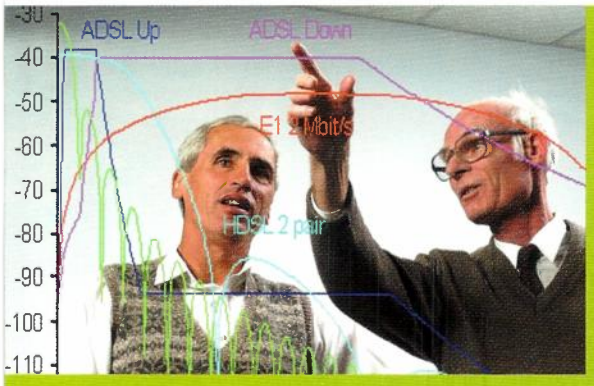
The traditional twisted copper pair cable used for the telephone service is now also being simultaneously used by ASDL (Asymmetric DSL) services. Those twisted copper pair cables are finding a new lease on life with the development of DSL services. ASDL can provide data rates from 10 to 100 times faster than conventional telephony modems. In order to deliver such high data rates, ADSL services use much higher frequency spectrum (about 1100 kHz) than telephone services (about 4 kHz) on the twisted pair.

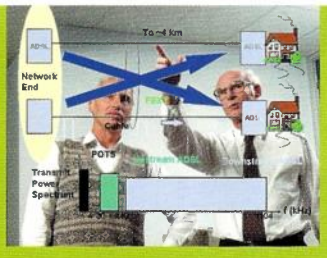
Because the access cables are made up of many twisted pairs bundled up together, there is crosstalk (electromagnetic coupling of signals) between the twisted pairs. While insignificant for the telephone frequencies for which the cable was designed, this may cause interference at the much higher frequencies used for DSL.

Network

SPECTRUM MANAGEMENT

...ASDL can provide data rates from 10 to 100 times faster than conventional telephony modems





When deploying DSL services on the cable, this crosstalk between like systems (eg. ADSL to ADSL) is taken into account as part of the design process, and results in limits on the reach of systems from the local telephone exchange. When many different DSL system types are permitted to share the cables, design to avoid excessive crosstalk in all possible combinations of system types can become very complex and problematic.

The many different types of DSL technologies that can be deployed all come with their own usage of the frequency spectrum. In particular ADSL, which is cleverly designed to avoid crosstalk from other ADSL services and achieves almost the full coverage of the telephony network, can be susceptible to crosstalk from other types of DSL. ACIF Code C559 ensures protection for ADSL by defining rules for the management of the spectral content and location of deployments relative to the local exchange.

The Spectral Compatibility Tool can assess the spectrum management requirements of new DSL systems under development and can be used to demonstrate compliance of a proposed DSL system and associated deployment rules with the benchmark performances established by Code C559 for systems such as ADSL, ISDN and HDSL. Compliance with industry deployment rules using the Spectral Compatibility Tool allow Telstra and others to use the twisted pairs for DSL with confidence that the crosstalk interference from other DSL systems in the same cable is controlled to meet these benchmark performances.

Mobile

The mobile telephone has been embraced by most Australians and it's hard to imagine doing business or conducting a social life without one...

Mobile FACT PAGE

MOBILE COMMUNICATIONS[14]

Telstra...

Owns and operates two world class cellular mobile phone networks.

Operates a CDMA cellular mobile phone network which covers 97.5 per cent of Australia's population.

Operates a GSM cellular mobile phone network which covers 95.3 per cent of Australia's population.

Has more than 5.9 million mobile services in operation.

Carried more than 1 billion SMS messages, sent by Telstra customers for the year ended June 2002.

Has coverage that reaches more than 1.1 million square kilometres.

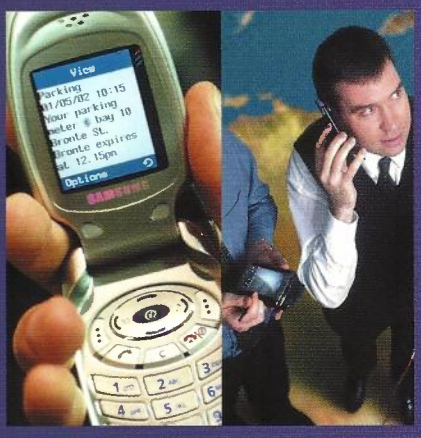
Currently has exclusive access to *The Blackberry* – Australia's first 'always on, always connected' [15] wireless email solution, which features built-in email, phone, SMS & organiser applications.

14 Excerpts from Telstra's Annual Review 2002, for the year ended 30 June 2002.

15 Provided you are in a mobile coverage area in Australia. The Blackberry and RIM families of related marks, images and symbols are exclusive properties of and trademarks of Research in Motion Limited – used by permission the Blackberry logo and *'Always on, Always Connected'* are registered with the U.S. Patent and Trademark Office and may be pending or registered in other countries. Research in Motion and the RIM logo are registered with the U.S. Patent and Trademark Office and may be pending or registered in other countries.

Feature

THE MOBILE PHONE – WE'RE TALKING ABOUT A REVOLUTION



GSM Cellular mobile network – celebrating 10 years in Australia in 2003.

Mobile phone technology has been embraced by most Australians and it is now hard to imagine doing business or conducting a social life without a mobile phone. Traditionally mobile phones were just used to make voice calls, but now we have the ability to send text messages and ring tones across the mobile network. We can even use the mobile phone as a radio, and more recently, communication has been extended to include other machines, giving users the ability to download emails from their laptop, using the mobile phone as a modem.

Andrew Scott, Leader of the Telstra Research Laboratories (TRL) mobile services group, says that the mobile phone is not just limited to interpersonal communication. Exciting developments now allow the mobile phone to interact with machines in a different way. *"Mobile Commerce, or m-Commerce, provides a new way to pay for goods and services with your mobile phone, and it is a concept that we believe will revolutionise the way mobile phones are used in Australia."*

m-Commerce helps overcome issues for both the vendor and the purchaser such as vandalism, coin collection, and finding the right change at the right time.

For example, a mobile phone can be used instead of coins to pay for things such as parking meters and goods from vending machines. These developments are currently being trialed. If eligibility criteria for the trial are met, the purchase price appears on a subsequent Telstra phone bill. A customer's mobile phone could become a personal payment device, as essential as the credit cards and cash in their wallet. An added bonus of paying for the parking meter with a mobile phone could be that the customer receives an SMS message, reminding them that their parking is about to expire[18].

In order to support scenarios like this, TRL has developed a generic vending protocol that connects a network of m-Commerce machines, such as parking meters, to a central m-Commerce platform. None of the existing standards for vending were sufficiently flexible, so a new protocol was needed. The resulting protocol supports machines from petrol pumps to golf-ball vending machines, and will allow Telstra to support new m-Commerce machines as needed.

Customers can communicate with the machines either through the network and a keypad on the payment device or via the infra-red function on their mobile phone. Currently the infra-red capability on the mobile phone is used to turn the phone into a wireless modem for use with a laptop. However, as Andrew points out, *"the infra-red interface in a mobile phone is capable of much more than simply providing a connection to the Internet"*.

A customer may pay for goods and services by activating the infra-red function on their mobile phone and pointing it at an appropriately equipped machine. The machine detects the infra-red signal, and uses it to connect – through the customer's phone – back to a central m-Commerce platform. When the platform has authorised the transaction, it sends a notification back through the infra-red path to the machine, signalling it to proceed with the transaction.

Since the machine uses the customer's phone, it does not need to communicate with the mobile network directly. This means that it is possible for the m-Commerce function to be added to certain existing machines in a cost-effective manner. Also, since infra-red operates along a line-of-sight, the customer may specify what machine they want to use by simply pointing their phone at it. Another benefit is that no numbers need to be dialled, reducing the complexity and time taken to use the service.

18 There are certain circumstances in which a customer will not receive the SMS, such as the mobile phone is switched off, they are not within a mobile coverage area, or their inbox is full. In such cases Telstra would not send the message beyond the meter expiry time.

The Mobile Phone Revolution

What is important to us is the consideration of how customers can better use the product or service to better integrate it into their lives."

Users may soon be able to wirelessly download software for games and instant messaging onto their mobile phones, making them more like PCs. Mobile phones as computing devices are, of course, more limited in terms of screen size, keypad, memory and processor speed than PCs. TRL is working with these challenges and aiming to solve the associated problems in order to enhance customer experience and make possible an exciting new wireless software market.

In the longer term TRL is researching the impact of Internet Protocol (IP) technology on cellular networks, which may be optimised to evolve into more cost-effective, general purpose, wireless data networks that may carry voice as well.

"It's great to be involved at the cutting edge of mobile phone technology," Andrew says. *"To be a part of something that changes so quickly and makes such a big difference to the way people communicate."*

"Originally mobile phones were the size of a briefcase, used only for talking to others, and their users were ridiculed. Ten years later, they can be as small as a matchbox and as varied as wristwatches; they are used for talking, texting, even storing birthdays. Around a billion people worldwide use a mobile phone as an integral part of their daily lives. It's exciting to think about what mobile phones will be like in another 10 years."

