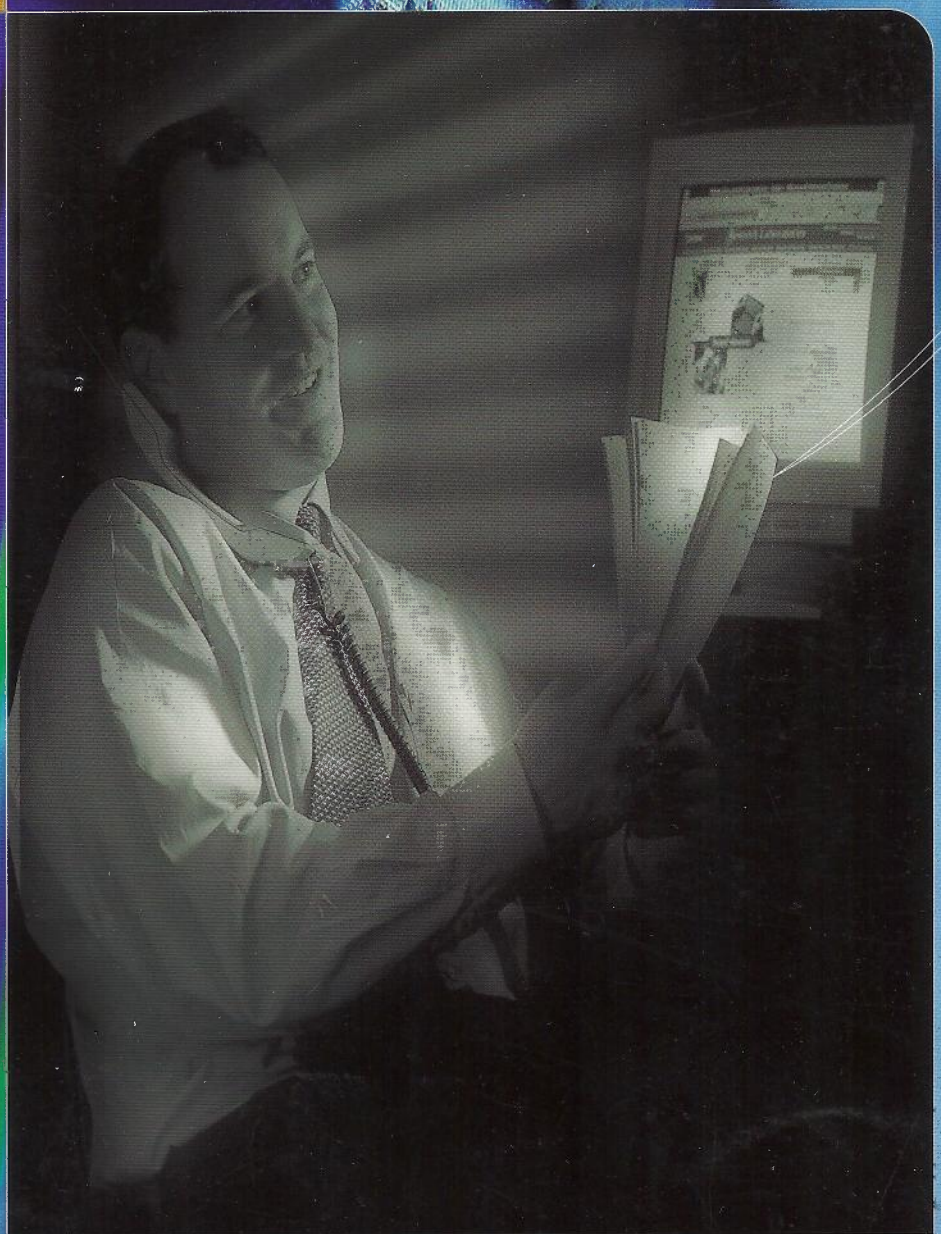
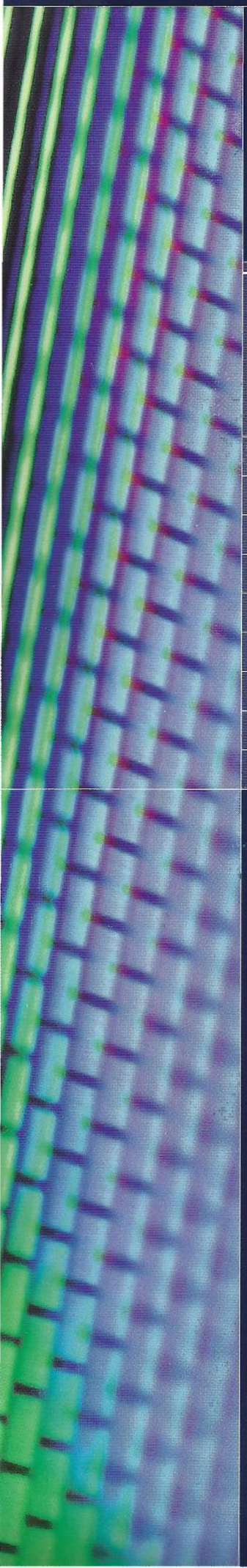


New Horizons

Telstra
Research Laboratories



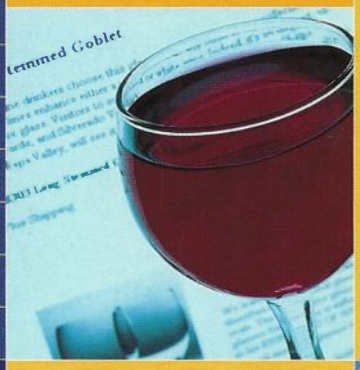
Highlights	Page 01
TRL: Making the Data Connection	Page 02
Home Communications	Page 04
Business Communications	Page 14
Mobile Communications	Page 24
Transforming Telstra's Network	Page 32
Partnerships	Page 46
Glossary	Page 54
Credits	Page 56

Highlights

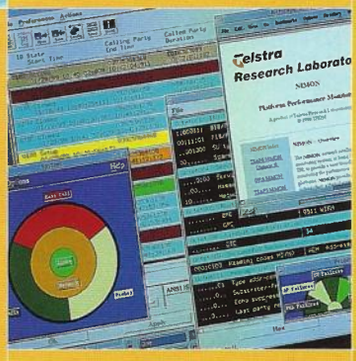
Data Mining
TRL has developed an artificial intelligence approach to data mining that produces comparatively simple and accurate results, which have been verified in a follow-up trial with Telstra customers. Data mining involves the use of software tools to 'dig' for distinctive customer profiles among huge volumes of data. Researchers applied standard data mining techniques to compress sample customer data, then applied their own pattern-recognition software to compress it even further into a summary 'profile' of targeted customers.

WebDial™ 1800
WebDial™ 1800 is a free-call, hot-link product that will enable a business to connect customers to its call centres through a clickable icon on the business's home page.TRL developed the underlying platform that provides call control and routing between the public phone network and the Internet. After a user registers for WebDial™ 1800, the TRL-developed platform responds to an icon click by automatically setting up a call to a selected phone, or to a virtual Web-phone in the same user session.

Webcast
TRL coordinated Australia's first broadband 'Webcast' of the nine-hour Concert of the Century held in Melbourne in 1998. Researchers brought together the resources for Telstra to deliver a broadband version of the 'Addicted to Noise' Internet coverage of the Concert to a small group of Big Pond Cable customers at ten times the speed of the narrowband Webcast.



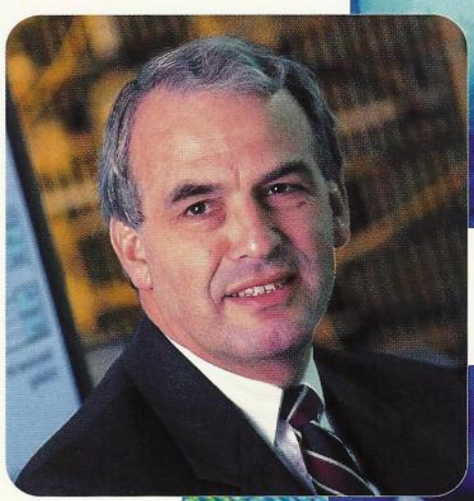
Telstra Find
Based on its expertise in natural language searching and advanced indexing, TRL has developed a new generation of Internet search engine that is being integrated with Telstra's public Web-site. The search engine, known as 'Telstra Find', can make sense of plain English user queries – anything from a short phrase to a long sentence – by recognising conceptually related words, and can present users with a list of matches categorised by context.



NIMON
To monitor the performance of Telstra's intelligent network (IN) platforms – at the heart of services such as 1800 and 13 phone numbers – TRL has developed a software tool called NIMON (Network Intelligence performance MONitoring). NIMON can collect and analyse data from different IN products, even during extreme situations of IN platform overload associated with mass calling events such as radio and TV phone-ins.

Call Preview Service
TRL developed software for a 'Call Preview' service to provide Telstra customers with Web access to phone account information between bills. Call summaries are presented on-screen as they would appear on a traditional Telstra telephone bill. Users can click on hyperlinks to access more detailed calling information, which they can sort using call destination, date, area code, or other criteria.

TRL: Making the Data Connection



Hugh Bradlow

The change to a network traffic mix in which data traffic dominates represents the most significant change in telecommunications since the emergence of telephony late last century.

Packet-based Internet Protocol (IP) is fast becoming the international language of communications. Internet traffic on Telstra's public network has grown more than 100-fold since 1994. Assuming that this exponential growth rate continues – and we believe it will – by the year 2003, data services, including the Internet, may account for 90% of global network traffic.

This change to a network traffic mix in which data traffic dominates represents the most significant change in telecommunications since the emergence of telephony late last century. At Telstra, we refer to this shift as moving to a 'data paradigm'.

For roughly a hundred years, the telecommunications industry designed networks optimised for voice communications. All other services, including data, were built as overlays on the voice network. The transition to a data paradigm creates a need for technology transformation. We need to design a public telecommunications infrastructure that is optimised for data communications without requiring overlay networks. This public infrastructure could efficiently carry all types of services – voice, video, audio or data.

The online environment has also created different expectations of customer service and control. Customers are demanding the ability to access and control their services via online interfaces, whether that's a home or office PC, fixed or mobile phone, or personal digital assistant (PDA).

This presents a significant challenge to the systems and processes Telstra uses to run its business.

To address these challenges, Telstra has set up a project known as DMO – Data Mode of Operation. Through the DMO project, Telstra is evaluating the technologies, systems, processes and business models it will need to thrive in the new data world. Fundamentally, the DMO project has identified the need to create an Internet-like core infrastructure on which Telstra can build all of its future services.

This IP-based network will present Telstra with opportunities to offer its customers innovative and enhanced services. TRL researchers have been exploring these opportunities, creating and prototyping services that will enable Telstra to offer real differentiation and value to business and consumer customers.

However, the IP-based network also presents significant engineering challenges. Public telephone networks have decades of experience behind them, and are able to serve millions of people and businesses simultaneously with incredible reliability. IP data networks, on the other hand, present new technical challenges that must be dealt with before these networks can deliver services as reliably as today's telephone service. TRL, with its strong technical skills base, is helping Telstra to make the often complex choices involved in finding solutions. For example, researchers here have been evaluating how Telstra can engineer IP and ATM (Asynchronous Transfer Mode) systems in the core network to guarantee high quality levels for time and mission-critical applications.

Despite the changes in technology involved in the DMO, Telstra's customers will continue to receive the reliable, high-quality telephony services they enjoy today. Further, the DMO does not mean that Telstra will change its telephone network overnight. On the contrary, the public voice network will be part of Telstra's infrastructure for years to come.

What the DMO does mean is that Telstra can start the new millennium with a core communications infrastructure that has the flexibility, robustness and capacity to support the huge bandwidth demands of digital convergence. One of the challenges of the data era will be finding the skills required to design, build and operate new, carrier-grade, data 'inter-networks'. TRL has been working on IP and other data technologies comprising the DMO for many years, and is thus in a position to help Telstra prepare its skill base for the new era.

TRL's 75th anniversary last year reminded us of the Labs' extensive track record in introducing innovative telecommunications technologies to Australia. Today, we are building on this long experience with new skills introduced by the many young graduates who have joined our ranks in recent years. The sheer breadth of our research – which now covers almost every area of Telstra's business – demonstrates TRL's success in translating knowledge into real value for Telstra.

Telstra will be faced with a staggering array of technology choices over the next decade.

Developing integrated networks on a global scale is a complex undertaking. It requires competence in a range of technologies, such as software systems architecture, software development, artificial intelligence, wireless and radio, digital switching, photonics and human factors design. Few companies have the depth of experience or the critical mass of R&D to develop such systems. Telstra is one of the few.

I invite you to browse through the following pages, and discover for yourself how our researchers are helping to bring about Telstra's vision of a digital world of online communities – where people with shared interests and values can interact, where access is universal, and where distance is no longer a barrier to vivid and compelling electronic communication.

Hugh Bradlow
Director
Telstra Technology
Strategy & Research


BUNDLES


home communications
5.43pm
"Hi Gran...
can't wait to see you soon."
Telstra

Along with the telephone and mobile phone, the Internet has come to occupy a central place in our day-to-day communications. In Australia, one in every five households has gone online. People young and old are learning for themselves that the Internet is not just about exchanging and storing data. Rather, it enables anyone to reach out beyond geographic and national boundaries, and participate - through images, sounds and words - in virtual communities built around common interests and shared values.

Through the Web, people can meet, chat, tell each other the latest news, share insights, shop, start businesses and make friends. While a keen collector can spend time bidding for rare items at virtual auctions in different countries on the same day, a busy office worker can order fresh groceries for the evening meal. Family members and friends living thousands of kilometres apart can exchange photos and news at any time of the day, any day of the week.

Making the world of e-mail and the Internet easier for Telstra's customers is an important part of TRL's work. For example, researchers here helped Telstra develop its easymail™ service, an e-mail-only system that can be quickly mastered by users with or without Internet experience.

Using easymail,™ home-PC owners can send and receive e-mail for the cost of a local call, without the need to subscribe to an Internet service provider. TRL also developed a number of prototype services that could enable users to switch between Web browsing and telephone calls. One of these is a 'virtual second line' that would be of interest to households with a shared telephone-Internet connection.

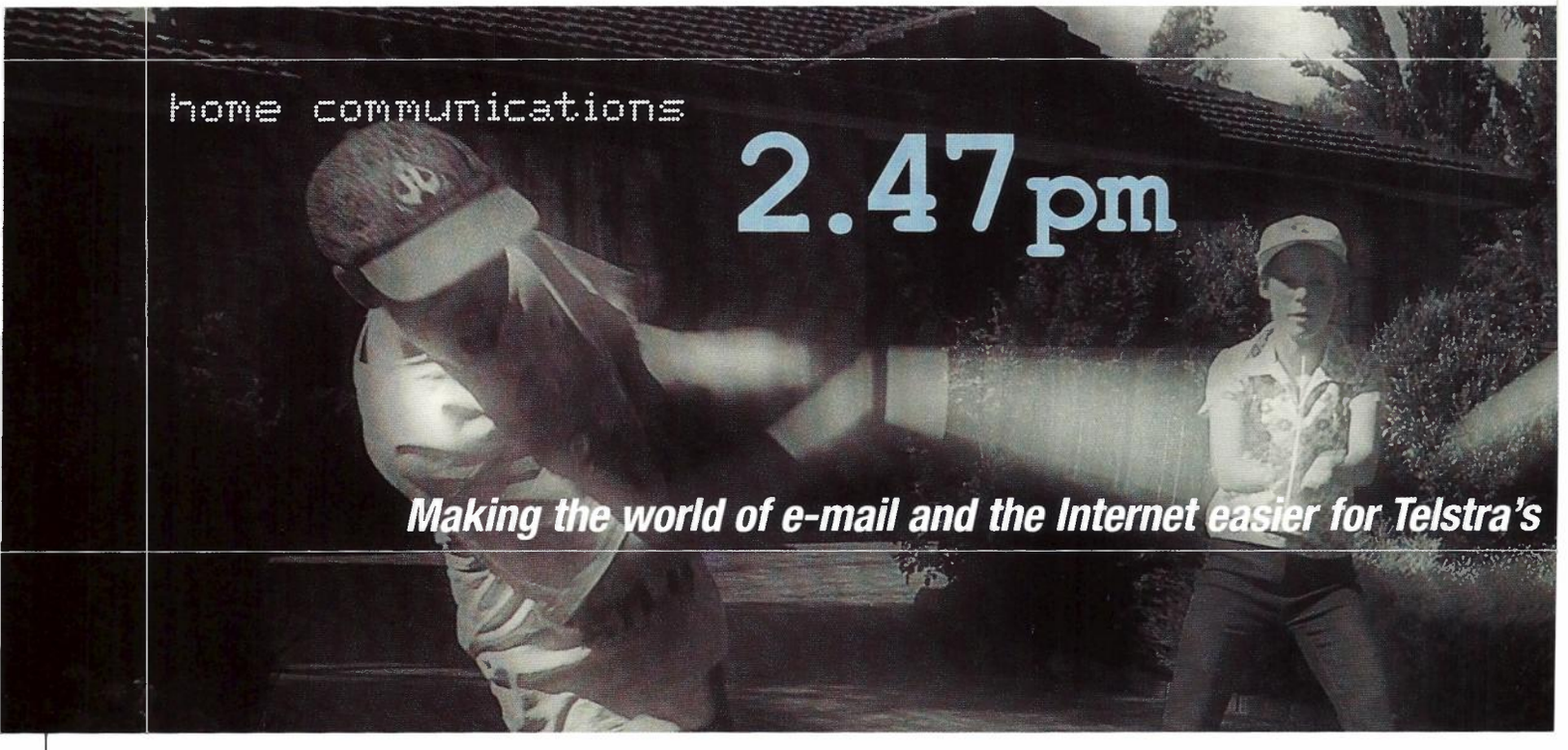
The Web now comprises hundreds of millions of pages, increasing at a rate of about 15 million per month. To carve out secure, easily navigable neighbourhoods in cyberspace, virtual communities can use shared information channels, like those offered by 'Web portals'.

Once a user keys in data such as locality, birth date and special interests, the Web portal automatically displays tailored information, suggestions and hot-links whenever the user logs on. Web portals may integrate e-mail, news, messaging, chat sessions, daily reminders and personal 'shopping agents'. In fact, some provide 'virtual shopping trolleys' with which users can browse through the tens of thousands of retail outlets in a single, online shopping mall.

TRL has been assisting Telstra in creating applications such as easy-to-use groupware, and an 'electronic village' Web-site to connect residents, local government, educational institutions, small businesses and other groups within a town or region.

As the number of residential connections to the Web increases, and as multimedia content becomes more widespread, the need for faster access and more compelling interfaces will increase. Higher access rates will be particularly important for remote and home-based teleworkers using conferencing, electronic whiteboards and other collaborative tools.

TRL has been evaluating the use of broadband access networks, Web-on-TV appliances and digital TV standards for delivering the next generation of interactive multimedia services to the home that combine the best of television and the Web.



It has also been developing prototype services, including a search tool for use over broadband Internet connections that would enable customers to access TV and video content as needed, outside the constraints of TV broadcast schedules.

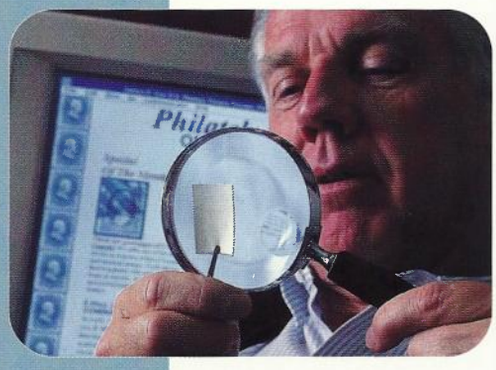
Researchers are also investigating how new technologies – such as virtual reality and home networking – could be introduced to Telstra's network, bringing new levels of convenience, control and interest to the way Australians communicate and organise their lives.

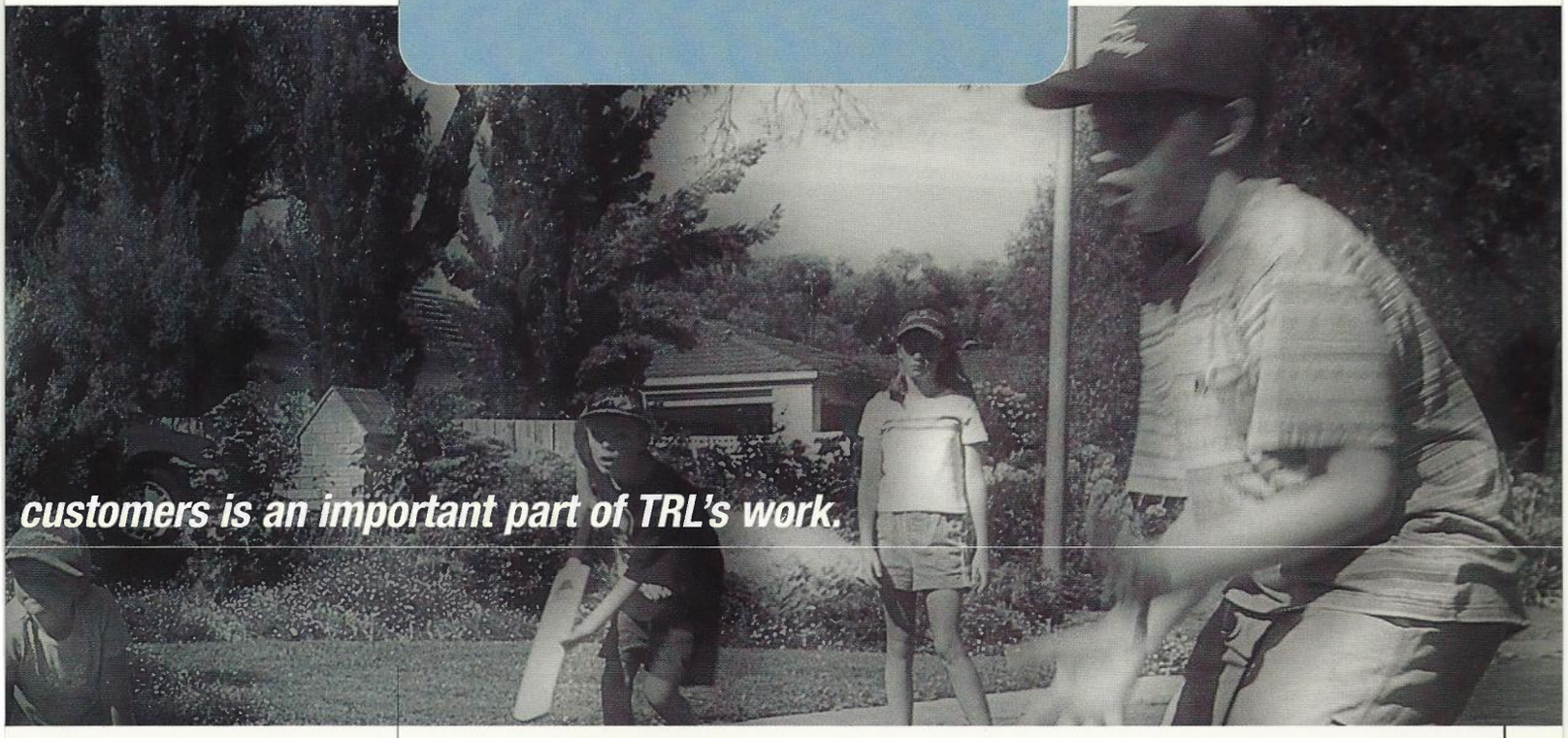
GroupCom designed to help communities go online

At TRL, researchers have developed a Web application for shared-interest groups called GroupCom. While similar applications have been appearing on large Web portals such as Yahoo!, the TRL application is designed to integrate Telstra services such as FaxStream® and MessageBank®. Further, GroupCom is targeted at novice Internet users and features a simple interface design to increase its usability and appeal to these users. Unlike other related products, GroupCom runs locally on the user's machine, rather than on the remote Web-site, making it faster and easier to use.

