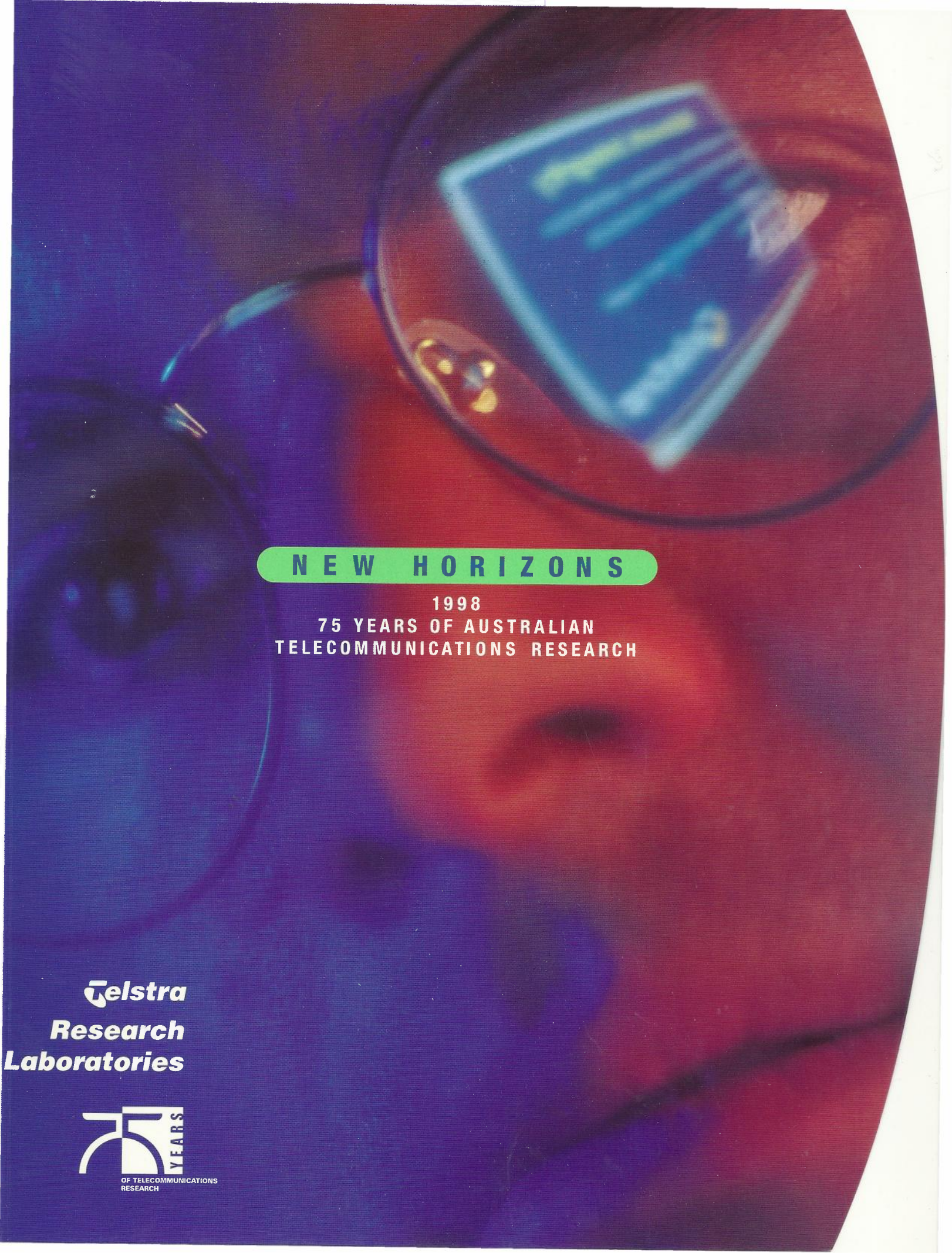

NEW HORIZONS

1998
75 YEARS OF AUSTRALIAN
TELECOMMUNICATIONS RESEARCH

Telstra
Research
Laboratories

75 YEARS
OF TELECOMMUNICATIONS
RESEARCH

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Highlights

> Through developing a server to 'bridge' the Internet and telephone network, TRL has enabled Telstra to create a new range of services. These include a 'virtual second line' for simultaneous phone and Internet access over a single line; a free-call hot-button link for Web sites; and a 'Net-kiosk' for public access to advanced communications in shopping malls and other public spaces.

> **TRL helped Telstra Multimedia develop Big Pond™ Cable, Australia's first broadband Internet service based on high-speed cable modem links to the pay TV network. The Laboratories designed the Big Pond™ Cable Web site and integrated the component technologies into the network.**

> Telstra's powerful View500™ electronic directory system, developed at the Laboratories, is now being used by many large organisations globally for electronic commerce and directories applications. TRL designed the system using an international technical standard that incorporates a provision for high-level electronic security.

> **Researchers created a new digital watermarking system to confirm copyright ownership of digital video footage that can only be detected using a secure software 'key'. The watermark technology is being assessed for commercial application and for use as an international standard. In contrast to earlier systems, TRL's solution does not require the original un-watermarked 'master' for decoding.**

> TRL Human Factors researchers helped Telstra design a secure Web-based government tendering system (TRANSIGO™) that should make it easier for external suppliers – particularly small businesses – to find out about, and bid for, government contracts.

> **Researchers have identified the network requirements that Telstra needs to put in place to deliver digital TV over the current Foxtel pay TV network. Because digital TV – which has a sharper picture quality than analogue – requires less bandwidth than analogue TV, more bandwidth will be available for value-added video services.**

In today's business environment, change is occurring at a shattering pace. So it's rare to come across a corporate entity with a 75 year history that is still going strongly into the future.

Welcome

> Telstra Research Laboratories (TRL) is one of Australia's largest industrial R&D organisations. It also represents the country's foremost indigenous technology capability in the telecommunications industry. TRL is different from other Australian R&D groups – not only in terms of its technical achievement, but in terms of its impact in helping generations of Australians to communicate across the continent, and the world.

> The story behind Telstra's enormously successful Priority™ One3 service is an example. In 1988, a corporate customer asked Telstra's Integrated Network Products (INP) group to help it streamline external calls to branch offices. The customer wanted to provide callers with a single number that would automatically connect them to the nearest branch office. INP had no off-the-shelf technology to meet this request, so it approached TRL to develop an in-house solution.

> TRL delivered a proof-of-concept proposal within weeks, demonstrating how databases and telephone exchanges could be linked through computers. Today, many organisations have come to rely on Priority™ One3, and other intelligent-network services, for more convenient customer access.

> Perhaps the greatest single achievement over recent decades has been the contribution TRL has made to the evolution of Telstra's network from analogue to digital. The advances in computer processing power and silicon-chip miniaturisation that caused the revolution in computing over the past decade have been applied to the telephone network, endowing it with higher levels of intelligence, and personalised service and control for users and providers. Now Telstra is equipped to become a major player in the global communications industry where the trend is towards digital convergence – of telecommunications, computing and broadcasting – and where competitive software is a key differentiator between players.

> Of course, the best example of digital convergence is the Internet. In the space of a few years, it has completely changed our ideas about telecommunications, from limited narrowband applications such as telephony, to broadband

to TRL

applications involving multimedia and richer interactivity. As you will notice in this special 75 year anniversary edition of *New Horizons*, the Internet has been a focus of recent TRL research.

> Where to from here? Telstra is poised on the verge of a new millennium, and technology is changing more rapidly than ever before. The choices laid before us are staggering. TRL's work involves helping Telstra achieve the best solutions to meet customers' needs, now and in the future. This requires us to cut through competing choices in technology to select only those solutions best suited to Telstra's vision of providing services and products with greater levels of customer intimacy. It also necessitates using new technology in creative ways, to formulate innovative solutions to human communication and information needs.

> Telstra's vision of greater customer intimacy will translate into features like a never-fail network... services that are complex in implementation, but easy to use for all customers...exciting and compelling user interfaces...anytime/anywhere access... increased levels of service control for users, access to integrated billing information... and guaranteed quality of service, a competitive market differentiator for Internet-based and digital mobile services.

> For 75 years, TRL has been leading Australian telecommunications into the future. As we enter the twenty-first century, TRL will continue to ensure that when breakthroughs in technology are made around the globe, Telstra can use them to provide its customers with leading-edge products that are smaller, faster, smarter – and easier to use than driving a car.

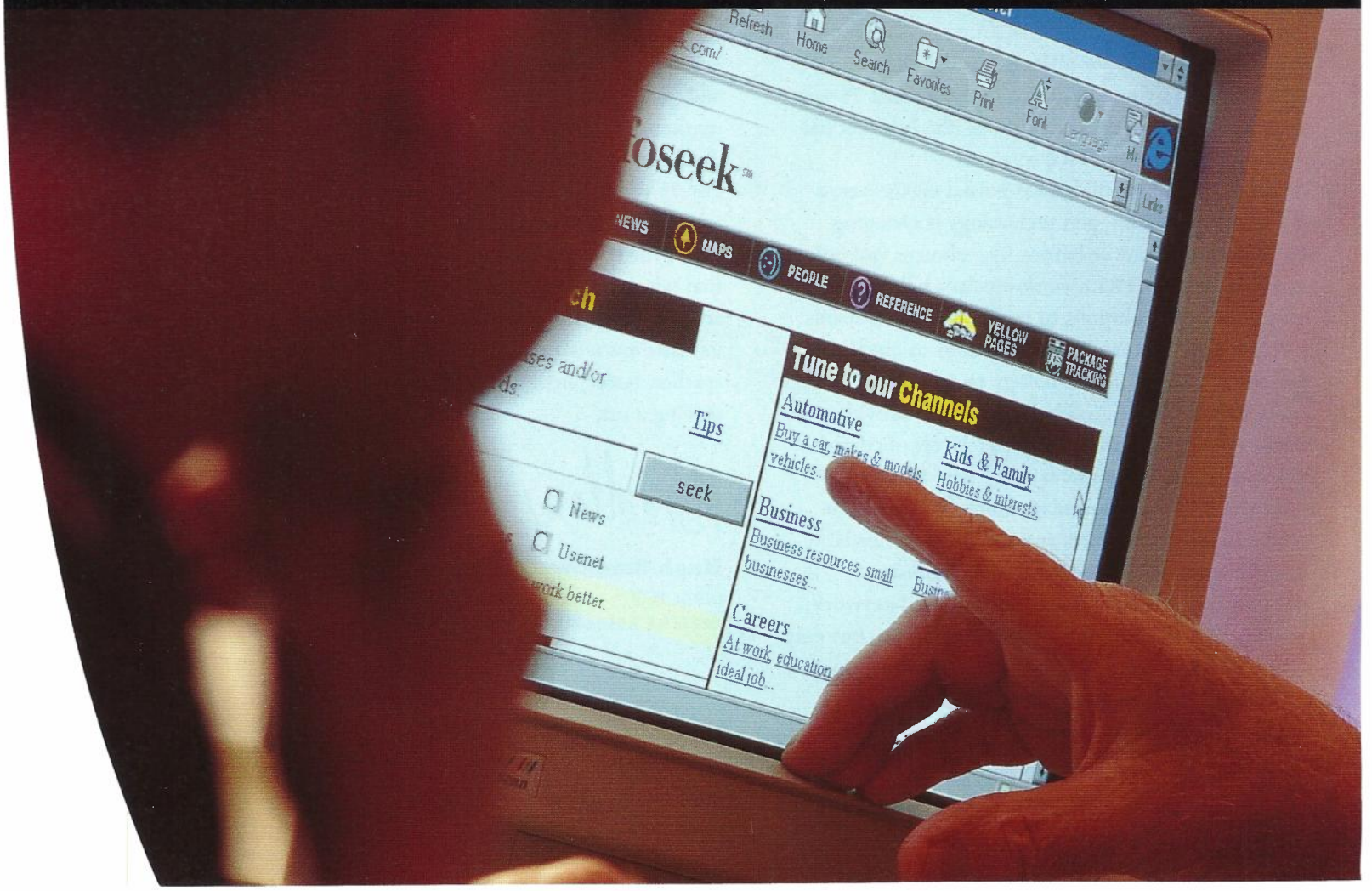
HBradlow

Hugh Bradlow
DIRECTOR
TELSTRA RESEARCH LABORATORIES

THE INTERNET AT HOME

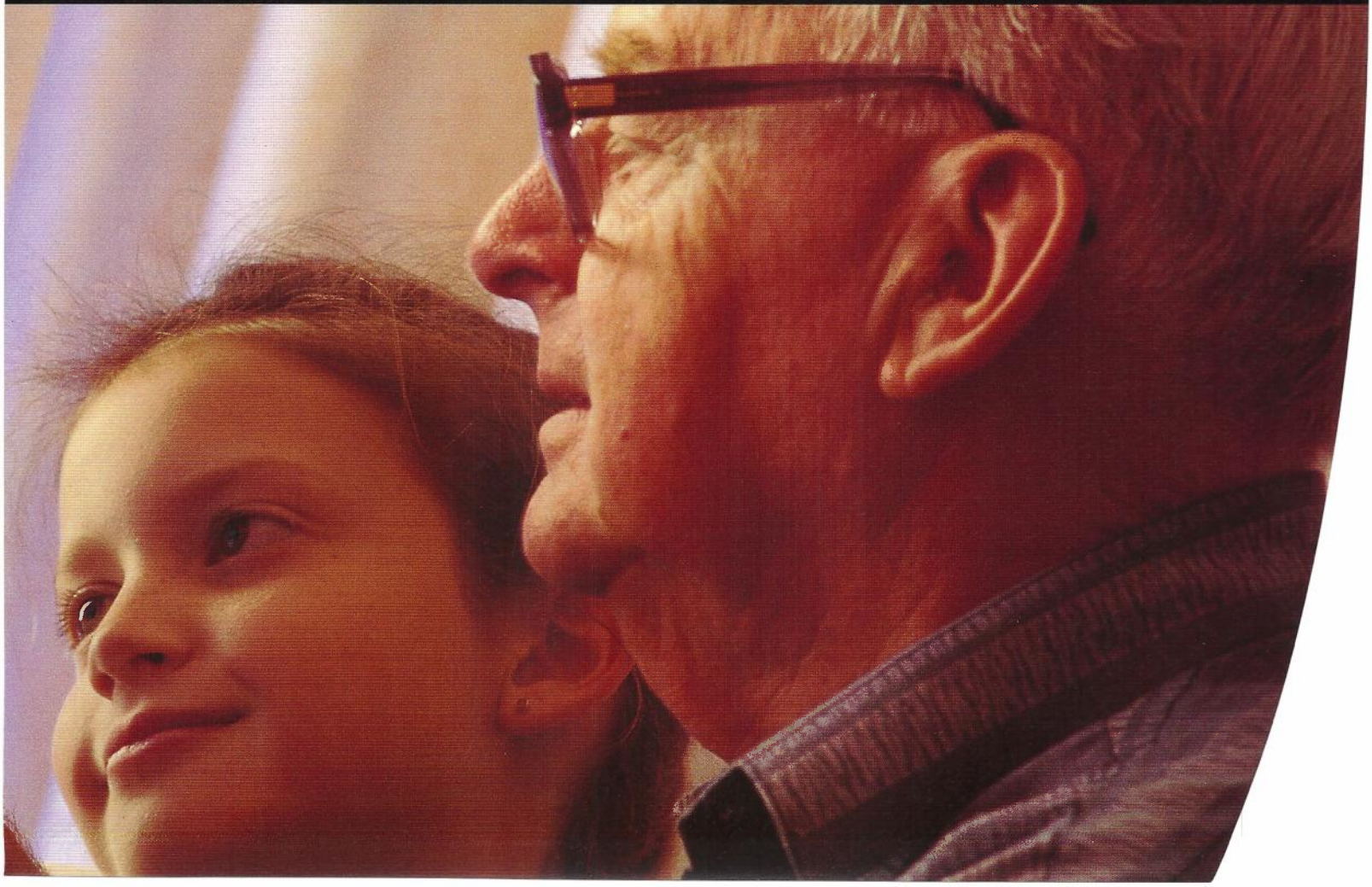
"I keep tropical fish, and sometimes I need some information about their care and feeding. Yes, I could go to the library and pore through a book...but I'll probably never find the right answer to my question. Or I can post a message on the Usenet group, alt.aquaria, and someone will respond in three minutes with exactly the information I need.

BIG POND™ CABLE CAN SUPPORT LARGE-SCREEN, HIGH-QUALITY VIDEO, HIGH RESOLUTION



The network is changing our basic notion of the nature of information. We can't think of information and community as separate concepts any more."

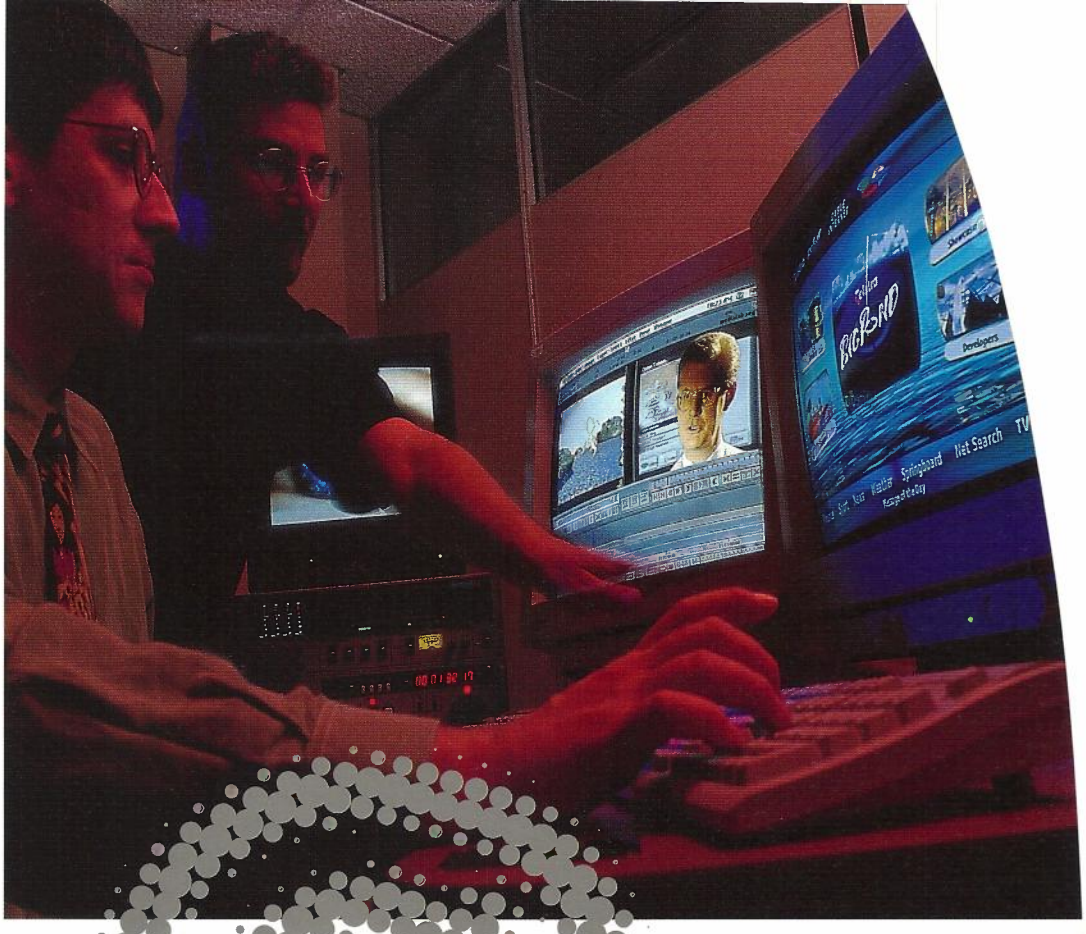
AMY BRUCKMAN 'SEVEN THINKERS IN SEARCH OF AN INFORMATION HIGHWAY', *TECHNOLOGY REVIEW*, 1994.