Further improvements in the future to the m-Commerce service may involve Bluetooth, a radio frequency alternative to infra-red that is currently available in some new mobile phones. There are limitations in sending data across the infra-red frequency; it is directional and needs a direct line of sight. Bluetooth uses radio waves rather than light, so there is no need to diligently line up the devices; all that is needed is to be within range. For example, from your laptop you could dial up your ISP (Internet Service Provider) using your mobile phone.

Another exciting application of m-Commerce is Mobile EFTPOS. Credit and debit cards can be used with a mobile phone that is fitted with a special EFTPOS keypad and card-swipe attachment. The Mobile EFTPOS connects through the wireless mobile network. It offers a payment option when there is no landline, e.g. in a taxi, or at moveable markets.

Just when you think that mobile phones can do about as much as they can, Andrew says that TRL believes there is still an enormous amount of growth in the development of the technology. *"To make this growth more relevant to our customers' needs, TRL's mobile services group extensively consults with customers. The information we gather from these consultations then influences and impacts on the design and delivery of Telstra's new products and services.*

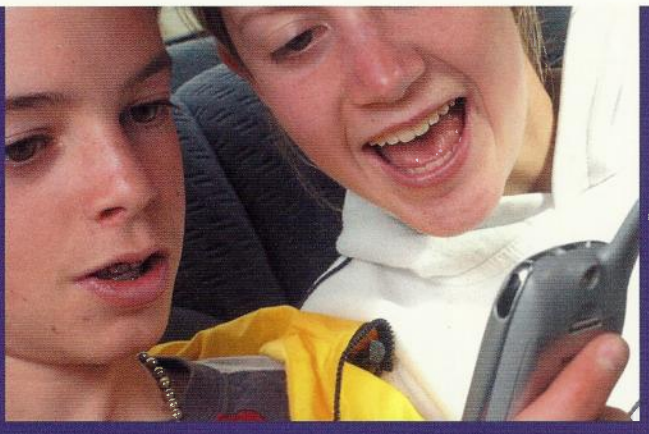
Mobile

JAVA[19] AND BREW[20]

Companies may want to integrate their services more intelligently onto the mobile phone

Making possible a wireless software market.

Java and BREW will make mobile phones more like PCs



Almost everyone has a mobile phone – now it just got smarter. Sun Microsystems' Java and Qualcomm's BREW software environments are being built into many of the latest phones. Java and BREW will make mobile phones more like PCs – able to be upgraded with new software whenever it is desired. These new PC-like phones are known as smart phones.

For developers, this is the first time that open programming environments can be used on mobile and wireless devices. Developers will now be able to write applications in Java or BREW that will be able to work on many different mobile handsets. They will be able to write software for mobile phones, and users will be able to buy and then wirelessly download this software in the same way that desktop users now purchase, install and run software on their PCs.

Phones as computing devices are more limited in terms of memory and processor speed than PCs, and handset users generally have higher expectations of quality and robustness. Telstra Research Laboratories (TRL) has been working to solve these challenges in order to enhance our customer experience and make possible, a wireless software market.

Mobile phone customers may expect a veritable flood of software to choose from – games and communications programs are touted as potentially being the most popular. Companies too, may want to integrate their services more intelligently onto the mobile phone by taking full advantage of the power of this new paradigm.

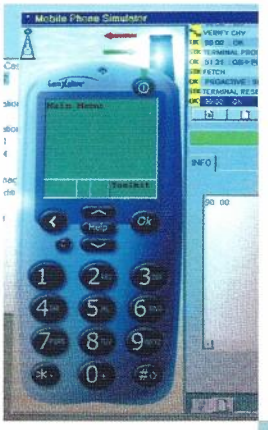
TRL has prototyped an email application for mobile phones, written in Java, which allows customers to check their email accounts and send email messages. Typically, phones are designed to enable voice communication, not email. TRL has overcome problems of developing complex communications-style programs for mobile phones to prototype this application.

19 Registered trademark of Sun Microsystems Inc., a Delaware Corporation.
20 Registered trademark of Qualcomm Incorporated.

Mobile

SIM TOOLKIT

An environment that is used to simplify the development of SIM card applications.



The SIM card in the back of your GSM phone is actually a smart card. As well as storing phone numbers, the SIM card holds secret information (such as your PIN) and runs tiny applications. Most of the GSM phones sold these days are capable of using these SIM card applications, and the SIM cards that Telstra provides have the PocketNews application on them for requesting text information to be delivered by SMS.

The SIM Application Toolkit or the SIM Toolkit for short, is the environment in which SIM card applications are developed. PocketNews is one simple example of the capability of a SIM card application.

Telstra Research Laboratories (TRL) has been investigating the potential of SIM Toolkit and building prototype applications. For example, SIM Toolkit can be used to create an application that will browse special sites on the Internet.

SIM Toolkit was used by TRL to prototype an application that could dynamically provide adventure or quiz style games. The games were played over SMS, but instead of typing text messages, the user could interact with the more usable SIM application, which provided simple selectable menus and options. Since text messages for games can be quite complicated, detracting from the game itself, this application proved a huge benefit when playing elaborate games.

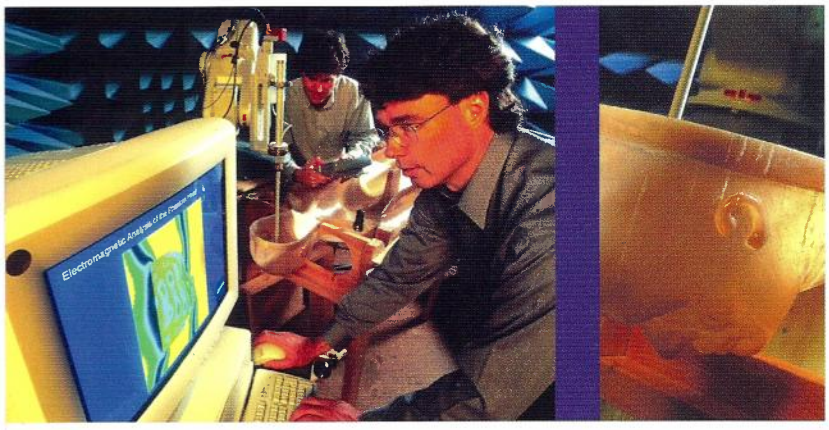
TRL has also examined the use of SIM Toolkit with new SIM cards that are implemented on a Java based smart card (JavaCard). Using JavaCard, a developer can produce a SIM application using a subset of the widely known Java language instead of the proprietary assembly languages that are commonly used for creating SIM Toolkit applications.

This should help simplify application development and potentially allow developers to write a single application that will run on multiple brands of SIM cards. SIM Toolkit allows applications to be developed that will assist Telstra to deliver new data services seamlessly across multiple GSM handsets.

Mobile

ELECTROMAGNETIC ENVIRONMENT SAFETY RESEARCH

Using human phantoms to test radio frequency safety standards.



As part of Telstra's on-going commitment to health and safety, Telstra Research Laboratories' (TRL's) Electromagnetic Environment (EME) Safety Research group evaluates new and emerging radio frequency (RF) technologies – such as third generation (3G) mobile phones, hands-free technologies, and next generation mobile radio network infrastructure – to ensure compliance with RF safety standards.

Both experimental and computational environments have been established to determine the levels of RF energy induced in the human body.

The experimental facilities feature a robot controlled measurement system, and a set of fibreglass human phantoms that can hold various human tissue equivalent liquids. A phantom can be exposed to a RF source under investigation, and the interior of the phantom scanned by the robot to determine the localised specific energy absorption rate (SAR). Measurement of the SAR level is presently the standard method of showing compliance with regulatory RF safety standards.

The computational modelling environment complements this experimental approach. Numerical models of the human body can be used for prompt evaluation of the SAR levels under a wide range of scenarios that may not be easily achieved experimentally. A computational model has been developed for the human phantom to verify the measured results.

To gain an understanding of the interaction between the RF and the complex nature of the structure of the human body tissue, data from the Visible Human project – a numerical model of a human that mathematically represents different body tissue – is being used as input to a high resolution computer model. The data originates from a research project sponsored by the United States National Library of Medicine.

This new computational tool will enable Telstra to continue to deliver new mobile and radio services more efficiently while ensuring that it complies with mandated regulatory RF safety standards.

Mobile

MOBILE MULTIMEDIA DEVICES

Mobile multimedia communication devices will be the way of the future.

In our view, personal communication devices of the future will be mobile, and more capable than existing mobile phones. Personal Digital Assistants (PDAs), third generation mobile phones, handheld games and MP3 players will merge to become devices capable of communicating and accessing information anytime and anywhere, as well as being able to present multimedia material in a variety of ways.

Roaming capability will be needed in the network so these devices can connect to the network anywhere, similar to mobile phones. However, unlike today's mobile phones, these devices will be able to connect using a variety of wireless and wireline technologies, taking advantage of broadband services in the home or office, and the wide-area coverage of wireless networks.