The TRL application offers group members e-mail messaging with voice and fax links, an online chat-room and whiteboard, a group scheduler and address book, and shared folders for information such as games, jokes or recipes. There are also areas where users can store personal information that other group members can access. Members can use the address book to set up distribution lists, send pre-formatted invitations or birthday 'e-cards' to other members, use the group scheduler to set up reminders for members about important dates, or set up hot-links to Web-sites. A group administrator or manager would be authorised to maintain and modify the group scheduler and member database.

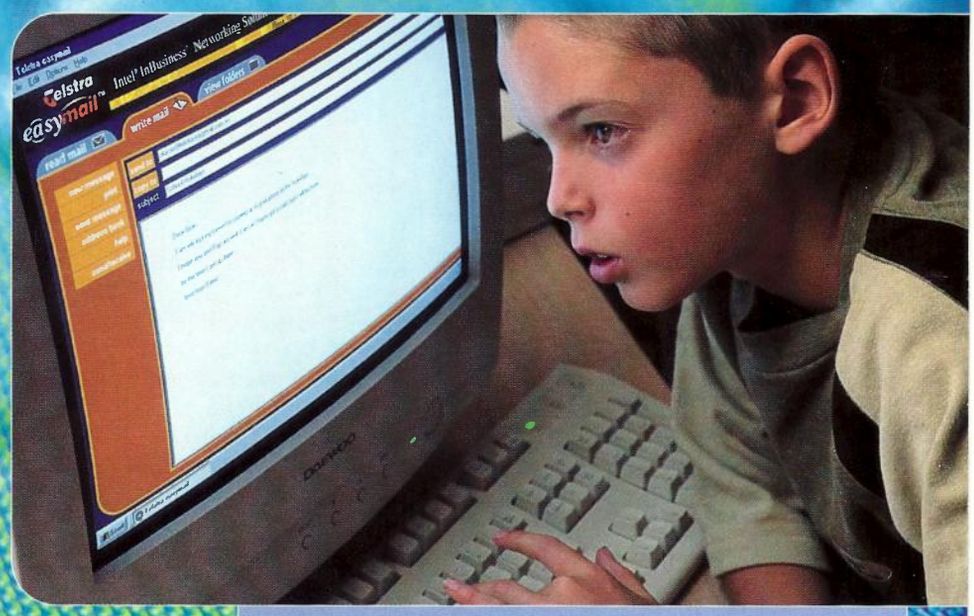
TRL is developing GroupCom for Telstra's business units, which in future may offer this type of application to its Big Pond® Internet customers.





customers is an important part of TRL's work.

TRL helped Telstra to get easymail™ ready for a customer trial within six months.

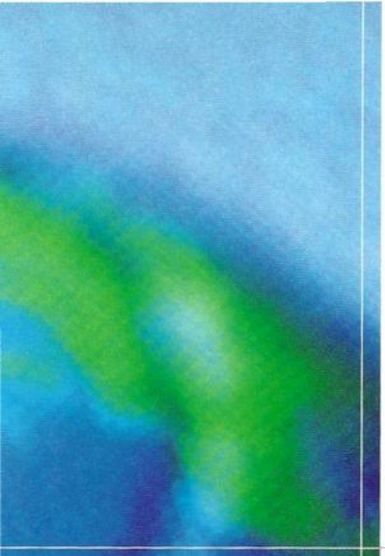


E-mail that is almost as easy as a phone call

Telstra has designed its easymail™ service to be cost-effective and easy to use, putting e-mail within reach of the two million or so PC-owners who have not yet come online, adding momentum to the growth of Australia's online community. Registered users pay no monthly or annual fees – sending and receiving e-mail costs no more than a local phone call. Easymail™ is particularly suited to customers in rural areas.

Human Factors experts and Media Lab designers at TRL worked together to produce the easymail™ interface of seven menu buttons. Working with the Internet IT Products Group from Telstra's Customer Processes and Information organisation, researchers also designed the end-to-end easymail™ system and demonstrated its feasibility, helping Telstra to get the product ready for a customer trial within six months.

Customers register for the service by using a CD available at Telstra shops. The CD self-installs the e-mail client software, programming the user's PC to dial up Telstra's DialConnect® 0198 IP local call redirect service for e-mail sessions. Upon registration, the user is also allocated an IP e-mail address, and has access to a dial-up helpdesk. Outgoing and incoming messages are limited to 10 text messages per call (without attachments). Access to easymail™ is not restricted to Telstra customers and its network.



Electronic village brings the Web closer to home

The aim of Web portals is to make Web browsing a familiar, comfortable experience, with the custom-designed portal interface becoming the electronic equivalent of home. But what happens when you set foot outside the front door? The next step for Web service providers is to 'localise' the content on personal Web portals, by providing secure, easy-to-use hot-links to local government, healthcare, education and commercial services.

TRL is working with the Launceston (Tasmania) community on a three year project – the 'Launceston e-Community' – that will link 200 households with local government, the university, healthcare groups, and shops and businesses in the area. Shared applications will include electronic news, messaging, family and business home pages, newsgroups and chat sessions, and a community calendar.

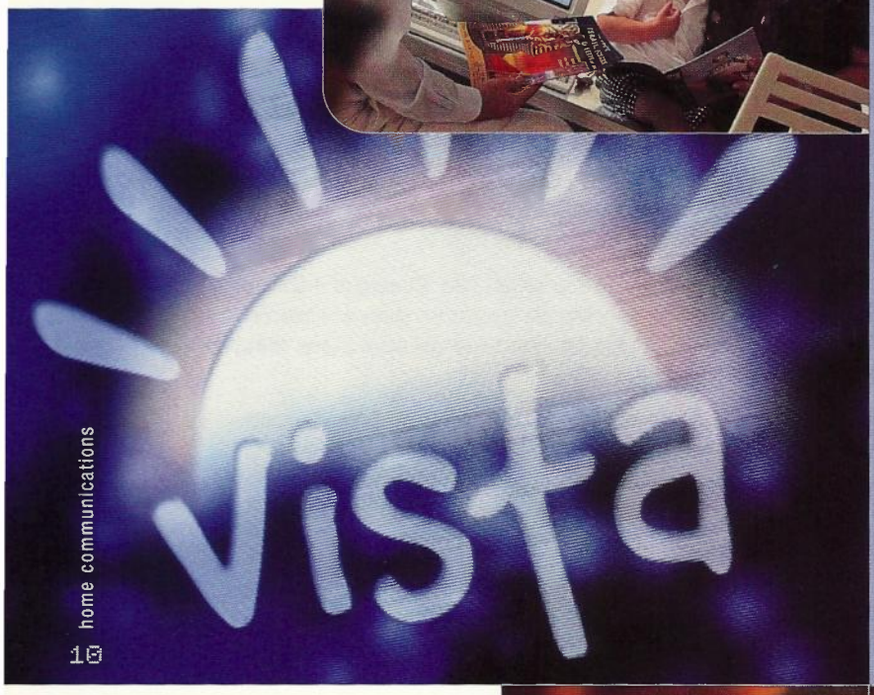
The e-Community, launched in early 1999, will open up new opportunities for small businesses in and around Launceston and further afield. For example, co-workers and field staff could communicate in a virtual office environment, using sophisticated messaging, conferencing and file-exchange tools to work collaboratively. As with larger commercial portals, once customers submit their queries to the information service database, they can be linked to local service providers offering relevant information and products.

TRL is developing the e-Community interface in association with On Australia and Big Pond®. The project brings together TRL's expertise across a range of key areas – understanding the socio-technical issues of Web technology; developing groupware for shared-interest groups; designing natural-language interfaces; personalising information transactions; and developing frameworks for electronic enterprises.

Touchscreen payphone for public access to multimedia services

TRL researchers worked with Telstra's Payphone and Card Services group to develop the interface, navigation system and network and server architecture to support a new payphone that combines telephony, multimedia and smart-card technology. Anyone can use the Multimedia Payphones – located in high-traffic areas such as shopping malls, tourist and transport locations – to gain access to a range of information and services. Multimedia Payphones have been installed in Adelaide and Sydney.

Users interact with the Multimedia Payphone via a touchscreen interface. Features include a built-in printer to issue tickets and a card-reader to read, validate, debit or re-load the Telstra smart cards. The Multimedia Payphone will also support e-mail and electronic bill payment services.



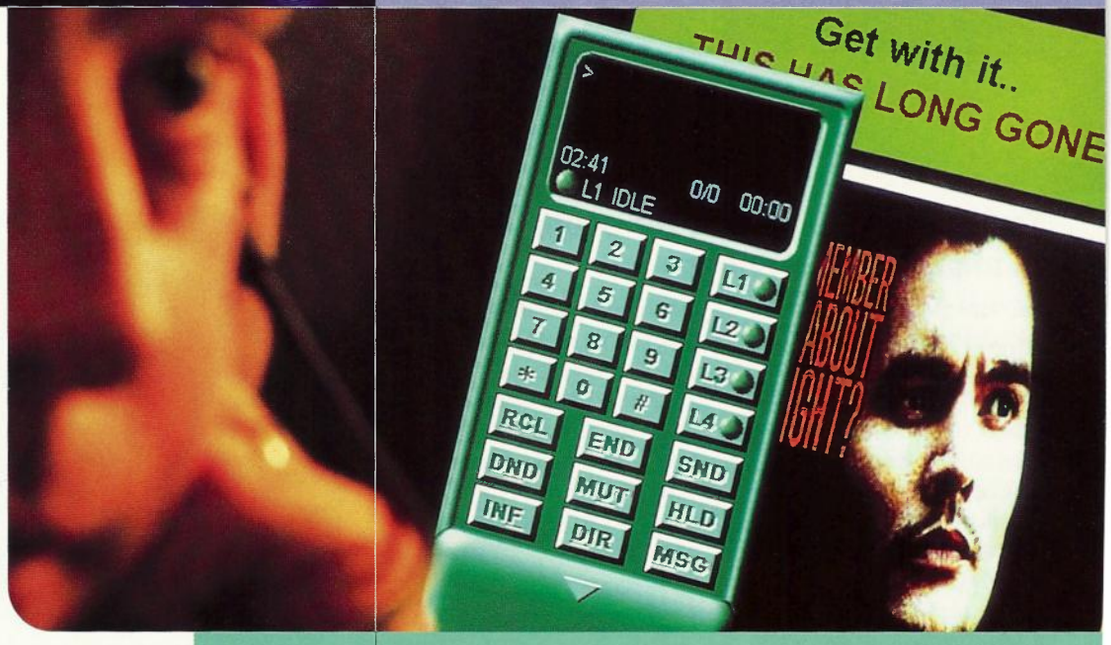
A VISTA of on-demand access to TV and video programs

VISTA (Video Integration with Stored Text Access) is a prototype Web search tool developed by TRL that automatically captures, stores and indexes TV programs – segment by segment – as they are broadcast.

This provides broadcasters, Telstra and their customers with the opportunity to derive value from archived TV material. For example, a broadband Big Pond® customer planning a trip to Fraser Island in Queensland could use VISTA to locate archived video-clips from TV travel programs that had recently covered the destination, without needing to know program titles or broadcast dates.

The VISTA indexing system is based on the normally invisible, text 'script' encoded into many broadcast-TV programs. TRL has also equipped VISTA with a facility to deliver personalised advertising, tailored to meet the customer's interest and location. This might, for example, be an advertisement announcing a special holiday package deal available through a local travel agent.

Services based on VISTA could be adapted to different broadband-Internet delivery modes (cable modem, ADSL or satellite). TRL is working with other Telstra units to evaluate VISTA as part of a large commercial trial, in 1999, of broadband-services delivery over satellite. Researchers are also investigating business applications of VISTA, such as corporate training and education.



When TV meets the Web in the living room

To bring the Internet to the mass market, computer companies in the US have introduced proprietary versions of Web television. This consumer take-up of Web television is, in turn, spawning a new generation of interactive services that integrate the information-browsing capability of the Internet with the compelling interface and content of TV.

The standard Web-on-TV system comprises a set-top unit with built-in 56 kbit/s modem, an infra-red remote control, and an optional remote keyboard. Recent systems offer a 'picture in picture' display mode, enabling viewers to interact with TV programs and access special Web pages or other information. A small icon on the top right-hand corner of the screen indicates that information associated with the current program or TV ad is available. Interested viewers click on the Web-on-TV remote control to access a related menu or Web page.

A viewer watching a car ad, for example, could click on the icon to access a modified Web page showing dealer locations and options for arranging a test-drive. Online home-shopping Web pages, on the other hand, could offer features like a 'personal budget' that automatically deducts credit card transactions from a predefined limit.

Apart from developing prototype services for Telstra, researchers are:

- comparing service delivery over different Web-on-TV set-top units
- evaluating return path connections (PSTN or cable) for interactive applications
- testing the ease-of-use of Web-on-TV interfaces navigation, menus and services
- developing scenarios for the phased introduction of Web television taking into account digital pay TV and full digital free-to-air broadcasting by 2008.

Single line virtually doubles for shared Internet-phone connection

TRL has developed a prototype 'virtual second line' aimed at making life easier for the increasing number of Internet home users relying on a single telephone line for data (Internet) and voice access. The Telstra solution provides better call quality than existing voice-over-the-Internet systems because the call is largely switched through the public switched telephone network (PSTN).

Each time a caller connects to the Internet to browse the Web, Telstra's Internet-PSTN platform could convert the incoming call to a stream of digitised voice packets for transmission over the Internet connection. The quality of the telephone call is as good as normal PSTN quality because the digitised voice and data signals are typically separated at an exchange located near the Internet user.

Not only would the virtual second line enable Telstra to deliver normal-quality voice connections for Internet users, it would also prevent customers from losing incoming calls, enabling Telstra to achieve a higher rate of completed calls over its network.

Paving the way for home networking

'Home networking' can mean anything from two home-PCs sharing a printer, to a fully automated smart house that controls communications, security and off-peak energy consumption. While home networking may one day provide unprecedented flexibility in personal communications and universal access, the technology today is far from mature. However, several consortia globally are working on home networking standards to inter-connect the home's electronic and communication appliances, and link them to the wider world.

In Australia, TRL has been working on a future-oriented research project on home networking to explore long-term product and application opportunities, and operational issues for Telstra.

Investigations have centred on the technical capabilities of a range of home network platforms based on wired, wireless and power-line links. Through exploring different home network configurations, researchers can identify opportunities for Telstra and potential benefits for customers. TRL has developed a home network test-bed to evaluate and demonstrate future home network applications, and assess their impact on existing services such as the telephone.

Watching it MUVE

Imagine walking through your dream home and discussing the placement of a staircase with the architect and interior designer – before the house is even built. This is just one of the many possible uses of a prototype multi-user virtual environment (MUVE) being developed at TRL based on 3D imaging and sound. The project brings together TRL's skills in 3D modelling and animation, audio over the Web, programming, human factors and user-interface design.

Researchers are studying the use of MUVEs for creating virtual meeting environments that are as close as possible to reality. Ambience is evoked through 3D sound.

The echoing sound of feet on wooden floorboards, for example, provides cues about the 'texture' and character of the space. Further, the sound of the same footsteps fading or growing louder alerts the user to the movements of other 'avatars' in the virtual space. (An avatar is simply an animated figure that represents its human 'owner' in virtual space.)

The 3D animated models used in the TRL prototype require far less bandwidth than video. Instead, basic information about each model and the virtual environment are delivered to the user's computer, along with motion information for animation. A multi-user server tracks the position of each avatar locally, updating changes in real time to render the different points-of-view as avatars interact and move around the space.

TRL Human Factors researchers are exploring how to make avatars more realistic and their interactions more natural.

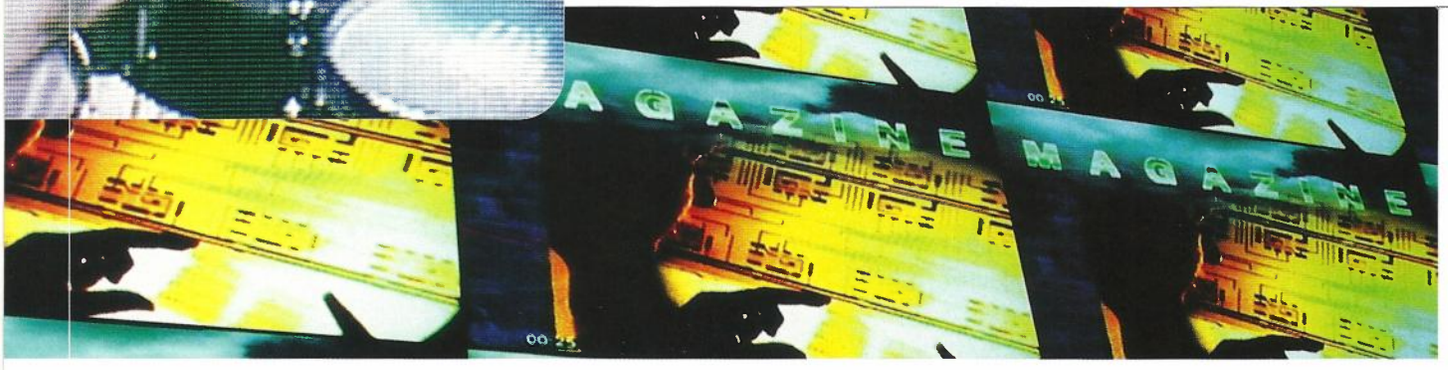
Potential applications of 3D-MUVEs include business (collaborative working via virtual-reality conferencing); education (perhaps enabling students to interact with historical figures); and entertainment (virtual plays or game shows with a mix of real and virtual performers participating from different locations in real time).

Successful trial of Australia's first live TV over broadband Internet

TRL researchers coordinated Australia's first public broadband 'Webcast' over Telstra's Big Pond®Cable network. The Webcast comprised special Internet coverage of the nine-hour Telstra Concert of the Century, which celebrated Mushroom Records' 25th Anniversary and was held at the Melbourne Cricket Ground in November 1998.

The broadband Webcast trial delivered live audio and video streams to a small group of Melbourne Big Pond® Cable customers at 10 times the bit-rate of standard Internet connections. The result was near-FM broadcast quality stereo sound, and video of markedly higher quality than its narrowband equivalent.

The success of this 'unicast' broadband trial has accelerated Telstra's interest in multicasting. Unicasting limits the number of customers who can simultaneously view a broadband Webcast. Multicast routers, however, create tunnels across the Internet through which a single stream of audio and video is sent. At the customer end of the network, the multicast routers locally broadcast or 'multicast' the single information stream to a potentially unlimited number of viewers. The result is a dramatic reduction in the bandwidth required to deliver broadband services over Big Pond® Cable. Multicasting is being introduced to Big Pond® Cable in 1999.



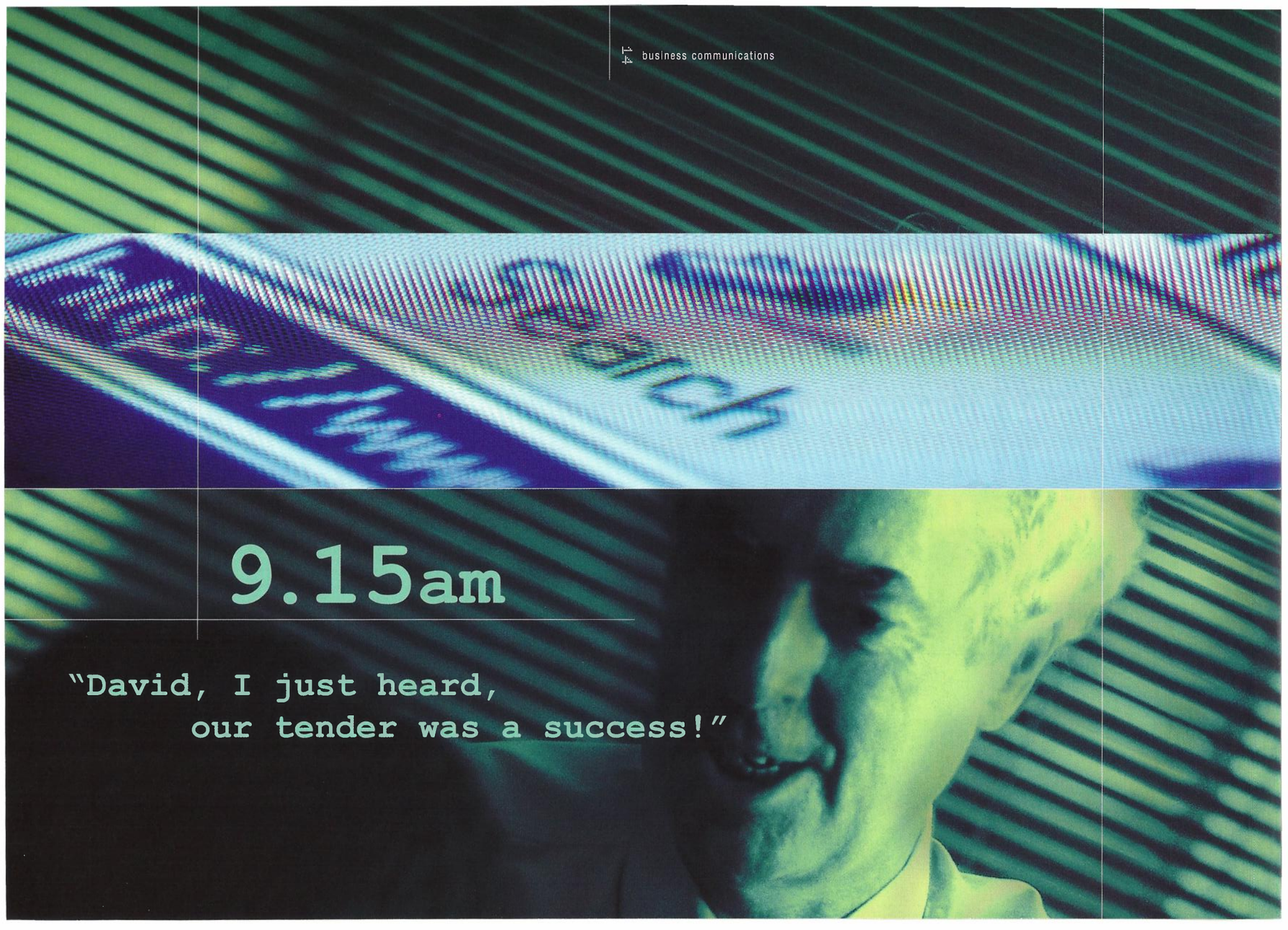
Digital TV – sharper image and a smarter use of bandwidth

How different will digital TV look from analog? A sharper TV picture without 'ghosts' or 'snow' will be the most noticeable change. But the real difference lies behind the scenes – with digital transmission, TV images can be compressed to occupy about seven times less bandwidth than analog signals. The existing broadcast spectrum could therefore be used to provide extra channels, digitally compressed high-definition TV, or multimedia information services and electronic program guides.