> Through linking the computers of approximately 75 million people in 200 or so countries, the Internet has brought the world closer than ever. In this global village, a teenager in north Queensland can chat online to another in Iceland about the greenhouse effect. A food importer in the US can learn about a gourmet product made by a small Australian company and place an order.

> Experts call it the era of social computing, in which the electronic intimacy of networked computers has changed our expectations of telecommunications. The key words are 'connectivity', 'rich' and 'customised'. At Telstra these ideas are being translated into services that provide customers with greater access, control, flexibility, and bandwidth than in the past.

> For example, home-computer users seeking an Internet service with an average waiting time of just a few seconds, CD-quality sound and high-quality video can subscribe to Telstra's Big Pond™ Cable Internet, which has transformed the earlier text-centric mode of Internet communications into a richer, interactive multimedia experience.



> Cable modems can retrieve information at up to 100 times the speed of a telephone modem, without the need for users to wait for dialling access – the service is always online. A Big Pond™ Cable connection comprises a cable modem at the customer end, linked to Telstra's pay TV network. Big Pond™ Cable can support large-screen, high-quality video, high-resolution imaging, CD-quality sound, fast information retrieval times, and virtual reality. TRL played a key role in helping Telstra develop what was Australia's first large-scale broadband Internet service, within reach of more than a million Australian households.

> Researchers also developed an interface that links the Internet and the public telephone network, enabling customers to browse the Web and make phone calls at the same time. Other customer solutions include a touch-screen communications 'kiosk' – to be located in shopping centres and public spaces such as hotel foyers – for wider public access to the Web and multimedia services.

Internet @ Home

> Where will the Internet take home communications next? TRL is looking at ways of using the power and intelligence of networked computing to make life easier for Telstra customers – for example, by turning mobile phones into Internet smart phones. In other work, it is setting up a prototype 'home network' to model the future integration of media appliances like the TV, telephone, mobile phone, home computer, sound system and digital camera or camcorder.

CABLE MODEMS CAN RETRIEVE INFORMATION UP TO 100 TIMES THE SPEED OF A TELEPHONE MODEM

PIONEER BROADBAND INTERNET SERVICE OVER PAY TV NETWORK

> Two years ago, cable modems were a fledgling technology. Telstra Multimedia Pty Ltd saw its value for delivering multimedia Web-type services to home computers via the pay TV network, but was faced with an array of competing products and equipment.

> TRL engineers selected different cable modem equipment and evaluated it in the Labs, comparing modem and network speeds (to and from the customer) and end-to-end performance within Telstra's broadband pay TV network. They came up with a modem network design that interfaced with the pay TV network and provided optimal capital and operational cost efficiencies for Telstra, saving an estimated $16 million.

> The network design included substantial caches, updated daily, on Big Pond™ Cable servers to enhance download speeds of popular sites. TRL has more recently been evaluating new cable modem switches with richer service features, and developing systems to improve and guarantee quality of service beyond the 'best effort' level associated with the narrowband Internet.

BIG COLOUR, BIG SOUND, FAST RESPONSE

> When Telstra launched its Big Pond™ Cable Web site in May 1997, Australians got their first taste of how broadband could improve the Internet. The Big Pond™ Cable home page included video links that downloaded in seconds, CD-quality sound and high-resolution 2D and 3D images.

> Many of the animation and navigation tools used by TRL's Media Lab in designing the site were then state-of-the-art. With the help of TRL's Human Factors group, the Media Lab applied these tools to the task of creating a Web site with an intuitive interface and a totally new 'look and feel'. Media Lab artists worked closely with cable modem network and systems designers in areas such as navigation, use of Internet programming tools like Java, and assessing the impact of broadband Internet services on Telstra's network and servers. Telstra Multimedia has made TRL's experience in developing the broadband Web site available to the wider multimedia producer community.

WEB-BASED FAMILY TIES

> Intranets have proved a cost-effective way of putting Web technologies – browsers, search engines, and HTML pages – to work for organisations. But they are too costly and sophisticated for small closed user groups, such as families, sporting and community organisations.

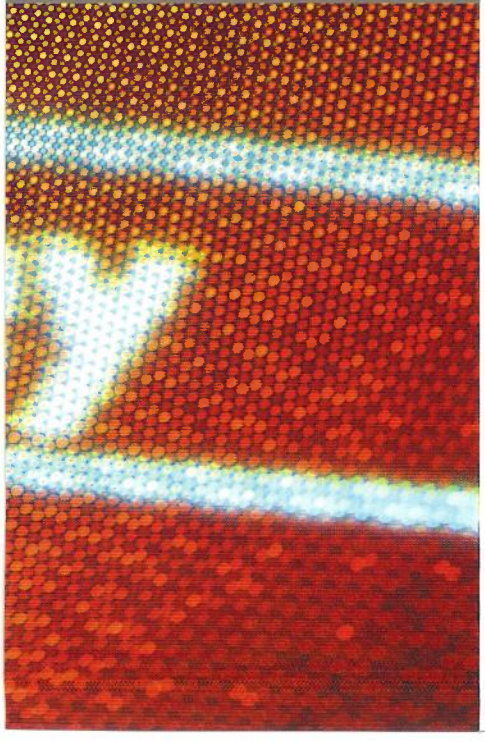
> TRL is developing a secure Web-based communications manager that integrates phone, fax, and e-mail messages in a single electronic mailbox, accessible via the Web and over the phone. The Web space also provides a forum for information exchange. A family group could use the communications manager to share holiday photos, letters and video footage (of baby's first steps, for example). Members might also use it to maintain individual and family schedules or a family directory, and as a virtual 'lounge room' for family chats.

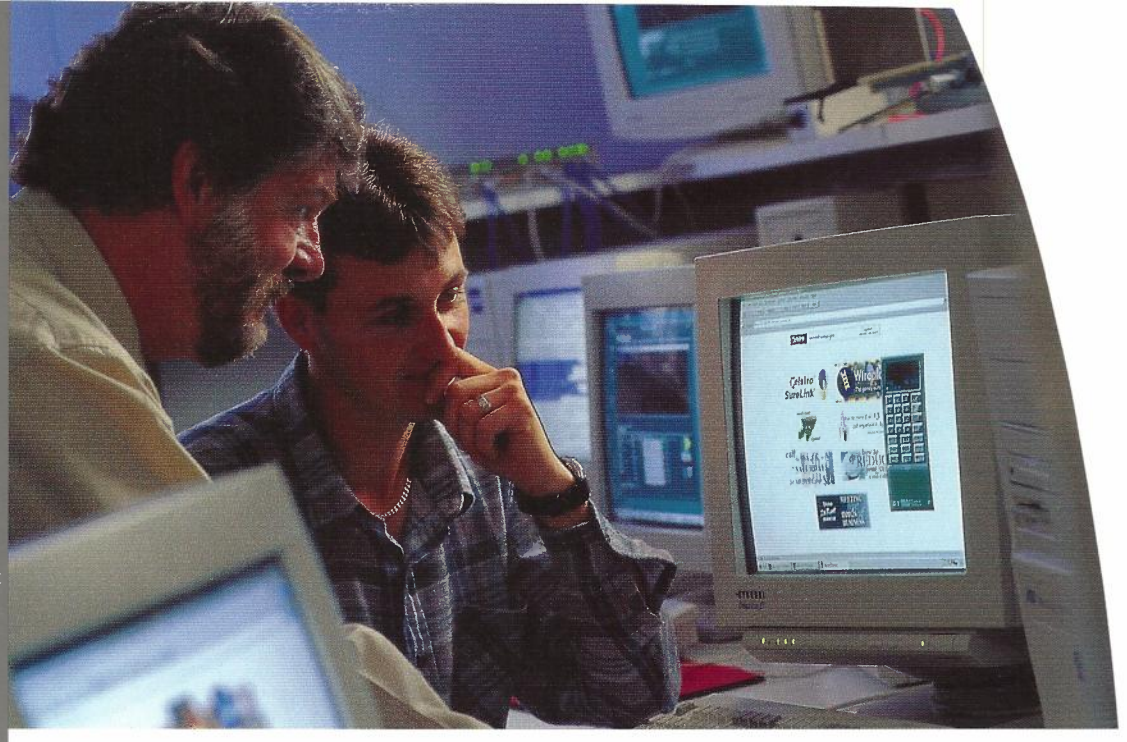
PHONE WHILE YOU BROWSE

> TRL built a server that connects the Internet and the public telephone network, enabling callers to make and take phone calls while browsing the Web. This enabled Telstra to develop a 'virtual second line' service for the high percentage of home Internet users who rely on a single telephone line for Internet and phone access. The service provides better voice quality than normal voice-over-the-Internet applications because most of the call is carried over the public telephone network.

> Each time a registered subscriber dials up the Internet to browse the Web, the Telstra server registers them as being able to take calls through their computer. When a call is diverted to the server, it converts the call from analogue transmission to digitised voice-packets for transmission over the Internet to the computer. Web-initiated phone calls can benefit business users who can use electronic directories to make calls, or build their own customised directory through their computer keeping track of outgoing calls.

> The virtual second line project is a collaboration between Telstra and US hi-tech firm, Netspeak. TRL worked with Netspeak to scale up its Internet voice technology application for the heavy duty call volumes handled by carriers such as Telstra.





RADIO ACCESS TO FIXED PHONE AND INTERNET SERVICES

> Telstra has successfully connected premises in some rural and urban fringe areas to the telephone network through a wireless local loop system. The system was developed by Nortel and tested and adapted for use in the Telstra network by TRL. The fixed radio access system comprises a transceiver located on the roof of the customer's home connected to a standard telephone, fax machine or modem inside the home. The transceiver receives and beams signals to a central radio base station connected to the local exchange. Telstra can supply the service rapidly in selected areas, alleviating 'held order' problems and augmenting copper for second-line telephone service.

TRL AND PAYPHONES SERVICES DEVELOP NET-KIOSK

> TRL researchers worked with Telstra's Payphone Services to develop the network and server architecture to support a public electronic 'kiosk' with touchscreen Internet access. The kiosks – to be located in shopping malls, hotel foyers and airports – could be used by anyone as a 'virtual serviced office' with access to e-mail, the Web, fax, telephone, account transactions and document printing. Users would be able to choose from a number of graphical interfaces – telephone keypad, Web browser, newspaper, e-mail or fax – depending on the task.

> The terminals will allow customers to send and receive e-mails and faxes over the public telephone network using electronic mailboxes. Features include a built-in printer to issue tickets and card-reader to read, validate, debit or re-load credit cards, Payphone cards and smart cards.

ONLINE SEARCHING AND SECURITY

Ask anyone how they routinely find a phone number, and the answer is likely to be the White Pages™ or Yellow Pages® directories. Easy. > Ask the same person how they look up information on the Internet, and the response would be less predictable. There are more ways than ever for users to navigate the maze of destinations on the Web, yet this

ONLINE SECURITY SYSTEMS ADDRESS ISSUES SUCH AS CONFIDENTIALITY, FOR EXAMPLE,

diversity does not necessarily make life easier for them – or make their communications more secure.

> This is where TRL is helping Telstra make a difference – by developing advanced electronic directories with intuitive interfaces that make life easier for customers, at home and at work, and by providing high-level electronic security for electronic commerce and e-mail.

IBM licensed Telstra's View500™ online directory system for its future electronic commerce and directory-based products. The reason? TRL based View500™ on a 'universal' directory standard – known as X.500 – that is powerful enough to manage public telephone directories, yet offer the rapid response times and breadth of information found in smaller corporate directories. Through its user-friendly interface, Telstra View500™ can offer single-point access to public and corporate online directories around the world.

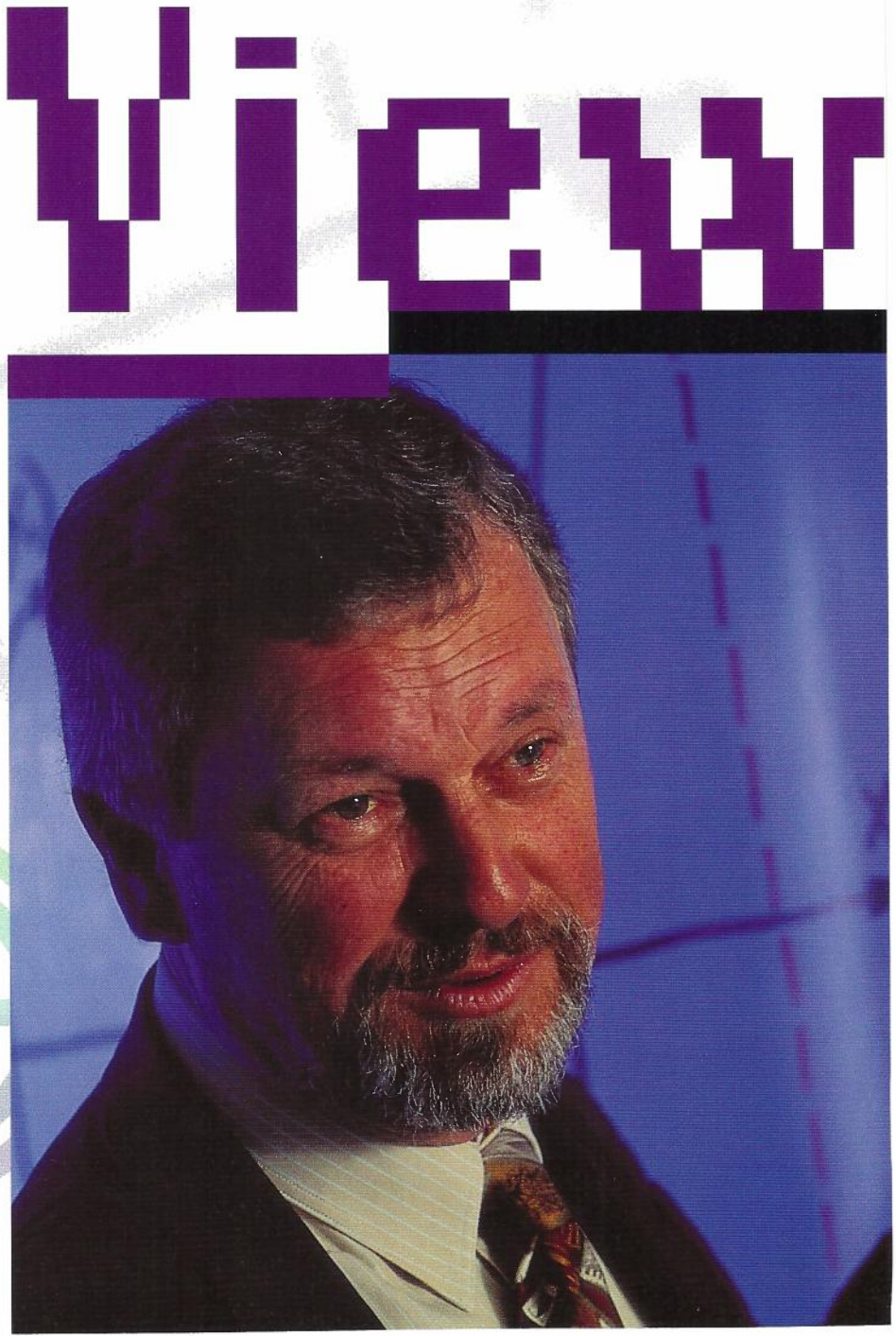
> Apart from traditional directory information, View500™ supports services such as authorisation of 'virtual credit cards' used in electronic commerce, Internet and e-mail hot links, printing of reports and directories, and online directory updating.

> View500™ has provided an ideal framework for the directory-based electronic security systems developed at TRL. With these systems, secure directory servers in different locations can authenticate user identification and certify message integrity during commercial transactions. TRL has been granted a patent for its cryptographic software, which protects messages from being read or modified by unauthorised users within, or outside, a network.

> Other developments that will make life easier for customers include: a 'plain English' directory interface that allows callers to submit search queries using their own words...information clustering and personalisation tools that tailor search results to user interests...automated voice interfaces, including speech recognition...and easier-to-use screen interfaces to directory-based services, developed and tested with the help of TRL's Human Factors experts.

VIEW500™ SETS THE PACE FOR GLOBAL DIRECTORIES

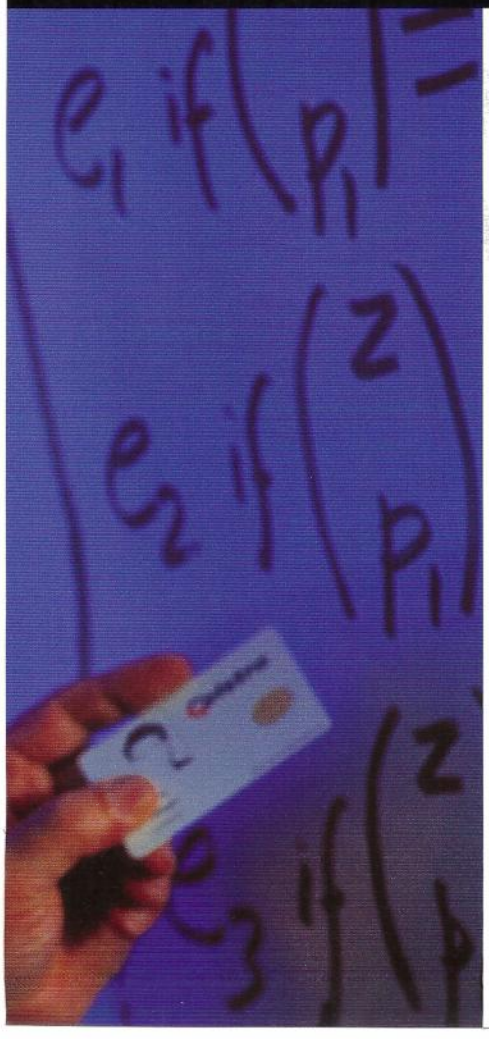
> TRL helped Telstra gain an advantage in the online services market by developing View500™, an electronic directory system selected by IBM for its future electronic-commerce and directories' products. The IBM announcement made the front page of US and Australian computer magazines, because TRL had transformed the X.500 online directory standard – regarded as too complex for commercial application – into a sleek, robust product that stood out from competing online directory systems.