Today's voice calls and Short Message Service (SMS) will evolve into Multimedia calls and Integrated Instant Messaging.

Telstra Research Laboratories has been investigating the key technologies of Mobile IP, IP Version 6 and IP Telephony that will be required to deliver these services. Prototype devices have been built to demonstrate these future service capabilities and fully understand the network requirements.

devices of the future will be more mobile, and more capable...

Mobile

SMS VOICE BASED CONFERENCING

Telstra Research Laboratories has designed a new way for groups of people to get together

Making conferences easy to set up.

Telstra has conducted a Short Messaging System (SMS) voice based conferencing trial.

Telstra Research Laboratories has designed a new way for groups of people to get together. By combining SMS text messages with a Telstra web-enabled Conferencing product (ConferLink Online ReadyCall®), people on the move should be able to spontaneously initiate phone-based meetings by simply sending a single text message with just the topic or reason for the conference.

Currently, to arrange and invite people to a voice-based conference the host needs to know three numbers each of 10 or 12 digits, which must be distributed to all guests in a timely manner. The SMS Conferencing service saves the host and guests from having to know any of these numbers. It also takes care of the distribution of the invitations, encouraging ad-hoc dial-in meetings.

The host, predefining the groups of people with whom they expect to SMS Conference, simplifies the distribution of the invitations. To set up a meeting, the host sends an invitation to the service containing a topic and group identifier. Access credentials for the meeting are automatically added to the host's original message and then automatically forwarded to each member of the group. Guests can simply join by replying to the message.

If the host is near a fixed phone and wishes to use it for the conference then the host simply adds the number of that phone to the invitation. Once again no conference numbers need to be remembered.

By incorporating mobile phones and making ConferLink more convenient to use, there is the potential for significant revenue benefits as well as increasing ConferLink's appeal and *stickiness*[21] in the competitive conferencing market.

® Registered trademark of Telstra Corporation Limited.

21 Stickiness is a term used in relation to the degree to which the existing use of a product or service encourages its continued use.

Mobile

LOCATION ENHANCED INFORMATION SERVICES

...quickly and easily accessing relevant information...

"Find me the nearest chemist."
Incorporating location technology to find products and services via SMS easily.

The mobile phone is becoming much more than a voice communication tool for people on the move. Customers are eager to access content from databases, such as the Yellow Pages® – via the enormously popular Short Messaging System (SMS) medium – but the challenge for Telstra has been how to deliver high value information over such a limited interface.

Telstra Research Laboratories has incorporated location technology in order to provide a way of quickly and easily accessing relevant information via SMS. The result is a prototype service – SMS FIND.

SMS FIND will allow users to search for facilities and services either in their current vicinity or in another nominated area. The search term, e.g. *'chemist'*, is sent to SMS FIND, which matches the request to a database and responds via SMS with the chemists closest to you. Or *'florists hampton'* lists the florists in Hampton.

Users should be able to quickly find health services such as doctors or chemists, entertainment and eating venues such as cafes and restaurants, or retail facilities such as petrol stations and florists.

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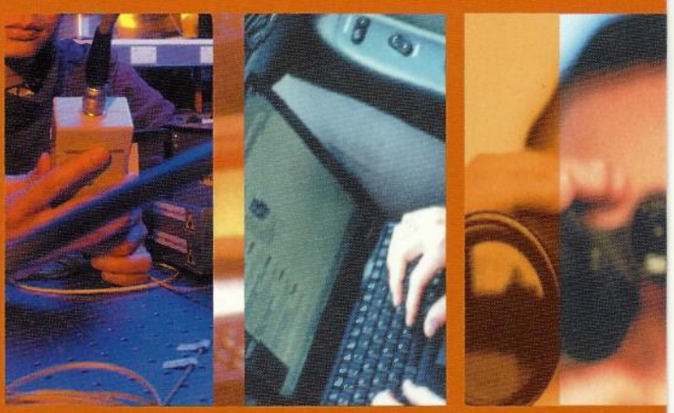
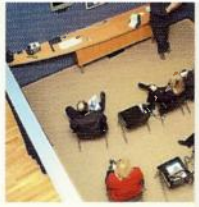
Internet



...Laptops, handheld computers and mobiles can all be used to communicate with the Internet. Many schools, offices, airports, hotels and homes have installed WLAN technology...



Internet FACT PAGE

INTERNET COMMUNICATIONS[22]

There are approximately 845 million Internet users worldwide.

Telstra offers three delivery technologies – cable, satellite and phone line – to ensure all Australian homes and businesses have access to high-speed, convenient Internet services.

Telstra two-way satellites now allow BigPond™ users to upload as well as download at higher connection speeds.

Telstra's continued rollout of ADSL, which converts the ordinary telephone line into a high-speed digital Internet access line, saw more than 800 exchanges ADSL-enabled at the end of June 2002.

Of these 800 exchanges, 252 were located in regional Australia.

In 2002, the Telstra Broadband Fund was launched to stimulate and fast-track the development of new and innovative broadband applications, tools and technologies.

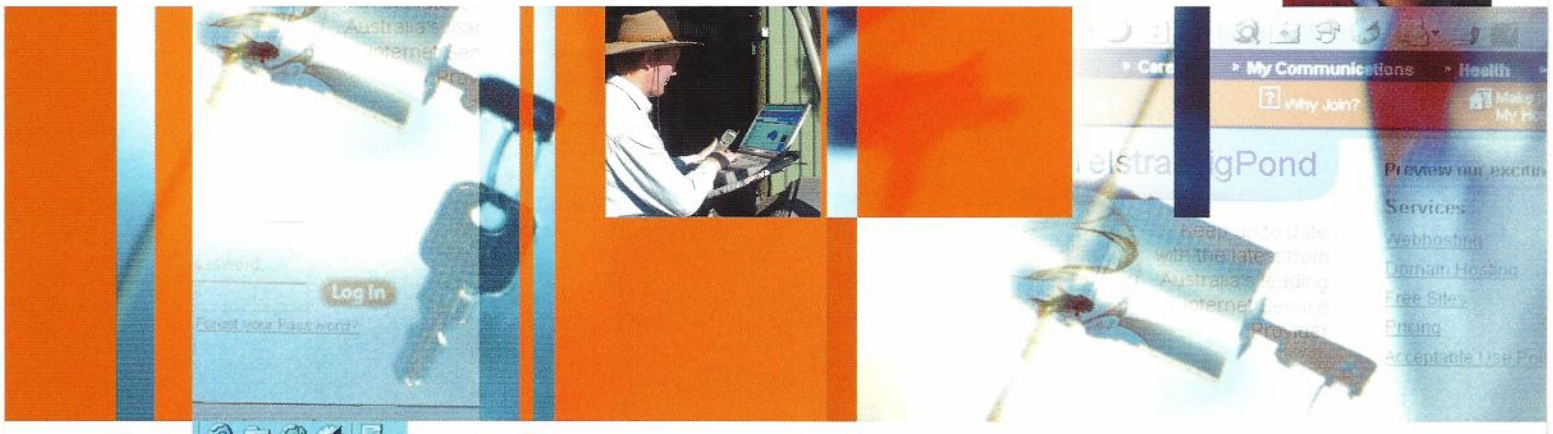
The next wave of wireless growth is expected to come from high-speed data (eg. using a personal computer with a wireless connection to the Internet).

22 Excerpts from Telstra's Annual Review 2002, for the year ended 30 June 2002.
™ Trademark of Telstra Corporation Limited.

Assessing

Internet update – some of the successes and the challenges ahead

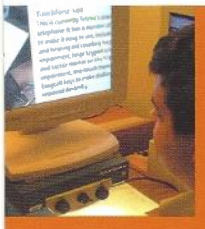
Geoff Huston
Chief Internet Scientist

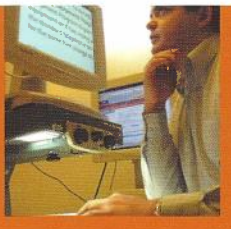


The initial research work that underpins the architecture of the Internet started in the 1960s and the basic specification of the protocols used by the Internet were completed by the mid-1970s. That is almost 30 years ago and what is surprising is that a communications protocol developed in that period was defined with sufficient generality and extensibility that it is now the foundation protocol of the global data communications industry.

Over the intervening three decades the Internet Protocol (IP) has scaled in almost every metric by a factor of millions. An IP circuit now operates at speeds of up to 40 billion bits per second and the network spans hundreds of millions of users and connects a similar number of end systems. Yet the core protocol, IP, remains essentially unaltered. Quite an impressive achievement in protocol design.

the Architecture of the Internet





However, not everything in the IP world has managed to scale as well as the base IP protocol. As the Internet grows, our dynamic routing protocols and the related area of traffic engineering continue to present challenges. Each order of magnitude of growth of the Internet has implied a need to refine the routing protocols to scale to the new dimensions of connectivity and policy. In addition, the *hop-by-hop* forwarding paradigm tends to aggregate traffic on major trunk routes, driving the Internet's demands for ever-faster base circuits.