In Australia, all free-to-air broadcasting should be digital by 2008, with pay TV ready to switch as soon as set-top units become cost-effective over the next few years. Telstra has commenced a digital TV trial in which TRL researchers will investigate how Telstra's HFC (hybrid fibre optic/coaxial cable) network will support digital pay TV alongside Big Pond® Cable and other analog and digital services. The trial will also give Telstra the chance to road-test different digital set-top units, which convert transmitted digital TV signals into the analog TV images required by standard TV sets used at the customer end.

Also to be tested are new services and features made possible by the digital pay TV platform. These include video-on-demand and near-video-on-demand, control of differential customer access to services, interactive communication through a reverse path from customer to service provider, a user-friendly electronic program guide for service navigation, and narrowcasting of specialist content nationally (for example, businesses with branches and customers around Australia).

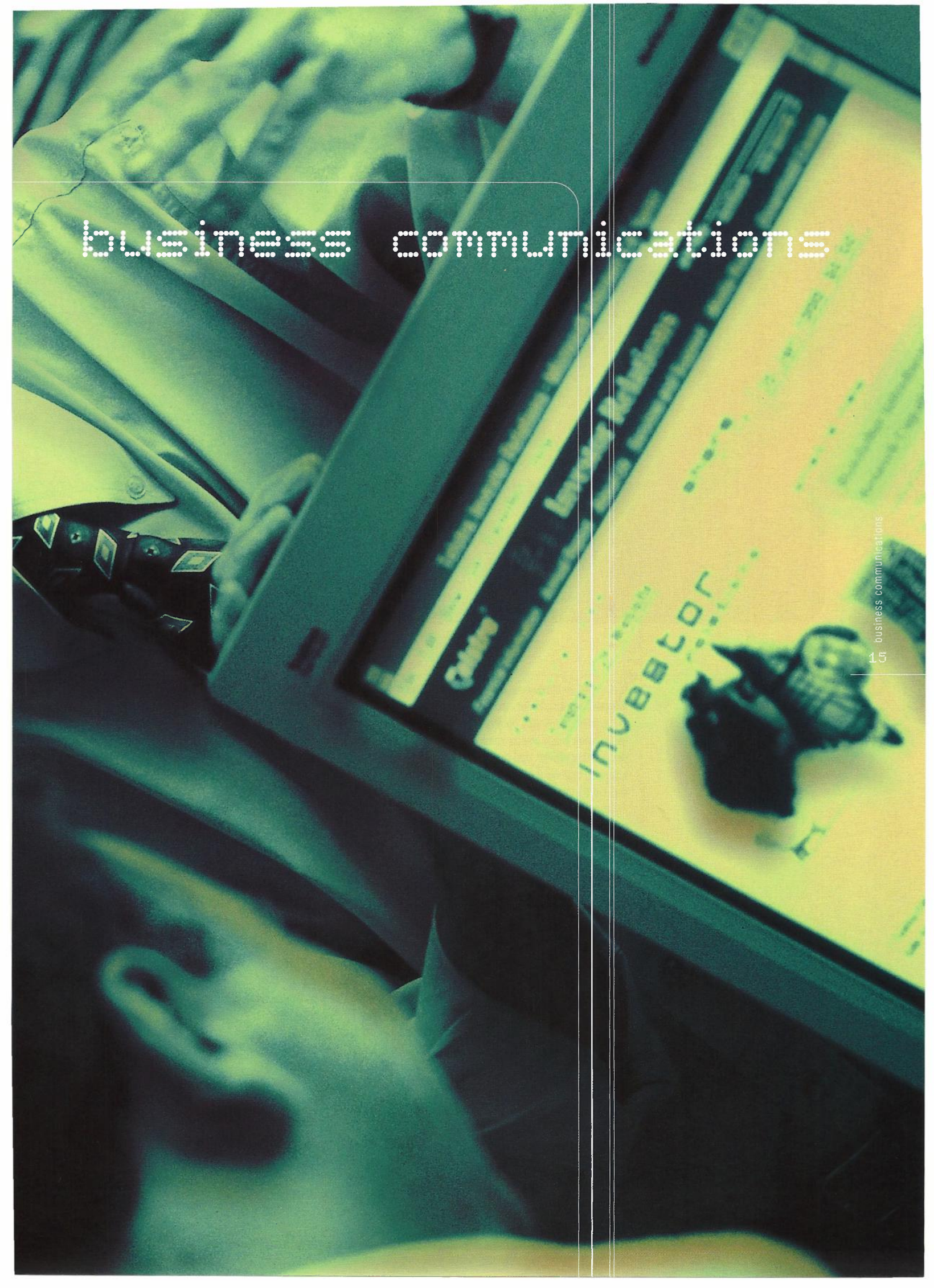
TRL has already examined the suitability of different digital TV standards – the European DVB and ATSC (used in the USA) – for terrestrial broadcasting in Australia. Telstra's findings were supported by the Australian industry's decision to adopt DVB, paving the way for detailed planning of new digital TV infrastructure, including set-top units.

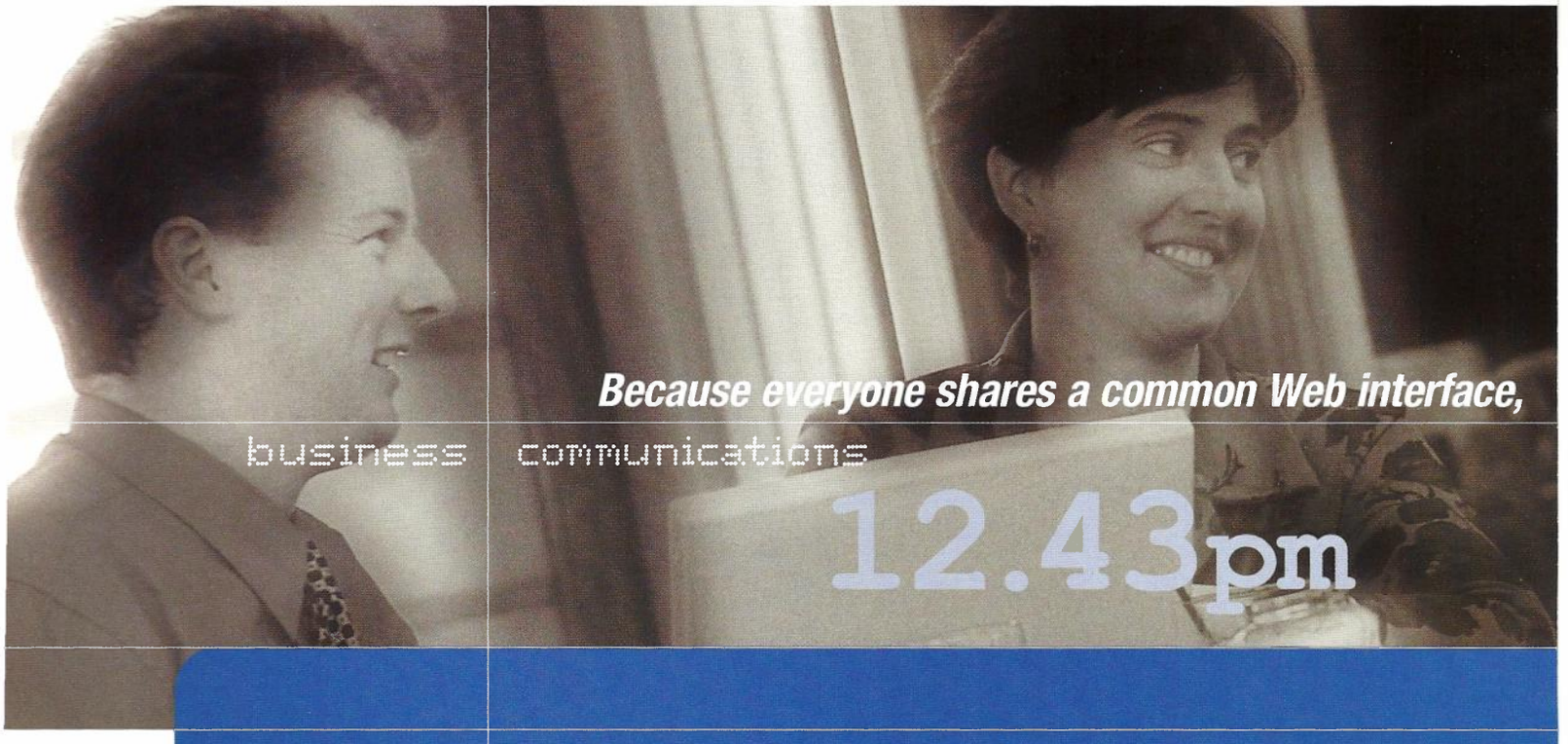


9.15am

"David, I just heard,
our tender was a success!"

business communications





Because everyone shares a common Web interface,

business communications

12.43pm

In the business world, the Internet has been changing the way we buy and sell, the way workers communicate and manage information, and even the way in which organisations are structured.

In a digital marketplace, the most efficient organisational structure is the online business community. Businesses today are as keen to develop 'extranets' that create alliances beyond the corporate firewall as they are to develop intranets that link their own people. Extranets can include suppliers, manufacturers, consultants, distributors, joint-venture partners and customers. All of these individuals and groups can interact remotely using the Web, e-mail, videoconferencing and shared applications to accomplish in minutes what once took days.

One of the most cost-effective ways for a business to link the different office and home computers, servers, call centres and mobile phones of its online community is by using virtual private networks (VPNs) based on a shared public infrastructure. Because everyone accessing the VPN shares a common Web interface, remote working becomes easier.

And having a common Web application-development environment overcomes incompatibility problems between different groups.

Further, by leveraging off public infrastructure, businesses save on the cost of buying or leasing lines. Instead, their voice, data, video and fax services are integrated over the VPN by Internet Protocol (IP). Closed user group security is built into the network hardware and IP layer, protecting traffic from intrusion at all points along the VPN.

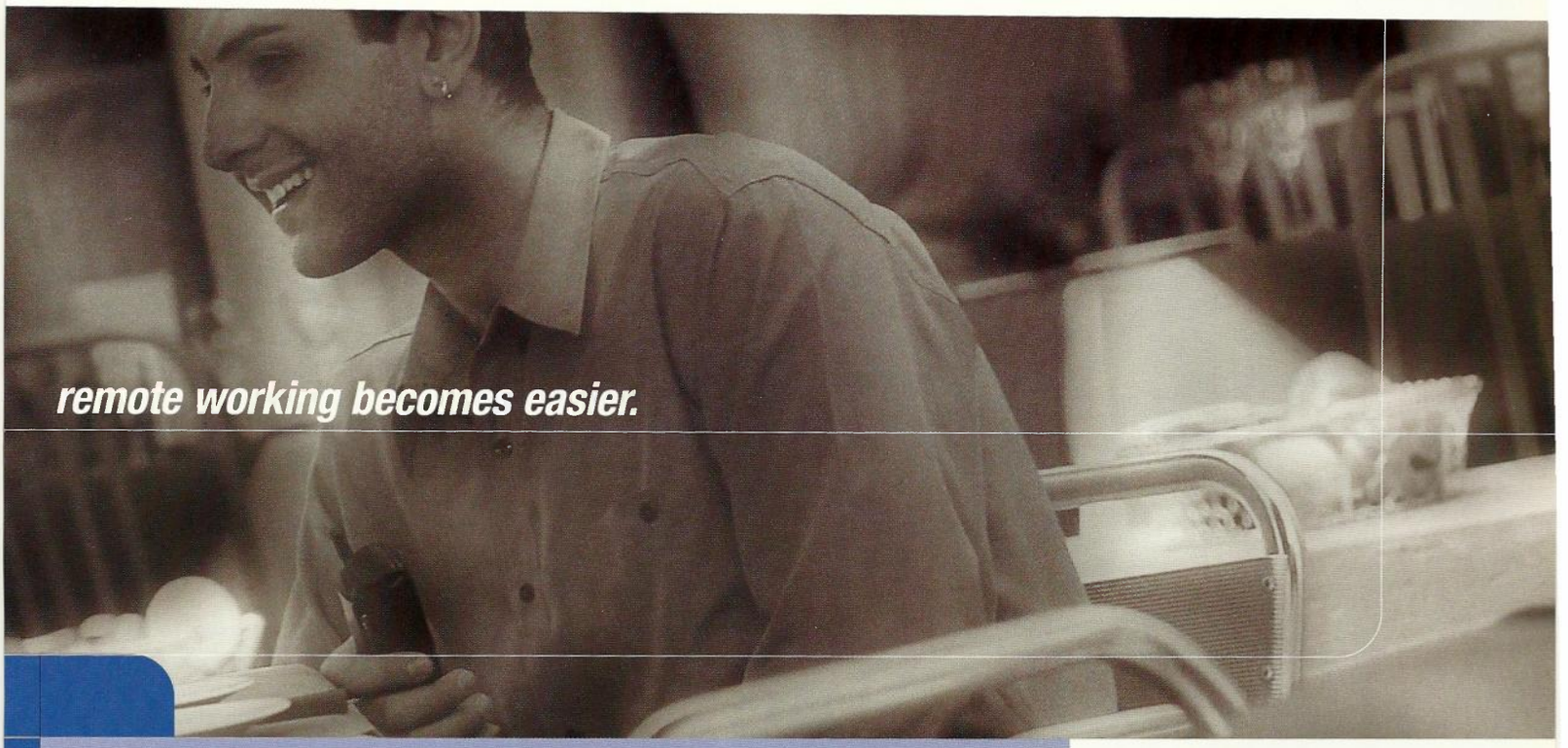
Security is critical to the success of business-focused Web services. Apart from developing secure VPN services for corporate customers, TRL has used its expertise in cryptography and audio-visual standards to develop advanced security mechanisms for protecting copyright images over the Web and for authorising customer access to Web-based services.

Organisations also require tools that can help their customers efficiently navigate through the Web's vast store of electronic information.

TRL has been refining a sophisticated search engine that features a natural language interface able to extract meaning from plain English words, phrases and sentences in such a way that users are not restricted to using key words and search strings.

In a further development, researchers have been building a prototype, automated speech interface to Telstra's product helpline. The interface is designed to 'converse' with callers to determine the best way of dealing with each customer query.

Call-centres are becoming an important tool for businesses in managing their customer relationships. TRL has developed software that is helping Telstra's corporate customers to manage more effectively high-volume, and fluctuating, call-centre traffic. In fact, TRL has a specialised Customer Access Laboratory that focuses on developing and integrating call-centre and Web access solutions for different areas of Telstra's business.



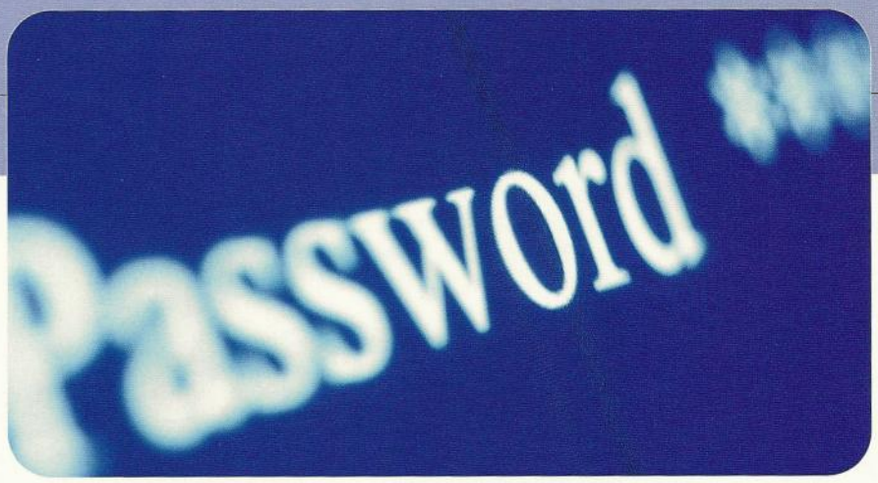
Secure 'tunnels' through public networks for private use

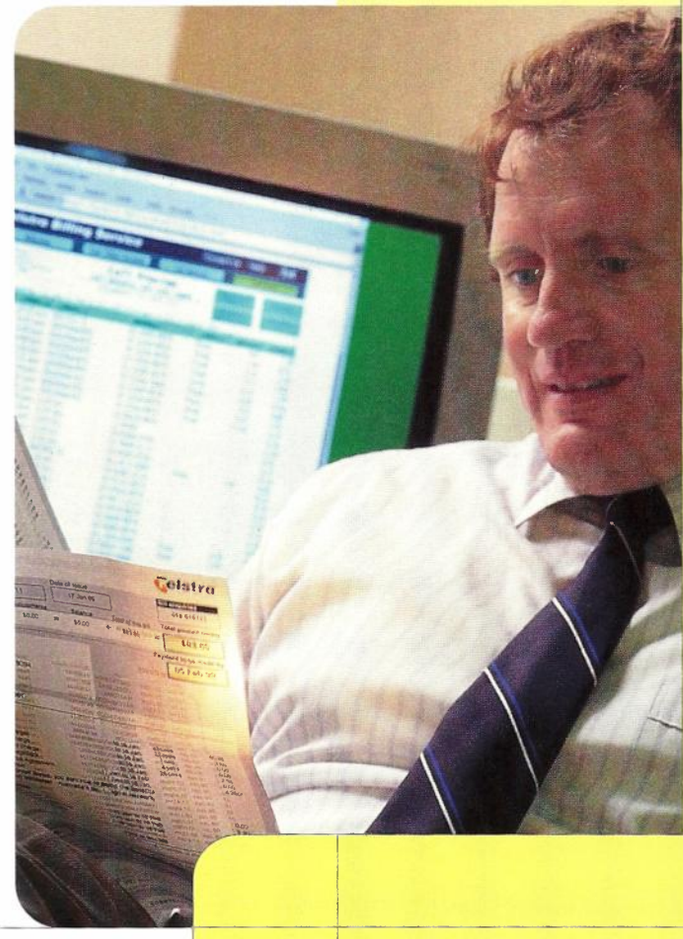
Virtual private networks (VPNs) are described as 'tunnels' within public domain networks. Through VPNs, organisations can securely interconnect their intranets, extranets and mobile users, forming closed community groups over a public IP infrastructure such as the Internet.

TRL has been working with TimeStep, the Canadian developer of a promising new VPN technology, to scale the technology up for use in carrier environments. A robust, centrally managed VPN solution could provide controlled communications access not only to small and medium-sized enterprises, but also to larger organisations such as banks, which could use the VPN to offer customers secure, controlled access to their services.

VPNs over the Internet should provide private connections between businesses and their suppliers globally, at relatively low cost, using readily available Internet infrastructure. VPNs can also be created over ATM or frame relay platforms to support applications where quality of service is required. For organisations wishing to interconnect their sites, installation is quite simple and has a minimal impact on current site-network configuration. For mobile users, only software installation is required.

Apart from banks, insurance companies, public organisations and Telstra's own business units are among the potential users of Telstra's VPN technology. A closed-community VPN solution based on internationally recognised security standards could support the evolution of virtual offices and organisations by extending an organisation's intranet to any access point of the global Internet.





'Self-service' bill access gives more control to customers

Small businesses, such as accounting and legal firms, should benefit from a prototype Web-based bill preview service developed and market-tested at TRL in association with Telstra's Products and Marketing unit.

The 'Call Preview' service will provide Telstra customers with Web access to their telephone account information between bills. Call summaries – minus discounts, which are calculated at the end of the billing period – are presented on-screen as they would appear on a traditional Telstra telephone bill. Users simply click on hyperlinks to access more detailed calling information, which they can sort using call destination, date, time, area code, cost or call-duration criteria.

TRL has also market-tested a second electronic billing service, 'T-Bill'. T-Bill offers features similar to Call Preview. Additionally, it notifies customers by e-mail when a new bill arrives. T-Bill was developed by CiTR, a Brisbane-based network and services management company, using TRL-developed intellectual property, including the Call Preview software.

To develop these electronic billing services, software architects in TRL's Customer Access Laboratory had to integrate security, user privacy, user-friendly interface design, and online helpdesk and registration support into core system design. For Telstra, online billing services could reduce the paper, printing and postage costs associated with paper billing. Electronic billing may also reduce the number of billing queries to call centres by providing further information, and may also direct customers to other value-added services offered by Telstra.

Certification the key to authorising Web services access

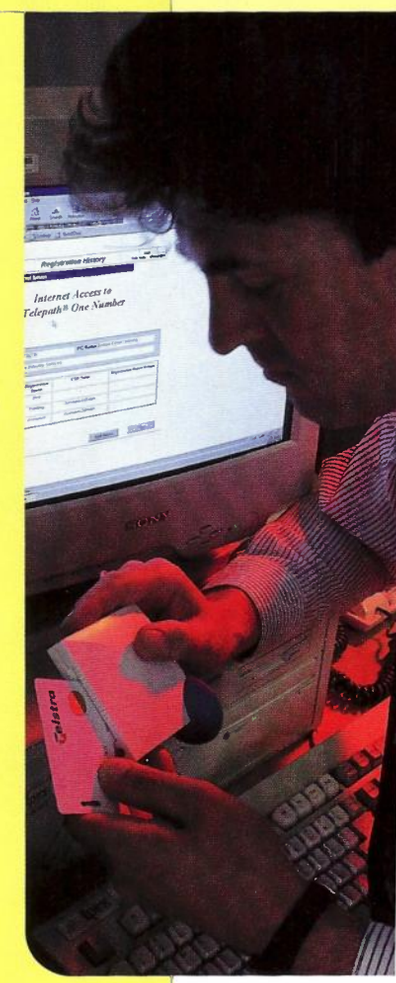
TRL created an automatic system that identifies Telstra customers with registered access to their Telepath® One Number service via the Web. The system, based on public key cryptography, is more secure than password-based systems, and is now providing transaction protection for other Telstra services.