> The ITU (International Telecommunications Union) developed the X.500 standard to create a single, global online directory system that integrates White Pages™ and Yellow Pages® directories, and corporate and government directories. A business or home user could thus access the world's phone numbers, fax numbers, e-mail addresses, corporate information, and hot links to corporate or government Web sites through a single search 'window'.

> The TRL team developed the software from scratch, putting special effort into creating user-friendly interfaces for Microsoft Windows, Macintosh and Web browsers. The X.500 search engine is designed to handle the millions of entries found in the White Pages™ directory, with fast response times and a special ability to match imprecise search queries to a likely result. As IBM discovered, no competing system matched View500™ for speed, scalability, flexibility and user accessibility.

500™



TRUSTED TRADING LINKS BASED ON VIEW500™

> Security must be maintained throughout the entire electronic communication process: when a user accesses the network (access control); when a sender or recipient submits a 'digital signature' to verify identity (authentication); and while the message is travelling over the network where it could be changed or read by unauthorised users (message integrity and confidentiality).

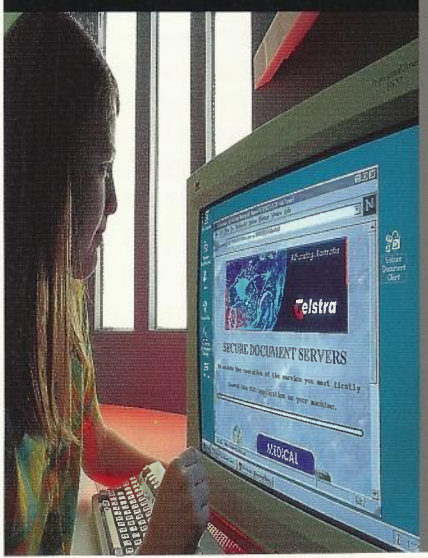
> Conventional online systems based on a single, secret software 'key' do not safeguard all aspects of security. TRL's electronic security systems, however, are based on public-key cryptography. This system provides a secret, private key to users – encoded onto a personalised smart card – along with a publicly listed key used by message recipients to 'unlock' encrypted messages. Combining public and private keys with message encryption enables users to set up highly secure data 'tunnels' within the Internet for services like online commerce and banking.

> View500™ gives Telstra an advantage in public key cryptography, because the X.500 standard on which View500™ is based includes a provision for issuing public-key certificates by trusted 'third party' certification authorities via linked online directories. Together with Telstra subsidiary company, QPSX Pty Ltd and Telstra business units, TRL has developed secure e-mail systems based on the BITS (baseline information technology security) smart card management system. A trusted authentication framework would give legal status to the use of digital signatures in electronic transactions.

MORE EFFICIENT MOBILE PHONE SECURITY

> In 1997, Telstra was granted an Australian patent for a smart-card personalisation system developed at TRL for the MobileNet Digital® network. TRL's system is based on public key cryptography and a special code for the SIM (secure identity modules) cards inside digital mobile phones. The code erases itself after the SIM card is personalised. The system enables SIMs to be initialised at the point of sale, rather than later, saving costs for Telstra and giving mobile phone buyers instant access to the network.

SECURITY MUST BE MAINTAINED THROUGHOUT THE ENTIRE ELECTRONIC COMMUNICATION PROCESS

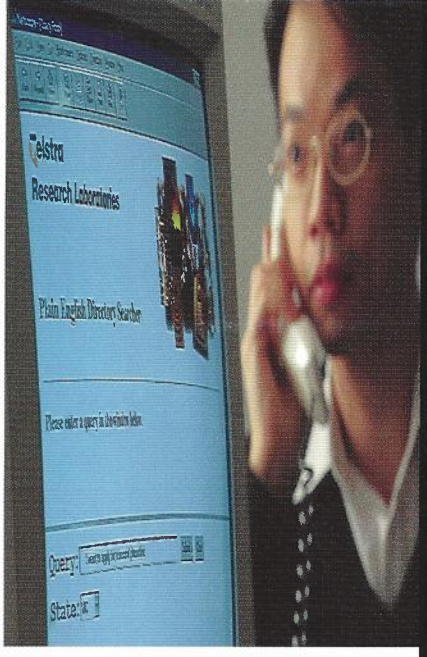


TOUGHER SMART CARDS AND CRYPTOGRAPHY

> To authenticate user identity, electronic commerce and multimedia service providers will use a combination of downloaded software, smart cards and digital signature techniques.

> But downloading software can undermine electronic security. TRL researchers are looking at ways of shifting software validation from desktop computers to tamper-proof smart-card readers with built-in PIN pads. They have subjected smart-cards to simulated 'hacker attacks' to develop counter measures against security flaws.

> Researchers have also developed cryptographic software with added capacity to withstand decoding attacks. Telstra has been granted a patent for TRL's 'elliptical curve public key cryptosystem', which in some cases appears to be more effective in withstanding hacker attacks than the earlier public key cryptography software, known as RSA, that was developed and patented in the US.



PLAIN ENGLISH COMPUTER INTERFACE

> Researchers at TRL have used artificial intelligence tools – including natural language processing and neural networks – to develop a plain English personal computer interface to online directories. The interface allows users to submit search queries in their own words, rather than using predetermined directory terms.

> This means that someone looking for information on 'licence plates' for example, would be directed to a motor vehicle registration authority. The use of everyday terms – rather than 'key words' which require some prior knowledge of the way a search engine works – provides a more intuitive way of finding information. The system also allows for the use of different expressions to search for the same information. For example, the queries "Where can I register my car?" and "Car registration" give the same results.

> The plain English interface has undergone a successful internal trial by Telstra joint venture, Pacific Access Pty Ltd, as an intelligent interface to government information in the White Pages™ directory. TRL has been working with Pacific Access to commercialise the product and incorporate it into View500™.

INFORMATION CLUSTERING IMPROVES PERSONALISED ACCESS

> **Artificial intelligence experts at TRL are developing advanced personalised search tools based on clustering algorithms. These algorithms cluster the information retrieved by a Web search engine around key words and summarise the results into a personalised report for the user, with entries presented in order of user preference. Researchers are currently refining the personalisation capability of the search tools and developing new visualisation techniques to present search results in an easy-to-scan form for users.**

'WATERMARK' SHOWS UP COPYRIGHT OF DIGITAL VIDEO

> TRL has developed an invisible 'watermark' to confirm copyright ownership of digital video footage. The watermark is being evaluated by audio-visual standards groups for use worldwide. 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 graphic, text or code watermark hidden within the video image. Watermarked sequences cannot be detected from normal, uncoded sequences by the human eye.

> Unlike analogue video, digital video image and sound quality do not become degraded after copying. Thus pirate copies can be made without the copyright owner being able to trace them. With video images and links now integral to Web and CD-ROM publishing, multimedia content providers such as film libraries need reassurance that copyright owners' legal rights can be clearly established. The TRL technique can also provide a watermark reading capability for video images stored on VHS tape.

> TRL's expertise in video compression and cryptography enabled it to develop a watermark that was invisible, machine readable, secure and robust enough to withstand compression-related signal degradation. It also does not require the original, un-watermarked 'master' for decoding, a shortcoming of earlier digital watermarking systems. Telstra has provisionally patented the technology and is in the process of commercialising it.

THE INTERNET AND BUSINESS The vast connectivity of the Internet has brought a new global market-place, and potential collaborators, within reach of all businesses, from home office-based sole proprietors, to senior executives working for large multinational corporations. > The traditional model of a workplace where employees commute to a central

A VIRTUAL WORK TEAM CAN RESPOND QUICKLY, BECAUSE IT IS ABLE TO DISPENSE WITH

corporate office is disappearing. New telecommunications and computer technologies have created an infrastructure to support remote working, enabling enterprises of all sizes to benefit.

virtual office

How is the Internet changing the way we work?

> For most organisations, the virtual workplace has two levels. First, there is the virtual office, a scenario in which members of a project-based team interact remotely through a desktop that simulates an office environment.

> The benefits of the virtual office include freedom for a company to mobilise its best people for a project, without having to take their office location into account. A virtual work team can respond quickly, because it is able to dispense with printed reports and work collaboratively on shared electronic 'information objects'. By communicating a consistent view of work in progress, team members can spot potential problems early and negotiate solutions before resources are committed – or an opportunity window closes.

> The larger virtual organisation is a short-lived alliance of companies – suppliers, R&D groups, designers, manufacturers, marketing companies, customers, perhaps even 'competitors' – set up for the duration of the project. Examples are already found throughout the entertainment and multimedia industries. Virtual organisations require a secure, common network through which users have controlled access to shared or private files. The network needs to have the capacity to modify user access as new projects are commenced and old ones completed.

> Security is critical to all business networks, large or small. Telstra offers its customers security at network switching and protocol levels, as well as at applications and user-access levels. Through Telstra's Big Pond™ Intranet, a small to medium-sized enterprise (SME) can have access to its own virtual private network with a Web interface. This network is protected from the public Internet by a secure 'firewall'. TRL has been developing new security and intranet features that will provide robust, safe and reliable networks for customers, yet offer the wide connectivity and cost benefits of the Web.

> Mobile working is also being taken care of, with the development of intelligent network systems that turn mobile phones into Internet smart phones. These will connect to personal organiser-type services that keep track of a customer's schedule and calling location. In fact, TRL has created advanced electronic directory products for Telstra and its business customers that make it easier to keep track of people, services and information.

> Researchers here are also designing a suite of compatible, easy to use desktop 'tools' for the virtual office – tools in which simple interfaces, logical navigation, and an intuitive look-and-feel are as important as the right hardware and software. And, in keeping with Telstra's vision of a new era in customer intimacy, TRL is investigating intelligent solutions to enable customers to select, activate, and modify services from the desktop, putting the resources of the network to work for 'the power of one'.

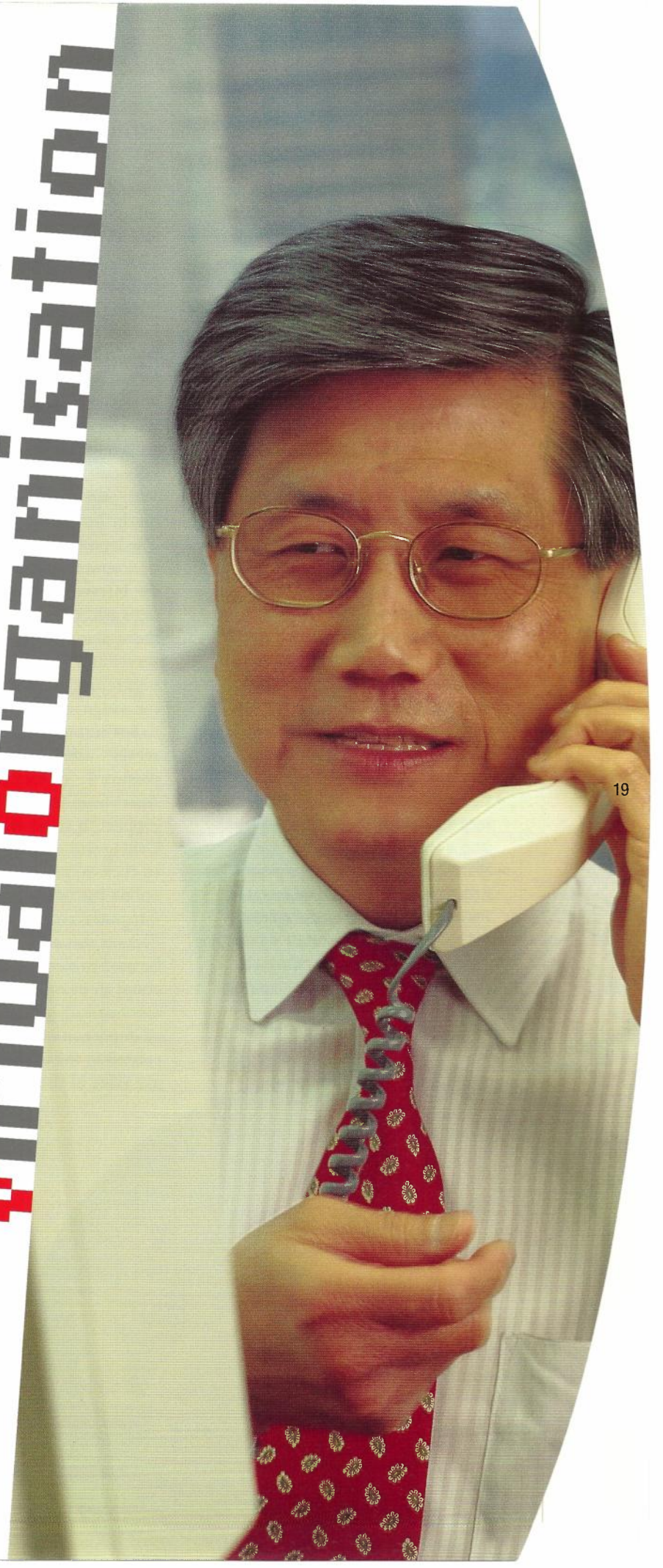
NEW SERVICES EVOLVED ON TRIAL ATM NETWORK

> Researchers from universities, CSIRO and hi-tech companies collaborated with Telstra, through TRL, to develop advanced multimedia applications for future broadband networks. The applications were developed over two years on the ATM-based Experimental Broadband Network (EBN), managed by TRL.

> One application has enabled students from two Monash University sites to access video files on a server at the main campus. Another application involved digitising Cinemedia's (the former Film Victoria) film library for the delivery of future film and video services to residential and business subscribers across Australia. Researchers also used the EBN to link supercomputers in Adelaide and Canberra, enabling them to process massive amounts of data from satellite imaging. Applications may include improved weather forecasts for farmers, bushfire and flood control authorities, and shipping companies. The system could also be used by banks and financial organisations.

> The EBN project included remote medicine and nursing applications – remote radiology imaging and consultation for example. One Queensland group installed videowall technology for collaborative working between people at different locations. The same group developed 'Supernova', an application that delivers video to the desktop at rates of up to 2,560 kilobits per second, and also supports text and image searches.

virtualorganisation



OPENING THE DOOR TO THE VIRTUAL OFFICE

> Web-based virtual office applications are already available. But the task of designing one desktop solution that integrates many shared applications – and is easy to use – remains a challenge. It involves understanding human behaviour and business culture, as well as new technology. What are the non-verbal 'cues' people use in an office or meeting to communicate? How can they be maintained in videoconferencing?

> TRL has assembled a team of experts with skills in human and organisational behaviour, advanced software, intelligent networks and mobile services to develop a suite of compatible, easy-to-use virtual office tools for Telstra business customers. These will provide:

- automatic document-version control to ensure consistency
- shared visual workspace (e.g. electronic whiteboard) for meeting participants
- videoconferencing with more effective 'electronic intimacy'
- a scheduler that keeps tracks of team members' schedules and negotiates meeting times
- the control power of intelligent networks to keep track of team 'availability' levels as programmed by each team member.

> The tools are being tested by a virtual office team based in Sydney and Melbourne. The next step will be developing access and security systems for virtual organisations that can flexibly respond to changes in organisational networks and membership.

POINT-AND-CLICK WORLDWIDE HELPDESK

> Internet-based service providers could offer worldwide customer support – and a Web version of FREECALL™ 1800 – through Telstra's 'Icon Calling' or 'Internet-800' service. With Icon Calling, a customer clicks on a hot button inside a company's Web page to initiate a call to the company's helpdesk or sales support team. A server then links the customer to the appropriate expert within the company, as indicated by the company's electronic directory. Billing can be to the Web page owner or caller, depending on the hot-button setup.

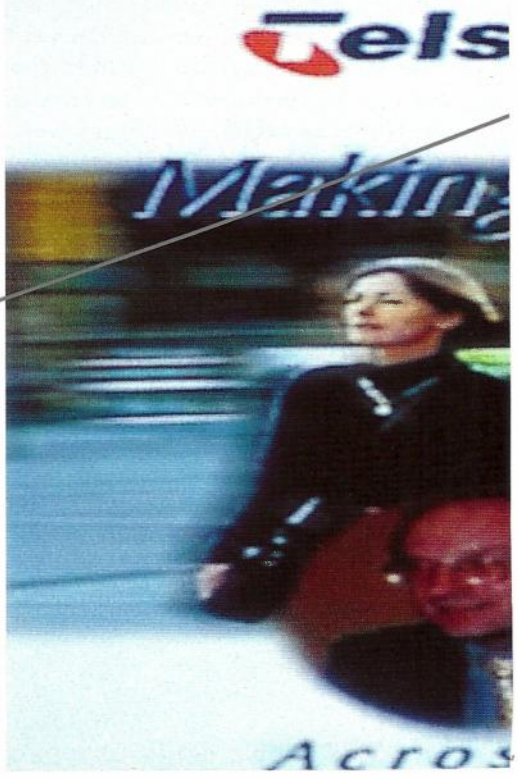
> The Icon Calling service is controlled by a server, built by TRL, connecting the Internet and public telephone network. TRL researchers carried out the systems integration of the Web server and telephone network. On registering for Icon Calling, a business can assign standard telephone numbers to hot buttons, or access the Telstra Web server – using a unique user ID and password – to control call destinations.

> Apart from providing global sales support to small enterprises, Icon Calling will encourage Web browsers to click in, make inquiries and become online customers. Another benefit of integrated computer-telephone help-desks is that computer intelligence can be used to alert a service representative about an incoming call, and automatically provide a screen display of important customer information related to the caller. This enhances the value of the call for both parties.

WEB-BASED GOVERNMENT TENDERING SYSTEM

> Government organisations – federal, state and local – are major sources of business for small to medium sized enterprises (SMEs) in Australia. TRANSIGO™ is a commercial Web-based tendering system developed by Telstra that has made the business of locating and applying for government business easier for external suppliers.

> TRL's Human Factors group played a key role in the design of the TRANSIGO™ Web site, ensuring that it was easy to use for people in SMEs, who may not be conversant with new information technology. Apart from monthly government gazette information, the site includes an 'electronic tender box', which offers security and confidentiality to companies lodging tender submissions through TRANSIGO™. Other features include top-level public key security, and a 'set and forget' option that functions like an Internet newsgroup, alerting registered users to government business opportunities in their areas of interest. The site also contains valuable information on how to do business with the government.