Mobility and high-speed wireless operations remain a real challenge for IP. With the advent of widespread adoption of the combination of personal digital devices and various forms of wireless connectivity, the mobile communications environment wants to break free from traditional voice and embrace the broader capability of the Internet. The match of IP to wireless mobility is not a natural one. 'Identity' is a weak concept in the IP protocol. IP assumed that computers never moved – probably a reasonable assumption in the mainframe days of the early 1970's!

If we want to support mobility as well as various security models, introducing some form of location-independent identity into the IP protocol model is a necessary change. Beyond identity, the medium of wireless is also a challenge for IP. The IP protocol specification – and the Transmission Control Protocol (TCP) in particular – make some inherent assumptions about the network, particularly relating to the stability of the round trip timers and the loss characteristics. Wireless can alter these properties and this can force the TCP to be very conservative about how much data can be passed through the network. If the promise of 3G high-speed wireless services is to be achieved we will need to examine how to further refine TCP to operate efficiently in this environment.

Despite these issues, there is a clear goal in sight. The numbers of mobile IP devices are set to dwarf the current numbers of conventional IP systems, and there is an expectation that there are valuable utilities that may be constructed from the building blocks of high-speed wireless and IP.

Security of our communications systems has been subject to intense scrutiny in recent months and the Internet is no exception. Much of the environment of the Internet relies on a distributed trust model. There are vulnerabilities in the protocol suite that are a result of this distributed trust environment, as trust without explicit authentication is always a risky proposition in a public communications environment. The ability to forge email headers and distribute vast amounts of unsolicited mail is just the tip of the 'distributed trust' iceberg of inadequate application security. Much remains in the effort to add explicit authentication as a precursor to trust.

While the Internet has achieved surprising results so far, that does not mean that the protocol design effort is over. There is still much work to be done in the IP world and that will – perhaps – always be the case.

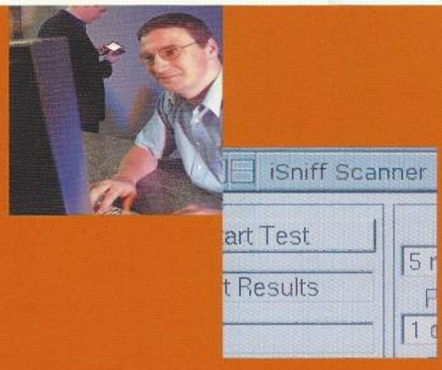
To quote Harald Alvestrand, the chair of the Internet Engineering Task Force: *"If you're not moving, you're dead"!*

Internet

WLAN SECURITY 'SNIFFER' TOOL

Sensitive company data may traverse a wireless network, and its users must be assured of both secrecy and integrity

Ensures a level of data integrity and secrecy in an increasingly risky wireless environment.



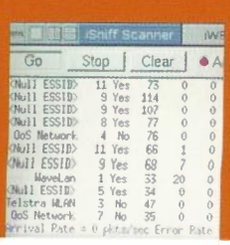
How safe is your wireless data? Could mercenary hackers be selling your corporate secrets to your competitors? Could individuals be downloading gigabytes of MP3 music over your expensive Internet link?

The susceptibility of wireless networks to intruders and eavesdroppers has become a significant concern for enterprises installing Wireless LAN (WLAN) equipment. As more workers embrace the freedom of networking without wires, the risks grow. Sensitive company data may traverse a wireless network, and its users must be assured of both secrecy and integrity.

Telstra Research Laboratories has created a WLAN security *sniffer* tool to help deal with these concerns.

This *sniffer* tool scans the surrounding area for WLAN access points and reports on their identity, characteristics and security features. Any rogue access points and any misconfigured network nodes will be quickly discovered. Unauthorised users placing devices on the network will also be revealed. Network administrators can get an overview of the security of their company's network and take action to plug the gaps.

An additional feature of the *sniffer* tool is the ability to monitor network traffic and make an estimate of the time it will take to break the default encryption scheme. This is dependent on how busy the network is and is a good illustration of why the default security mode is potentially inadequate. By analysing and exploring the shortcomings of current WLAN security, this tool serves to guide investigation into future wireless security schemes.



Internet

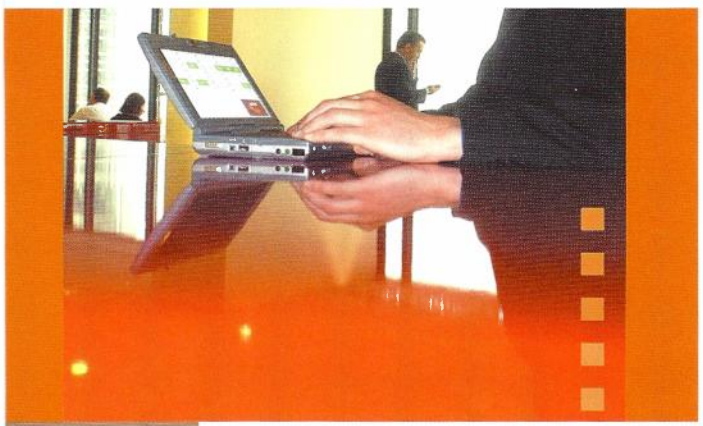
WLAN – WIRELESS LAN MADE EASY

Users free to roam wireless internet sites with...

- A single access point to multiple services
- An authentication process
- A single customer bill from all sites

...by just using their mobile phone.

High-speed Internet without wires is a reality. With cheap Wireless LAN (WLAN) equipment, also known as Wi-Fi, anyone can wirelessly connect to their existing home or office Internet connection at speeds as fast as on offer via ADSL (Asymmetric Digital Subscriber Line) technology.



Laptops, handheld computers and mobiles can all be used to communicate with the Internet. It is anticipated that many schools, offices, airports, hotels and homes will be installed with WLAN technology, and hospitals, restaurants and shopping centres will join them. However, WLAN can become problematic when all of these WLAN sites are owned and operated by different people. For example, if different accounts and passwords were needed for access – or there was a different configuration for each site – it would restrict people's ability to roam from site to site freely...and some of the benefits of WLAN would be lost.

There needs to be a single access point and authentication process for people to log in. Telstra Research Laboratories (TRL) has developed an authentication mechanism based on use of a mobile phone.

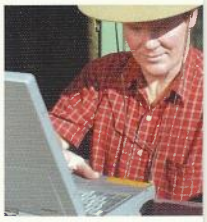
Using this solution, Telstra would make available a common web page to each site, where a WLAN user would enter their Telstra mobile phone number. A text message would be sent to that mobile containing a unique password. After the WLAN user has submitted that password to the web page, they could access the Internet using the WLAN connection, and have usage charges billed to their mobile phone account until they disconnect.

TRL has developed a solution that does not require proprietary hardware or special software to be used in the laptop or handheld computer and could potentially be extended to allow non-Telstra mobile phones to log-in, with charges billed according to inter-carrier agreements. This would take advantage of existing roaming agreements between carriers and could even work for overseas travellers with mobile phones.

Wireless LAN is an amazing technology, with the potential to allow people to connect to – and browse – the Internet as freely as they talk on their mobile phone. TRL is working to make this vision a reality.

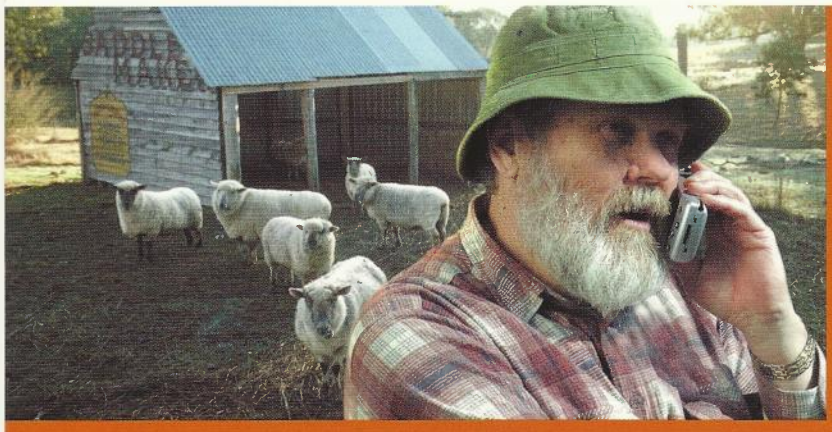
Internet

FOCUSSING ON TELSTRA'S RURAL AND REMOTE CUSTOMERS



Telstra has established an Internet Assistance Program to assist customers

Advancing Telecommunications Services for Telstra's rural and remote customers with the aim of:



- Enabling high speed Internet services by increasing ADSL coverage and other technologies;
- Improving Internet connection speeds for dialup customers.

Telstra Research Laboratories (TRL) has a range of projects to develop and advance services to Telstra's customers in rural and remote areas of Australia.

Big Pond® Broadband Satellite

The Big Pond Broadband satellite is Telstra's platform to deliver high-speed Internet services to remote regions of Australia. To ensure that this platform meets customer expectations of service quality, TRL developed a series of tools that analysed the performance experienced by customers.