With public key cryptography, each user is assigned two unique 'keys' (in reality very long numbers) – a private key kept only by the user, and a public key that can be made public, yet is still secure. A special system known as a certification authority (CA) creates data (known as a 'digital certificate') that associates the user's identity with his or her public key. The private key is typically stored in a user's personal computer. When the user accesses a service, the private key establishes a communication channel that is protected from tampering and eavesdropping.

The network checks the user's digital certificate to verify that the correct public key is being used to establish the connection, thereby identifying the user with a high degree of confidence.

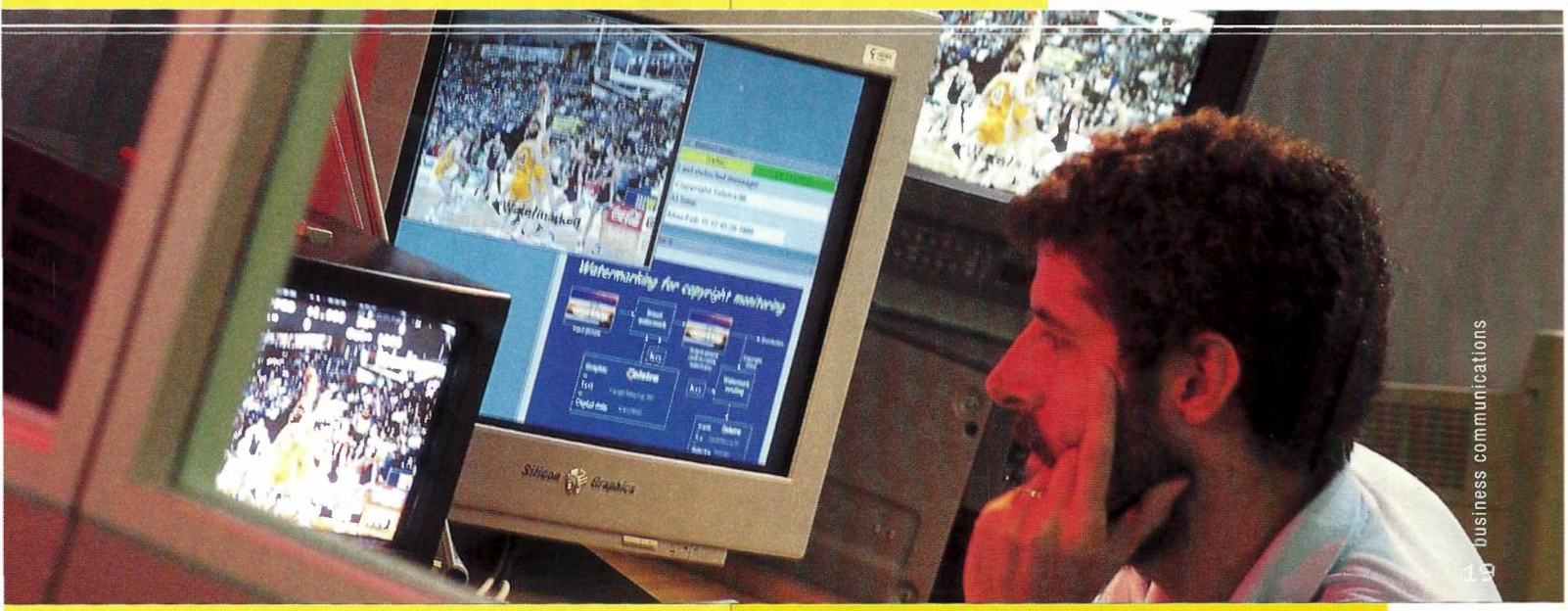
TRL researchers combined their expertise in public key cryptography and international electronic directory standards – which include a specification for CAs – to develop, within months, the critical systems for securing Telepath® One Number Internet access. Telstra has also used TRL's system for its Web-based Call Preview trial. The system may become central to future electronic-commerce applications.

As well as applying advanced cryptography to Telstra products, TRL has been investigating the smart card technologies and systems required to support the use of 'micro-payments' – transactions involving perhaps a few cents – over the Internet.



Watermark identifies copyright on video and still e-images

TRL has developed an invisible 'watermark' to confirm copyright ownership of video content. The system is based on a highly secure software 'key' held only by the copyright owner. The key is used to encode and decode an identifying watermark in the form of a graphic, text or code invisibly embedded within a sequence of video frames. To the human eye, watermarked video sequences are indistinguishable from unwatermarked sequences.



While analog video image quality degrades with successive duplication, digital video images do not. Thus, copies of unwatermarked digital video can be readily made without the copyright owner being able to detect and legally challenge copyright infringement. TRL's expertise in video compression and cryptography enabled it to develop a watermark that is invisible, machine-readable, secure, and robust enough to withstand compression-related signal degradation. It also does not require the original, unwatermarked 'master' for decoding, a shortcoming of other watermark systems. The TRL system could offer protection against product piracy to publishers using DVD-ROM (the digital video equivalent of a CD-ROM).

Researchers are adapting the watermark system for real-time use, making it possible for commercial broadcasters, for example, to monitor live signals from other broadcasters continuously, automatically detecting any copyright infringement. The watermarking technique has also been applied to still images used on the Web, a more difficult challenge, as the watermark has to be buried within a single frame and must accommodate a range of different picture formats and possible picture manipulation. TRL has demonstrated the feasibility of the concept and developed a prototype Web-crawler capable of tracking down Web-sites containing unauthorised copyright images.

TRL has developed a prototype Web-crawler capable of tracking down Web-sites containing unauthorised copyright images.

Call-centres lose wait with PACT

Telstra has assisted corporate client Centrelink to reduce customer call-waiting times through PACT (Performance Analyser for Call-centre Traffic), a unique and powerful call-centre simulation tool developed by TRL.

Centrelink–the former Department of Social Security (DSS)–has Australia's largest call centre network, with 3000 operators located in branches across the country. Centrelink's customer calling patterns and response times can vary widely–for example, lines can become jammed on days when social security payments are issued.

To manage its call-centre operation more efficiently, Centrelink needed tools for making effective decisions about:

- the longest desirable waiting times for calls to be answered
- the queue size beyond which subsequent calls should be 'blocked' (met with a 'line busy' signal)
- staffing requirements for different call-centre groups
- optimal routing of calls between call-centre groups to maximise the number of calls answered.

TRL developed PACT to simulate the performance of the real queue system using call-arrival data from the Centrelink network and Centrelink staffing profiles.

PACT optimises various aspects of call centres including staffing profiles; network dimensioning; call-blocking thresholds; queuing strategies; and IVR (interactive voice response) strategies. By changing each input while keeping the others constant, PACT is able to show which strategies will produce an optimal call-handling outcome for Centrelink, with a minimum waiting time for callers.

When Centrelink implemented the changes, it found that the results were as PACT had predicted, with reduced call-waiting times and a higher call-response success rate. TRL has also used PACT to simulate the performance of the 13 22 00 Telstra call-centre network.

TRL's natural-language interface to electronic information systems can interpret complex queries, from short phrases to long sentences.

Online searches made easier, faster, more accurate

Most electronic information systems work by identifying key words in a search query and matching these with words in a database. Context, however, is critical. The queries 'a glass of wine' and 'a wine glass' share identical key words. Yet the slight variation in wording makes a big difference to the meaning.

TRL has developed a natural-language, or plain English, interface to electronic information systems that incorporates a robust language processor to interpret complex queries, from short phrases to long sentences.

The interface can be rapidly plugged into any Web-based service query system. As well as public electronic directories, it could be applied to corporate intranets, electronic customer access systems, knowledge management systems, government services directories and even non-English language directories.

Apart from being able to understand English grammar rules, the interface can recognise related concepts. For example, if someone submitted a query about 'building permits' to the Web-site of a local government organisation, the interface would automatically cross-reference information about 'building approvals'.

Researchers here are incorporating the natural language interface into 'Telstra Find', a new search engine developed by TRL for Telstra's public Web-site. They are also adapting the natural-language processing technology to speech-recognition interfaces. Because the interface is programmed to analyse strings of words for overall meaning – by locating nouns and verbs, for example – it could enable voice-based directory systems to make better sense of the spoken queries interpreted by speech-recognition systems. A TRL 'dialogue manager' would also enable computers to query users about ambiguous terms.

WebDial™ 1800 keeps customers connected

A WebDial™ 1800 free-call system that has been tested online by operating through Telstra's SureLink™ integrates the Internet's browsing capability with the call management quality and control of the public switched telephone network (PSTN).

The system enables a business to hot-link a WebDial™ 1800 icon on its home page to the telephone number of its call centre. An online customer can set up a free telephone call to the call centre by simply clicking on the icon. Customers initiating calls from shared phone-Internet lines can remain connected to the Internet by downloading a virtual 'mini Web-phone'. The Web-phone, accessed through the computer's microphone and speakers, pops up on the screen for the duration of the session.

At the heart of the service is a platform developed at TRL that provides call control and routing between the Internet and the PSTN. After a user registers for WebDial™ 1800, Telstra's Internet-PSTN platform responds to the user's Internet address information, and places a call to the selected 'phone', whether it's a virtual phone on a PC or a separate phone with dedicated line.

Telstra is carrying out another click-and-call trial, based on call initiation through a corporate electronic directory (CED), rather than a Web page. With Corporate Directory Dial, call initiation occurs through hot-linked directory telephone numbers instead of icons, and calls are carried out through the user's normal desk telephone.

Automated phone interface to streamline customer queries

Customers calling Telstra's 13 21 25 helpline use an IVR (interactive voice response) system that guides the caller to an appropriate call centre by asking them to select a product about which they require information. But Telstra sells more than 1200 products – far too many to list for customers using a touch-tone phone interface (the current system lists less than 20 products). Further, about one-third of the calls made to 13 21 25 are queries about bills, not products.

TRL researchers saw an opportunity for using a two-tiered automated voice system to improve the usability, and decrease the cost, of the existing service.

The first stage comprises a menu-driven, speech-recognition component that would converse with customers to determine the purpose of the call and route it to the appropriate call centre. This process is known as 'pre-call routing'. The second stage comprises a more sophisticated speech-recognition component that would converse with customers to handle any queries relating to Telstra Easycall® products.

Researchers are working with other Telstra business units to prototype and test each stage separately. The pre-call routing component has already been built for testing in a customer trial.

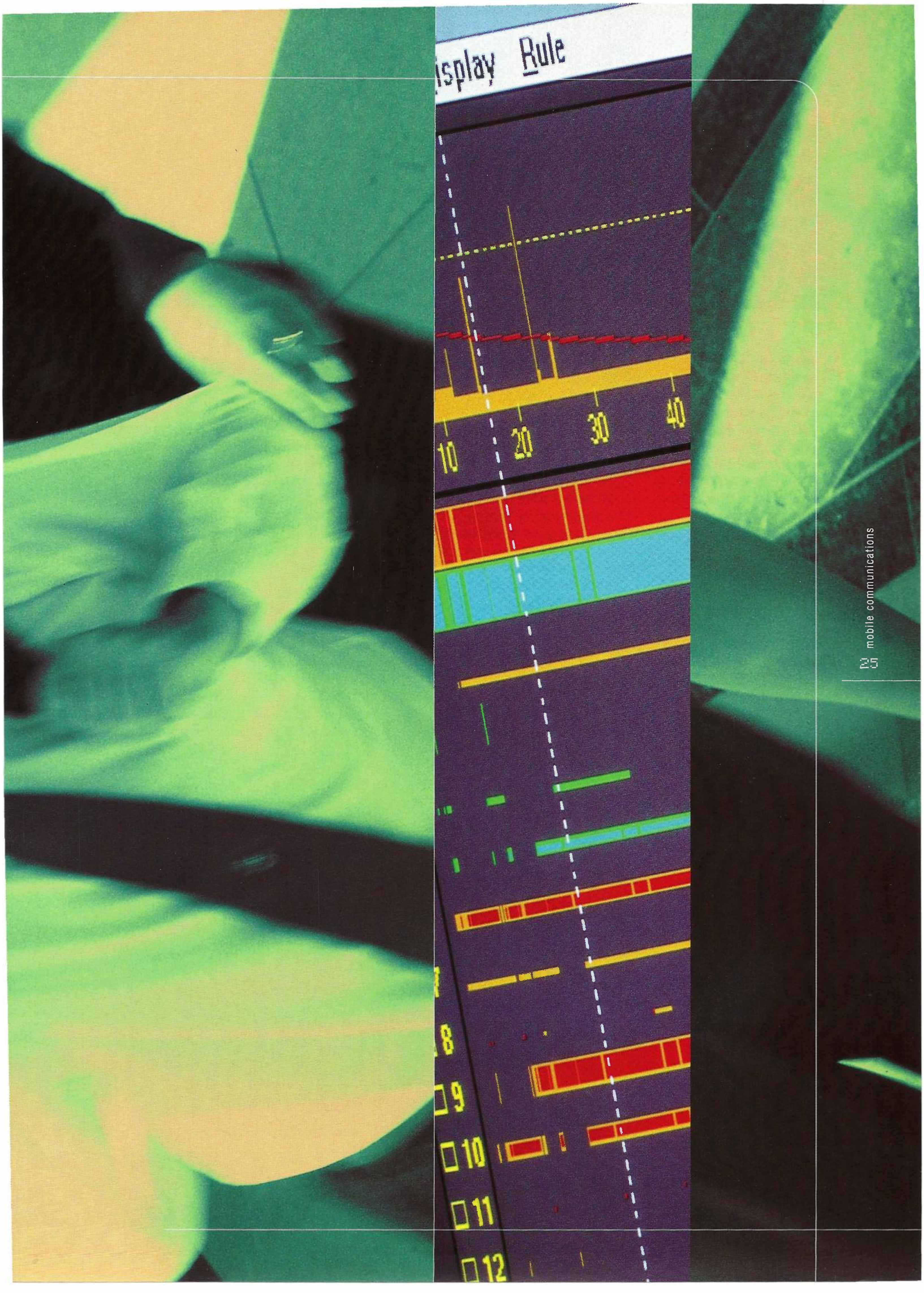
During the trial the speech-recognition system is being evaluated for its robustness in interpreting different word combinations, and in allowing for differences in accent among Telstra's huge customer population.

The second stage will enable customers to obtain information about Easycall® services by conversing in a manner similar to speaking with a customer service representative. The system will be capable of activating certain Easycall® features. It could also play recorded voice announcements and fax, e-mail or mail information to customers on request.

"Hello Jeff,
Thanks for
returning my call."

2.58pm

mobile communications


isplay Rule
10
20
30
40
8
9
10
11
12

The transformation of Telstra's public telephone infrastructure – from one optimised for telephony, to one equipped to handle voice, data and multimedia services – is being replicated in its mobile networks. As Telstra phases out its first-generation, analog cellular phone service in most parts of Australia by 2000, it will have begun rolling out a new digital mobile network, capable of offering users wider coverage, and enhanced data services in the future.

The coverage and anywhere, anytime connectivity of mobile phones have made them essential to most businesses. Telstra currently operates Australia's largest GSM digital cellular network, MobileNet® Digital, which offers narrowband (9.6 kbit/s) fax and data services as well as voice services.

The task now facing Telstra – and mobile network operators globally – is to provide seamless, fully integrated, interconnection with the fixed network and the Internet, giving mobile phone users direct access to the sort of broadband (2000 kbit/s or 2 Mbit/s) data services currently delivered over desktop computers.

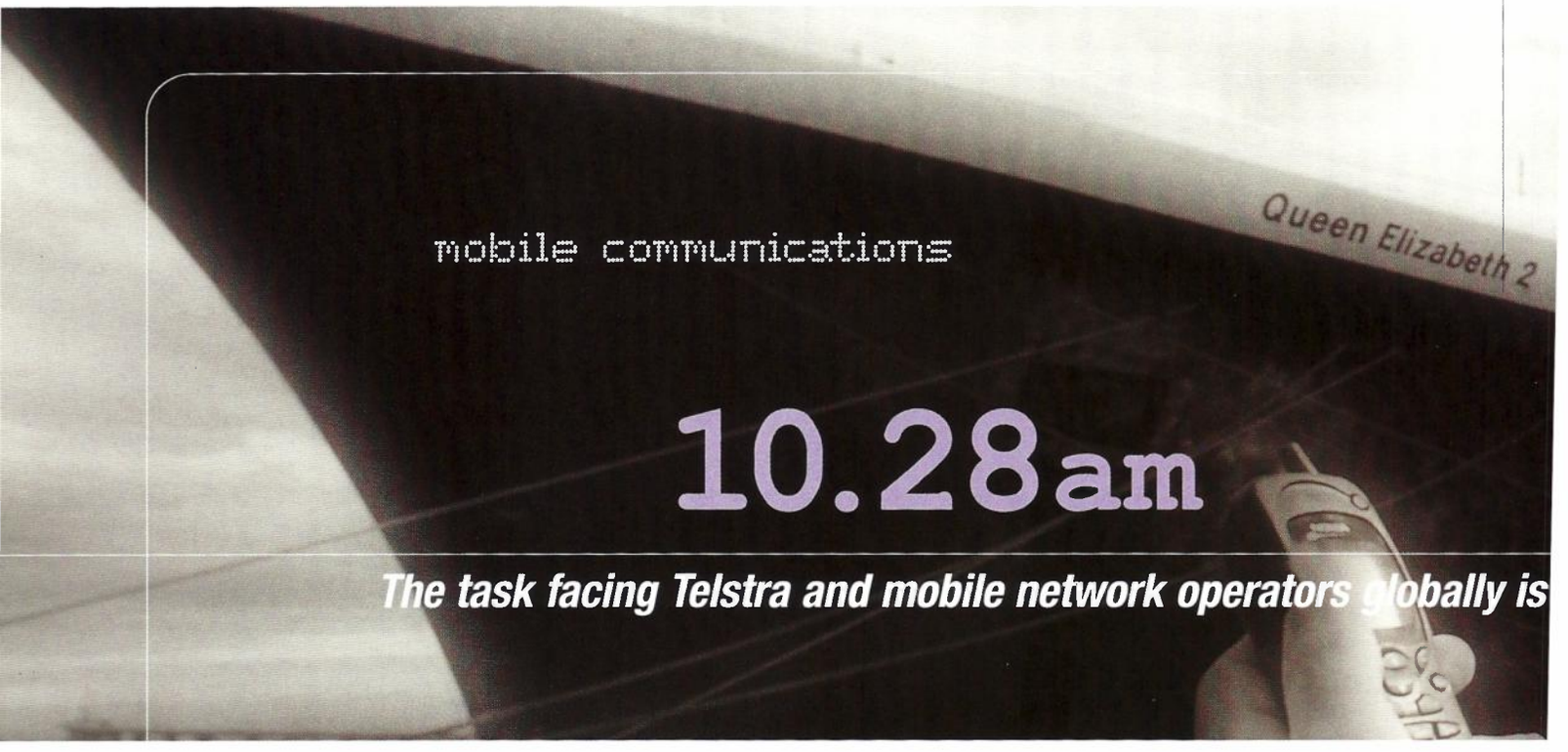
This is where third-generation networks come in. International standards groups are planning a global, mobile telephony standard that will make it possible for users to access high-bit rate services from any location. Third-generation mobile networks will be designed to support high bit-rate broadband services incorporating images, graphics, multimedia and even virtual reality. In fact, individual mobile handsets may become network nodes, linking local devices such as printers or digital cameras via short-range radio technology to cellular, fixed and satellite networks and the Internet.

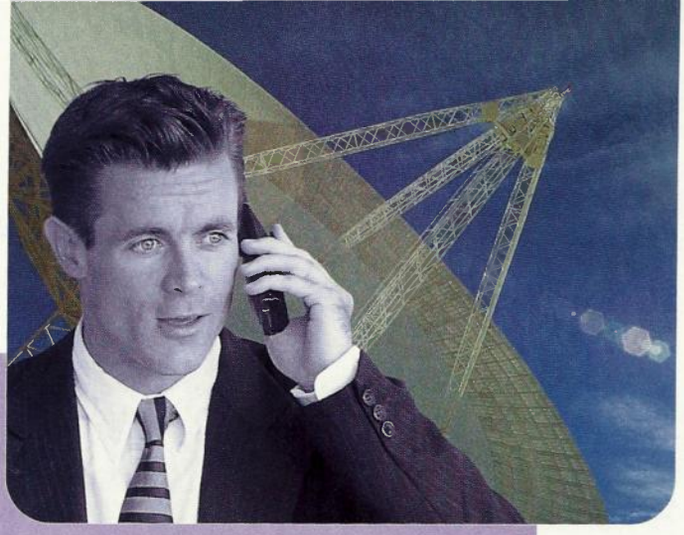
One of the most talked-about wireless technologies to emerge over recent years is a short-range radio technology called 'Bluetooth'. The small Bluetooth chip sends and receives low-power radio pulses that could interconnect mobile phones with desktop and notebook PCs, printers, and pagers. The idea is that, when devices come within range of each other, they automatically connect and exchange data, without the need for cables or infra-red line-of-sight. For instance, a mobile phone receiving e-mail would automatically send it to a notebook computer in the user's briefcase nearby, or a user could instantly transmit a photo 'postcard' from a digital camera across the globe via a mobile phone.

New wireless protocols and mark-up languages have also been developed to equip mobile devices with Web functionality, in the same way that hypertext transfer protocol and mark-up language (HTTP/HTML) have transformed desktop computers into Web browsers.

Telstra has been evaluating the use of mobile phones with an embedded 'microbrowser' for receiving text versions of special Web pages from intranets or the public Internet. The microbrowser is based on Wireless Application Protocol (WAP) and uses Wireless Markup Language (WML).

Artificial intelligence and neural networking are another way by which Telstra can add value to its mobile services. TRL researchers have developed an innovative 'annotated places' concept that could enable mobile phone users to share their impressions of city recreational venues such as cafes, clubs, bars, shops and galleries by leaving messages that could be accessed by or delivered to other customers in the vicinity of the venue.





Data mining is one of the advanced software tools that large businesses can use to gauge customer preferences. Every day, commercial enterprises such as Telstra's mobiles business, generate and record millions of units of data about customer transactions. Until now, this information has been buried in databases. TRL has developed data-mining tools based on artificial intelligence that can extract value-added knowledge from the routine detail, enabling Telstra to tailor its services more effectively for individual customers.

TRL researchers have continued to help Telstra maximise the capacity and quality of its existing analog, digital and digital data networks, as well as ensure staff safety around network transmitter equipment.