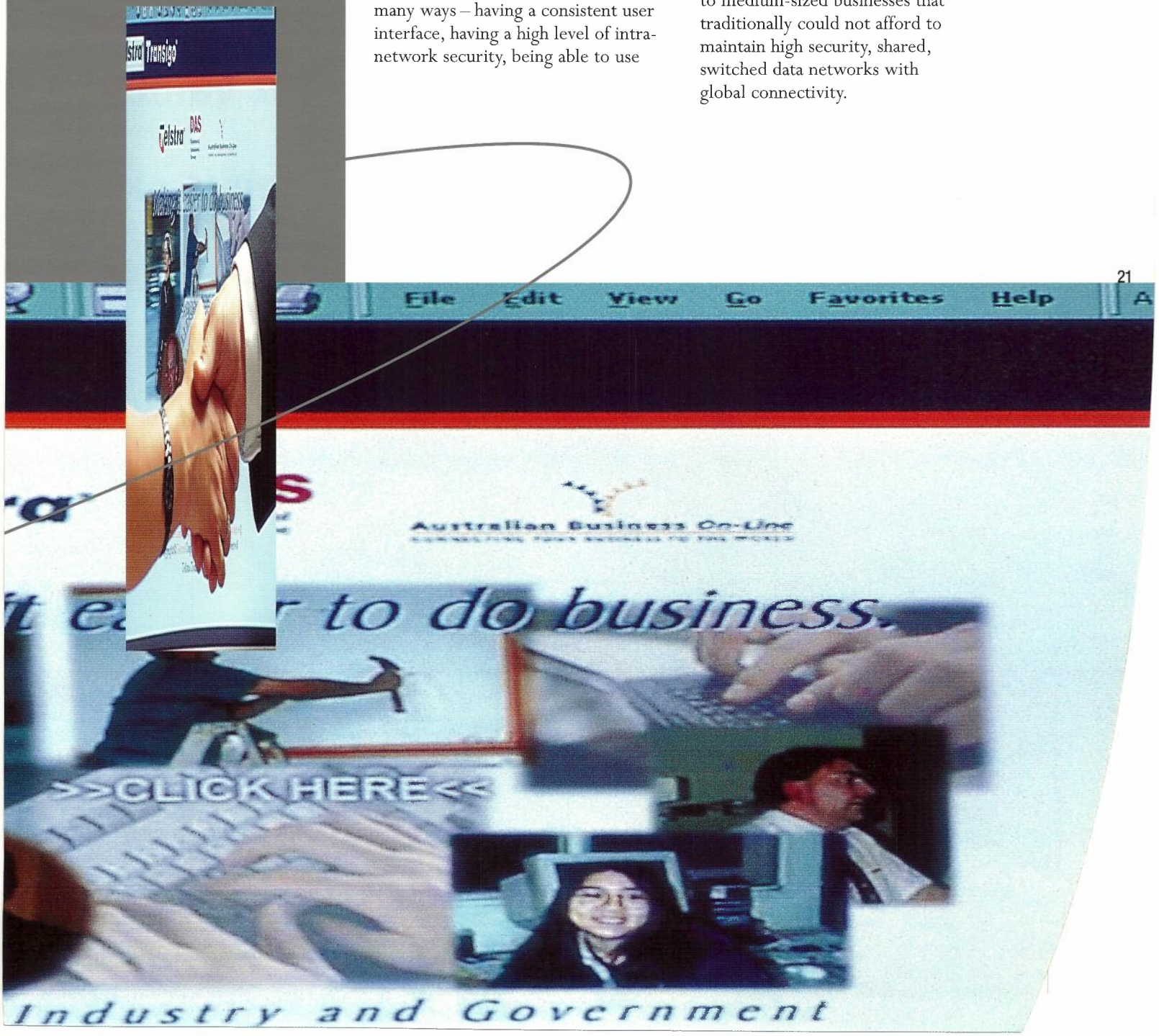
> Telstra developed the site in partnership with the Commonwealth Department of Administrative Services, and manages access to the site for registered users, who pay an annual licence fee to Telstra. The government is benefiting from a more efficient, streamlined and responsive tendering system, and Australian SMEs benefit by being more informed about government business opportunities. The next step will be to include state and local government business in the site.

NETWORK ARCHITECTURE FOR BIG POND™ INTRANET

> Intranets are corporate networks that run Internet Protocol (IP), enabling them to carry low-cost technologies such as Web browsers, search engines and e-mail. While a firewall at the intranet-Internet junction ensures that unauthorised traffic cannot enter the intranet, members of the 'closed' user group can get external access to the Internet.

> Telstra's Big Pond™ Intranet integrates cost-effective Internet technologies into a single end-to-end solution based on IP. Business customers benefit in many ways – having a consistent user interface, having a high level of intra-network security, being able to use low-cost, readily available Internet software and Web tools such as browsers and search engines, and having simpler and more reliable desktop and server systems to maintain. TRL designed the network architecture for Big Pond™ Intranet, involving software and hardware integration, network-based server design, global access mechanisms, and network security.

> Big Pond™ Intranet enables customers to create an 'electronic intimacy' with suppliers and other business partners via the Internet. This, and its low cost, makes it an ideal solution for small to medium-sized businesses that traditionally could not afford to maintain high security, shared, switched data networks with global connectivity.



MOBILE COMMUNICATIONS What is TRL doing for Telstra's mobile communications customers? It's enriching services with advanced features...such as more natural call interfaces, including speech recognition, and automatic switching between mobile and cordless modes to provide the best value for customers. > It's helping Telstra make mobile signal

TRL HAS HELPED TELSTRA DEVELOP ONE OF THE MOST ADVANCED

quality even clearer... make more efficient use of mobile networks... provide better and faster customer response... and rigorously monitor and maintain human safety standards, for the wider community as well as for Telstra's staff and customers.

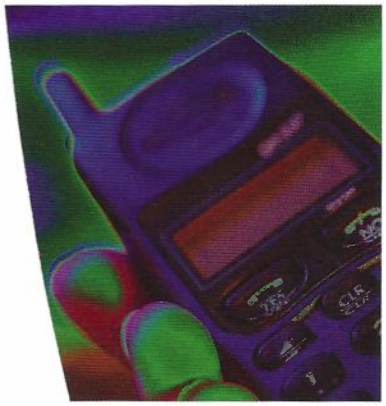
Mobile Communications

TRL has created software for applications as diverse as increasing the capacity of the existing MobileNet® network, and selecting new radio technologies to expand the network in urban areas by the end of the century.

> TRL has evaluated dual-mode mobile/cordless handsets and spoken-word directories and developed systems that allow customers to navigate the real and virtual worlds via their mobile phones. It has helped Telstra design new mobile base station structures that visually blend into the background of suburban environments.

> Then there's the Internet. The future of mobile communications is not just about smaller mobile phones – it's about integrating the ubiquitous access of mobiles with the intelligence, capacity and processing power of fixed networks. TRL has been exploring new ways of using the tetherless freedom of mobile phones to access the global connectivity offered by the Net.

> Researchers at TRL are equipped to help Telstra develop a new generation of mobile technologies, by applying scientific know how to the investigation of emerging digital radio technologies and standards, advanced software, intelligent networks, multimedia access, and higher levels of service quality for Telstra's customers.



ONE OF THE MOST ADVANCED MOBILES FAULT MANAGEMENT SYSTEMS IN THE WORLD

QUOKKA

SMART QUOKKA DEBUGS ANALOGUE AND DIGITAL NETWORKS

> Artificial intelligence experts have applied neural-network techniques to the management of faults in Telstra's analogue and digital mobile networks. The national 'Quokka' intelligent fault management system, named after the Australian marsupial, is one of the most advanced systems of its kind in the world. Quokka feeds into a sophisticated, easy to use automated Mobiles Help Desk. Service staff can provide customers with vital information about current network irregularities and remedial action being taken to fix them. The benefits of Quokka include smoother network performance and customer savings, improvements in staff productivity and a dramatic reduction in staff training time.

> TRL first developed Quokka for Telstra's analogue network in 1991, and took only three months to modify it for later use in the GSM digital network. Quokka's advantage over past fault-monitoring systems is its capacity to automatically collect and analyse large volumes of network performance data – up to 100 megabytes a day – and spot discrepancies in complex data patterns, providing a daily diagnosis of network health.

> In the past, data collection and analysis was more labour-intensive, limiting monitoring to a weekly analysis of small parts of the network. This meant that subtle faults, such as an antenna knocked out of alignment by strong winds causing a slight loss of throughput capacity, could not be readily identified.

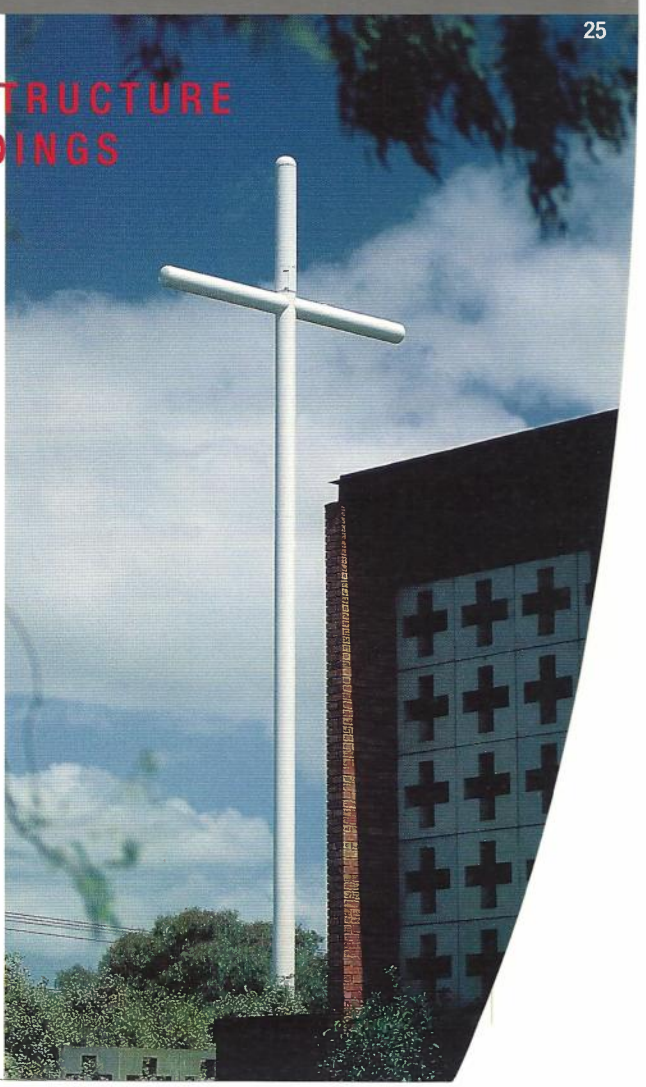
A CELLULAR MOBILE BASE STATION STRUCTURE THAT CAN BLEND INTO ITS SURROUNDINGS

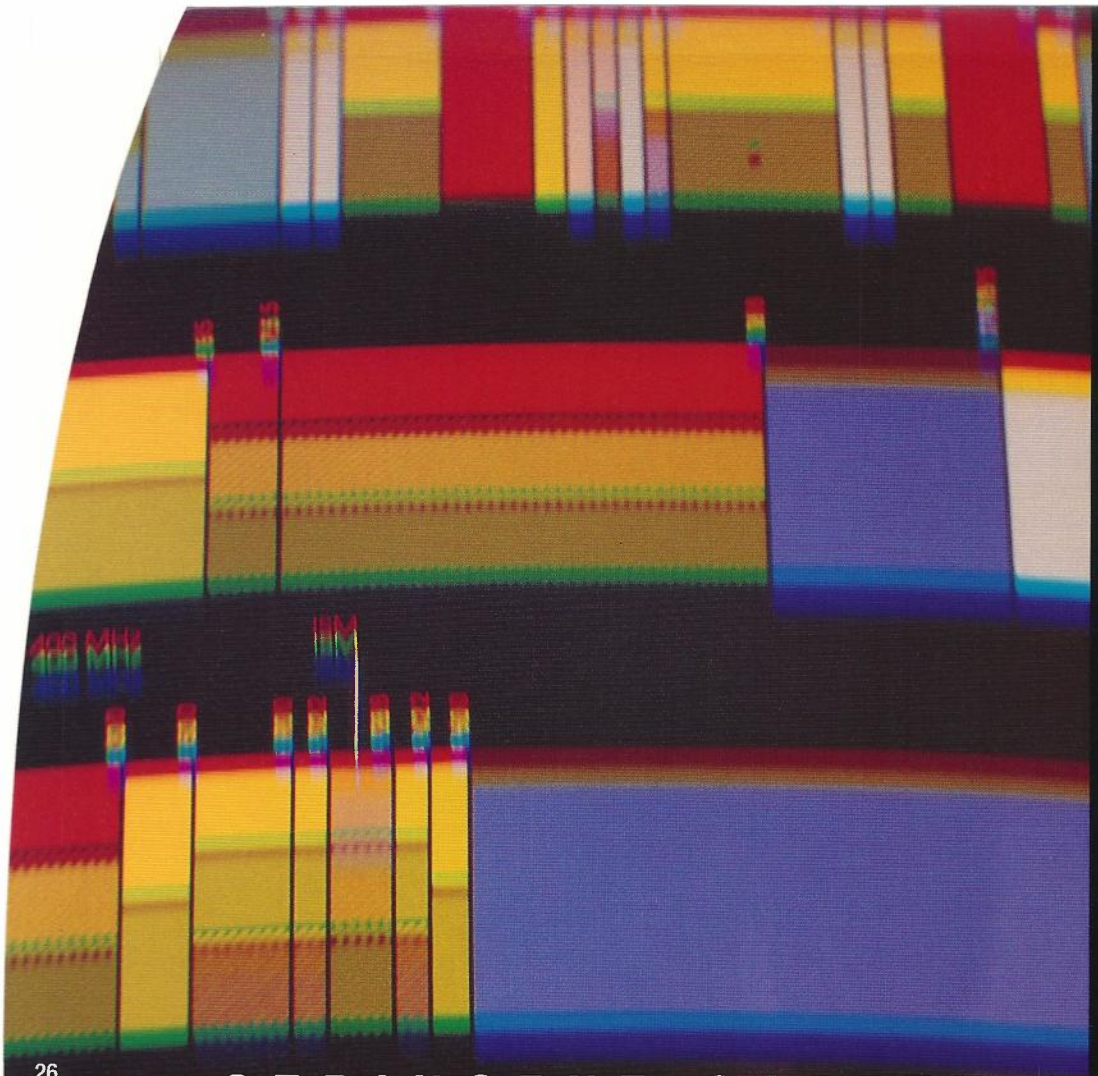
'INVISIBLE' MOBILE BASE STATIONS

> TRL has helped Telstra Mobile Communications develop a mobile base station structure that can blend into its surroundings. The sleek cylindrical design can be integrated into existing structures – such as a cross on a church steeple. Public concern about expanding mobile phone infrastructure has led to the development of a national code to reduce the visual impact of base stations and towers.

> In response to the code, Telstra and local company, Argus Technologies, have developed a range of prototype antennas that were more compact than the traditional three-sided array of transmit and receive antenna panels – the familiar crown seen on older base stations. The final design was tested and refined at TRL until it was ready to introduce into Telstra's mobile network.

> Now that Telstra has shrunk mobile base station phone antenna structures from a diameter of five metres to one-third of a meter, regional Mobile Communications staff are experimenting with innovative ways of integrating the structures with local streetscapes.

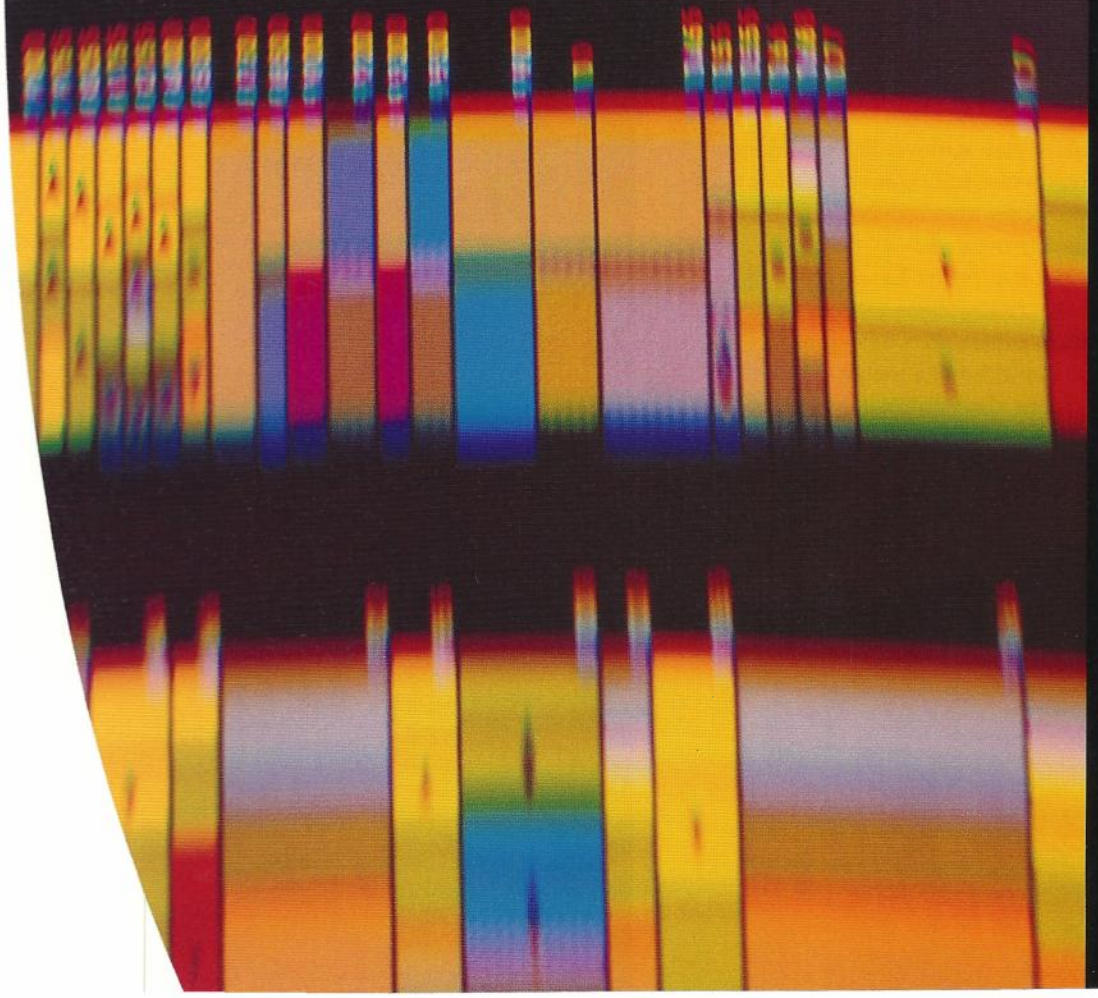




> TRL is involved in radio-frequency (RF) standards committees and monitoring of health and safety issues related to mobile communications. This ensures that Telstra complies with Australia's RF exposure standard, one of the most rigorous in the world. For the past 10 years, TRL has been developing safe work practices for Telstra staff working around radio-transmitters. This expertise has more recently been widened to include consideration of health issues for the general community, including assessments of possible mobile phone impacts on hearing aids and pacemakers.

> Apart from safe work practices, Telstra staff now have software tools that generate 'safe-area' maps of radio-transmitter sites to protect staff working very close to antennas from straying into strong RF fields. Another development – a personal 'Go-NoGo' RF hazard monitor – has generated commercial interest overseas. The personal monitor provides added assurance for staff that transmitters are off when they are working near them. If the user enters an unsafe RF field, an alarm is triggered.

STRINGENT SAFETY STANDARDS



> TRL has worked with the hearing-impaired community, the Royal Melbourne Hospital, the Australian Therapeutic Goods Administration and the Australian Communications Authority to research the effects of mobile phones on hearing aids, heart pacemakers and other medical equipment.