These findings were used in making recommendations for network settings and upgrades.

Accelerators for Dial Modems

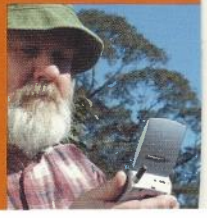
Telstra has established an Internet Assistance Program to assist customers – especially those in rural areas – that might experience lower Internet connection speeds through their dial modems. One possible solution to improve connection speeds, on offer through the Program, is the provision of modem accelerator technology which can enhance the customer's experience of the download rate of both web pages and email.

TRL has made significant contributions to the adoption of these accelerators by technically evaluating commercial accelerator products and then working closely with the chosen vendor to improve the product for Telstra's needs.

Rural ADSL Coverage

The introduction of ADSL (Asymmetric Digital Subscriber Line) into rural Australia highlights issues such as long copper access lines and other technologies that could potentially limit ADSL coverage to some customers.

Based on its detailed knowledge of ADSL transmission and a statistical survey of the rural Customer Access Network copper cable plant, TRL has provided recommendations to assist Telstra in achieving its aim of maximum ADSL coverage for its rural customers whilst still providing a high quality service.



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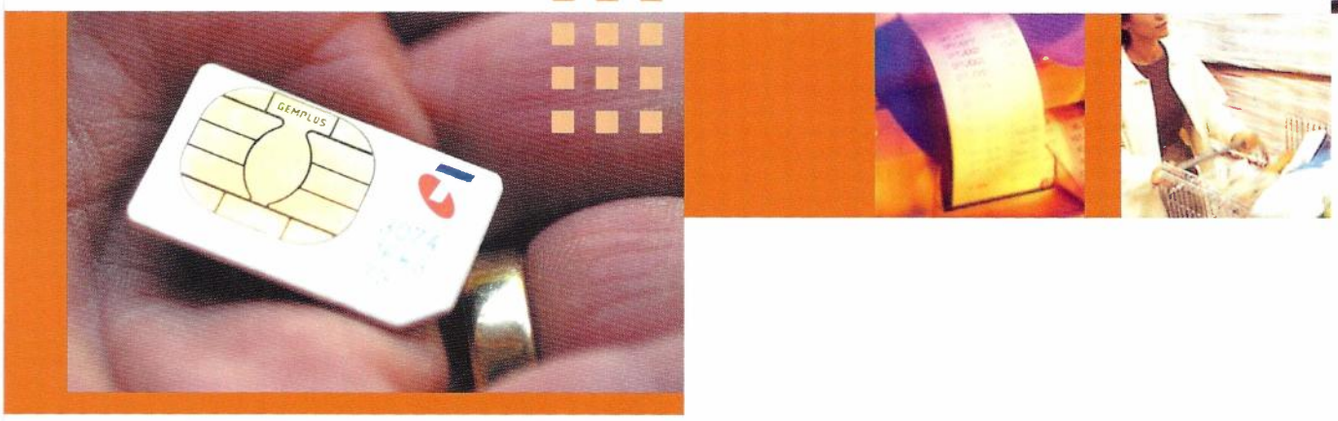
Internet

SMART CARD COMMANDS

Smart cards are increasingly being used as a security token



Enabling smart cards to interact with the cardholder independently of the application.

Smart cards are increasingly being used as a security token – for example, to authenticate the owner to remote applications. A typical smart card is a credit card (or smaller) sized piece of plastic with an embedded computer chip containing secure memory and optionally a cryptographic processor.

However, the card does not have its own screen and keyboard. The card has to trust the application to correctly manage these controls, so the application must implement access control rules for the card, for example, how and when to present a PIN (Personal Identity Number) request. In the current standards, these access control rules are limited: the application needs to inform the owner how it is using their card.

Telstra Research Laboratories' (TRL's) Security Researchers have been investigating solutions that enable the card to interact directly with the cardholder and where one card may behave differently to another, according to the preferred settings of its owner.

As an example, if an application sends a request to a card to digitally sign an authorisation to pay $30, one user's card may request the operating system to display a confirmation dialogue for the user to re-enter his or her PIN. Another user's card may not make this request as the amount in question falls below the user's threshold, which could be $50.

TRL has already built a demonstration of these solutions and is investigating their commercial applications.

Internet

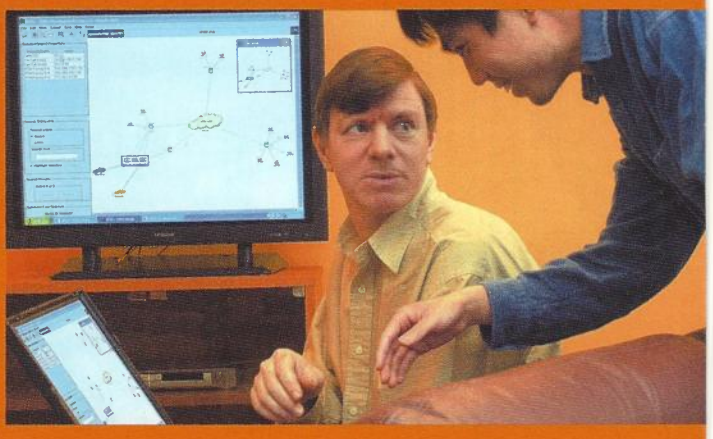
IPVIS – INTERNET PROTOCOL VISUALISATION

Building a clear diagram – representing Telstra Private Internet Protocol (TPIPS) network services – for better management, dynamic diagnostic tests and superior customer care.

The Internet Protocol Visualisation (IPVIS) is a tool that helps improve customer relationships by providing elegant solutions in the sales, activation and management of Telstra's Private IP (Internet Protocol) products. TPIPS, as the service is known, delivers virtual private network solutions with quality of service to corporate customers. IPVIS is an easy to use web interface that draws a clear diagram of a Telstra Private IP customer service from data that is in the live network.

This presents a number of benefits for the customer, including:

- Service issues may be resolved faster due to a better understanding of the customer's service at first glance;
- Documentation on a customer's service is accurate and up to date, based on the live network data;
- The customer relationship is improved as a result of better reporting.



The visualisation of the service is presented in a web browser that can be made available to different audiences. For example, Telstra has the ability to check the running state and perform connectivity tests using the network drawing shown in the web browser, where a customer or communications consultant is usually only able to view the service and not perform any dynamic tests.

IPVIS provides an end-to-end view of a customer service in a single coherent interface. This means that whatever products a customer has purchased may be shown as one service for that customer. As well as Telstra's Private IP network, current developments could see the inclusion of the Dial IP, Wideband IP and Digital Subscriber Line products.

In order to provide more details, Frame relay and ATM (Asynchronous Transfer Mode) switching protocol are also candidates for inclusion in the tools. These additional developments could bring us closer to that single interface that permits a coherent view of a customer's service.

IPVIS – Internet Protocol Visualisation

IPVIS provides an end-to-end view of a customer service in a single coherent interface

IPVIS not only provides a clear visual representation of a network, it also provides a consistent interface that could be used over the entire life cycle of a service.

Further value added IPVIS processes include:

- Automating various design aspects;
- Dynamically documenting the service by producing network diagrams;
- Managing the network from within the network diagram;
- Providing service assurance views imposed on the network diagram;
- Allowing a customer to see what their service looks like.

To achieve this IPVIS:

- Manages data effectively;
- Makes the data easy to access;
- Separates the intelligence from the presentation;
- Has a powerful presentation layer;
- Has in-built security to protect the privacy of customer information.

There are many other features that can be added to the IPVIS interface, and Telstra Research Laboratories is identifying those elements that will provide added flexibility and improved customer service.

Our peopleLEADING R&D EXPERTS

...The most rewarding aspect of this work is that you're always at the coalface, always seeing the tangible results of your effort. Much of your work is visible to the public...

Michael Beresford

Human Factors Specialist

Our peopleTRL STAFF RECOGNISED AS WORLD LEADERS

Winning a prestigious worldwide competition.

Adam Kowalczyk and Bhavani Raskutti – artificial intelligence technologists from Telstra Research Laboratories (TRL) – have won the prestigious 2002 Knowledge Discovery and Data Mining (KDD) Cup at the annual KDD conference in Canada.

Bhavani Raskutti and Adam Kowalczyk

Competing against 54 world-leading teams in data mining, Adam and Bhavani developed a mathematical model to predict Yeast Gene regulation.

The KDD cup is a prestigious worldwide competition held annually within the field of knowledge discovery and data mining. Adam and Bhavani are in good company as previous industry winners of this competition include Amdocs, Salford systems and e-steam, with honourable mentions going to industry heavy weights such as SAS, AT&T and Blue Martini.

Data mining is used within Telstra to analyse customer data for fraud detection and to predict customer churn. Adam and Bhavani's success is indicative of the power and the breadth of the technologies developed within TRL for these purposes.

Adam and Bhavani's solution defeated some stellar competitors from leading universities, biomedical research companies and corporations.