Web browsing and roaming in the next generation

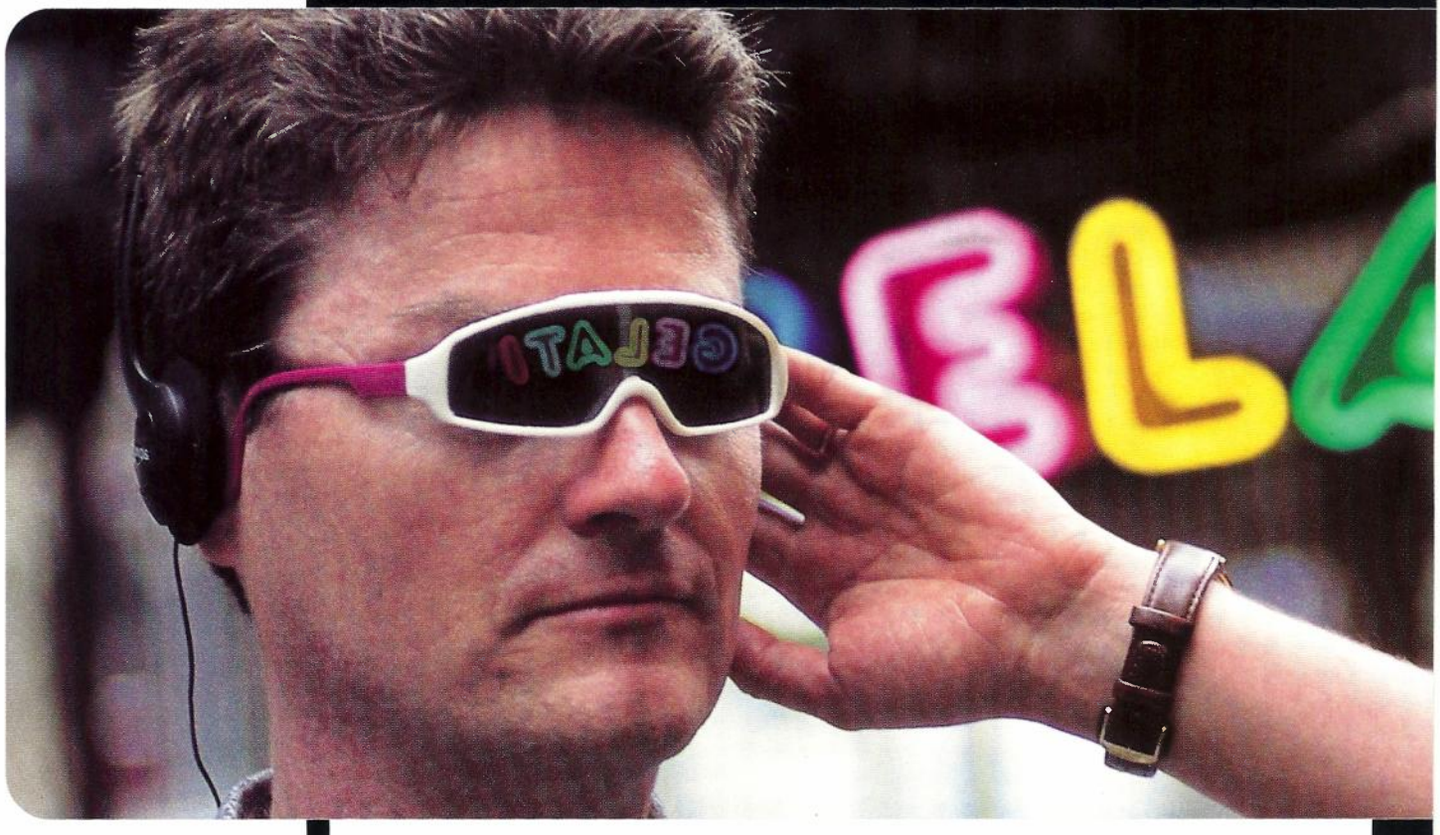
In evaluating advanced second- and third-generation mobile communications technology for multimedia and enhanced voice services delivery, TRL has been working with the University of South Australia's Mobile Communications Research Centre.

The Centre has already developed new mobile receiver techniques for obtaining near-optimal network performance, with increased call availability and decreased error rates. A mobile network with faster, high-quality links would support the introduction of more digital data services, including Web browsing. Researchers are studying the speed and efficiency of Web browsing in the new receiver system. They are also studying the increase in the number of sessions possible for a given amount of radio resource, so that more users could use that resource to perform more tasks with better results.

Third-generation mobile systems will support roaming between different networks – terrestrial or satellite, indoor or outdoor. The South Australian Centre is investigating how these networks could be seamlessly integrated, so that users experience minimum inconvenience in moving between them.

to provide seamless interconnection with the fixed network and the Internet.

TRL is working on an 'annotated places' project to demonstrate the audio side of an 'augmented reality' experience through a mobile phone.



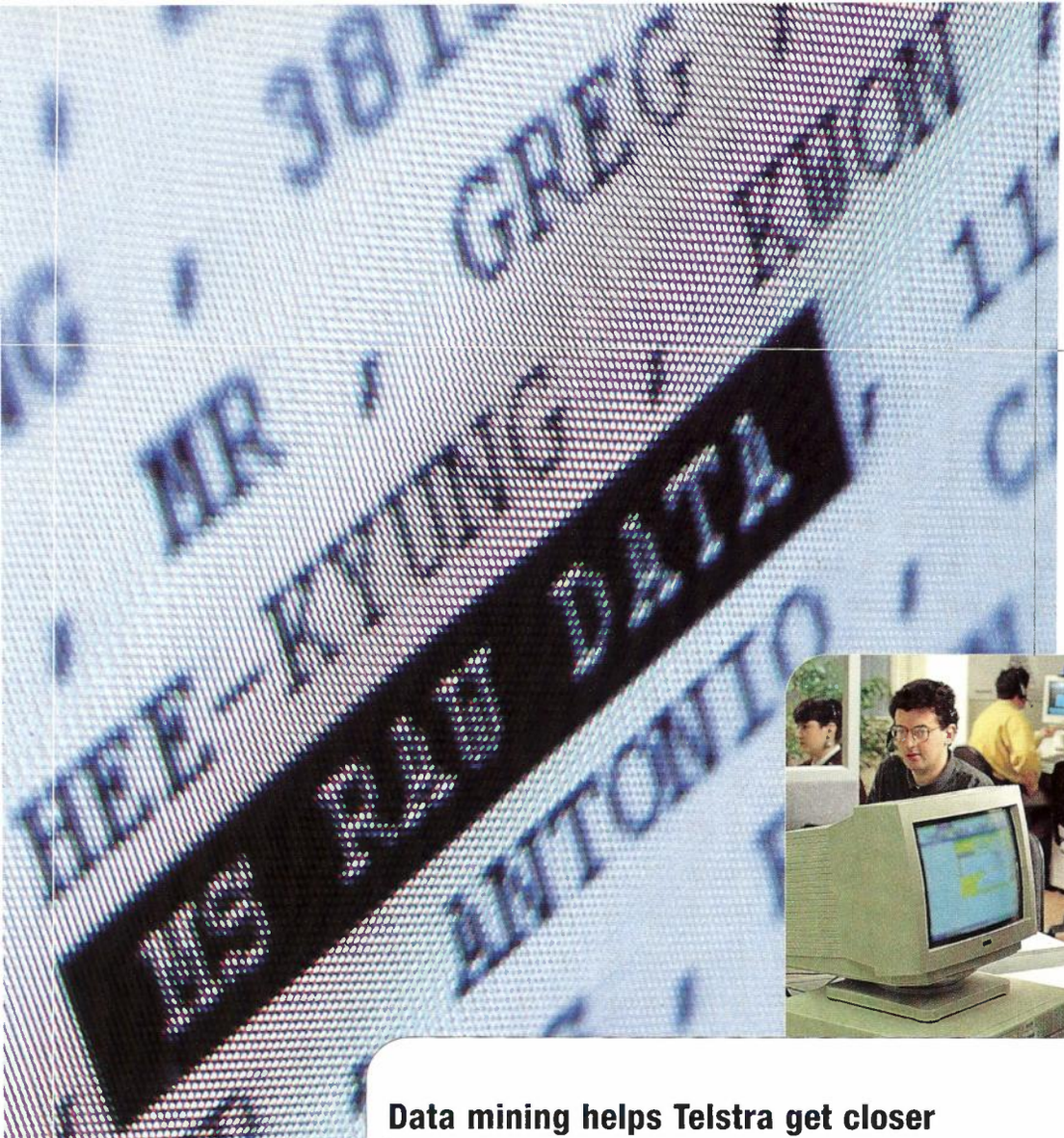
You may be entering an annotated zone

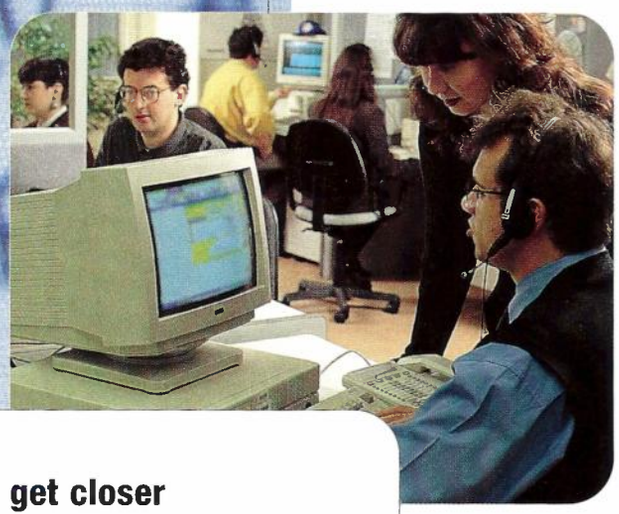
Unlike virtual reality, 'augmented reality' does not interfere with a user's sensory experience of reality, even though she or he may still wear special glasses and headphones. For instance, someone walking down the street looking for somewhere to eat might see posters 'floating' outside a cafe. When the user gets closer, a voice begins to read out the contents of the nearest poster, which is in fact a review of the café left by a previous patron, visible and audible only to users wearing augmented reality gear.

TRL is working on an 'annotated places' project that will demonstrate the audio side of an augmented reality experience through a mobile phone. Using their mobile phone, subscribers to the service could leave audio annotations associated with a location, and other subscribers could either listen to them on their way there, or program the service to ring them whenever they enter a place with an annotation and play it back to them.

As there may be a potentially large number of annotations at some locations, TRL has applied its expertise in intelligent agent technology to the filtering and matching of annotations to individual users. Over time, these agents would observe a user's behaviour, comparing their actions with other subscribers, and noting when they hung up during annotation playback. Because clusters of subscribers with similar interests would be presented with each other's annotations, the service would foster the growth of virtual 'communities of interest'.

Although there are no plans for an 'annotated places' service at present, it would be ideally suited to inner city areas, where GSM cell sizes are small and call localisation is easier. The system could also be developed for business applications, such as in the construction industry, where there is a need for hands-free services and site-specific information, which could be captured as place-based annotations.





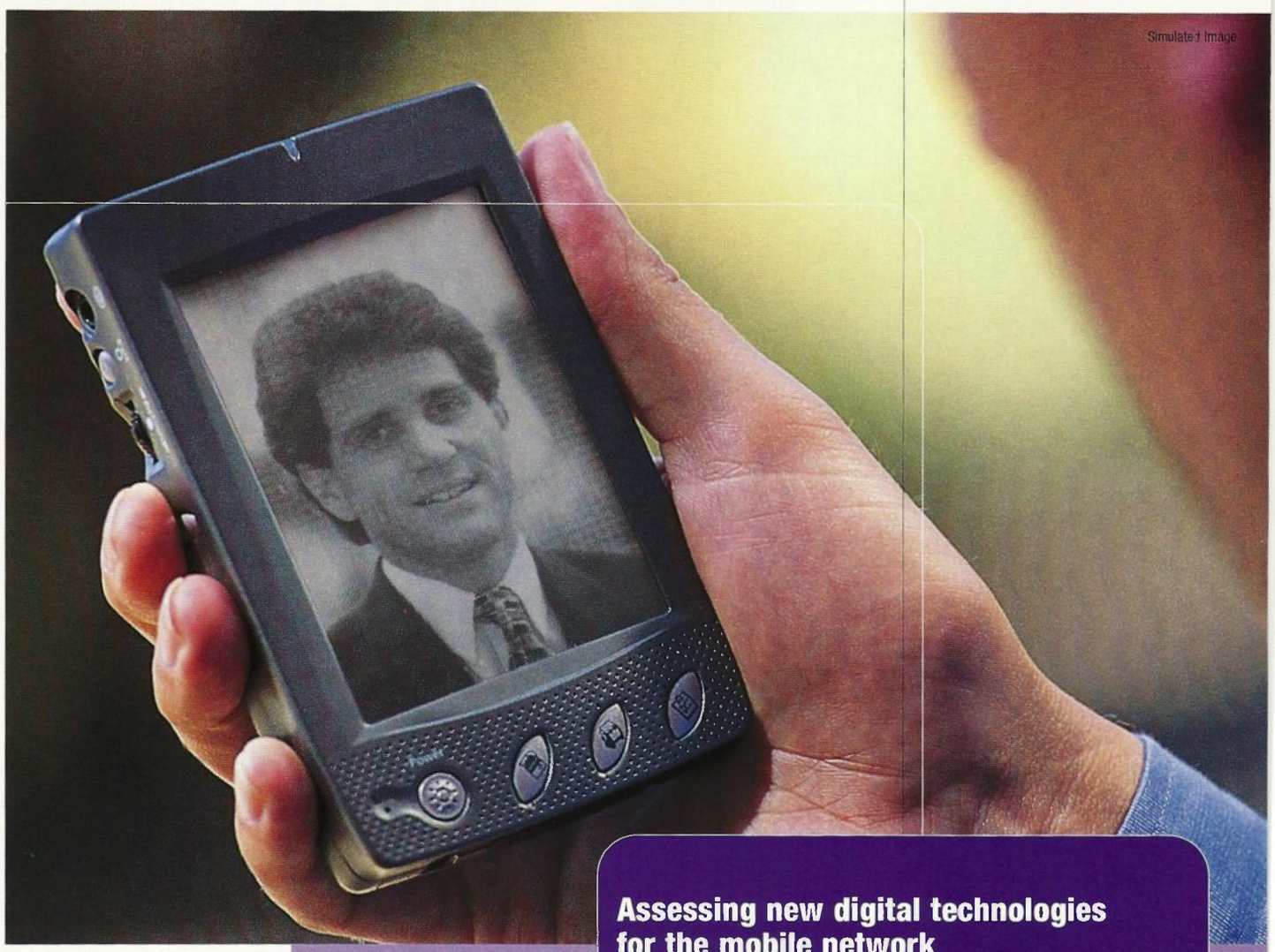
Data mining helps Telstra get closer to customers

Data mining involves the use of software tools that 'dig' for distinctive customer profiles among the mountains of customer-to-business transaction data. It is ideal for large organisations like Telstra that deal with millions or thousands of customers daily, because it fosters the development of customer intimacy, allowing large organisations to respond to customers with the kind of personal touch associated with much smaller businesses.

Existing data mining techniques use either statistical analysis to produce complex but accurate results, or artificial intelligence to produce simpler but less accurate results. TRL has developed a neural networking approach that produces simple and accurate results, which have been verified in a follow-up trial with Telstra mobiles customers.

The work began when a unit within Telstra approached TRL to find a way of identifying mobiles customers who were likely to disconnect from their Telstra service in the near future. TRL researchers applied standard data mining techniques to compress 9 gigabytes of sample customer data into 2 megabytes, then applied their own pattern-recognition software to compress this further into a half-page summary 'profile' of customers likely to disconnect.

Telstra has been applying the TRL technique in a large customer trial that will enable researchers to refine it. Further down the track, Telstra could use advanced data mining techniques to identify and characterise emerging market segments, and tailor new products for these customers in a process known as 'mass customisation'.



Assessing new digital technologies for the mobile network

This year, Telstra will begin replacing its pioneering AMPS analog mobile phone network with digital CDMA (Code Division Multiple Access) technology. Like all cellular mobile systems, CDMA is 'multiple access', enabling a large number of users to share a common pool of radio channels. The difference with CDMA is that, instead of separating communication channels by radio frequencies ('slicing up' the radio spectrum), it separates them using a unique digital code shared by the mobile phone and base station. Thus, many users can share the same RF band.

The benefits of replacing AMPS with CDMA are that the latter has a much higher traffic capacity and can provide standard digital services and privacy levels. CDMA also has a high call quality – reducing the effects of multipath fading and call handoff failures – and reasonably equivalent coverage. TRL has used its expertise in CDMA to assist Telstra in validating and optimising the rollout of the new network.

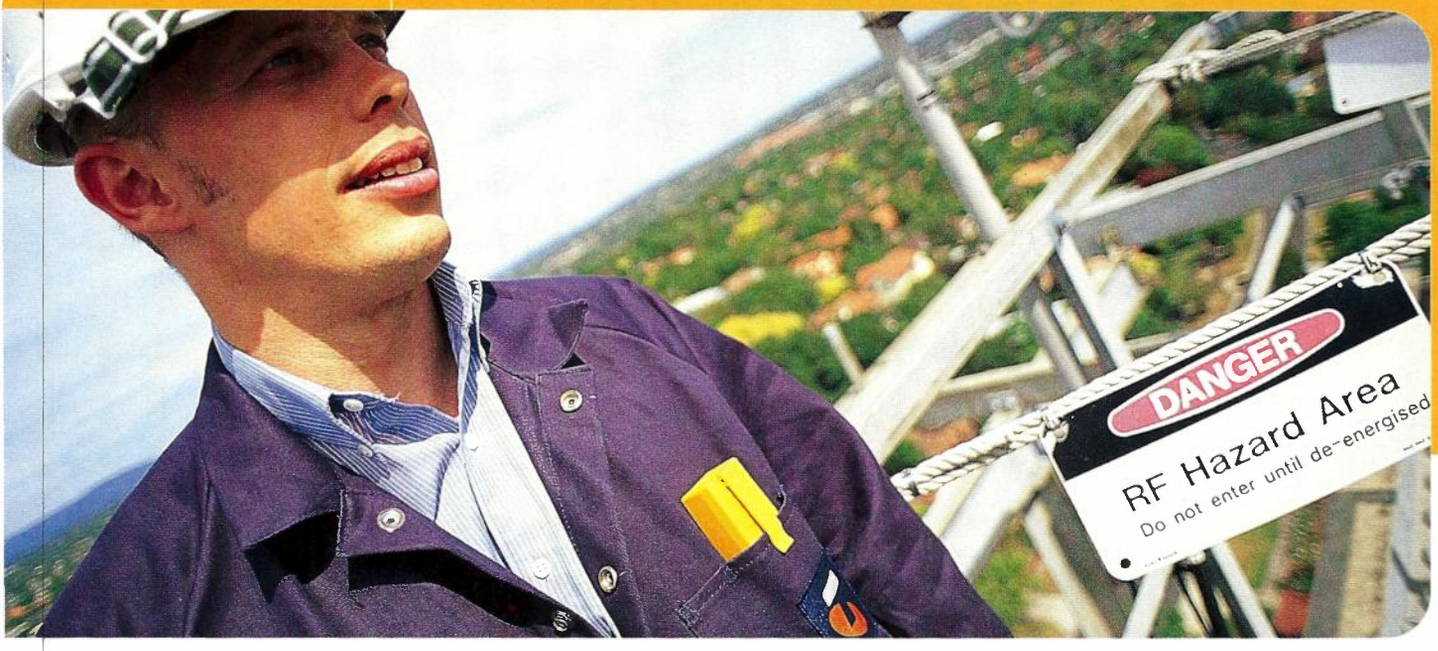
TRL also investigates the economics of different network architectures in delivering new mobile services profitably for Telstra. For example, it has been collaborating with global suppliers to estimate the cost of a broadband CDMA network, and to understand how different CDMA network architectures will support new data and Web-based services. Further, researchers advise Telstra on the technical and economic potential of different parts of the radio spectrum to assist Telstra in making decisions about licensing spectrum for future use.

FASE squeezes extra capacity from mobile networks

A mathematical algorithm that optimises radio-frequency allocation between mobile network cells is at the heart of a cellular-network design application developed for Telstra by TRL and CSIRO. The FASE (Frequency Assignment by Stochastic Evolution) software has enabled Telstra to squeeze extra capacity from parts of its GSM network through more efficient use of available frequencies.

Since radio spectrum is a limited resource, one of the challenges facing network operators is dividing bandwidth among as many users as possible while maintaining call quality. In digital and analog mobile networks, for example, the same radio frequency can be reallocated for use in different cells. If cells are too close together, however, reuse of the frequency can cause interference. This is where FASE has made a difference, by reallocating frequencies among different cells within a region to achieve the highest capacity with the least interference. Telstra's mobile network engineers have been using FASE for a number of years to re-tune radio frequencies over an entire region, as well as to add new cells by re-tuning a sub-set of cells within a region.

The success of FASE is the result of continued collaboration between TRL and CSIRO. To improve its value to Telstra, the R&D team has responded to a number of suggestions by users of FASE and modified the original software. Among the latest features are interactive interference analysis capabilities that enable network designers to explore different network options. Telstra has also deployed FASE in a GSM network in India that was established through a joint venture between a local company and Telstra.