CLEARER DIGITAL MOBILE CONNECTIONS

> In service organisations, the customer should be the main determinant of quality of service. For mobile phone customers, that means the clarity of voice signal they hear when using handsets, rather than 'objective' technical quality measures. This subjective measure can be linked to appropriate network parameters. TRL's resources for 'subjective testing' include scientifically designed soundproof listening rooms.

> TRL's expertise was used to test new echo cancellers for the MobileNet® Digital network. The cancellers were to be introduced to MobileNet® Digital to cancel the echo-effect heard by a small number of callers at the PSTN-end of mobile phone connections. TRL identified an audible side-effect of the cancellers, and developed software to counter the problem before the devices were activated.

> Researchers are now working on improving the general quality of sound carried over MobileNet® Digital. Their aim is to improve quality of service for customers without 'over-engineering' the network. The same research team is testing the possibility of sending data over mobile digital networks by squeezing it between voice packets, making more efficient use of the network, while maintaining sound quality.

SOFTWARE TOOLS TO OPTIMISE MOBILE NETWORKS

> SEXTANT (Spectrum EXpendiTure And Network Tool) is a user-friendly computer modelling tool developed by TRL to enable strategic network planners to evaluate new mobile technologies on the basis of relative performance features, infrastructure costs and radio-spectrum requirements.

> Telstra has made use of SEXTANT in its long-term planning and in developing its bidding strategy for the national PCS (Personal Communication Services) spectrum auctions scheduled for 1998. The easy to use spreadsheet modelling tool has been used by Telstra's Business and Government unit in preparing business cases for new mobile communications technologies.

> Another software tool, developed jointly by TRL and CSIRO, is FASE (Frequency Assignment by Stochastic Evolution). FASE enables Telstra's cellular radio designers to optimise the assignment of frequencies to the base stations in Telstra's analogue and digital mobile networks. This is critical in achieving high capacity and quality-of-service at a low cost. FASE is highly flexible and can be used to perform both total and partial network retunes.

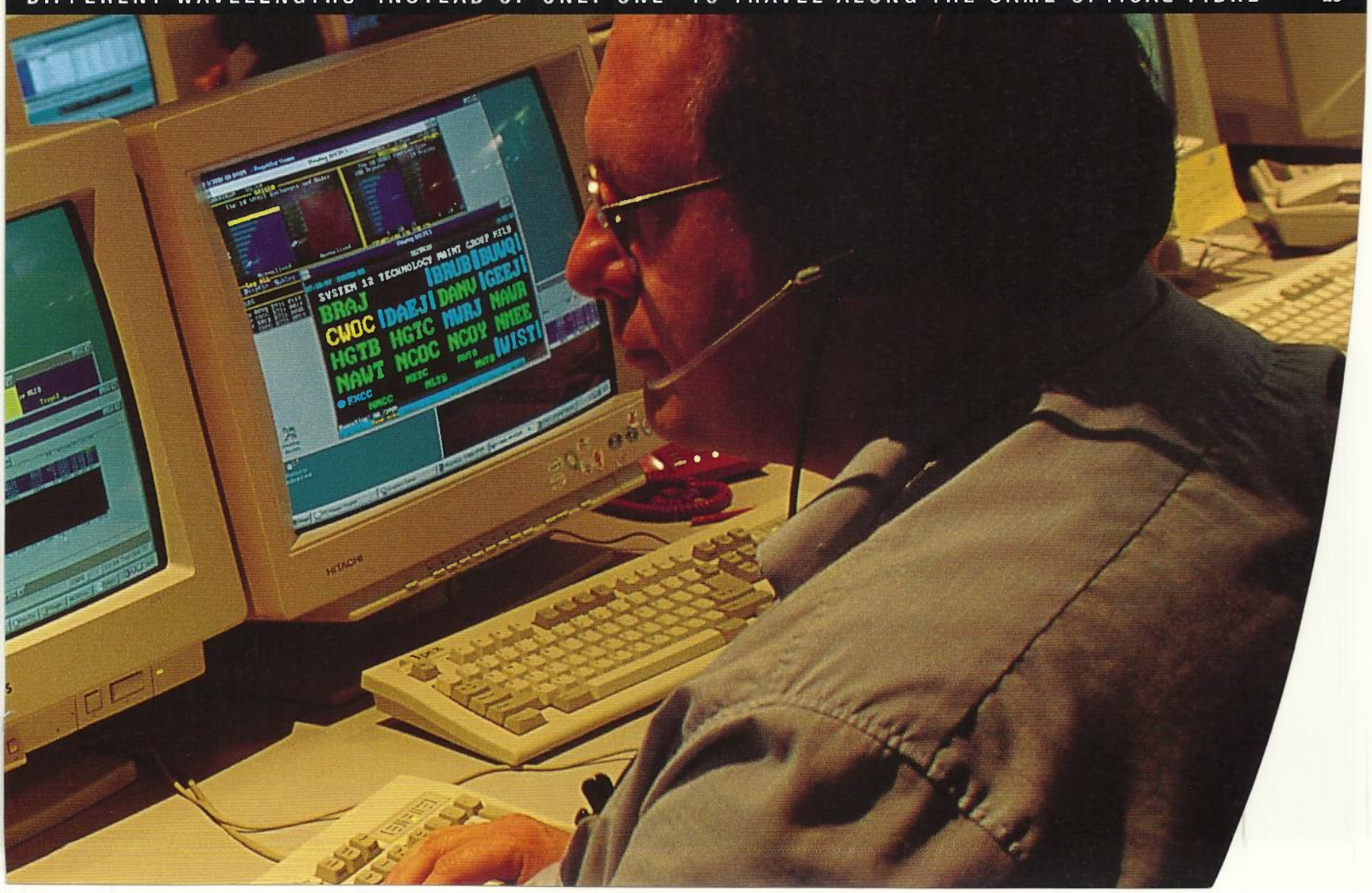
IMPROVING THE GENERAL QUALITY OF SOUND CARRIED OVER MOBILENET® DIGITAL

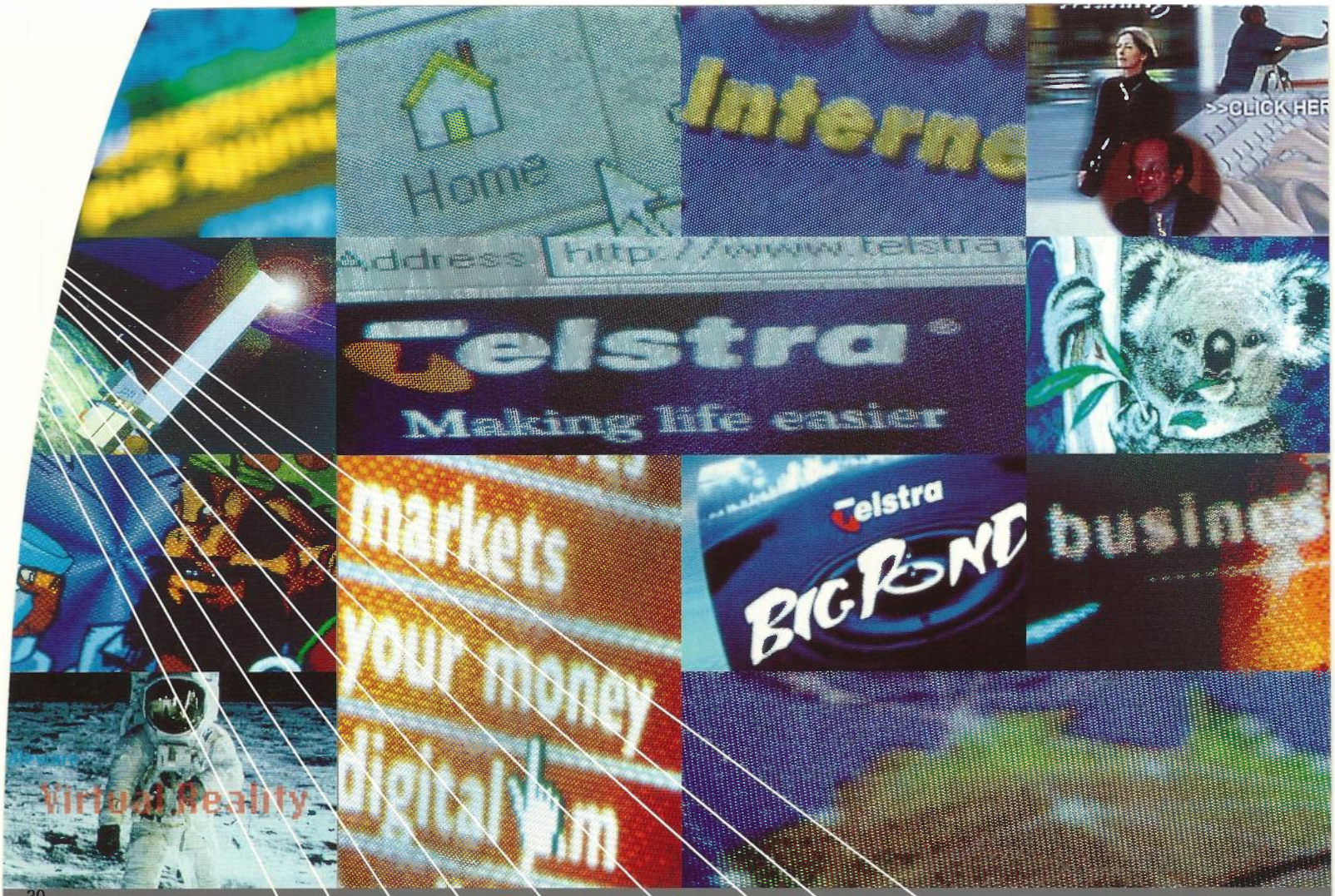
BUILDING A BETTER INTERNET Today's Internet has been called 'the new dial-tone'. It connects 75 million people around the world in hundreds of countries – wherever there is a telephone connection. It has created unprecedented demand for richer global communications based on images, sound and text as well as voice and data. > The Internet changed suddenly, in the

WAVELENGTH DIVISION MULTIPLEXING ENABLES EIGHT OR MORE STREAMS OF LIGHT OF

early 1990s, from a government-owned esoteric research tool, to a mass-market commercial service. This transition was made possible by the user-friendly World Wide Web graphical interface, which gave non-technical users point-and-click access to global information resources.

DIFFERENT WAVELENGTHS – INSTEAD OF ONLY ONE – TO TRAVEL ALONG THE SAME OPTICAL FIBRE

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Virtual Reality

inter net

> While the Web radically changed the face of the Net, Internet Protocol (IP) gave it the potential to become universal.

> IP is an inter-network 'language' that enables computers to 'talk' to each other over different infrastructure. It integrates the tens of thousands of smaller networks that make up the Net. They might range in size from a home LAN linking two PCs, to corporate intranets. In an IP network, a well-designed Web page can be accessed on a Unix workstation, PC or Macintosh with the same result.

> The Internet's rapid growth, however, has come at a price – the Net is fast reaching the limits of its 32-bit IP-address capacity, and its capacity to handle delay-sensitive services.

> Telecommunications and information technology companies have joined forces to develop a faster, more reliable Internet. Telstra is ideally placed for such a task. Its accumulated knowledge and experience, gained from building and managing telecommunications infrastructure for Australia, have given it expertise in such critical areas as:

- maintaining quality over a large, complex, international network
- network dimensioning for real-time services
- building and operating national broadband and data networks
- developing software and 'intelligent network' solutions to support products such as FREECALL™ 1800
- integrating new platforms and technologies such as cellular mobile, cable, cordless, ATM and optical fibre into the established network.

> For the past 12 years, TRL researchers have been experimenting with ATM (asynchronous transfer mode), a cost-effective platform for seamless delivery of voice, video and data over different networks. Three years ago, Telstra incorporated ATM into its core network. In 1997, it launched 'Accelerate™ ATM', its first commercial ATM product in the access network. TRL researchers are assessing how wider implementation of ATM can contribute to Telstra's business, and how ATM will work with IP and the Internet.

> TRL is also assessing network protocols to complement IP. Apart from pre-empting the IP address shortage, these advanced protocols support multicasting – a bandwidth-efficient way of streaming interactive multimedia services to many customers at the same time. New Internet protocols will also enable providers of interactive services such as multimedia telephony to avoid long, 'round-trip' delays, such as those that used to be experienced on satellite voice links.

SOFTWARE FINDS WAYS TO SHARE AND OPTIMISE RESOURCES

> Computerised evaluation tools are being used by TRL to re-gear Telstra's network for carrying new products and services. This benefits Telstra and its customers by saving money and improving network performance through more efficient use of existing resources.

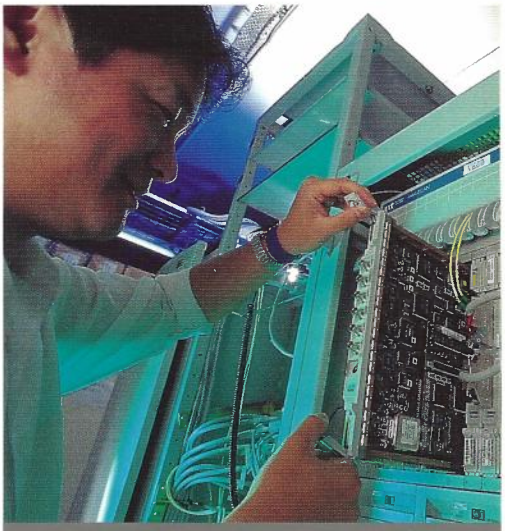
> ORINT (Optimal Routing of International Network Traffic) is a software program that optimises the number of circuits required between a coalition of three international carriers, reducing international transmission costs. ANDES (Advanced Network Dynamics and Economic Simulation) evaluates initial investment and subsequent operating costs of network equipment, providing long-term product unit cost-benefit comparisons for competing network architectures.

FINDING A LANGUAGE FOR THE MATURE INTERNET

> Internet Protocol (IP) has come a long way for a protocol devised to allow researchers to exchange data files and short messages over long distances. But it has problems. It is even-handed to a fault – treating all traffic in the same way, whether delay-sensitive or not – and was not designed for real-time services such as audio and video.

> Among the more advanced Internet protocols TRL has been testing are RSVP (resource reservation protocol), RTP (real time protocol) and IPv6 (version 6 of IP; IPv4 is the current version). RSVP is designed to give priority to delay-sensitive IP traffic, and is useful for example, for prioritising videoconferencing services over data in heavily loaded intranets. However, it needs to be implemented in the Internet with care. Researchers believe that problems could be averted by appropriate network management and new capabilities in network routers.

> IPv6 corrects many of the shortcomings of IPv4, and will better support RSVP and real-time services. For example, IPv6 has a bigger capacity for IP addresses and makes more use of multicast. An experimental multicast network (the 'M-Bone') in the US has provided a test bed for multicasting videoconferences and lectures to thousands of subscribers using new Internet protocols.



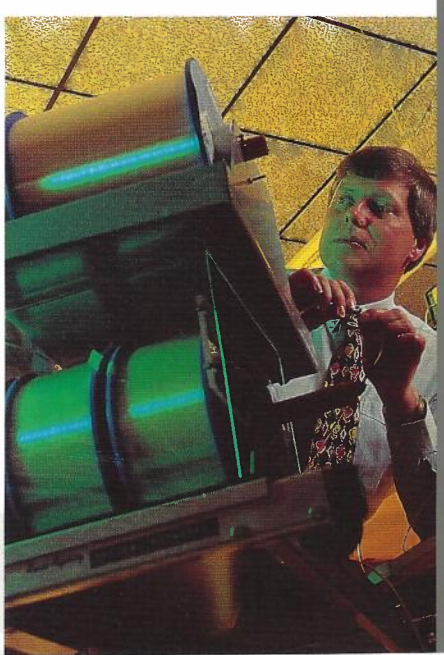
ADDING COLOUR TO BOOST THE SPEED OF FIBRE

> In association with strategic industry partners, TRL is helping Telstra develop new optical fibre systems capable of meeting the increased bandwidth demand created by current and future Internet and broadband services.

> Rather than requiring additional inter-capital cables, the new systems build on Telstra's installed network of 2.3 million km of single-mode optical fibre. Transmission speeds in the present network are constrained because the optical fibre operates on a single wavelength of light through a transmission technique known as time division multiplexing (TDM). The current TDM inter-capital optical fibre links transmit at a rate of 2.5 Gigabits per second (Gbit/s), which is equivalent to about 30,000 simultaneous telephone calls per fibre-pair.

> The new systems being developed by Telstra will, per fibre-pair, keep up with demand. This has been achieved through wavelength division multiplexing (WDM), which enables eight or more streams of light of different wavelengths – rather than only one wavelength – to travel along the same fibre. Further improvements to transmission technology, being made by TRL and its industry partners, will enable further increases in capacity in the future to keep track of demand.

> As WDM is introduced to the inter-capital network over the next few years, Telstra customers will benefit by having access to a state-of-the-art core transmission network, which can carry high-volume, high-bandwidth traffic at a low cost, and can be readily adapted to meet future service and bandwidth requirements.



INTELLIGENT NETWORKS TO ENHANCE ATM INTRANETS

> Big Pond™ Intranet customers could benefit from IP/ATM intranets, because ATM has the potential to help solve some of the security and quality of service problems associated with the Internet and traditional IP router networks. This involves the application of intelligent networks to enhance the existing capabilities of ATM for prioritising different user traffic and controlling call set-up.

> TRL has been developing intelligent networks and security algorithms that work with ATM to screen access to closed user groups by unauthorised users. The intelligent network 'talks' to the ATM switch, encoding a 'digital signature' in the ATM call set-up message, which verifies user or recipient access and signals any message tampering.

> Intelligent-network boosted ATM could be used to sort and prioritise communications traffic on intranets. This would ensure that real-time services such as phone calls have right of way over data traffic on shared-bandwidth ATM 'highways'.

CONVERGENCE OF ATM AND IP/INTERNET

> ATM and IP are packet switching technologies – that is, data is carried in discrete, labelled 'packets' across the network, and recombined at the receiver end. Each switching technology, however, is designed for a different purpose. This may make them a potentially strong partnership in the future Internet, because ATM seems to have many of the features lacking in IP.

> ATM is a telecommunications switching protocol designed for guaranteed quality of service, and dynamic and flexible allocation of network resources to handle all traffic types, including voice, data, image and video. It does this by reserving bandwidth across a network for the duration of a call. ATM is a technology that can be scaled to handle LAN or carrier-volume traffic.

> The Internet, on the other hand, is geared to deliver 'best effort' service only – users are at the mercy of network traffic jams. Yet it also offers a standard medium for communication between computers around the world, including a friendly graphical interface, advanced browsing and searching tools and personalisation of information.