The combined team of ClearForest and Celera, the company responsible for mapping the human genome, won the other section of the 2002 competition.

Data mining involves inferring knowledge from big quantities of data and, in particular, includes the ability to mine from text. Using tools and techniques developed at TRL, Adam and Bhavani came up with the winning solution.

"We loaded data using 15,000 parameters – including a dictionary of terms, words and symbols – to develop the most predictive model," Adam said. *"After a series of agonising trials, we came up with a very unusual solution which ignored 97 per cent of the given data. Then we realised we had a serious chance of winning."*

"We know that Telstra can benefit from text mining techniques – in areas such as fraud and churn prediction – so this win has relevance to our business. The win reinforces that we are world-class in our research and development and you don't need to look elsewhere to source this type of technology."

Our people
– LEADING R&D EXPERTS

Paul Howell BEd

An open mind and enthusiasm for work in new areas is essential at TRL. I have been here for seven years now in a variety of different roles. A broad background of skills and interests has prepared me to work in fields as diverse as broadband Internet applications, interactive TV programs, interface design and 3D-computer animation.

The work here is creative, challenging and rarely repetitive. I have worked on literally dozens of projects such as Telstra's first broadband internet site, minute graphics for WAP mobiles and an interactive television pilot featuring a solar-truck driving talking frog.

As for the people... where else could you find colleagues prepared to dress up as an amphibian and drive a solar powered truck?

Paul Howell Lee-Anna Caccioppo Joseph Lizier Dr. Milosh Ivanovich

Lee-Anna Caccioppo
BSc, Grad Dip Ed, Grad Dip IT, MBA

Working at Telstra Research Laboratories (TRL) means working with creative people who willingly take risks. Teams of people from diverse areas of expertise are given the opportunity to think independently and cooperatively. Sometimes the search for results leads in unexpected directions and to new ways of thinking.

One of the most successful projects for my team has been the development of a tool to assist in the evaluation of Research and Development projects, a project generated from our Future Orientated Research Development Program.

Much of my work in the two years I have been with TRL has included research into industry portals, the development of risk assessment models related to networks and e-commerce, price modelling of products and services and the development of Telstra's product delivery processes.

We always seem to be challenging approaches; it is exciting work in an environment that is both motivating and rewarding.

Joseph Lizier BSc, BEng (Hons)

I arrived at Telstra Research Laboratories (TRL) Sydney as a student on a work experience placement through a co-op program that TRL sponsored. It was a great opportunity for me – and one that I am still grateful for. I joined the company after graduating a year later and have now been here for two years.

My reasons for joining TRL – after that initial experience – are still those that excite me about the labs today. TRL offers me exposure to a very wide range of cutting edge technologies. Personally, I have worked across a diverse range of projects incorporating mobility, ebusiness, pervasive computing, web services and other Internet technologies, and have gained valuable experience from each.

Furthermore, TRL is in the rare and powerful position of having the potential to genuinely change user paradigms and indeed people's lives. For me however, it is the talent and enthusiasm of my colleagues that I find the most rewarding and inspiring thing about working at TRL.

Dr. Milosh Ivanovich
BEng (Hons), MComp, PhD

My first experience with Telstra Research Laboratories (TRL) was in the Network Analysis section as part of a vacation project between the third and fourth years of my Electrical and Computer Systems Engineering degree.

I distinctly recall being amazed at the number of colleagues who were world-class researchers in fields such as queuing theory, network and graph theory, reliability theory and many other areas of operations research.

TRL provides both the depth and breadth of interesting and challenging projects. I have been here for six years, and currently lead the Wireless Networks group within the Radio Networks section, with a focus on mobile Internet technologies and modelling.

My day to day work deals with areas such as queuing theory, teletraffic modelling and analysis of wireless networks, the performance of TCP/IP in the wireless environment, as well as medium access control and link layer modelling and analysis.

The satisfaction in my work derives from being able to predict the behaviour of complex systems and networks, in a manner that is both useful and of real value to Telstra.

Our people
– LEADING R&D EXPERTS

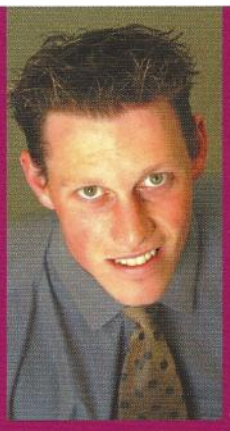
Michael Beresford BSc (Hons)

Working as a Human Factors specialist entails so much more than understanding and analysing customer behaviour and tailoring existing products to suit user requirements. There is a demand to examine customer opinions of, and demands on, current and future technologies and applications. This can shape the offerings that are delivered to market and the strategies employed by our clients.

The most rewarding aspect of this work is that you're always at the coalface, always seeing the tangible results of your effort. Much of your work is visible to the public, whether it is websites you have designed, a product you have improved or a concept that has been developed into a product resulting in a launch.

There is no other environment where you are exposed to the latest technologies, devices and innovative ideas. Being able to take these ideas to customers and provide input on their development to save people time is truly satisfying.

Michael Beresford | Mary Cudmore | Ming Zhao | Mathew Mirabella



Mary Cudmore
BEng (Ist Class Hons), BSc

I joined Telstra Research Laboratories (TRL) three years ago and now lead the Private IP Service Management project. This project helps Telstra to continually improve the level of service management we provide for the customers of our complex IP solutions. This is both very challenging and rewarding – the scope of technology, processes and systems involved in providing and managing a large corporation's Intranet, access technologies and applications provides many opportunities for innovation in service management.

I'm intrigued by the complex and somewhat unpredictable interaction between people and technology; and I enjoy being able to communicate the technical, business and the human aspects of Telstra's complex solutions to others.

I really appreciate the opportunity TRL provides to be involved in such a huge range of work – from configuring and managing GPRS phones and carrier-grade switches, to working with Marketing, Sales and Product Management – in order to understand and add value to the way our technology translates into products and solution sets designed to meet the business requirements of our customers.

Ming Zhao PhD, MEng, BSc, GCM

In sport I always play defence. In TRL I do the same thing. I have worked in a number of different areas of service assurance to defend our customers and telecommunication networks from faults.

In the past, the focus of my work was on system solutions. I developed novel algorithms and expert systems to analyse fault data and to assist human operators.

Now the focus has shifted to the effective use of existing knowledge. I lead three projects in knowledge management – studying knowledge approach to empower people, improve job efficiency and retain and share corporate experience.

I am excited that the enthusiasm in knowledge management is very high across Telstra. I hope my projects will contribute to the continued formation of a knowledge organisation.

Mathew Mirabella
BA (SocSci) (Hons), BSc (Hons)

In a company like Telstra, technology is a key element of business success. I am pleased to have the opportunity to help Telstra bring the technology to our customers and realise the full business benefits.

Recently, my work has primarily focused on providing the technological know-how and the business strategy to help Telstra align its online standards with good human factors and usability principles as well as the W3C[23] (world wide web consortium) technologies and guidelines for universal design and accessibility.

The positive attitudes towards these standards have seen Telstra move forward, not only in improving the customer experience with our online services, but also in providing access for people with disabilities.

I am happy to be a part of a team that helps our diverse range of customers empower themselves in the online environment, as well as helping Telstra reap the clear business rewards that come with delivering a useable and accessible Internet.

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Our people
– LEADING R&D EXPERTS

Hans Trinkle BEng (Hons), BSc

A productive team environment, close customer relationships, and the constantly changing nature of the work make my time at TRL interesting and rewarding. In my nine years here, it has been great to see projects mature from the initial idea, to network deployment and actually making a difference to Telstra and its customers.

Currently I am looking at identifying new, compelling product opportunities by integrating voice and data communications. I'm finding this work particularly interesting because it gives me an insight into retail as well as infrastructure drivers, and allows me to experiment with cutting edge technology.

My role is to understand the emerging technologies and to look for product opportunities. This involves building prototypes – and working closely with retail and infrastructure groups – to quickly determine which ideas are most promising. I find it especially rewarding when I can look at a commercial product and know that I have directly contributed to its success.

Hans Trinkle

Belinda Ward BSc, BEng, MEngSc

I have a Masters Degree in Cognitive Science – which is the science of thought and the human mind. I'm also doing postgraduate studies in Intellectual Property Law.

I love working at Telstra Research Laboratories because it really does give me a chance to play! My job here offers an opportunity to experiment with emerging technologies and use them to prototype new products to enhance people's lives. I have a keen interest in how people relate to technology... and how we use technology to relate to each other.

In my 10 years here I've worked in such diverse areas as electromagnetic compatibility, artificial intelligence and mobile product innovation. Currently I'm working on location-based services – finding new ways of bringing people relevant information while they are on the move.

Belinda Ward

Glenn Colville BEng (Hons)

With the rapid rate of change in technology, the telecommunications industry and customer needs, a challenging aspect our role in R&D is to create timely and effective technical solutions.