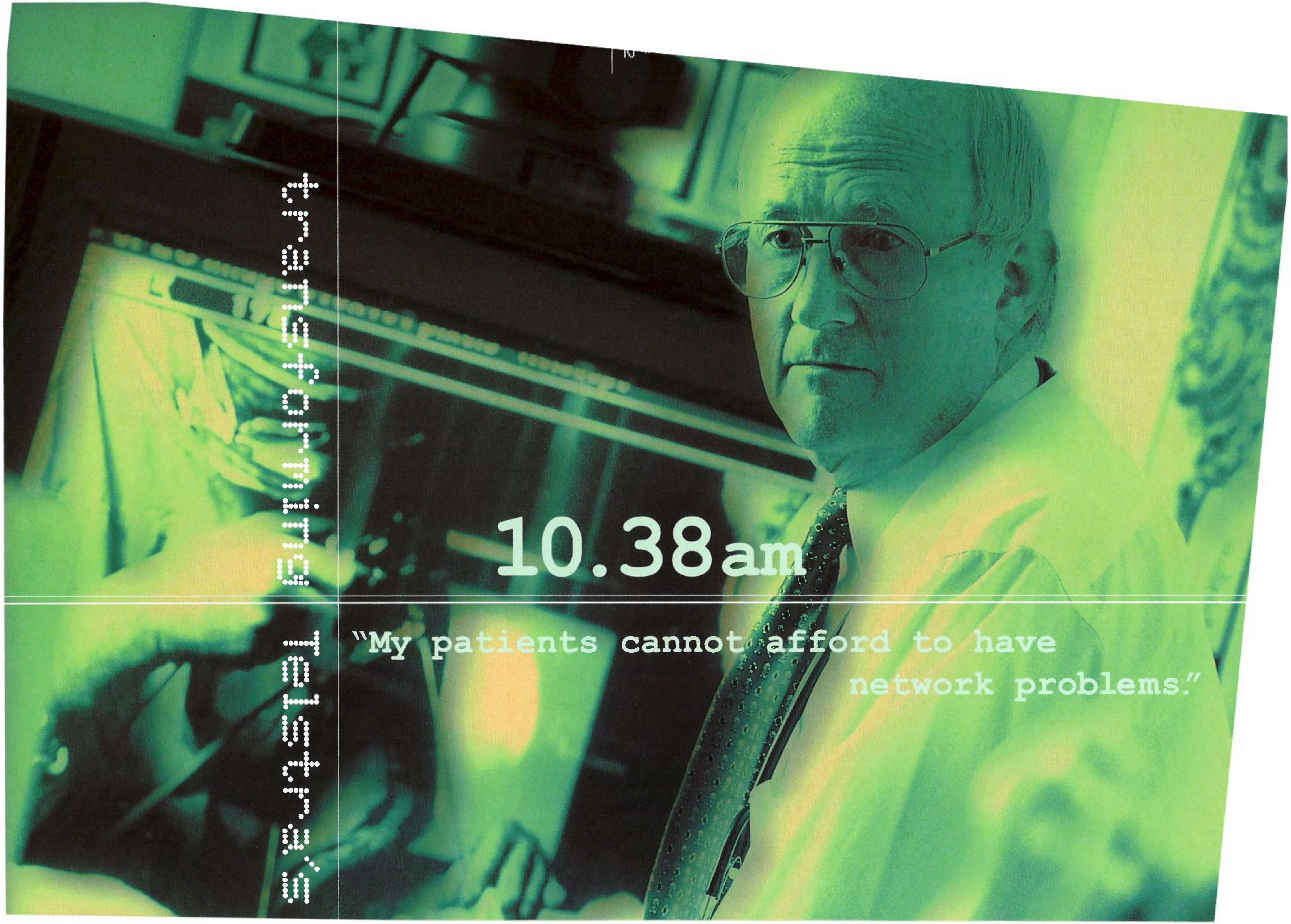
Safety first with RadHaz and Go-NoGo

Ensuring human health and safety in and around its mobile network base stations is a responsibility that Telstra takes seriously. For more than 10 years, the corporation has been investing in electromagnetic energy safety research at TRL. This has led to the development of some unique tools, including the 'RadHaz' software package and the 'Go-NoGo' handheld monitor. Both tools alert Telstra base-station maintenance staff and contractors to the presence of strong but invisible radio-frequency (RF) fields very close to antennae.

RadHaz is an intelligent mapping tool that records RF intensities around base station antennae, mapping the RF-hazard zones with the help of specialised drawing tools. Telstra Network Design and Construction staff use RadHaz to develop a library of pre-measured hazard zones, which authorised users can download from an Intranet site maintained by TRL. This service provides users with accessible, consistent and up-to-date RF safety information. RadHaz is also being expanded to include new radio-spectrum frequencies allocated for future services (e.g. 1800 MHz).

TRL designed the Go-NoGo handheld RF monitor to be robust, compact and easy-to-use, in contrast to the large, complicated and fragile monitoring devices already on the market. The Telstra monitor simply triggers a 'NoGo' alarm when it senses electric and magnetic fields of about half the strength of the current Australian standards for human safety. The device is being commercialised by a German instrument manufacturer, which has redesigned it to be pocket-sized. The Australian RF safety standard is one of the most stringent in the world, which is why Telstra had to develop its own, unique intelligent monitoring solution.

TRL has continued to contribute to national and international standards forums on behalf of Telstra, and collaborate with universities and medical research teams around Australia to investigate any subtle effects of electromagnetic fields on the human body and on devices such as hearing aids and pacemakers. Researchers here have also developed and presented training materials for Telstra staff on safe work and design practices for RF equipment.


10.38am
"My patients cannot afford to have network problems."
transforming Telstra's

network

A data-mode infrastructure would be optimised to support data services,

This year, Telstra is developing its Data Mode of Operation (DMO) strategy—a comprehensive program to create a common core-network infrastructure, develop advanced systems and processes to support this infrastructure, and train Telstra staff in the delivery of new Internet and other data services. Through the DMO, Telstra's core network will be transformed to better handle data and multimedia services than today's voice-oriented core network.

How would a DMO network differ from a traditional voice-oriented network? The main difference lies in the greater degree to which packet technology would be deployed in the public network. Data traffic such as the Internet is 'bursty', and better suited to a network optimised for packet transmission, rather than the fixed-bandwidth circuits used for telephony. Packets can efficiently fill available communications capacity, while resources for circuits must be reserved for the duration of a call, regardless of whether or not all of a circuit's capacity is continuously used.

Another difference lies in the availability of different quality of service (QoS) levels. Today's Internet-based technology can only offer what is known as a 'best effort' service delivery, meaning that a user requiring time-critical delivery of their data services, such as multimedia conferencing, across the Internet or a corporate intranet can experience the same delays as someone casually browsing the Web. Through a DMO network, Telstra plans to offer service level agreements for corporate intranets which support guaranteed, end-to-end QoS.

TRL has been closely involved with the DMO program, identifying the key technology issues for Telstra, and evaluating vendor equipment and systems to ensure that each solution meets Telstra's comprehensive technical specifications.

Apart from providing more efficient switching, the DMO infrastructure will require increased bandwidth transmission capacity in Telstra's core network for the widespread delivery of multimedia services. Among the innovative network technologies being investigated by TRL are optical-fibre systems based on DWDM (Dense Wavelength Division Multiplexing). DWDM enables each hair-thin, glass fibre within a cable to carry many light beams of different wavelength simultaneously, dramatically increasing optical transmission capacity without the need for additional cables. The next generation of optical systems will be able to transport information at the rate of 1 terabit per second (Tbps or 1000 gigabits per second) over a typical optical fibre cable. This is equivalent to more than 12 million phone calls, carried simultaneously over a cable little more than 4 cm in diameter.

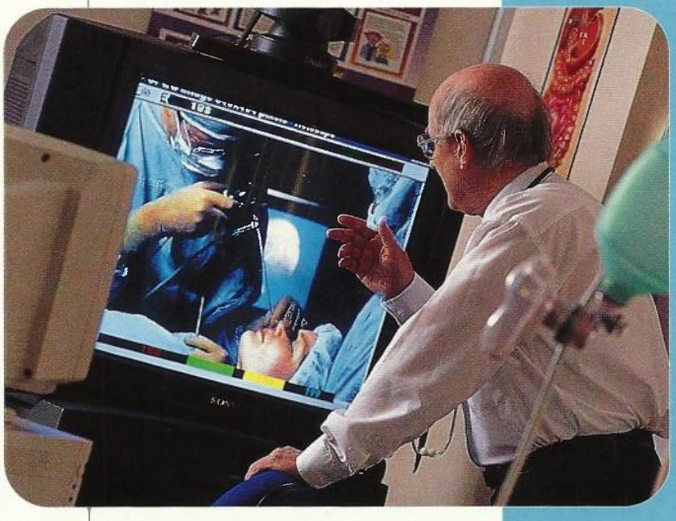
To enhance the management of Telstra's networks, TRL has developed a range of monitoring tools to measure critical aspects of performance such as Internet traffic volumes, intelligent-network operation, network congestion, cable modem network operation and international call quality. Some of these tools include graphical Web interfaces that make them easier and more effective for Telstra network staff to use. Researchers also helped Telstra to identify, and solve, an unusual call-quality problem specific to rural areas.

The transformation of Telstra's core network through the DMO strategy will be accompanied by changes in the much larger access network to optimise it for broadband and high-speed data services. TRL has been evaluating the effectiveness of different DSL (Digital Subscriber Line) technologies for delivering high bit-rate services over the existing copper access network to home and small business customers. The delivery of high speed Internet services using DSL technologies will complement the delivery of services over the pay-TV cable network. Telstra is also investigating the use of low-earth-orbiting satellites for broadband-Internet service delivery in areas where cable and DSL are not suitable.

7.50pm

transforming Telstra's network

and flexible service access and delivery.



In a future IP-based public network, different quality of service levels will be essential.

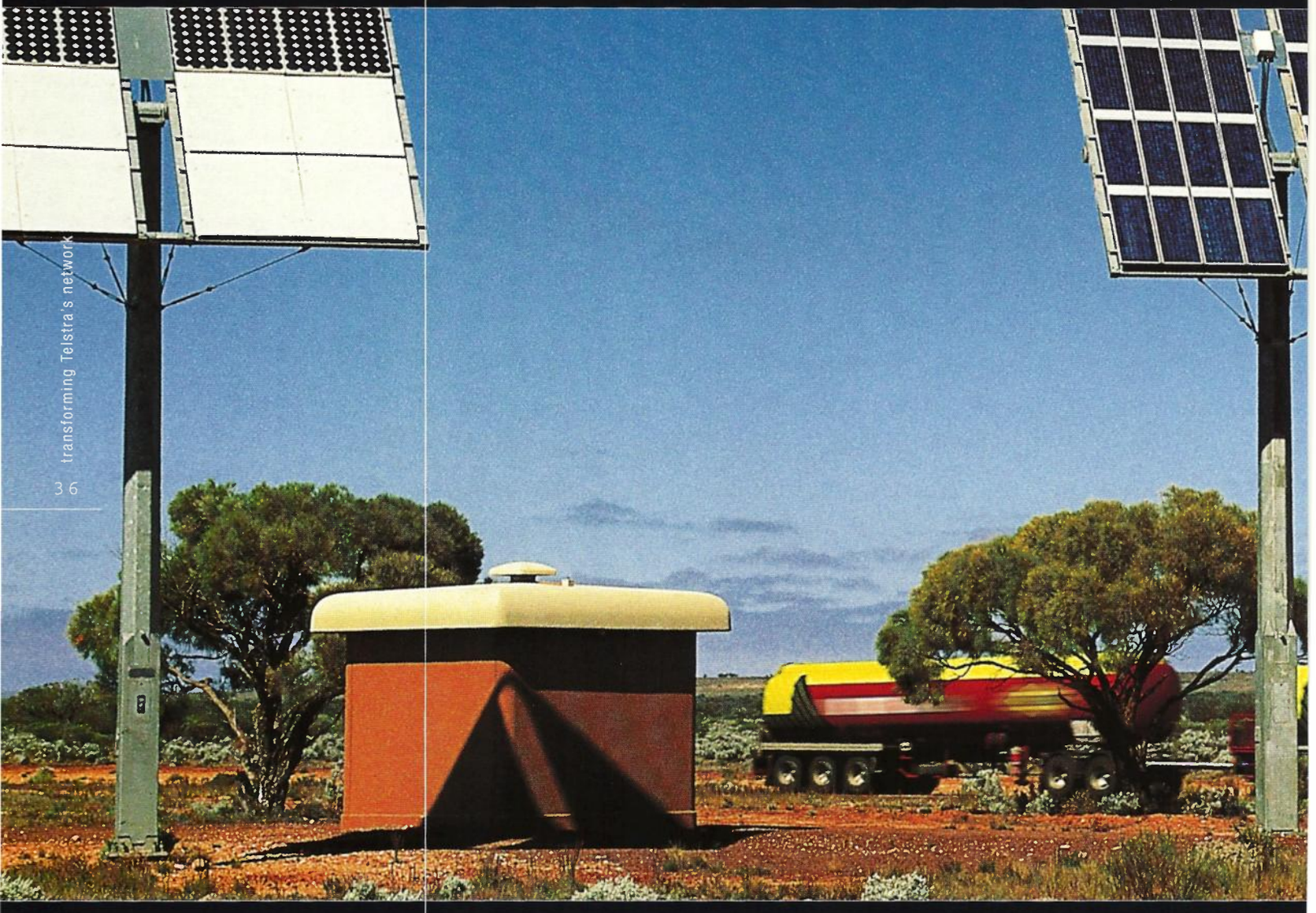
A switch in time for critical voice, video and data

In a future IP-based public network – supporting thousands of business intranets and millions of users, each running applications that may be time-critical (voice and video) or not (Web browsing and e-mail) – different quality of service (QoS) levels will be essential. Today, businesses are wary of using the Internet for time-critical applications because of its 'best effort' level of delivery, which gives no precedence to higher priority traffic. Telstra must ensure that its IP-networks can reliably deliver the high service levels set down in customer service level agreements.

So that Telstra can deliver commercial and general IP services at different QoS levels, TRL is evaluating a range of IP network technologies. For example, one technology provides a 'soft QoS' capability, with each packet being allocated a forwarding and discard priority. A high forwarding priority ensures that a packet will be sent through the network with fewer delays than lower priority traffic. A packet's discard priority is only used during network congestion, when all low priority packets are discarded in preference to high priority packets. The QoS is referred to as 'soft' because network performance is difficult to guarantee if there is too much traffic at a similar priority level. The reliability of 'soft QoS' depends on good traffic engineering to maximise network performance and minimise congestion.

Another technology delivers 'hard QoS' by making use of the inherent capabilities of ATM (Asynchronous Transfer Mode). Rather than route packets through the network on the basis of priority, ATM's 'hard QoS' reserves connection resources (such as bandwidth and switching) across the network. The end-to-end reserved resources form what is known as a virtual connection. The resources for each virtual connection are allocated exclusively, and traffic on one connection cannot interfere with traffic on another. ATM's 'hard QoS' technology can support service level agreements for IP and IP-VPNs.

TRL's findings are helping Telstra add to its Big Pond® product range for business customers, with the introduction of secure, virtual IP-network services that provide data traffic separation, security and guaranteed quality of service. This enables businesses to take advantage of the substantial infrastructure cost-savings from sharing a public data network.



Many wavelengths make light work of heavy traffic

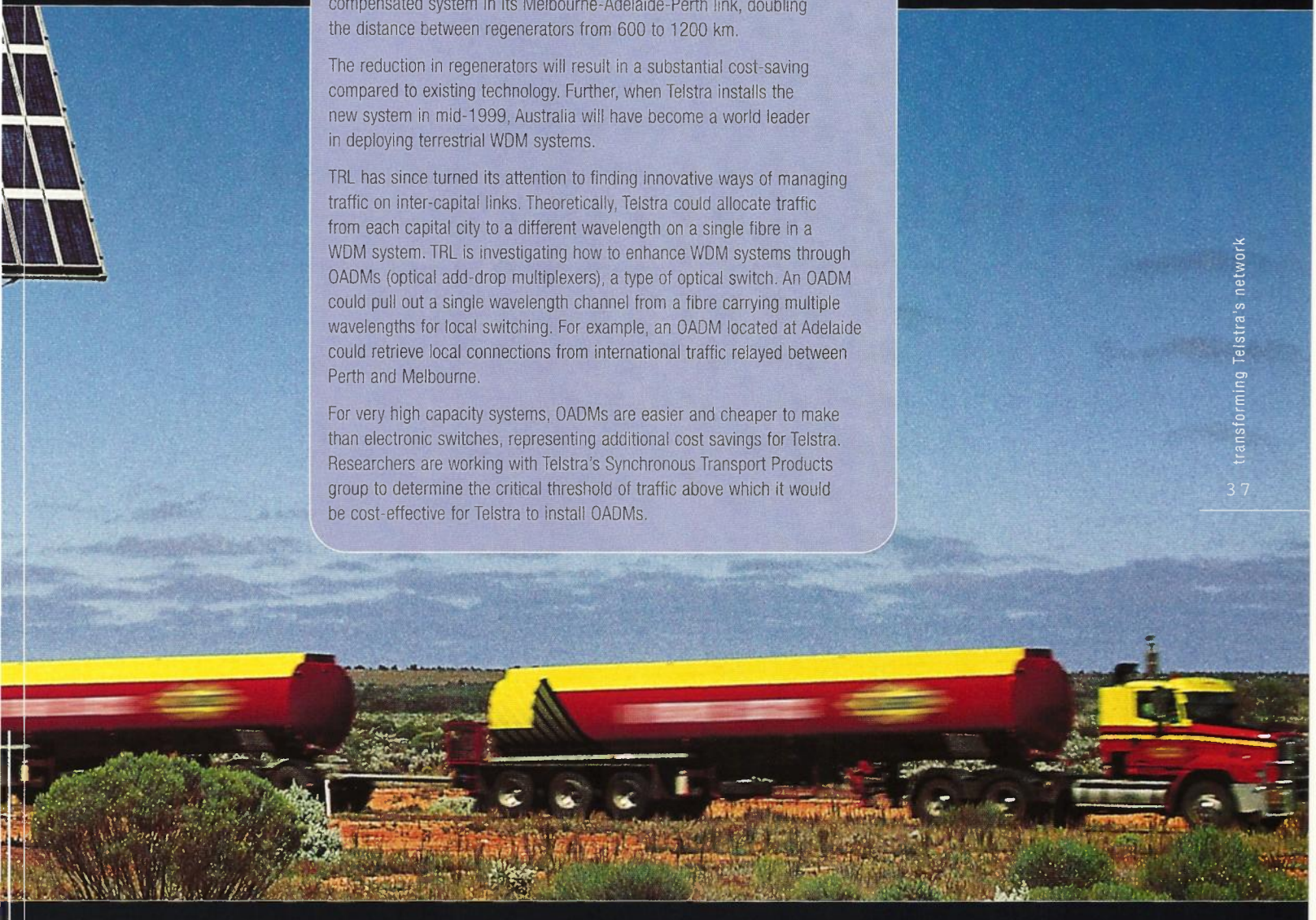
TRL has been investigating how to increase the capacity, and reduce the cost, of Telstra's core optical-fibre network through wavelength division multiplexing (WDM), which enables a single optical fibre to carry many light-streams, or channels, of different wavelength.

Researchers have demonstrated the effectiveness of a special fibre that compensates for the dispersion of colours as light pulses travel along a glass fibre. This solution means that light pulses can travel longer distances over optical fibre before requiring 'repair' by an electronic regenerator. Consequently, Telstra plans to install a dispersion-compensated system in its Melbourne-Adelaide-Perth link, doubling the distance between regenerators from 600 to 1200 km.

The reduction in regenerators will result in a substantial cost-saving compared to existing technology. Further, when Telstra installs the new system in mid-1999, Australia will have become a world leader in deploying terrestrial WDM systems.

TRL has since turned its attention to finding innovative ways of managing traffic on inter-capital links. Theoretically, Telstra could allocate traffic from each capital city to a different wavelength on a single fibre in a WDM system. TRL is investigating how to enhance WDM systems through OADMs (optical add-drop multiplexers), a type of optical switch. An OADM could pull out a single wavelength channel from a fibre carrying multiple wavelengths for local switching. For example, an OADM located at Adelaide could retrieve local connections from international traffic relayed between Perth and Melbourne.

For very high capacity systems, OADMs are easier and cheaper to make than electronic switches, representing additional cost savings for Telstra. Researchers are working with Telstra's Synchronous Transport Products group to determine the critical threshold of traffic above which it would be cost-effective for Telstra to install OADMs.



Consequently, Telstra plans to install a dispersion-compensated system in its Melbourne-Adelaide-Perth link, doubling the distance between regenerators from 600 to 1200 km.

One-stop shop for broadband services access

How will Telstra's customers, particularly residential customers, access the range of service quality levels – for voice, data and multimedia – and other services offered over a public data network?

TRL is investigating a broadband services access server that would present a single interface to customers logging on to the network through different modes – cable modem, DSL (Digital Subscriber Line, a protocol for carrying broadband over phone lines), mobile or satellite. As soon as a user selected a service, the network would automatically verify user identity and chosen class of service, and deliver application bandwidth as required. The Telstra access server could allow customers to connect to service providers other than Telstra.

Through the server, suitable service providers could deliver value-added services such as streaming video and audio, and electronic games to Telstra customers. Telecommuting services such as videoconferencing between office and home could be offered over secure corporate VPNs (Virtual Private Networks). The server would also provide a framework for Telstra to 'wholesale' infrastructure and network capacity to other service providers.

TRL has completed a proof-of-concept laboratory trial on the service selection component of the access server. This included testing selection of services via a Web interface, testing the access server's capability to integrate multiple access networks, and evaluating technology performance.

The direct Internet links provide faster, more reliable international connections, with fewer 'hops'.

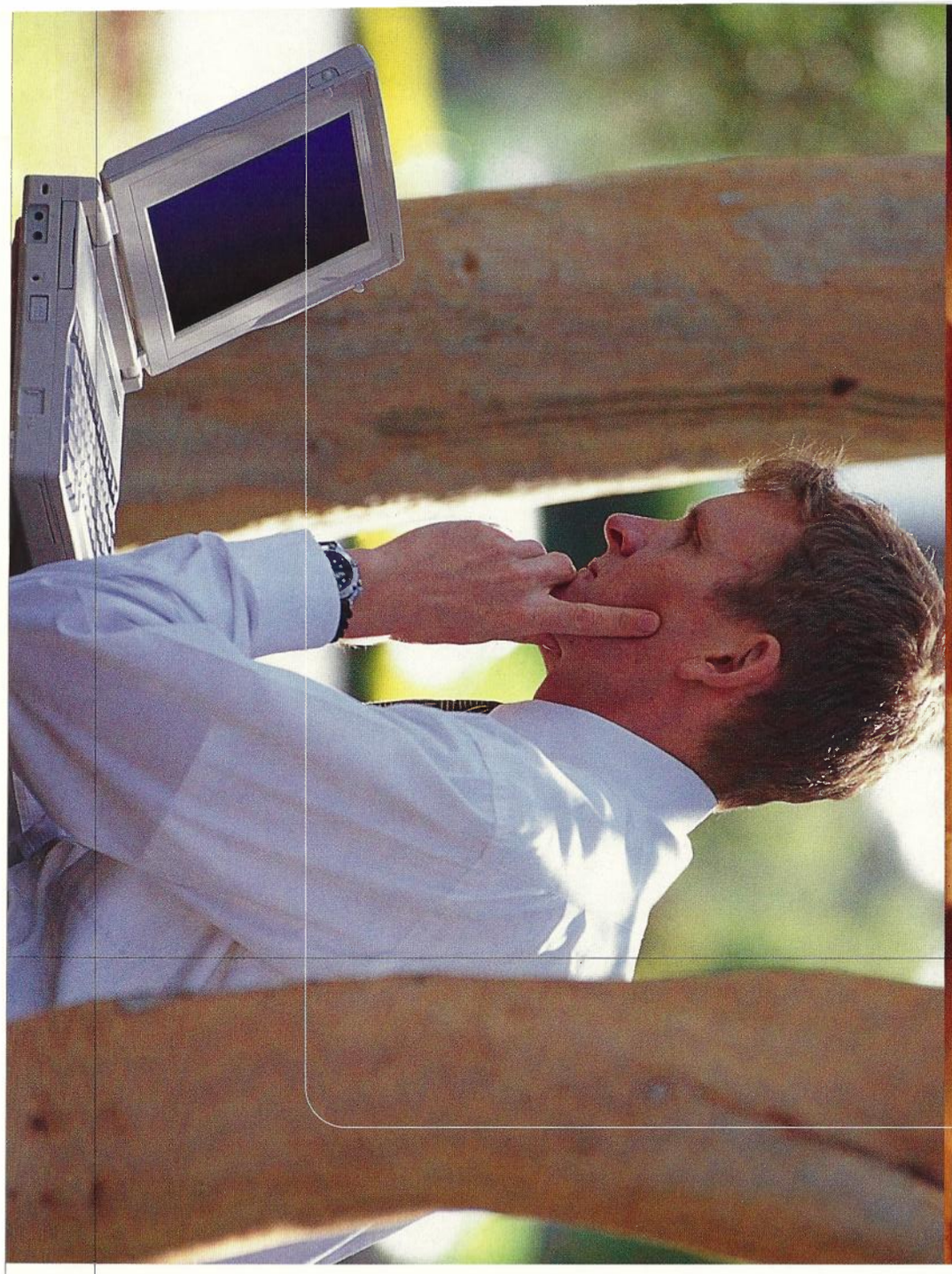
Monitoring tool leads to faster global Internet links

TRL has developed a monitoring system for determining the global movement of Internet traffic from Australia, enabling Telstra to set up direct links to major overseas destinations and save many millions of dollars in service fees associated with traditional traffic routes via the USA. The direct Internet links provide faster, more reliable international connections, with fewer 'hops'. The system makes Telstra one of the few companies in the world able to monitor its Internet traffic dispersion.