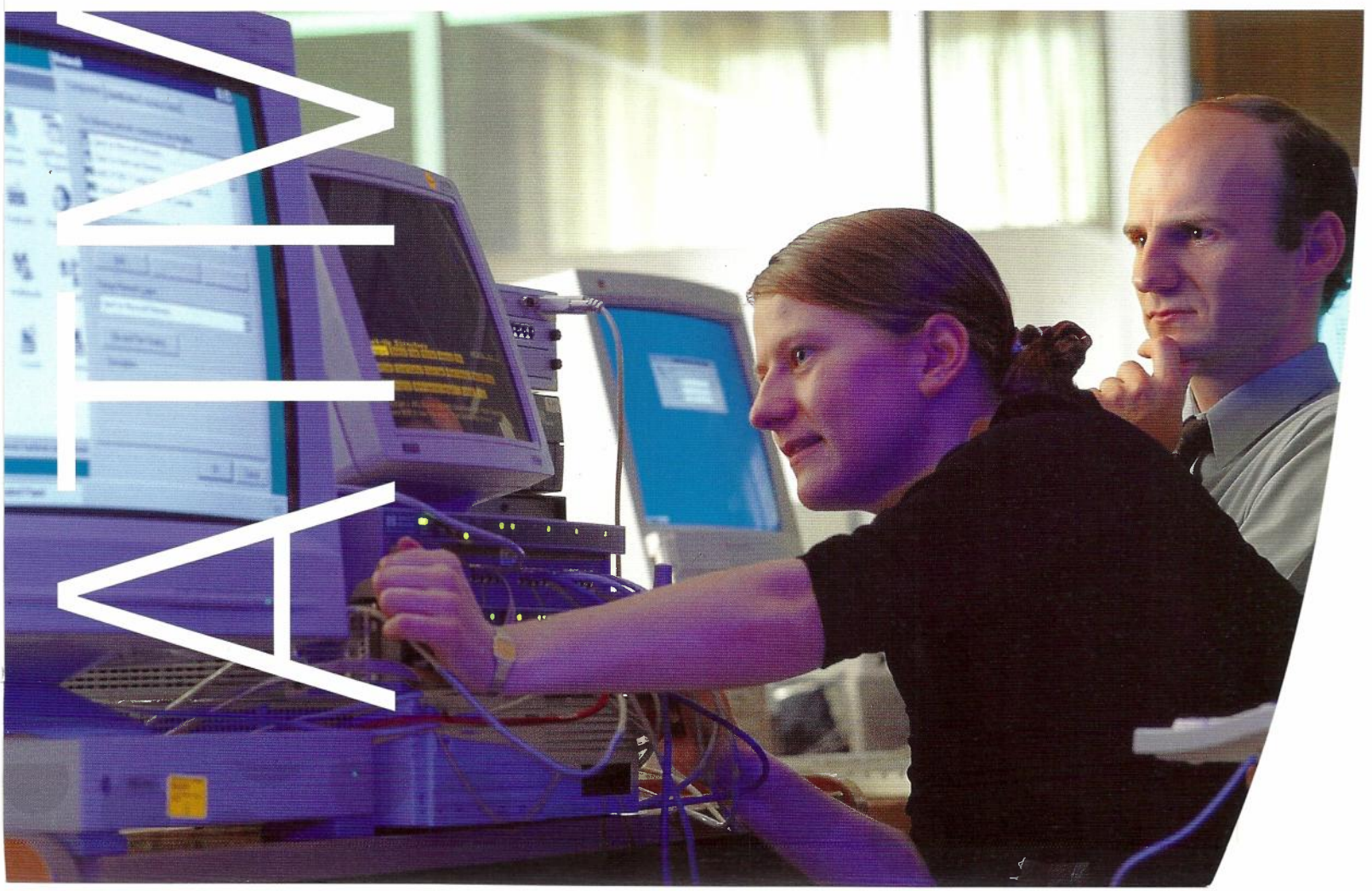
> TRL has evaluated the performance of IP over ATM and identified the potential benefits that would come from integrating the protocols onto a single, low-cost platform. This would be capable of delivering data, text, audio and video content with equally high levels of service quality and a personalised Web interface.

KEEPING THE DATA NETWORK UP TO SPEED

> As far as large businesses are concerned, a good return on investment in new communications technology is the 'bottom line'. This means performance levels need to be measured and be realistic in terms of capabilities of component technologies.

> TRL has developed methods to measure end-to-end network performance using 'Network Metric' parameters based on statistical information collected from the network nodes. Network Metric parameters can be used to dimension the network and indicate current performance levels to customers. This allows Telstra to meet customer demands for reporting on performance measures such as transit delay, loss ratios and network availability. The parameters will also allow Telstra to measure and report accurately on network performance for statistically multiplexed data services, differentiating Telstra as a market leader. TRL is considering Web-based access for delivering performance reports to customers.

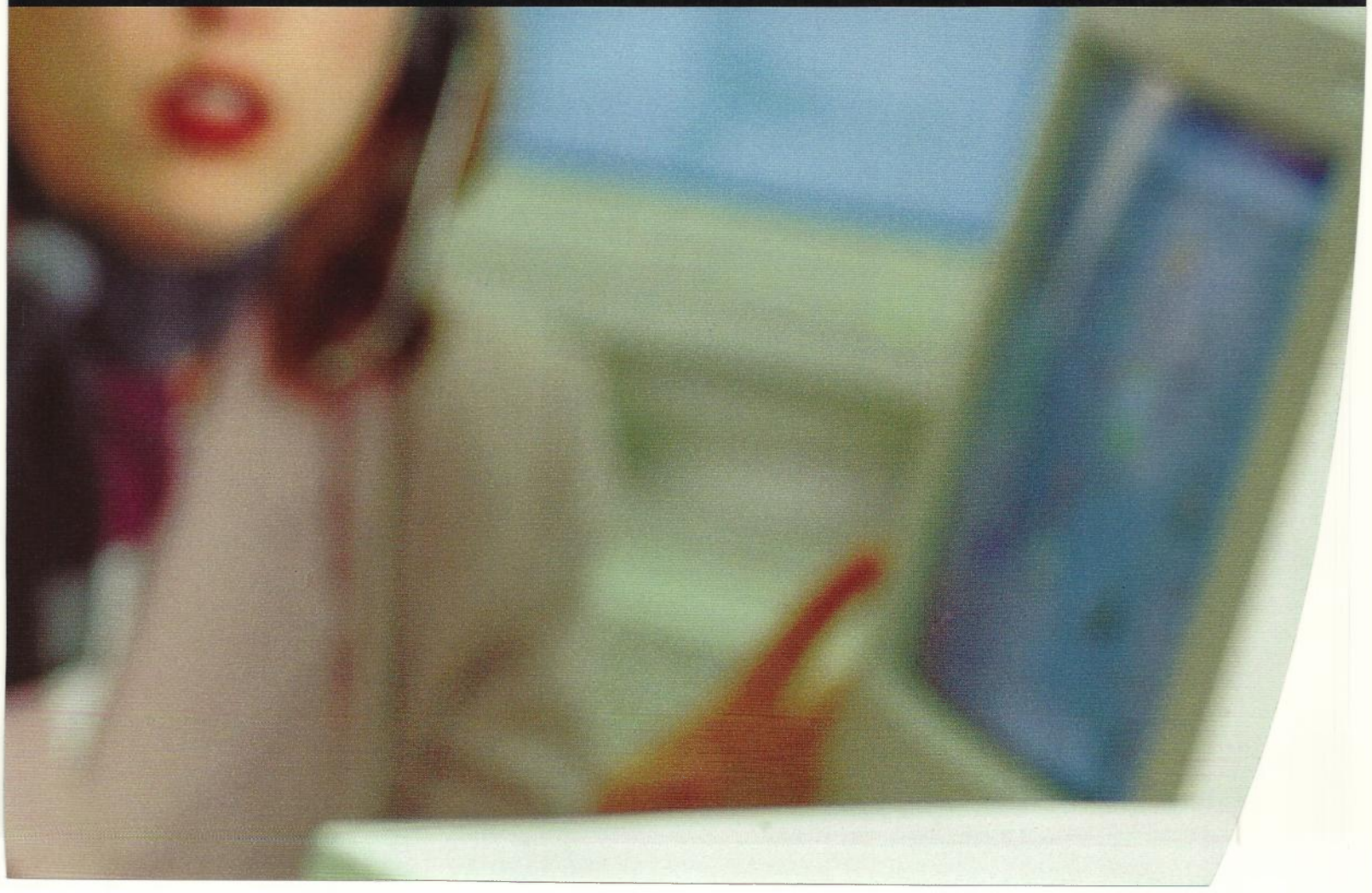
> TRL has also developed a software tool called ANDIT (ATM network dimensioning tool), which optimises the design of the switched data network (SDN), providing service and cost advantages for Telstra customers. ANDIT minimises transmission costs of the SDN subject to performance, reliability and routing constraints. For example, it can be used to indicate the level of increased traffic the SDN can support without the need for upgrading. Or it can be used to estimate the extra capacity required should new services be added to the core network.



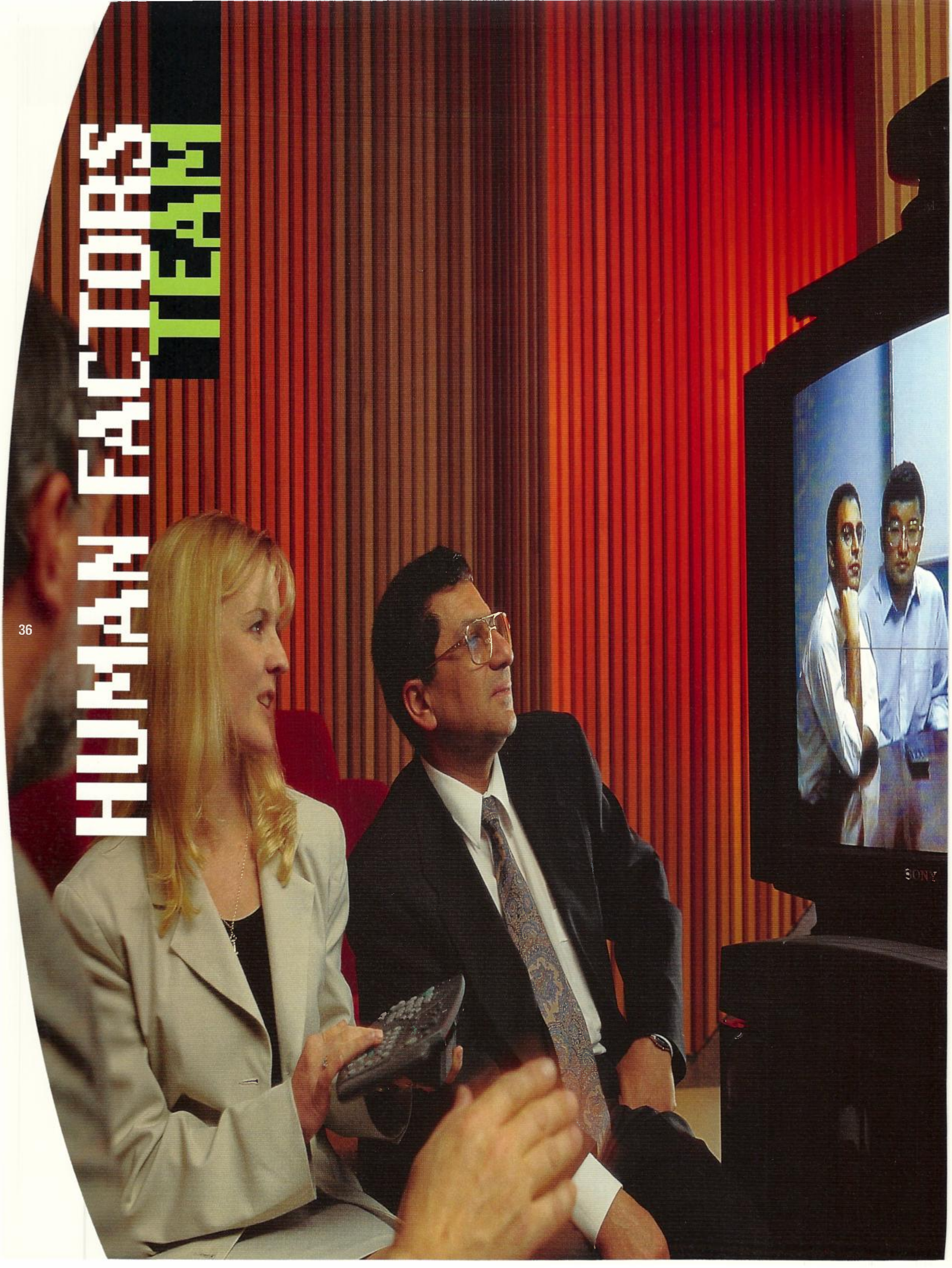
NEW TECHNOLOGY– MAKING IT EASIER In a deregulated telecommunications environment, quality of service is a key differentiator between competitors. As well as high product quality and competitive price, today's customers expect higher levels of after-sales support, ease-of-use and a 'personal touch'– services shaped to meet their specific needs. > TRL has more than

34 A SIMULATOR CAN MODEL A NETWORK OF CALL CENTRES, ENABLING STAFF TO IDENTIFY

10 years' experience in identifying human factor and socio-technical issues in human-machine interaction, as well as the impact of technology on different industries and organisations.



HUMAN FACTORS TEAM



> A detailed knowledge of customer needs – whether a home Internet user, a large corporation, or even another business unit within Telstra – is critical to product uptake. No matter how many advanced features a Web site may offer, a user may not subscribe if the interface is slow to respond, hard to navigate, or not designed for use on their computer. Telstra's approach is to segment the market as precisely as possible, and tailor products and services to match the needs of each niche.

impaired people may translate into hands-free Internet access for business users.

> The idea of universal customer access is taken further with the concept of personal communication services (PCS). These blend the intelligence and advanced service features of the fixed network and Internet with the wireless access of radio technologies. The idea is that the network is available to the customer, wherever they are, whatever time, and whatever mode of access. Telstra's Telepath® One Number service is a step towards the PCS future.

> Another development that has increased Telstra's responsiveness to customers is automated call centres. These display a customer's details on the computer screen of a customer service representative before a call is taken. This increases the value of the call for both parties because of the faster response by the customer service representative who has instant access to the customer's service profile

It lets customers accept calls, faxes and e-mails on the equipment of their choice, in their office or the office they are visiting, or store the message in a unique mailbox for later access. Customers can use their mobile phone to access their service, or, if it's more convenient, use a fixed phone or the Internet.

> TRL Human Factors researchers worked closely with the manufacturer and the PCS production team to tailor these interfaces for use in Australia. The results of the Human Factors studies may influence the implementation of the service in other English-speaking countries.

PSYCHOLOGYPSYCHO-LINGUISTICSSOCIOLOGISTS

> TRL Human Factors researchers with expertise in psychology and psycho-linguistics help design, test and evaluate voice and screen interfaces to many of Telstra's telephone and computer-based services. Sociologists and others carry out user-needs analyses and scoping studies of customer needs to understand the wider context in which people use communications technology.

> The Human Factors team conducts focus groups, holds design workshops and evaluates services by conducting rigorous useability tests. It helps Telstra define and maintain a quality level for voice services – in both the mobile and fixed networks – based on the useability of the service, not just technical merit.

> TRL is examining how to provide universal access to Telstra's products and services, for all customer groups, including older customers and those with disabilities. Product and service interfaces – based on the principles of ease of use and convenience – designed for this customer group may be of interest to other customers. For example, a 'talking Web page' for sight-

A NETWORK TUNED IN TO THE USER

> Among the PCS (personal communications services) technologies tested at TRL are dual-mode wireless phones that automatically switch from mobile mode to cordless mode when they come within range of the cordless frequencies. Researchers have assessed the requirements of personal phone technology, how fast it responds to the availability of a cordless network (and vice versa), and how easy it is for new customers to use.

> Another development is the Telstra ExecConnect™. This enhanced mobile network service innovation designed for small businesses and busy executives allows customers to use their mobile phone number to receive incoming calls, faxes and e-mail messages when and how they choose.

FACTORING USERS INTO THE PRODUCT DEVELOPMENT PROCESS

> Building useability criteria into Telstra's product development process results in the detection and elimination of potential customer problems before product rollout. Useability problems in commercial systems tend not to be corrected, and reduce the likelihood of customer loyalty and repeat business. TRL has ensured that useability considerations are incorporated into Telstra's Product Development and Improvement Process. Researchers are developing guidelines for business units on how to incorporate product useability into tenders, contracts and specifications for external suppliers to ensure a consistent look and feel across all Telstra products.

SOCIAL SCIENTISTS EVALUATE ADVANCED NETWORK TRIAL

> TRL worked with engineers and Telstra's Retail Products and Marketing unit to evaluate a two-year trial of a leading-edge broadband network based on ATM, known as the Experimental Broadband Network (EBN).

> The EBN network stretches from Queensland through the eastern states to South Australia. For two years, eight R&D groups – working in areas such as supercomputers, information technology, media, education and defence – used it as a test-bed to develop new broadband applications. Among the new applications were video to the desktop over different platforms, telemedicine and remote medical consultation, distance education and training, advanced videoconferencing, and smart tools for locating, retrieving and editing footage from remote film and video libraries.

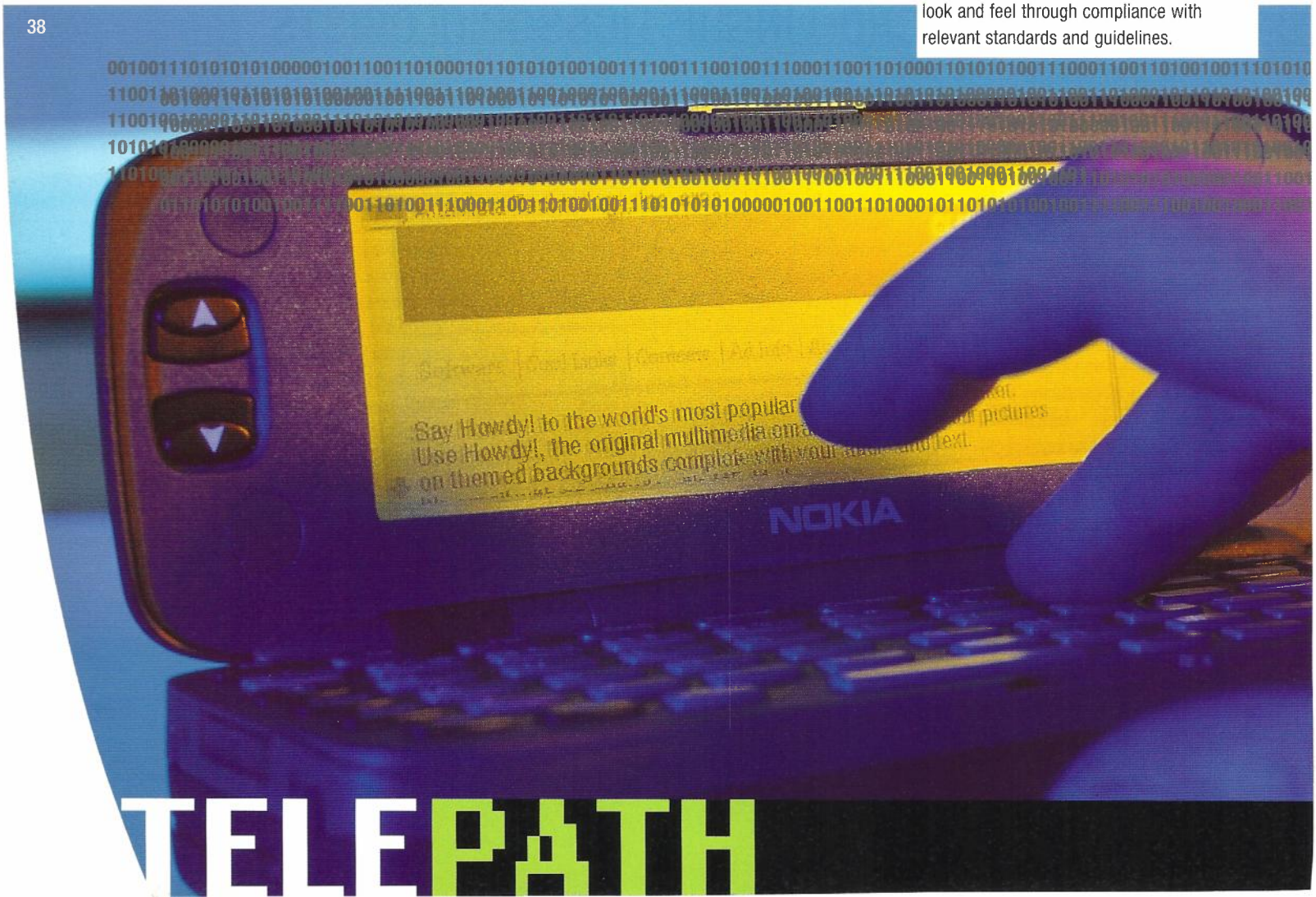
> Apart from seeking feedback from trial participants, TRL initiated demonstrations of the new applications and organised forums for participants to compare notes. Among the issues they identified for future networks were equipment interoperability, development of 'middleware' for browsing and distributing tasks among remote users, copyright protection of video images, and access and pricing of new broadband products for smaller organisations.