I have been with Telstra for 17 years and a member of TRL for seven. I currently manage a team that addresses three major areas: new IP based voice and multimedia applications; next generation contact centres – with a focus on improving the way customer service is delivered; and the management systems that are used to support many new services.

Our team typically undertakes product prototyping, strategy development and technology evaluations. Working amongst many Telstra groups, I find the mix of business, technology and operations in a fast changing environment both challenging and exciting.

Glenn Colville

Geoff Huston

Geoff Huston
BSc (Hons), MSc

I've been working in the area of computer networking since 1980, working first with DECnet and then with a plethora of protocol and transmission technologies in the ensuing years. I've worked in networking projects that have connected up campuses, cities, nations and the globe over this time.

Since 1988 I've been working in the area of the Internet and I've watched it grow from an interesting research experiment to a mainstay technology for the communications industry. As it continues to grow, the Internet continues to challenge our assumptions both about IP (Internet Protocol) itself and the manner in which communications services are constructed and presented.

How far can we scale the base IP technology? What forms of service quality can we offer as part of our services? How do we combine scale, speed and mobility in the emerging wireless IP environments? How can we make the Internet more secure? Within Telstra my client is Telstra Internet Direct, and I provide specialist technology support to make this network one of the world's best IP service networks.

We've come a long way with the Internet in a very short period of time – and I suspect that the story has only just started. There is a lot more we will learn and apply to our services in the coming years.

Our people
– LEADING R&D EXPERTS

Brad Starkie BEng (Hons)

I've spent a lot of my spare time dabbling in other professions including working as a musician, making documentaries and running for parliament. Most of these activities have convinced me that engineering is what I do best.

The aim of my current work is to teach computers human languages so that – one day – we will be able to interact with machines as we do with people and that machines will learn in the same way humans learn. That day is some way off and along the way there will be numerous products and services, of use to people, that should deliver a return for the investment in the research. An example of this is the Telstra Lyrebird™ product that has been designed to speed up the development of speech recognition systems. The task is a hard one but I enjoy the challenge, and I still believe my best work is ahead of me.

Brad Starkie

My current pre-occupations include helping to raise my daughter and trying to complete my PhD. I also enjoy an evening of karaoke and some of my more enjoyable evenings have been spent in a foreign country, trying to learn the local language from watching the bouncing ball on the karaoke screen.

Bhavani Raskutti Btech (Elec Eng), PhD (Comp Sc)

With the advent of the Internet, there are tons and tons of text winging our way. How can we get computers to distil intelligent information from this incredible volume of text and ease the manual processing? This is just one of many questions I grapple with when I work on text mining at the Research Labs.

As part of my job, I can be reading or writing a research paper on some completely novel algorithm or be thinking of a great new application. There is constant pressure to be at the cutting edge and that means we need to keep learning. One of the best parts of my job is the fact that I get to interact with some very intelligent people.

While it is great working on cutting edge technology, it can often be frustrating that there will be times when many of these technologies are not used by the business until years later. So it is always a great feeling when something one of the team has produced makes a difference to the business or gets trialed by Telstra customers.

Bhavani Raskutti Adam Kowalczyk Andrew Scott

Adam Kowalczyk
MSc, PhD (Maths)

Computers are ubiquitous in today's offices. Can we make them clever assistants rather than the relatively dumb tools they are now? This depends on whether we can make them more intelligent...and making them *learn* is the very first step in this direction. This is where my research efforts have been concentrated for a number of years.

Applications – including speech recognition, customer churn prediction, fraud prevention through to cancer prediction from genomic data – are examples of where we have demonstrated practical benefits from cutting edge advancements in this area of development at Telstra Research Laboratories.

Each such successful application and demonstration or presentation to our colleagues in Telstra is my motivation and what keeps me moving forward. Demonstrating to peers and colleagues ways of greater efficiency and productivity in the near future is a great motivational experience and personally rewarding. It is these step-by-step advancements and successes that shape Telstra's future. The frustrating part of the job is the actual number of steps it can take to get there – which can seem scarier than a nightmare at midnight!

But this, I know, is the price I must pay to sit at the cutting edge of research and development.

Andrew Scott BCM (Hons), BLitt

What gets me out of bed in the mornings is my job. I know that I can be reading an article on some new technology, get a cool idea, and be able to bounce it off some very intelligent people who work within earshot. If it's got some merit, then it can quickly evolve and become prototyped within a very short time.

I work for clients in the mobile area of Telstra and grapple with technologies such as Wireless LAN, WAP, Java[24] and MMS. It's a great feeling when something one of the teams has produced makes a difference to the business or gets trialed by Telstra customers.

Although we always try to think about trends and the future, it's pretty tricky. I never imagined when I started that six years later I would be experimenting with software on Java-enabled mobile phones. Fortunately I get a kick out of learning... and there's so much happening in this industry.

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24 Registered trademark of Sun Microsystems Inc., a Delaware Corporation.

Glossary

802.11
Refers to a family of specifications developed by the IEEE for wireless LAN technology. 802.11 specifies an over-the-air interface between a wireless client and a base station or between two wireless. There are several specifications:

- **802.11** – provides up to 1 or 2 Mbps transmission in the 2.4 GHz band
- **802.11a** – provides up to 54 Mbps in the 5GHz band.
- **802.11b** – provides up to 11 Mbps in the 2.4 GHz band
- **802.11g** – provides up to 20+ Mbps in the 2.4 GHz band.

ACIF (Australian Communications Industry Forum)
An industry body that represents the telecommunications industry in the development of technical, network, operational and consumer industry codes of practice under telecommunications self-regulation in Australia. Members of ACIF include carriers, service providers, equipment vendors, industry associations and user/consumer groups.

ADSL (Asymmetric Digital Subscriber Line)
A technology that transforms ordinary copper phone lines into high-speed digital lines – Up to 1.5 Mbit/s downstream (from the exchange to the end user) and up to 256k upstream. See also xDSL.

AI (artificial intelligence)
The science and engineering of making intelligent machines, especially intelligent computer programs. It is related to the similar task of using computers to understand human intelligence.

ATM (Asynchronous Transfer Mode)
A high-bandwidth, low-delay, packet-based switching protocol that allows voice, video, text and data to be multiplexed together into a single transmission network with different qualities of service.

Big Pond®
Telstra's public Internet service.

Big Pond® Broadband
Telstra's fast, broadband Internet service delivered over hybrid optical fibre/coaxial cable, satellite or ADSL.

Bit/s or Kbit/s or Mbit/s or Gbit/s (bits or kilobits or megabits or gigabits per second)
Units for measuring rate of digital information transfers. A kilobit per second is a rate of one thousand bits per second; megabit per second is a rate of one million bits per second; a gigabit, one thousand million bits. New optical fibre technologies can transfer information at the rate of one thousand gigabits, or one terabit, per second.

Bluetooth
Wireless technology – enables links between mobile computers, mobile phones, portable handheld devices, and connectivity to the Internet.

BREW[1]
Provides applications for CDMA 1X Brew handsets. The handsets themselves have an application installed, so customers can browse a catalogue of other applications, purchase them and then download them over the air.

Broadband
A general term used to describe transmission at bandwidths higher than 100 kb/s (eg high-speed data and video services).

Browser
Desktop computer application offering an easy-to-use graphical interface for browsing and retrieving information over the Internet.

Call centre
The 'front end' of an organisation or business, comprising a group of people equipped to communicate with customers about bill queries, service issues, technical support, service access and other customer service functions.

CDMA (Code Division Multiple Access)
A digital standard, designed for use in cellular mobile networks, which assigns a unique code to each user and spreads transmission of user channels across a wide band of radio frequencies. CDMA mobile technology was introduced in Australia from January 2000.

Circuit
In traditional PSTNs, telephone connections are made as fixed 64 kbit/s channels or circuits. The alternative to a circuit-switched network is a packet-switched network.

CMMI[2] (Capability Maturity Model Integration)
The Capability Maturity Model Integration framework is an internationally recognised process improvement model for organisations, especially where software is developed or acquired.

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1 Registered trademark of Qualcomm Incorporated.
2 Registered Service Mark of Carnegie Mellon University.

Glossary

code c559
ACIF defines the performance requirements for DSL and other technologies on copper access network. The Code offers a coordinated approach to reduce the risk of interference between services deployed over access networks.

Contact centre
The next evolution of a call centre which may allow customers to interact with a business via any electronic medium (fax, email, web, as well as voice).

Crosstalk
Electromagnetic coupling of signals.

GSM (Global System for Mobile Communications)
European digital standard for mobile phones based on time division multiple access (TDMA). TDMA allows several conversations to share a single radio channel by each transmitting digitised voice within its allocated timeslot. GSM is the second-generation mobile network used in Australia.

Hop-by-hop
The way in which data packets move from router to router. Generally the less hops, the faster the server can access an Internet website.

Digital TV
The digital transmission and processing of video signals provides a number of benefits over conventional analog TV. These benefits generally include more TV channels, better picture quality and greater reliability.

Distributed trust
To provide an approach for enforcing security policies in pervasive computing environments.