The work began in mid-1996, when managers in Telstra's International Network Planning Group needed to plan future capacity for direct Internet traffic routes, yet were unable to quantify traffic volumes flowing on the US route to and from individual countries, as Internet monitoring was then non-existent. Within a few months, TRL had developed a mathematical model, which predicted that Internet traffic to Japan would accelerate to a level of 1 megabit per second (Mbit/s). Telstra installed a direct link to Japan and, as predicted, traffic flow reached 1 Mbit/s. Consequently, Telstra's international network planners requested TRL to develop a larger-scale Internet traffic-monitoring system.

Researchers sourced a software package from Auckland University, modifying it to handle the enormous traffic volumes present on the Internet. The TRL team also developed a unique software program for resolving IP addresses into country domains, and an accurate statistical procedure for sampling Internet flows from busy international routes. The end result provides Telstra with a complete breakdown of inbound and outbound traffic associated with each country (source or destination) visible on the particular Internet link.

As a result of using the system to monitor Internet traffic, Telstra has set up direct links to some regions, providing faster connections for customers and more cost-effective traffic routing for Telstra and the carriers supporting the links. Because Internet traffic information is critical to Telstra's traffic forecasting and capacity planning, researchers are also monitoring the proportions of traffic associated with different applications, such as Web browsing and Internet telephony.



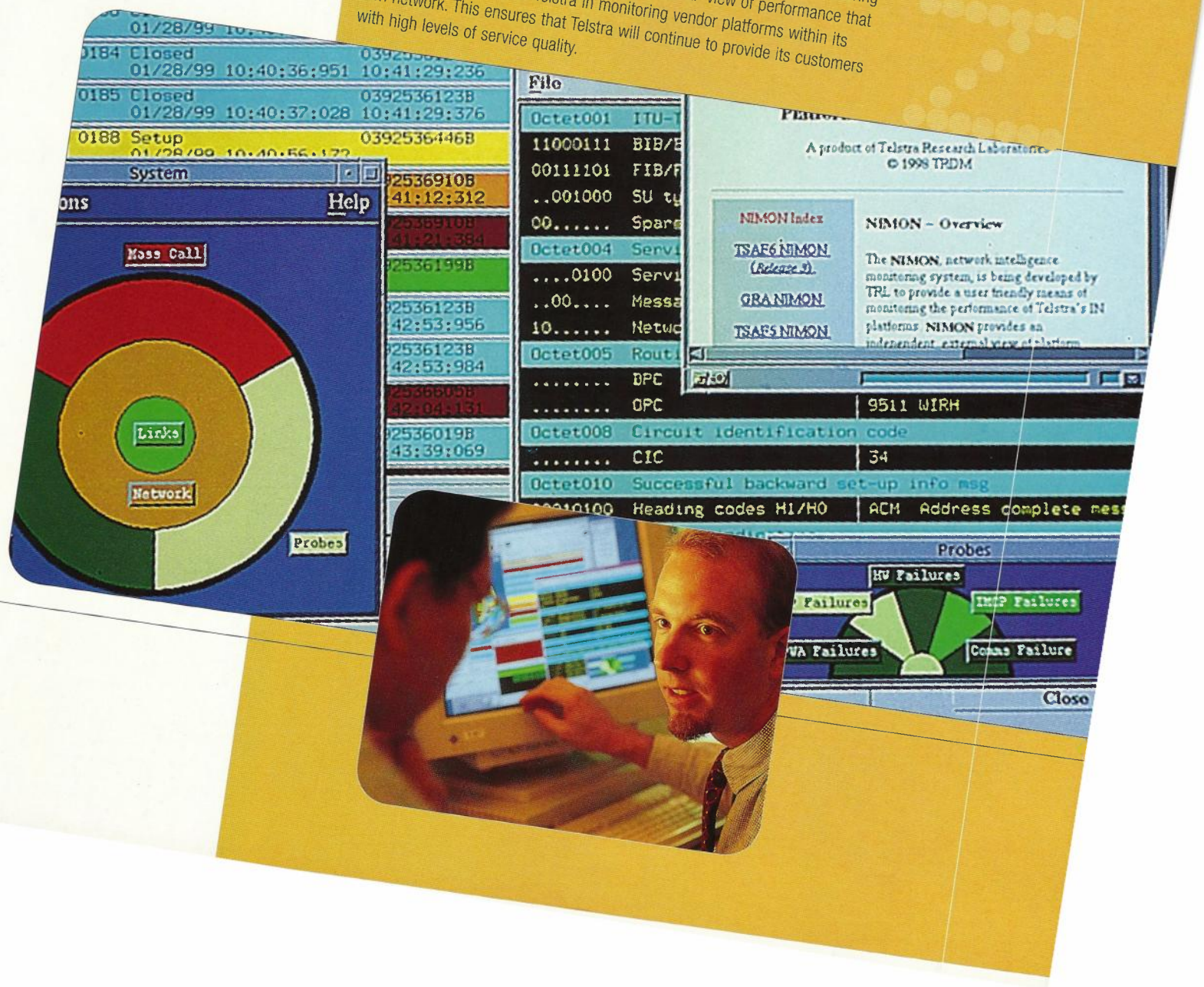
NIMON doesn't miss a thing

HomeLink®, Freecall™ 1800, Priority® One3, InfoCall® 190, Telecard®, and PhoneAway™ are high-profile, customer-critical Telstra products with one thing in common – they are all delivered over intelligent-network (IN) platforms. This makes it important to monitor IN network performance continuously, especially during mass calling events such as radio and TV phone-in competitions when IN platforms are subject to overload. Yet detailed monitoring of Telstra's IN platforms, particularly during overload, has not been technically feasible, until recently.

Enter NIMON (Network Intelligence performance MONitoring), a user-friendly tool developed by TRL for 'live' monitoring of Telstra's IN platforms. NIMON collects and analyses signalling data from monitoring equipment inserted between two critical parts of the IN platform – the service control point, which translates the 1900 or other special number into a standard call destination number, and the service switching point, which implements calls in the network based on service control point instructions. This configuration means that 'objective' data is always available, even during the stress of a platform overload.

NIMON features a Web interface that allows Telstra staff in IN-related areas – products, network operations, business and international, or network dimensioning – to access and analyse data on performance measures such as call delay times or successful call rates.

Another innovative feature of NIMON is that it can report separately on call patterns in different IN products, such as InfoCall® and Telecard™ – the output depends on which product the user is interested in. Most other IN monitoring systems cannot do this. NIMON offers an 'external' view of performance that has proven very useful to Telstra in monitoring vendor platforms within its own network. This ensures that Telstra will continue to provide its customers with high levels of service quality.



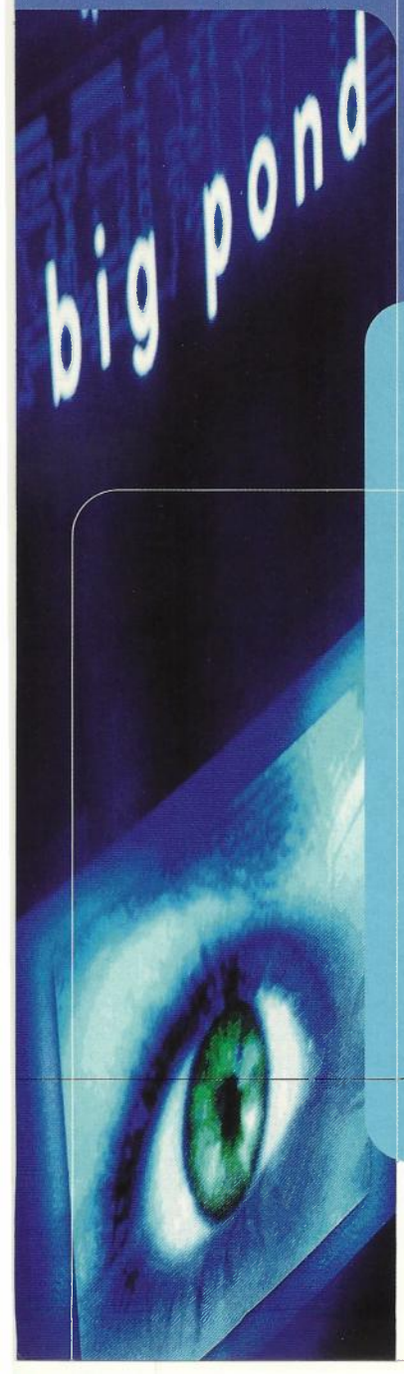
Seeing network delays before they stop traffic

TRL researchers have developed a prototype integrated visualisation and data-filtering tool for faster, real-time analysis of network performance data. The tool—'VisCaFE (short for visualisation of call failure events)—would enable network managers to locate the source of network problems as they emerge, reducing the likelihood of outage. While VisCaFE was designed for the public telephone network, the same technique could be applied to identifying sources of Internet traffic delays.

The switches in Telstra's public telephone network generate an enormous amount of performance data, which until now managers could only partially analyse using static network display tools. VisCaFE, however, can retrieve live performance data from the PSTN to build up a dynamic, graphical model that links network nodes (switches) displaying a similar problem.

Because the network layout display is continually updated as new data arrives, users can quickly spot the main source of congestion and its 'sphere of influence' across the network. Different coloured links between the displayed nodes indicate the relative severity of a problem. This would give network managers a clearer picture of which part of the network they need to deal with. VisCaFE also enables users to gain a more detailed understanding of the problem by drilling down through data from selected switches with the click of a mouse.

VisCaFE's dynamic display function is based on a mathematical algorithm known as 'spring embedding' layout, innovatively adapted by TRL to draw together correlated network nodes on the screen model. Researchers have also developed a related application known as 'VisTab', which could assist managers in diagnosing the nature of a network problem once it was located. Both visualisation tools could be adapted to Telstra's mobile or broadband Internet networks to monitor latent performance problems, and to detect intrusion or fraud.



Feeling the pulse of Big Pond® Cable

A system developed by TRL for monitoring the performance of Big Pond® Cable will help Telstra maintain quality of service as the number of pay TV and cable modem connections to its hybrid fibre-optic/coaxial-cable (HFC) access network continues to rise.

Cable modems connect Internet users to the HFC network, the same network used to carry pay TV. Data can travel much faster over the HFC/cable-modem network than over the PSTN, the standard means of Internet access. These higher speeds are ideal for delivering near-real time video and sound and for faster Web access. However, higher speeds also make the service sensitive to delays caused by retransmission of 'lost' data packets, a problem associated with 'noise' in the cable-modem network.

The largest single cause of noise is from inappropriate wiring extensions on customer premises, which combine to create a compound effect at the cable-modem network 'headend'. While the lower noise levels do not affect quality of service, once the noise level reaches a critical threshold, service quality could drop markedly. The TRL monitoring system assists by automatically monitoring the 'pulse' of the cable modem network.

The Big Pond® Cable performance monitoring system comprises a laptop computer at the customer end that collects statistics on delays between the customer's cable modem, the Big Pond® server complex, and the cable-modem network headend. The part of the network where the laptop is located is connected via Telstra's HFC network to a laboratory-based, packet-loss measurement system. The monitoring system is being used by Telstra's Internet IT Products Program as part of its Quality of Service initiative. When automated and integrated with Telstra's network for wider use in its commercial service, the measurement system will form part of a continuous quality assurance process.

Keeping phone calls clear across the world

TRL has worked with Telstra's Network Quality group to develop a unique monitoring system that automatically alerts network operations staff to the appearance of echo. The system comprises two units that have been operating at Telstra's two international gateway exchanges since 1997. Each unit can monitor up to 3840 voice circuits (each circuit carries one phone call), giving Telstra the ability to monitor up to 7680 voice circuits for echo.

All telecommunications carriers must install echo cancellers on international links. These cancellers, however, can either fail or be removed from service. When this happens, callers may hear echo. Echo can be detected 'passively' – that is, without injecting any form of test signal into the network. This is what TRL has achieved with the distributed network analyser (DNA).

DNA monitoring is an automated process in which five-second fragments of live phone conversations are analysed by specialised equipment for impairment such as echo. Because 'live' call fragments are used, what is measured and analysed is exactly what the customer hears. A quality profile of an international route being monitored by the DNA can be built up within just four hours. If the quality falls below a specific level, an alarm is automatically raised, alerting an operator to a problem that otherwise could only be detected through complaints from callers.

The latest version of DNA has enough capacity to cover some of the major call destinations that carry most of Telstra's international voice telephony traffic, as well as known 'problem' destinations. The DNA builds on earlier in-call, passive monitoring technology developed by TRL, and interfaces to the network at the 2 Megabit-level used in today's voice communications networks.

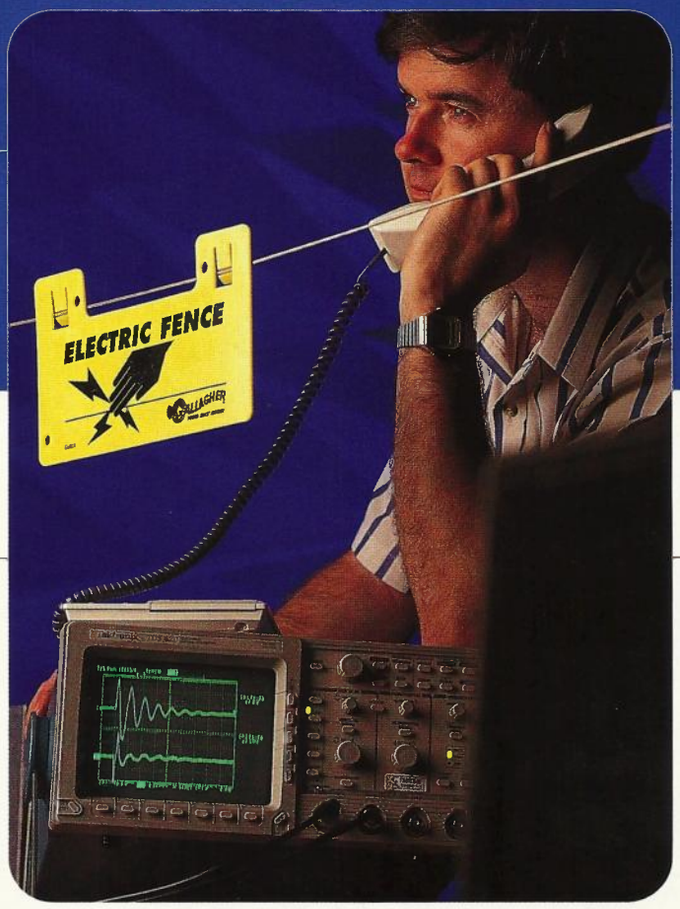
Immunising the rural network against electric fence clicks

After TRL researchers discovered in 1996 that the mysterious regular 'clicks' reported on some rural phone connections were caused by electric fences, they developed an antidote to what was regarded as a uniquely Australian problem. Since then, however, the problem has been reported in the UK, Sweden and Brazil. So TRL has used its expertise to draw up what may become an international standard for 'immunising' small-scale electronic exchange equipment used in rural areas against interference.

The clicks are initiated by high-voltage pulses from electric fences near copper wire pairs. While clicking has always occurred on a small number of rural calls, it became more common during recent years as Telstra progressively replaced older electro-mechanical exchange equipment with electronic equipment, which is more susceptible to electromagnetic interference.

TRL worked with two Telstra business units to design a low-frequency filter to protect affected phone lines, an immediate antidote to the problem. But electric fences are becoming more widespread because they cost less than conventional fencing. So researchers looked at a longer-term network 'immunisation' solution. This has taken the form of an in-house technical standard–based on extensive laboratory and field studies–to be adopted throughout Telstra for electronic exchange equipment.

The next step will be to get international recognition and endorsement of the standard. This will ensure that exchange equipment manufactured by Australian and overseas suppliers will have built-in protection against electromagnetic interference, creating long-term benefits for carriers and rural customers.

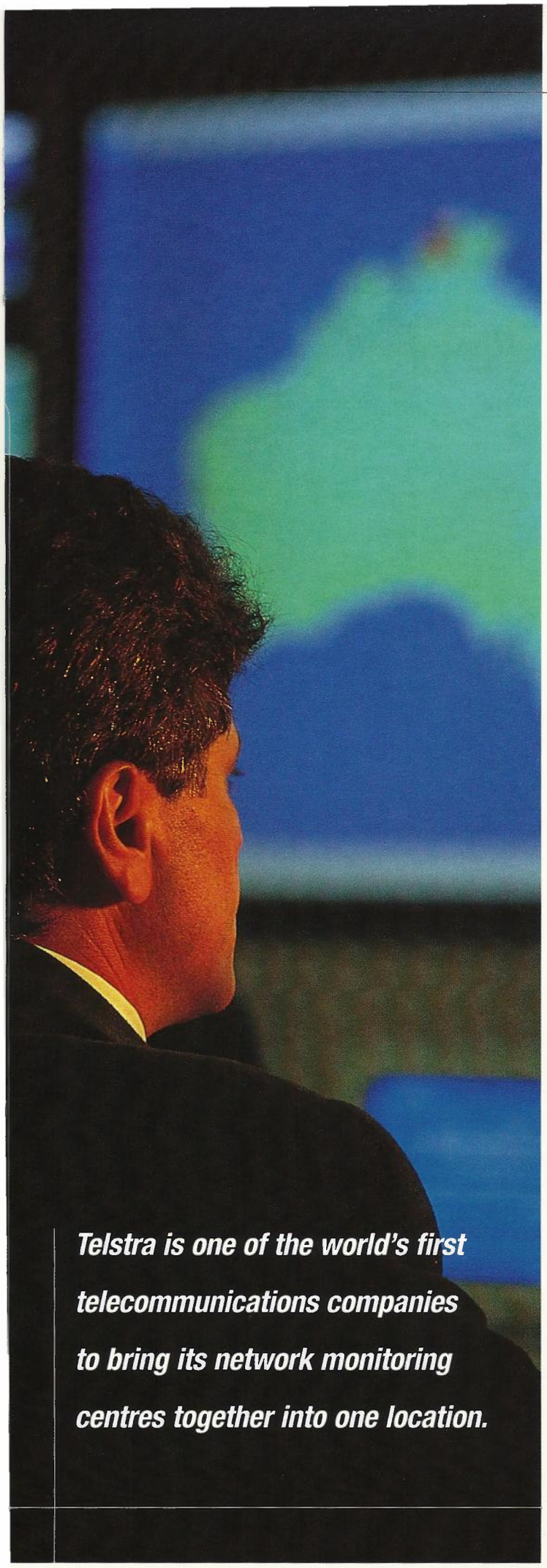


When interface design really is a big issue

A huge video wall, 30 metres long and 4 metres high, will provide staff at Telstra's Global Operations Centre with a 'state of the network' overview of Telstra's national and international network elements. TRL human factors experts have been helping Operations Centre managers to determine an optimal interface design for the 96 video cubes to ensure that information at any point along the screen is visible to the relevant work group in the Centre's surveillance hall.

The video wall is designed to allow Centre managers to change the position of displays of different network elements, not only for different Operations work groups, but also for customer presentations. TRL's human factors team is building and testing electronic simulations to determine the most suitable display configurations for enhancing interaction between Operations work groups. Timely interaction between Operations Centre groups – who separately monitor switching, transmission and power to exchanges – is particularly critical for effective management of events such as outages.

Telstra is one of the world's first telecommunications companies to bring its network monitoring centres together into one location, creating an opportunity to set new benchmarks in network management efficiency and network performance.



Telstra is one of the world's first telecommunications companies to bring its network monitoring centres together into one location.

Broadband digital access networks – assessing the bits

To deliver broadband Internet services over copper telephone access networks in Australia, Telstra may eventually deploy ADSL (Asymmetric Digital Subscriber Line).

Telstra is interested in future DSL customer access because it would complement Big Pond® Cable in connecting small and medium businesses and residential customers to the Web and to the intranets and extranets of other businesses.

However, ADSL would need to be implemented carefully.

TRL has used its expertise in pair cable transmission and crosstalk interference modelling and measurement to identify a range of technical issues. The most important is the potential problem of crosstalk or electromagnetic interference caused when different service delivery equipment shares the same copper-pair infrastructure. Researchers have developed a set of network design rules that Telstra would need to apply to prevent failures in any future ADSL system, or in current telephony services.


"Our organisation is extremely pleased
to be associated with Telstra."
12.38pm

partnerships

Partnerships extend Telstra's knowledge base, providing it with the flexibility to tap into special areas of expertise that add value to its diverse products, services and network infrastructure. Business partnerships also enable Telstra to develop and commercialise innovative, in-house product or service ideas that lie outside the scope of its core business.

As Telstra's R&D arm, TRL brings a valuable technical insight and telecommunications knowledge to partnership alliances. Its pool of highly qualified researchers can communicate at a detailed technical level with independent research groups across Australia. Among these are specialist Cooperative Research Centres (CRCs), established through a national CRC program launched by the Federal Government in 1990. CRCs are collaborative R&D partnerships that bring together researchers from universities, the public sector and business. As well as conducting high-quality collaborative research, CRCs have a strong focus on capturing research and skills benefits through commercialisation and education programs.