CLEAR, CONSISTENT VOICE PROMPTS

> Interactive voice response (IVR) systems allow Telstra's customers to use the telephone as a simple computer terminal – with voice prompts offering a 'menu' of choices that enable users to navigate to the desired destination. The benefits of IVR are 24 hour access to Telstra services from any phone, and a secure means of communicating confidential information such as credit card numbers.

> Useability experts at TRL assess IVR applications for unambiguous wording, logical menu structure and navigation, speech recognition accuracy, consistency with similar products, and sound quality. With speech prompts and automated voice features on equipment designed overseas, word usage is also important – one country's 'vacation', for example, is another's 'holiday'.

> Apart from working closely with the vendor on the IVR scripts of the Telstra ExecConnect™, TRL useability experts have recently helped Telstra develop a number of other IVR systems. These include the Telstra MobileNet® Information Service and the Automated Reverse Charge Service. A goal of IVR useability work is to maintain a consistent look and feel through compliance with relevant standards and guidelines.



HELP DESK

REDUCING CALL WAITING TIMES FOR GOVERNMENT SERVICES

> Every year, Australian government departments – such as the former Department of Social Security (DSS) – receive millions of calls about pensions and other payments. The problem is that many of these calls are made around the same times – on or around the day on which age pensions and other benefits are issued. In the past this has resulted in long call waiting periods, which can be frustrating for customers.

> The government's Centrelink service agency has recently taken over customer contact from DSS and related departments. Telstra's Business and Government unit, with the help of TRL, won the contract from Centrelink to manage the national call centre network. Telstra developed an improved call distribution system for managing social security calls between its 400 offices around Australia. The system reduces the time customers need to wait in call queues.

> A key to the increased call centre efficiency was a call centre network simulator, developed by TRL in the absence of a commercially available solution that could handle complex call centre situations. The simulator can model the operation of a national network of call centres, enabling network staff to identify potential problems and improve customer service, while optimising resources. Apart from providing Centrelink with a tool for future network and resource planning, the TRL simulator provides Telstra with a competitive edge in bidding for similar contracts and in streamlining its own call centre management.

CUSTOMER ACCESS LABORATORY

> TRL has established a Customer Access Laboratory, which Telstra business units can use to test new service ideas and configure existing products and services.

> For example, TRL is implementing a trial of an Internet-based pre-bill service, which provides customers with account information between bills. Researchers have developed software components that promote scalable and easily managed 'electronic customer care' services, giving Telstra the flexibility to develop tailored applications requested by customers.

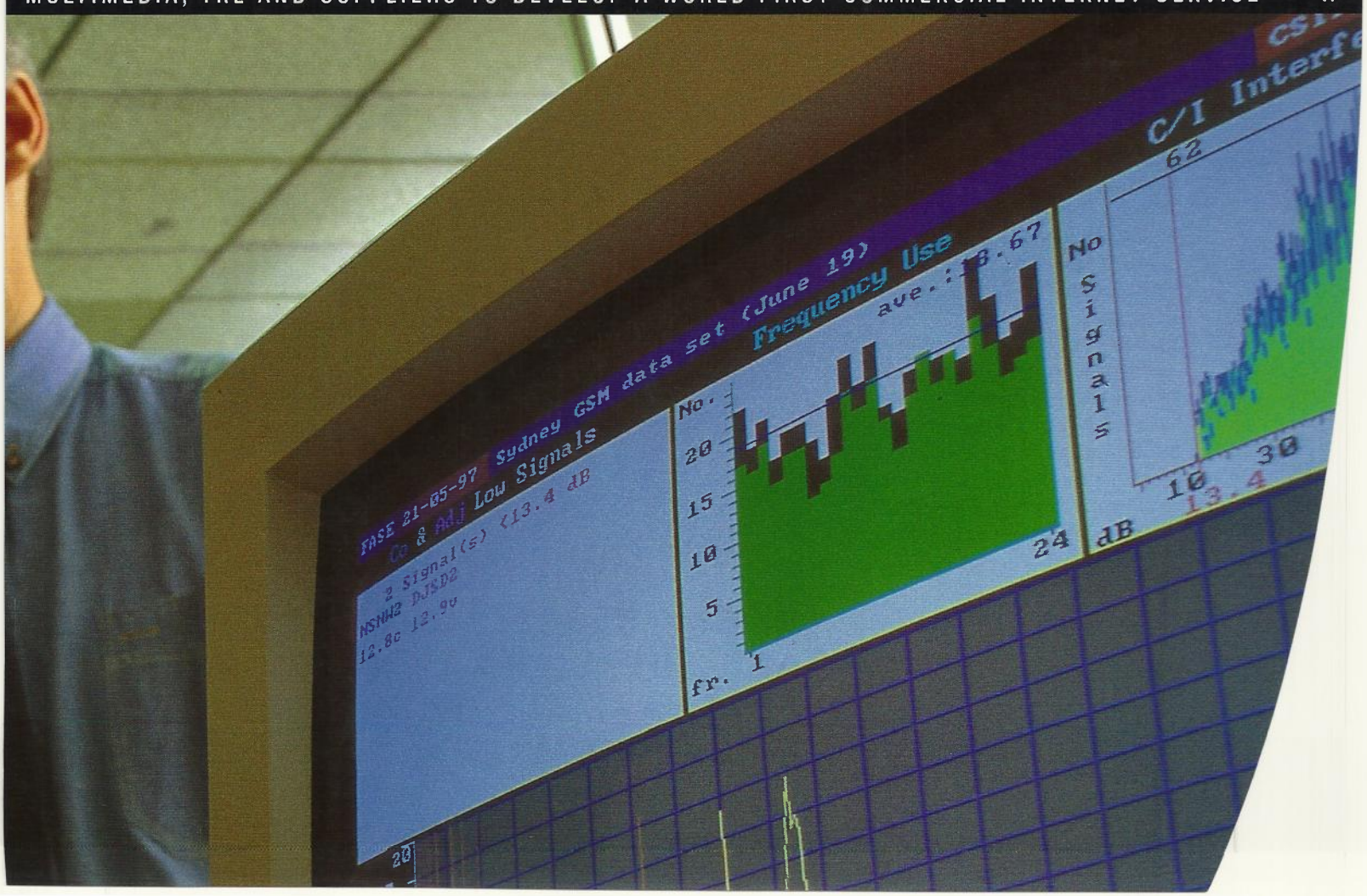
> In another project, TRL is developing call centre solutions that enable call centre staff and customers to be linked via phone calls made using icons or electronic directory listings on a Web browser. This work is leading to multimedia links between customers and call centre staff. Researchers are also examining the network architecture upon which Telstra's Callex™ product range is based, adding call centre features to 1800, 1300 and One3 products.

> The Customer Access Lab draws together TRL's skills in distributed software design, Internet telephony, network intelligence, voice recognition, security, human factors and service quality.

WORKING TOGETHER To deliver competitive products to customers and add value for shareholders, Telstra is forging global alliances and partnerships that bring together the world's leading software and hardware companies, systems integrators, R&D organisations and universities. > Increasingly, TRL is working directly with Telstra's business partners around

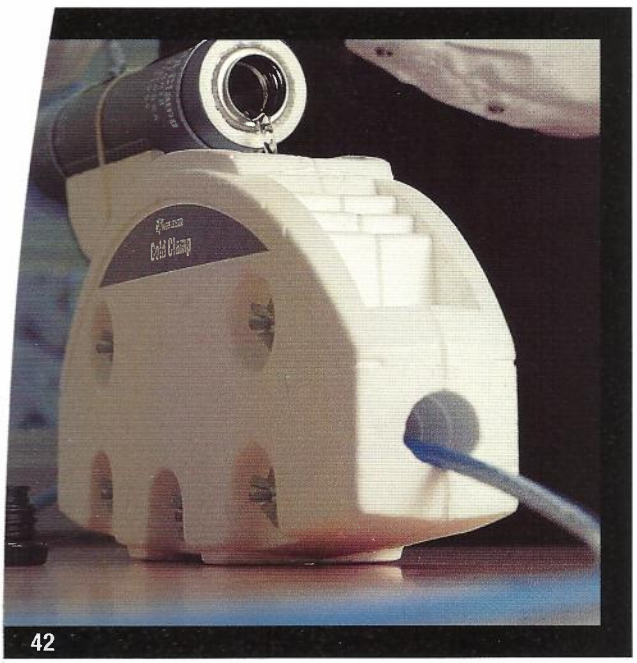
TELSTRA'S BIG POND™ IS THE CULMINATION OF A CONCENTRATED EFFORT BY TELSTRA

the world, as well as with Australian companies involved in the development of new products and services.



Working together

Increasingly, TRL is working directly with Telstra's business partners around the world, as well as with Australian companies involved in the development of new products and services.



> Through their detailed understanding of technology – and the impact of the technology on Telstra's network and the end-user–TRL researchers can identify and evaluate new technical developments of potential value for Telstra. They work closely with vendors and suppliers to adapt new software and equipment for Australia – ironing out idiomatic differences in automated voice prompts, for example.

> TRL researchers work closely with all Telstra business units that rely on its R&D to gain a leading edge over competitors. These in-house, project-based partnerships ensure that managers across the corporation have access to TRL's technology skills. Researchers benefit by gaining a deeper insight into Telstra's day-to-day operations, services and customers. With Telstra Multimedia Pty Limited and its suppliers, for example, TRL developed the Big Pond™ Cable broadband Internet service – from working prototype to commercial launch – in the space of four months.

> TRL's partnerships are not just commercial ventures. It contributes its expertise in research on the health effects of electromagnetic emissions from mobile phone towers and equipment to groups responsible for formulating national standards, and to medical and health groups responsible for developing safety guidelines.

> TRL researchers also maintain strong links with universities and research groups, locally and internationally.

WORKS CLOSELY WITH VENDORS AND SUPPLIERS TO ADAPT NEW SOFTWARE AND EQUIPMENT FOR AUSTRALIA

AN IMPROVED PERFORMANCE GUARANTEE FOR WAVE-DIVISION MULTIPLEXING (WDM) TRANSMISSION SYSTEMS

GUARANTEED PERFORMANCE FROM NEW OPTICAL FIBRE SYSTEMS

> TRL negotiated with one of Telstra's strategic business partners, Siemens, to obtain an improved performance guarantee for wave-division multiplexing (WDM) transmission systems. Telstra will incorporate optically amplified WDM systems in its inter-capital network from late 1998. WDM is able to transmit different wavelengths of light through the same infrastructure, offering increased capacity and reduced capital costs for Telstra.

> Due to TRL's input, Siemens' WDM transmission system is now designed to deliver world-class performance in terms of capacity, regenerator spacing, and fibre losses. Telstra is the first customer to implement this new product. Early commercial implementation will help reduce the costs of these systems and enable Telstra to tailor the product for its specific needs.

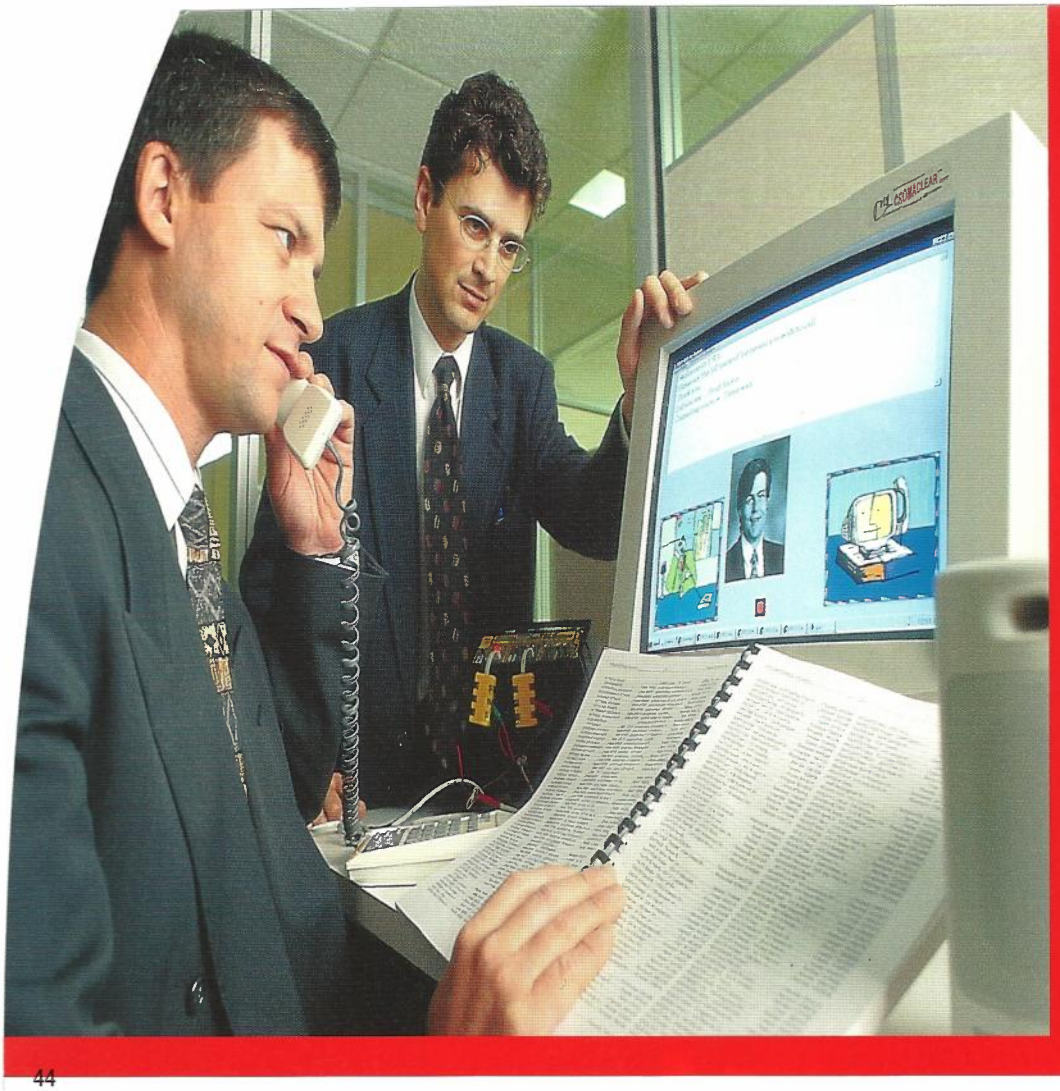
CONTRACTING R&D TO UNIVERSITIES AND CSIRO

> TRL focuses its in-house research in areas of particular competitive advantage to Telstra. In addition, it contracts research to outside groups in cases where the required expertise and facilities already exist, or where the research is more effectively located within a basic research environment.

> Research groups within universities based in Adelaide, Canberra, Sydney, Wollongong and Melbourne are currently working on Telstra projects through liaison with TRL. Telstra is also tapping into CSIRO's expertise in clay soils, and in construction technology.

> These research contracts will contribute to Telstra's business in many ways. Among the issues under investigation are more efficient ways of utilising mobile phone frequencies, optimisation of bandwidth and video transport in ATM networks, improved videoconferencing and collaborative work systems for the building industry, health effects of radio frequency radiation, new technologies for optical fibre networks, and customer-based quality of service in mobile and security networks.

MAINTAINS STRONG LINKS WITH UNIVERSITIES AND RESEARCH GROUPS IN AUSTRALIA AND OVERSEAS



TRL SOFTWARE SAVES MONEY FOR INTERNATIONAL PSTN ROUTING

> TRL has developed an optimal routing tool that takes advantage of the different telecommunications traffic 'lows' around the globe during the day to overflow traffic 'peaks' from country to country. The ORINT (Optimal Routing of International Network Traffic) tool has enabled Telstra, MCI (in the US) and BT (in the UK) to apply a traffic routing scheme that is saving the Australian carrier millions of dollars annually on the costs of multiplexers and transmission capacity.

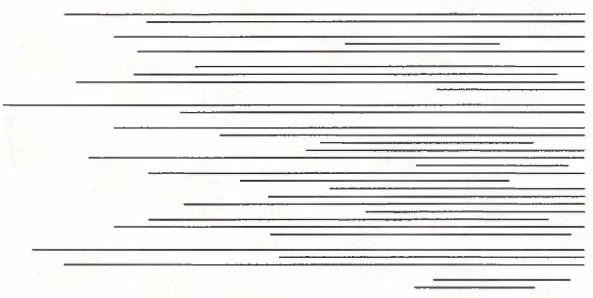
> In the past, telephone networks had to include enough permanent circuit capacity to handle peak volumes (often on Sundays in Australia), even though only a fraction of them are used during low-traffic periods. With ORINT, however, fewer circuits are required, because excess peak traffic can be directed via another country's network, which will be operating below its capacity (traffic peaks occur during week-days in the US and UK). Additional international arrangements are being considered to provide additional savings down the track for Telstra and other participants.

PC-VOICE TECHNOLOGY SCALED UP FOR CARRIER TRAFFIC

> There is a huge variation in the sound quality of voice over the Internet applications. TRL researchers had this in mind when choosing a commercial partner to develop a virtual second phone line service that will allow customers to browse the Net and make phone calls at the same time.