DSL (Digital Subscriber Line)
See xDSL.

EME
Electromagnetic Energy.

Frame relay
A simplified packet transport protocol used to connect local area networks (LANs) over large distances. Also, a packet switching technology used for voice, data and video signals which uses packets of varying lengths, or frames. Frame relay can be used with any data protocol.

GPRS (Generalised Packed Radio Service)
A data service (eg for Internet access) using packet switching rather than circuit switching. It is compatible with GSM and is regarded as a second generation plus (2G+) mobile technology.

IDE
Integrated Development Environment.

IEEE (Institute of Electrical and Electronics Engineers)
An organisation composed of engineers, scientists, and students best known for developing standards for the computer and electronics industry, in particular the IEEE 802 standards for local-area networks.

IM (Instant Messaging)
Instant Messaging is a rapidly growing area of Internet communications, involving the delivery of short messages.

Infra-red (IR)
A process of transmitting data via light (or radiation) through a wireless digital protocol. It can operate anywhere from half a metre up to hundreds of metres away.

IN (Intelligent Network)
A telecommunications network architecture that employs computers to customise services for specific needs, such as call diversion, call waiting and number portability.

Internet (or the Net)
A global inter-network of computer networks, connected via Internet Protocol (IP) and the world's telecommunications infrastructure. IP enables applications such as email, the web, file transfer and other services to run across different networks and operating systems.

IP (Internet Protocol)
Part of the family of protocols describing software that tracks Internet addresses, directs outgoing messages and recognises incoming messages. Used in gateways to connect networks at a high level.

IP telephony
Enables people to place telephony calls over IP networks instead of public switched telephone networks. It is also known as Voice over IP or Internet Telephony and it represents the technology which uses IP-based data networks to transmit telephone calls.

IP-VPN
See VPN.

IPv6 (Internet Protocol Version 6)
'next generation' protocol designed to replace the current version Internet Protocol, IP Version 4 (IPv4). IPv6 fixes a number of problems in IPv4, such as the limited number of available IPv4 addresses. It also adds many improve-ments to IPv4 in areas such as routing and network autoconfiguration. IPv6 is expected to gradually replace IPv4, with the two coexisting for a number of years during a transition period.

ISDN (Integrated Services Digital Network)
A digital service providing switched and dedicated integrated access to voice, data and video.

ISP (Internet Service Provider)
A company that connects individuals or organisations to the Internet. Can range in size from an individual operating dial-up access, to providers operating substantial network backbones and fast cable modem access (eg Telstra's Big Pond® services).

IVR (Interactive Voice Response)
Automated customer service or information selection based on pre-recorded voice prompts controlled by a touch-tone telephone or speech recognition system.

J2Me
A highly optimised Java run time environment which covers the range of extremely tiny commodities such as smart cards or a pager all the way up to the set-top box.

Java[3]
A portable computing platform based on the power of networks and the idea that the same software should run on many different kinds of computers, consumer gadgets, and other devices. Allows you to run the same Java application on lots of different kinds of computers.

JavaCard
Allows Java technology to run on smart cards and other devices with limited memory.

JAWS[4] (Job Access With Speech)
A screen reader that works with a PC to provide access to software applications and the Internet. Information from the screen is read aloud to the user.

m-commerce (Mobile-COMMERCE)
Using mobile technology with wireless connections to place orders and transact business over the Web.

MIDlet (Mobile Information Device Application – or Applet)
Users can download and run software authored in J2ME MIDP (Mobile Information Device Profile) just as they would software for their PC, opening up a new world of totally configurable, cross-platform applications.

Mobile IP
Emerging set of protocols allowing the roaming concept of cellular telephony, where a user can make a single call to an IP-based network and maintain what appears to be a single Internet Protocol (IP) connection even as the system is handed off from one IP network to another.

MP3
Also known as MPEG layer 3 – a compressed audio format that reduces file size greatly without much loss in quality. You may shrink down the original sound data from a music CD by a factor of 12, without losing sound quality. Factors of 24 and even more still maintain a sound quality that is significantly better than what you get by just reducing the sampling rate and the resolution of your samples. Basically, this is realised by perceptual coding techniques addressing the perception of sound waves by the human ear.

3 Registered trademark of Sun Microsystems Inc., a Delaware Corporation.
4 Registered trademark of Freedom Scientific.

Glossary

Mpeg (Moving Pictures Experts Groups)
A group of people that generate standards for digital video (sequences of images in time) and audio compression.

Mpeg-2
Covers a definition of MPEG-2 Video, MPEG-2 Audio, and MPEG-2 Systems.

Mpeg-4
Covers a definition of MPEG-4. These standards made interactive video on CD-ROM and Digital Television possible.

Multimedia
Combination of multiple forms of media in communication of information between users and machines. Communication formats include voice communications (speech recognition, speaker verification and text-to-speech), audio processing (music synthesis, CD-Rom), data communications and video.

Optical fibre
A strand of hi-tech glass that carries signals in the form of laser light pulses. An optical fibre pair can simultaneously carry many thousands of telephone conversations, or a mix of video and voice. An optical fibre cable may contain tens or even hundreds of fibres.

Packet
In a packet-switched network, such as the Internet, data is packaged and routed in 'blocks' or packets, each having a header with the network destination address. Packet switched networks are also described as 'connectionless' because the paths selected by routers can vary from moment to moment, as each router is updated with current network information.

PDA (Personal Digital Assistant)
A small, portable device which is used to carry personal data.

Pervasive paradigm
A world where computers are embedded in all parts of our environment.

PIN
Personal or Private Identification Number

Portal
An individual's customised 'gateway' to the Internet, a portal is a web page designed to allow different users to tailor and aggregate content according to individual preference. Web ports include global and special instant messaging, email and chat facilities to encourage the development of electronic communities.

PSTN (Public Switched Telephone Network)
Generic term for public telephone networks.

QoS (Quality of Service)
Some customers require specified throughput of information for particular services (eg delay sensitive voice traffic) which is referred to as a specific QoS.

RF (Radio Frequency)
The frequency in which information is transmitted through the air for communication purposes.

SAR (Specific Energy Absorption Rate)
An indication of radiation absorption.

SIM (Subscriber Identity Module)
Smart-card with phone features and customer preferences that is inserted into GSM (digital cellular mobile) handsets when purchased, and which incorporates security devices such as encryption.

SMS (Short Messaging System)
Text based message service on mobile phones.

STB (Set Top Box)
Connects customers television to a source of TV other than free-to-air. Sometimes referred to as a STU (Set Top Unit).

Stickiness
Term used in relation to the degree to which the existing use of a product or service encourages its continued use.

TCP
Transmission Control Protocol.

TCP/IP
Transmission Control Protocol / Internet Protocol.

Tech-wreck
Refers to the dot.com crash of April 2000 where a large number of Internet companies worldwide collapsed financially.

Third Generation (3G) Mobiles
Analogue and digital mobile voice networks account for the first and second generations respectively. 3G mobiles are the next generation mobile networks that will handle high bit-rate data connections.

TPIP (Telstra Private IP)
A high quality IP service for office-to-office networking in metropolitan, regional and rural areas. Private IP allows use of a single data connection in each location, and then relies on the built-in intelligence and security of the IP network to manage the routing and delivery of data between locations, almost anywhere across the nation or overseas.

VoD (Video on Demand)
A service through which customers could access large remote databases of movies and other video programs through a multimedia interface, and control program viewing in the same way as a VCR – for example, using pause and rewind.

VoiceXML (Voice Extensible Markup Language)
A programming language designed for creating audio dialogs that feature synthesised speech, digitised audio, recognition of spoken and DTMF key input, recording of spoken input, telephony, and mixed initiative conversations. Its major goal is to bring the advantages of web-based development and content delivery to interactive voice response applications.

VoIP (Voice on Internet Protocol)
Voice calls over the Internet or a private IP network.

VPN (Virtual Private Network)
Uses a third party (Telstra's) intelligent network to combine all communications between sites and mobiles, including international branches, giving the benefits of a private company network without the cost.

W3C (World Wide Web Consortium)
Provides technologies, guidelines, specifications and tools for universal web design.

WAN
Wide Area Network.

WLAN (Wireless – Local Area Network)
Allows devices such as laptop or palmtop computers equipped with wireless cards to connect to the internet at designated sites, or 'hotspots', using 802.11b technology at speeds of up to 2 Mb per second.

WAP (Wireless Access Protocol)
A protocol that enables mobile phones equipped with the appropriate browser to access Web pages from the public Internet.

web (or WWW – World Wide Web)
A series of interlinked computer documents 'marked up' with HTML to display text, graphics, images and sound. Users browse the documents via a graphical user interface. Web sites are like multimedia magazines, with interactive features and links to related sites.

Wi-Fi (Wireless Fidelity)
Generic reference of any type of 802.11 network, whether 802.11b, 802.11a, dual-band, etc.

xDSL
A technology that enables the copper telephone loop to carry high-speed data streams. The 'x' denotes that there is more than one DSL technology (eg ADSL, HDSL and VDSL).

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