TRL staff also collaborate with the many small and large high-tech companies in Australia and overseas that supply equipment, new software applications and specialist skills to Telstra. From such collaborations emerge innovative products and services like the WebDial™ 1800 free-call facility, and the T-Bill online customer account access system.

Partnerships, in some cases, may involve the wider community – local government, schools, tertiary institutions and special interest groups. TRL has been working closely with communities (for example, Launceston in Tasmania) to develop Web applications that will enhance communication between local residents and organisations, including small businesses.

TRL continues to support Telstra's business units by providing skills in areas such as software engineering, artificial intelligence and neural networking, systems integration, interface design, human factors research, broadband services delivery and optical fibre technologies. For example, TRL evaluated the use of dispersion-compensating fibre on Telstra's inter-capital optical cable routes, demonstrating to Telstra decision-makers the potential for the fibre to halve the number of costly regenerators between cities. TRL worked with Siemens to develop a network architecture that integrates equipment based on the dispersion-compensating fibre. The new system represents a significant cost-saving compared to current optical networks.

Communication and information exchange is central to all business partnerships. TRL maintains both Telstra-wide and public Web-sites with information about significant or interesting research, and graduate work opportunities. The Laboratories also holds an annual 'Technology Showcase' for Telstra staff to demonstrate the potential of new technologies to relevant business units.

In 1998, TRL played a lead role in helping Telstra host the Globecom '98 international conference on telecommunications held in Sydney. Globecom – organised every year by the Institute of Electrical and Electronics Engineers – last year brought together more than 1500 delegates from leading communication and information technology organisations worldwide to discuss current and future trends in global telecommunications technology.

Telstra hosts landmark global communications conference

Globecom '98 – the largest telecommunications research conference ever to come to Australia – brought together 1567 experts from around the world over five days in November 1998. More than a thousand of the participants came from outside Australia.

As principal sponsor of the conference, Telstra provided most of the financial and organisational support, and made a significant contribution to Globecom 'mini-conferences' and technical management briefing sessions. These dealt with areas such as telecommunications for the Sydney 2000 Olympics, the Year 2000 bug, and the future of network business models, given changing business imperatives and consumers' ability to choose services and systems.

TRL took the opportunity to celebrate its 75th anniversary by showcasing its own technologies, products and services through a series of displays at the Globecom conference exhibition. These included:

- FASE, a software tool to improve cellular radio-frequency assignment (p.31)
- a natural language-based interface for information retrieval from web sites and large corporate directories (p.21)
- NIMON, an innovative tool for monitoring network performance (p.40)
- RADHAZ, a radiation-level software analysis package for ensuring the safety of rigging staff working near mobile base-station antenna systems (p.31)

Globecom '98 is the largest telecommunications research conference ever to come to Australia.

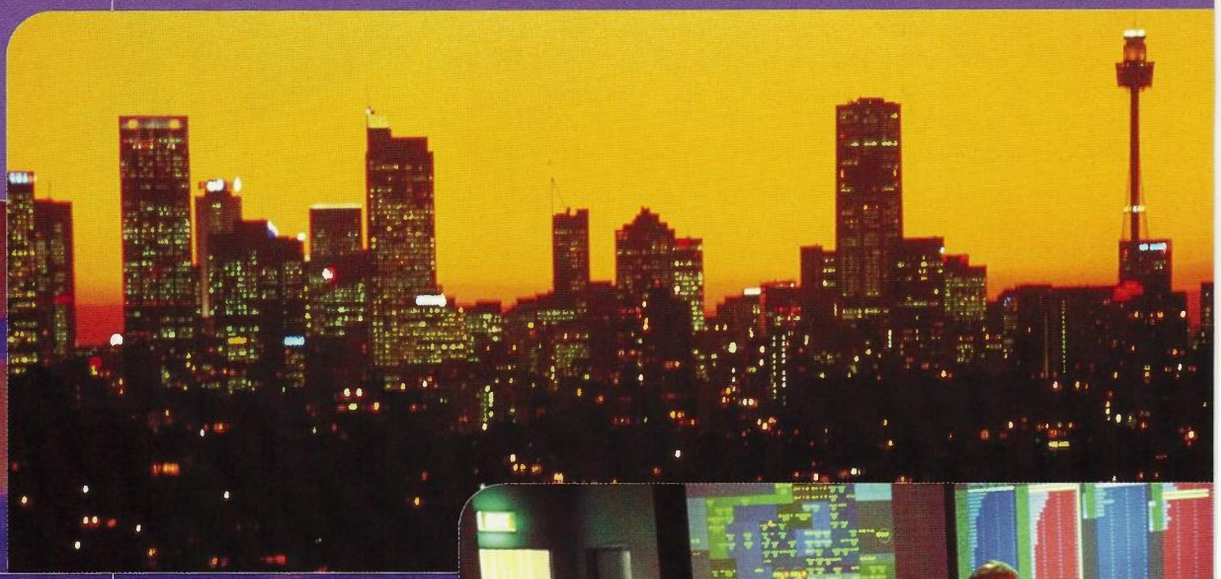
WebDial™ 1800, and the T-Bill online customer account access system.

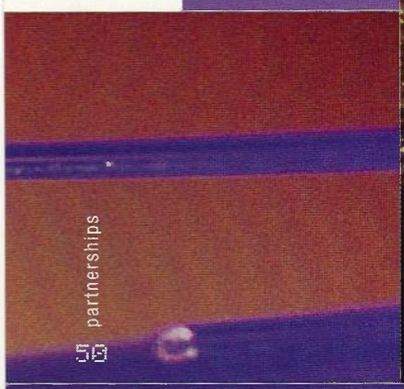
International collaboration on the 'last mile'

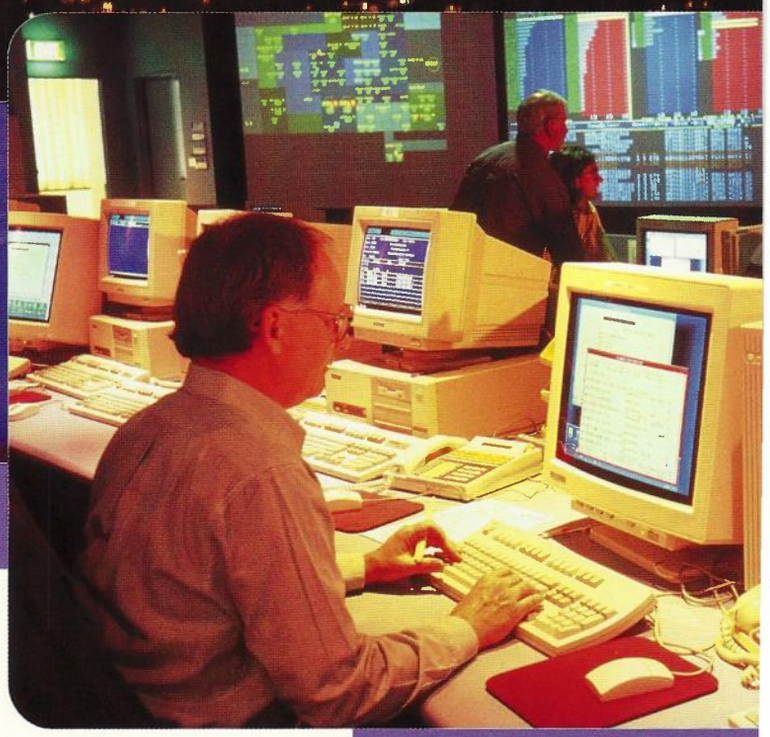
An important issue facing telecommunications companies (telcos) and equipment vendors around the world in delivering broadband and high bit-rate data to the home is the issue of access networks. While the basic technologies – DSL, coaxial cable, satellite and optical fibre – exist, telcos face challenges such as finding a common architecture that compatibly integrates the different systems into a cost-effective, reliable services infrastructure.

Through TRL, Telstra has been participating in a global Full Services Access Network (FSAN) initiative, which includes leading companies like BellSouth (US), BT (UK), NTT (Japan), Deutsche Telekom (Germany), Bell Canada, France Telecom, and GTE (USA). During the Ninth International Workshop on Optical-Hybrid Access Networks convened by TRL as part of the Globecom '98 conference, FSAN participants met to discuss the latest ideas on access networks.

Workshop participants discussed issues relating to new optical technologies and devices. The FSAN Workshop also presented the latest findings on DSL spectral compatibility and crosstalk issues.

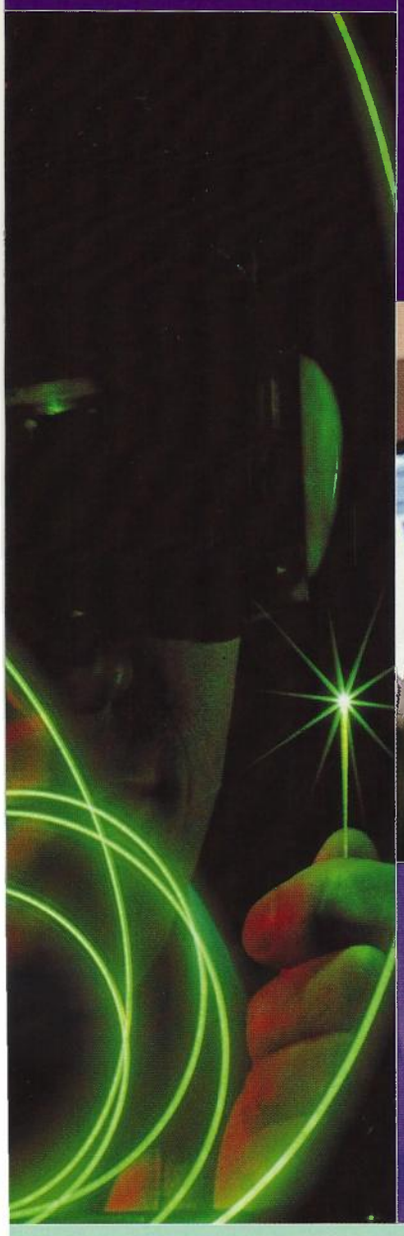






Local company commercialises unique customer access system

Telstra has licensed a Queensland company, CiTR, to commercialise and market internationally an online billing system developed at TRL's Customer Access Laboratory. The commercial system, known as 'T-Bill', offers customers 24-hour Web access to review and control their accounts with Telstra and other service providers. CiTR, which has developed network management products for international information technology companies such as Hewlett-Packard and NEC, is targeting the T-Bill system at overseas telecommunications companies, utilities and government agencies.



Monitoring tool supports data-network performance guarantees

ANDIT (ATM Network Dimensioning Tool), an automated monitoring tool that validates the performance of Telstra's Switched Data Network, is a product of TRL's partnership with the University of Adelaide's Teletraffic Research Centre. ANDIT takes statistics on the amount of traffic planned for the Switched Data Network and calculates the optimal capacity required on each link. It also designs routing to minimise transmission capacity cost within given quality-of-service and robustness levels.

ANDIT can be used to verify whether alternative network designs satisfy specified performance objectives.

The Teletraffic Research Centre has also been collecting and analysing data on Internet traffic passing through the University of Adelaide network gateway for comparison with similar data collected at other sites by TRL. The aim is to characterise the nature of Internet traffic to assist Telstra in its network planning.

Faster routing to meet demand for Internet services

The Internet, unlike the public telephone network, works through packet switching. Information is carried across the Internet in the form of 'packets', in the same way that letters and parcels are carried by parcel post. Devices known as 'routers' read the addresses in packets to determine where each packet should be sent. With the exponential rise in demand for Internet services, however, the load on routers has increased to the point where they may contribute to traffic bottlenecks.

The Switched Networks Research Centre at the University of Wollongong is investigating a number of technologies to deal with this. These include label switches, switched cut-through connections and high-speed packet-forwarding. Manufacturers are now adopting telecommunications standards such as MPLS (Multi-Protocol Label Switching) and MPOA (Multi-Protocol over ATM) based on these technologies. The University of Wollongong is evaluating the comparative performance of these technologies to determine how they could be applied to meeting the growing demand for Internet services by Telstra customers.

Network 'trading service' wins Award for Excellence

Distributed systems technology, which allows software applications to be distributed over many computing platforms linked by a telecommunications network, is becoming increasingly important to Telstra. The technology will be the basis of Telstra's future internal operational support systems, and provides a means of delivering advanced, innovative services over intranets. For the past seven years, TRL has been collaborating with the Distributed Systems Technology Centre (DSTC) to experiment with, and develop, this technology.

The DSTC was recently awarded the Queensland 'IT&T Award for Excellence in Research' for developing a software 'trading service' for use in large networks. The DSTC's CORBA 'Trader' service solves the problem of resource discovery in large, distributed networks (such as a corporate intranet) by intelligently locating processes and services using only a description of requirements.

The DSTC has successfully developed an international standard for Trader, using the standard to build an industry-strength Trader product. Telstra will use Trader in the future deployment of new services and applications.

IP (Internet Protocol)
Part of the TCP/IP 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-VPN
See VPN.

ISP (Internet Service Provider)
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 (e.g. Telstra's Big Pond® service).

intranet
A network connecting an affiliated set of client computers using standard internet protocols such as TCP/IP and HTTP. Many intranets now take the form of an IP-based network of nodes behind a firewall, connected by a secure virtual private network (VPN or IP-VPN). Intranets between cooperating companies can be called extranets.

Mbit/s or Gbit/s (megabits or gigabits per second)
Units for measuring rate of digital information transfer – a 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.

MPLS (Multi-Protocol Label Switching) and MPOA (Multi-Protocol Over ATM)
Packet switching standards for transporting data across networks such as the Internet.

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.

multiplexing
Carriage of multiple channels over a single transmission medium; any process by which a dedicated circuit can be shared by multiple users. Typically, data streams are interspersed on a bit or byte basis (time division), or separated by different carrier frequencies (frequency division).

MUVE (Multi-User Virtual Environment)
Virtual environment shared by remotely located participants in which remote interaction is enhanced by 3D or virtual imaging and 3D sound.

narrowband
Communication technologies with a data transmission capacity of under 1 Mbit/s. Includes online interactive services (e.g. Internet), voice, facsimile services, slow-scan video images and low-rate data transmission.

neural networks
A form of artificially intelligent software that attempts to mimic nerve cell/brain functioning to allow computers to handle tasks that may be too difficult for conventional software techniques.

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

PABX (private automatic branch exchange)
A small-scale switching system located in an office or building that provides voice and data extension lines and an access point to the public network.

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.

portal
See Web portal.

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

public key cryptography
A communications security system under which each user is issued with a confidential private, electronic 'key' and a public key, providing more extensive privacy protection than single key systems.

QoS (Quality of Service)
For corporate data services, business customers require different levels of telecommunications service (e.g. fast access, reliability and error-free performance) for different needs. Target service levels are specified in service level agreements between the telecommunications provider and customer.

regenerator
A device used in digital networks to pick up the attenuating signal and send an identical but stronger signal to the next part of the network.

RSVP (Resource reSerVation Protocol)
A signalling protocol on the Internet that provides network applications with a means of 'asking' routers to reserve bandwidth.

VDSL (Very-high rate Digital Subscriber Line)
See DSL.

video compression
A method of transmitting analog television signals over a digital channel by processing the signal digitally. Video signals can be digitally compressed by up to a factor of 100 for transmission at rates of between 1.5 and 6 Mbit/s.

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 – using pause and rewind, for example.

VPN (Virtual Private Network)
A private network provided on a public network infrastructure. An IP-VPN is a VPN provided over the Internet.

WDM (Wavelength Division Multiplexing)
A technology that enables light-waves of different wavelengths to be multiplexed down a single optical fibre, resulting in the creation of 16 or more 'virtual' fibres. Dense Wavelength Division Multiplexing (DWDM) is an advanced version of WDM that can carry many hundreds of wavelengths over longer distances.

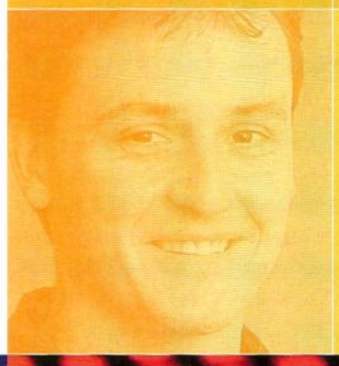
Web (World-Wide Web)
A series of interlinked computer documents 'marked up' with HTML to display text, graphics, images and sound. Users browse the documents via a graphical user interface. Web sites are like multimedia magazines, with interactive features and links to related sites.

Web 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 portals include global and special instant messaging, e-mail, and chat facilities to encourage the development of electronic communities.

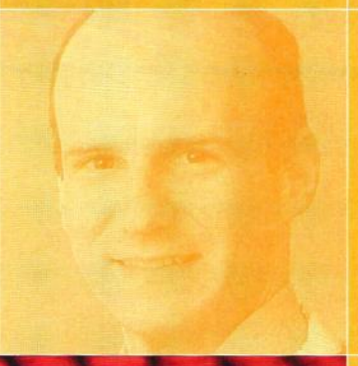
WAP (Wireless Access Protocol)
Protocol that enables mobile phones equipped with the appropriate browser to access Web pages from the public Internet.

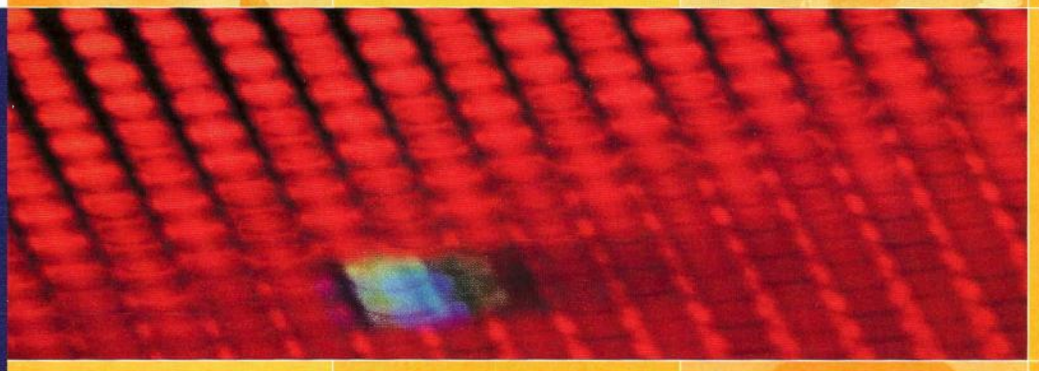
WML (Wireless Markup Language)
Code for marking up Web pages for access by WAP-equipped mobile phones.

xDSL
See DSL.



Telstra Research Laboratories
770 Blackburn Road Clayton
Victoria 3168 Australia

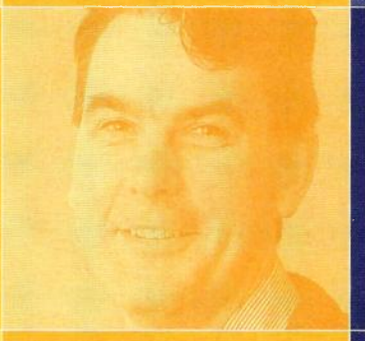


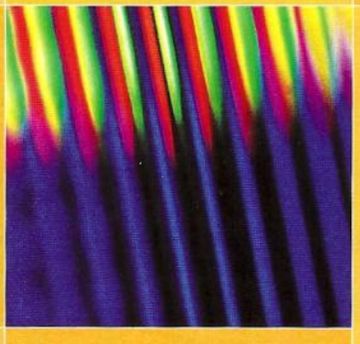


Telephone
National 03 9253 6444
International +613 9253 6444

Facsimile
National 03 9253 6789
International +613 9253 6789

www.research.telstra.com.au





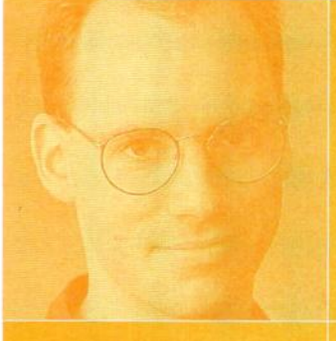
Project Manager
Colin Block

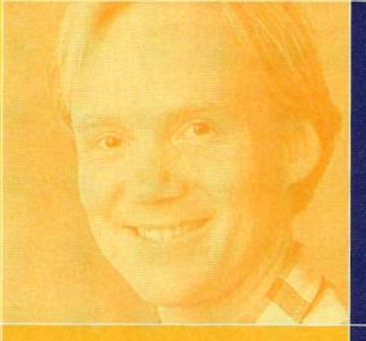
Writer/Editor
Mary-Lou Considine

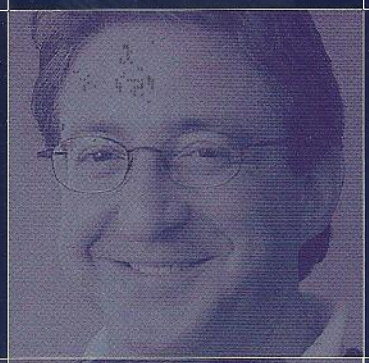
Photography
Andrew Lucas Photography

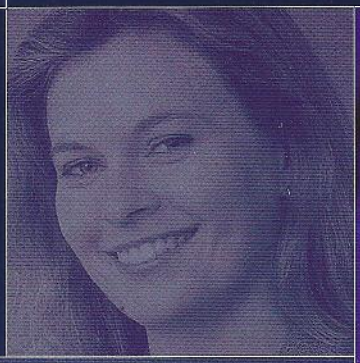
Design and Production
Brian Pascoe Design

Printing
PMP Communications

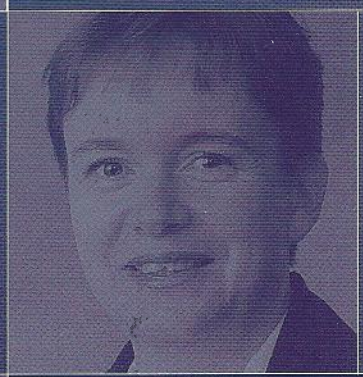




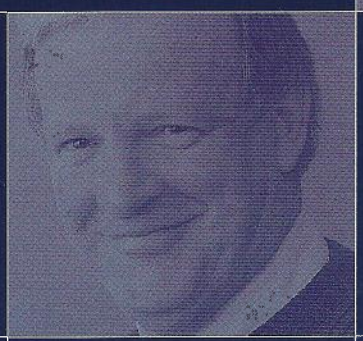




Acknowledgments
Yamagata Teppanyaki Japanese Restaurant
Via Veneto Restaurant
The Alford Family
Chadstone Shopping Centre



Printed in 1999
ISSN 1326–222X



Telstra Research Laboratories 770 Blackburn Road Clayton Victoria 3168 Australia
Telephone National 03 9253 6444 International +613 9253 6444 Facsimile National 03 9253 6789 International +613 9253 6789

www.research.telstra.com.au

Telstra
Research Laboratories