> After evaluating the products of several leading US firms, TRL selected Florida-based Netspeak, whose product proved technically superior in the lab. The product, however, was designed for very small networks. Researchers worked with the company to scale up the application to handle the much larger number of connections in Telstra's telephone network. To do this, TRL used its expertise in common channel signalling systems and large-scale telephone-Internet gateways.

> Telstra will benefit by being able to introduce a high-quality service for customers, and from commercial sales of the product.



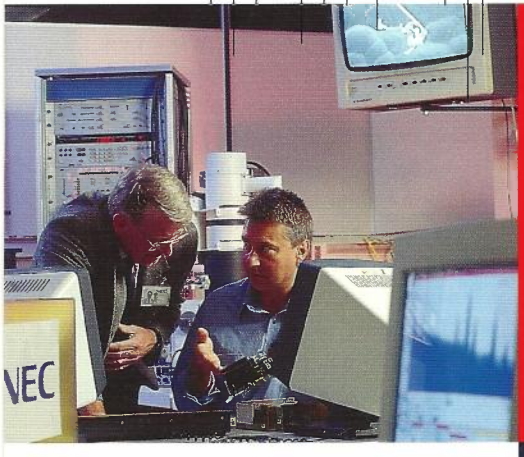
EXCESS PEAK TRAFFIC CAN BE DIRECTED VIA ANOTHER COUNTRY'S NETWORK

A SAFETY ALLIANCE

> Through TRL, Telstra can access the findings of the latest international and Australian research on electromagnetic emission, including TRL's own research.

> For example, TRL worked with other mobile phone carriers, the Australian Communications Authority and the hearing-impaired community to test the possibility of digital mobile phones interfering with hearing aids. This led to improved hearing-aid design and the development of a handset adaptor for easier mobile phone use. Researchers also worked with the Australian Therapeutic Goods Administration and the Royal Melbourne Hospital to determine a safe minimum distance between mobile phones and medical equipment such as heart pacemakers.

> Through TRL, Telstra is working with the peak industry body the Australian Mobile Telecommunications Association to develop standards and a consumer information resource on the safety of current and future mobile phone technologies.

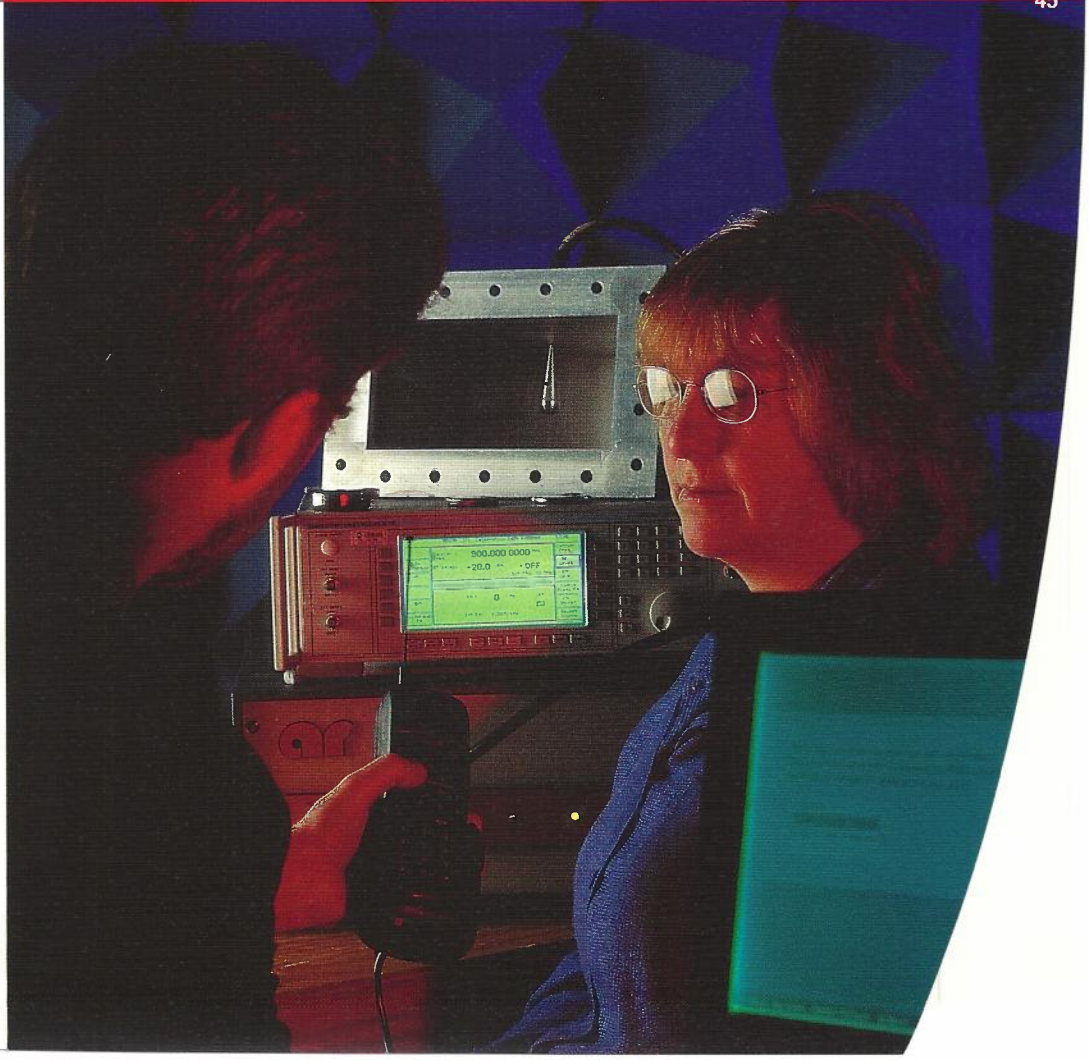


DEVELOPING STANDARDS AND A CONSUMER INFORMATION RESOURCE ON THE SAFETY OF CURRENT AND FUTURE MOBILE TECHNOLOGIES

THE TEAM BEHIND BIG POND™ CABLE

> The launch of Telstra's Big Pond™ Cable broadband Internet service last year was the culmination of a concentrated effort by Telstra Multimedia, TRL and suppliers to develop a world-first commercial service. TRL's contribution was advising Telstra Multimedia on 'best of breed' equipment, designing an end-to-end network architecture, carrying out systems integration, and developing the Web interface.

> For international companies Motorola, Hewlett-Packard and NEC, Big Pond™ Cable offered an opportunity to work with Telstra in building a world-class infrastructure. Australian multimedia developers also benefited from the applications guidelines made available to them by TRL, which designed the Big Pond™ Cable home page.



Much of Telstra's history as the nation's pioneering telecommunications service provider has to do with the conquest of distance and climate. Researchers at Telstra Research Laboratories have played a key role in helping Telstra overcome the problems of long distances, harsh environments and climate extremes that are unique to Australia.

> TRL began in June 1923, with the establishment of a one-person research unit within the former Postmaster-General's (PMG's) Department. Sidney Witt was given a charter to "study the latest discoveries, inventions, and developments in electrical communications" and to advise the PMG on those "which are promising and likely to benefit the Department's telephone and telegraph services".

> During the intervening decades, TRL played a key role in introducing television to Australia in 1956, in installing one of the world's first three electronic (stored-program control) exchanges in the Melbourne suburb of Windsor, and in developing one of the world's first digital radio telecommunications systems for the outback–a milestone in helping Australia defeat the tyranny of distance.

> For 75 years, TRL has maintained its pre-eminent role in Australian telecommunications research, and continues to do so in today's deregulated, competitive business environment. In fact, more than ever, TRL is being called on by Telstra to apply this tradition of excellence in research to the job of making communications easier and better for Australians adding value to the organisation for Telstra shareholders.

75 YEARS OF TELECOMMUNICATIONS RESEARCH

A great Australian Pioneer

MILES FROM NOWHERE, A PHONE CALL FROM THE WORLD

> In the 1970s, Telstra (then the Postmaster-General's Department) made a commitment to provide all Australians living in rural and remote areas with a reliable telephone service. At the time, people in the outback either did not have a telephone service, or used any of the 10,000 privately operated telephone lines, often made from fencing wire, bottle tops and hand-cranked magnetos.

> At the heart of Telstra's program was a digital radio concentrator system (DRCS), developed by TRL especially for Australia's sparsely settled land mass as a much cheaper alternative to a proposed satellite service. The system was based on the use of radio signals, beamed in concentrated bursts, to link customers to the nearest automatic exchange where calls were slotted into the national trunk network. Up to 13 repeaters were used in a single DRCS line, allowing a maximum distance of 600 km between the exchange and the customer. The mast, solar panels and radio transceiver used by customers of the service have become a symbol of modern telecommunications in the outback.

> To increase system capacity, Telstra later introduced a new generation of High Capacity Radio Concentrator Systems (HCRCS). Apart from connecting the outback to the rest of the world, the HCRCS has provided thousands of new telephone services to remote Aboriginal and Torres Strait islands communities.

THE MAKING OF PRIORITY™ ONE3

> In 1988, the South-East Queensland Electricity Board (SEQEB) asked Telstra for a service that could automatically connect calls to the service branch nearest a caller's location. Having no suitable off-the-shelf technology available, Telstra turned to the Research Laboratories to develop a solution. Within weeks, TRL researchers had produced a proof-of-concept, demonstrating how databases and telephone exchanges could be linked under computer control. This was an application of TRL's research into what was a new generation of telephony control systems–the first 'intelligent networks'.

> Soon, many businesses and government agencies had come to rely on Priority™ One3 for their communications needs. This presented Telstra with a new challenge–how to maintain service quality during rapid market growth. TRL worked with staff across Telstra to devise a 'war games' approach. By simulating the full range of possible customer responses and load conditions, they took the service platform to its limits in the laboratory, resulting in enhancements to the platform and to traffic management strategies. The Priority™ One3 platform is now able to deliver high-performance, robust, advanced services to corporate customers.

> Today, TRL supplies a modern version of the equipment used in the original prototype, and other technology components to support Priority™ One3 and related Telstra services. TRL has maintained close ties with in-house development groups that took the prototype service to commercial success.

'23

1923 Sidney Witt was given a charter to "study the latest discoveries, inventions, and developments in electrical communications".
> Established the PMG Department's first reference standards for telephone transmission performance and telephone quality assurance.

1925 Applied new repeater technology–the vacuum tube amplifier–to voice-frequency trunk service. Installed the first 3 channel carrier system in Australia on the Sydney-Melbourne trunk route.

1928 Set up Australia's first high-frequency (HF) radio transmitter station at Lyndhurst, Victoria. (In 1934 this station began to provide broadcast services to listeners beyond the reach of medium-frequency transmission).

1928 to '44 Carried out studies of telegraph systems, and multiplexing of telephony and telegraphy services over the network. Contributed to the establishment of an emergency telegraph service during World War II.

1935 Assisted in laying the coaxial submarine cable between the mainland and Tasmania via King Island–at the time, the longest submarine cable in the world.

1939 to '45 Assisted in developing radar systems and radio communications systems for armed services, including evaluating radio transmitters and receivers for air, ground and armoured vehicle use.

1940

1946 Conducted the first experimental studies of VHF mobile services.

'46

1923 1928 1933 1938 1943 47

1925 Engineered the first simultaneous interstate radio broadcast between Melbourne, Sydney, Brisbane and Adelaide via a network hook-up of six stations (2FC, 2BL, 3LO, 3AR, 4QG, 5CL).

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

1927 Engineered a national radio broadcast relay network for the opening of Parliament House, Canberra, by the Duke of York.
> Established facilities and standards for precise measurement and calibration of telecommunications test equipment.

1931 Began scientific research program–chemistry, metallurgy and applied physics. This became important for reliability assessment and quality control of telecommunications equipment.

1937 Engineered the first Australian 12 channel VHF (very high frequency) radio telephone system between Victoria and Tasmania–a distance of 168 miles across Bass Strait–to provide a service while the submarine cable was under repair.

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

'48

1948 Initiated Australia's first fax service – the 'picturegram' – between capital cities. The service was largely used by newspapers for transmitting news photographs.

1954 First telex service introduced to Australia (followed by international telex links in 1959).

1955 Received one of Australia's first samples of epoxy resin. Subsequent research and development produced a range of products and techniques for sealing and jointing cables.

'63

1959 First use of transistorised equipment in the Australian network on the Normanton - Burketown route.

1960 Began investigating digital coding and transmission using semiconductor devices. (Preliminary studies of digital coding and transmission led to the later introduction of Pulse Code Modulation – PCM – systems in the Australian network.)

1961 Designed and built a 20 line, experimental all-electronic PABX.

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

1968 Completed field trial and recommended introduction of nylon-jacketed cable, which was resistant to termites. (Previously, termites were a significant threat to plastic-sheathed cables in Australia.)

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

'56

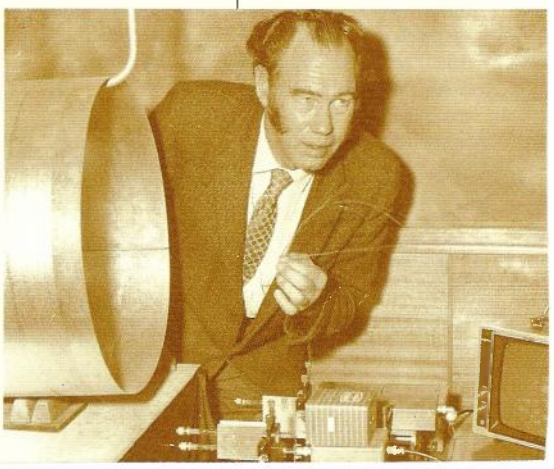
1956 First television broadcast in Australia. TRL played a key role – it recommended the adoption of the 625 line standard after years of research, including development of a video transmission test set in the early 1950s.

1962 Commenced first tests of data transmission over the switched analogue network, at speeds of up to 2,400 bits per second. This was focused on the NASA moon landings, for which TRL received NASA recognition. (Emphasis later shifted from transmission to data networks based on the analogue telephone network, particularly the Digital Data Network.)

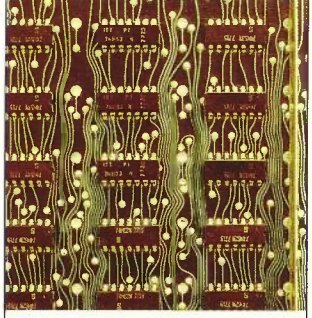
1967 Began participation in international CCITT (now ITU) field trial of a common channel signalling standard. This led to the design in the 1970s of the first fully electronic telephone exchange to switch live telephone traffic in Australia.

1971 Commenced investigations into use of optical fibre for communications.

1972 Developed prototype videoconferencing system, tested in satellite linked trials between Australia and the UK. Demonstrated transmission of analogue video signals over optical fibre.



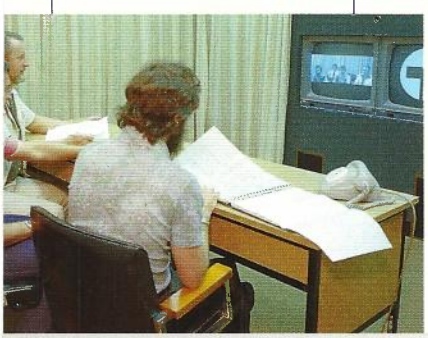
1973 Telstra commissioned an integrated switching and transmission (IST) model exchange, the first fully electronic telephone exchange to switch live telephone traffic in Australia. It incorporated digital switching and transmission (PCM – pulse code modulation) and stored programming control (SPC), the forerunner of computer-controlled switching. PCM reduced noise and crosstalk on telephone lines, and reduced the need for wiring between exchanges. SPC offered greater call control, with new features requiring additional software, not hard wiring.



1978 Commenced work on digital transmission in customer access network pair cables. This led to transmission network designs for basic rate ISDN in the access network.

1979 Developed specifications for digital radio concentrator system (DRCS) to provide telephony services to outback Australia.

> Evaluated packet switching techniques and protocols (forerunners of today's ATM technology) to prepare for the introduction of a national data network.



1983 Carried out significant studies of packet switching and multimedia requirements for digital networks, including use of electronic directories, encryption and access control.

> Recommended that Telstra construct an all-digital network.

1984 Telstra introduced Digital Radio Concentrator System service to outback Australia.

> TRL demonstrated that gel type filling compounds widely used in the US for waterproofing cables were not suitable for Australian environments, and demonstrated superior performance of Australian made compounds.

1985 Began investigating the use of the ATM (asynchronous transfer mode) packet switching platform to support potential interactive multimedia services.

1988 Began investigating the technical and economic viability of satellite-based mobile communications to remote areas using helicopter-borne test transmitters.

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

1989 Developed expert system, EXPRES, to enable field staff to locate faults in cable plant faster and more precisely, resulting in more efficient repairs and preventative maintenance of external cable plant.

1993 FMO (Future Mode of Operation) project announced – Telstra to build an all digital network that will support broadband video services to the home, telecommuting, telemedicine, distance education, videophones, and enable call waiting, call forwarding, caller identification and multi-party conferencing. TRL provided key technical advice on FMO digital standards, switching and intelligent networks.

1994 Carried out field trial of ADSL (asymmetric digital subscriber line) for delivery of video services to the home over the copper network.

> Developed an easy to use helpdesk system for use by customer services staff in Mobile Communications Services.

1973 1978 1983 1988 1993

1995 Began building the ATM-based Experimental Broadband Network (EBN) and connecting R&D customers to the trial.

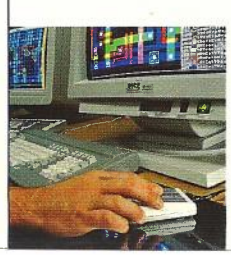
> TRL was one of two telco R&D groups globally to develop the concept of passive optical networks (PONs) for home access. Researchers here later pioneered the development of a prototype fibre access system (MACNET) to demonstrate PON architecture for laying optical fibre to the home, which was trialled at Wollongong. PONs have since been recognised internationally by the ITU to reduce the amount of fibre and optoelectronics required for optical access to clusters of homes.

> Developed high-level security system for electronic funds transfer (EFTPOS) services based on public key cryptography.

1987 Evaluated speech privacy systems for analogue and digital networks, which led to the development of the SpeakEasy speech privacy product.

1981 Experimental optical fibre link installed between two exchanges near TRL for testing and evaluation. TRL recommended use of single mode optical fibre for the long distance network, making Telstra one of the first telcos in the world to install single mode optical fibre networks in the mid to late 1980s.

1990 Investigated environmentally appropriate options for protecting the optical fibre cable link between Perth and Adelaide from service disruptions caused by the native 'Christmas tree', a parasitic plant with roots adapted to slice through host plant roots (or cables). Another in a series of projects aimed at protecting telecommunications lines and equipment from Australia's climate extremes, vegetation, termites, parrots, wombats, native rats and expansive soils.



1996 Collaborated with Telstra Multimedia to develop Australia's first broadband Internet service – Big Pond™ Cable.

> Initiated work on Plain English interface to White Pages™ and Yellow Pages® directories, which allows for widespread variation in words and phrases used in common search queries.

> Solved potentially costly traffic overload problems associated with Priority™ One3 platform.

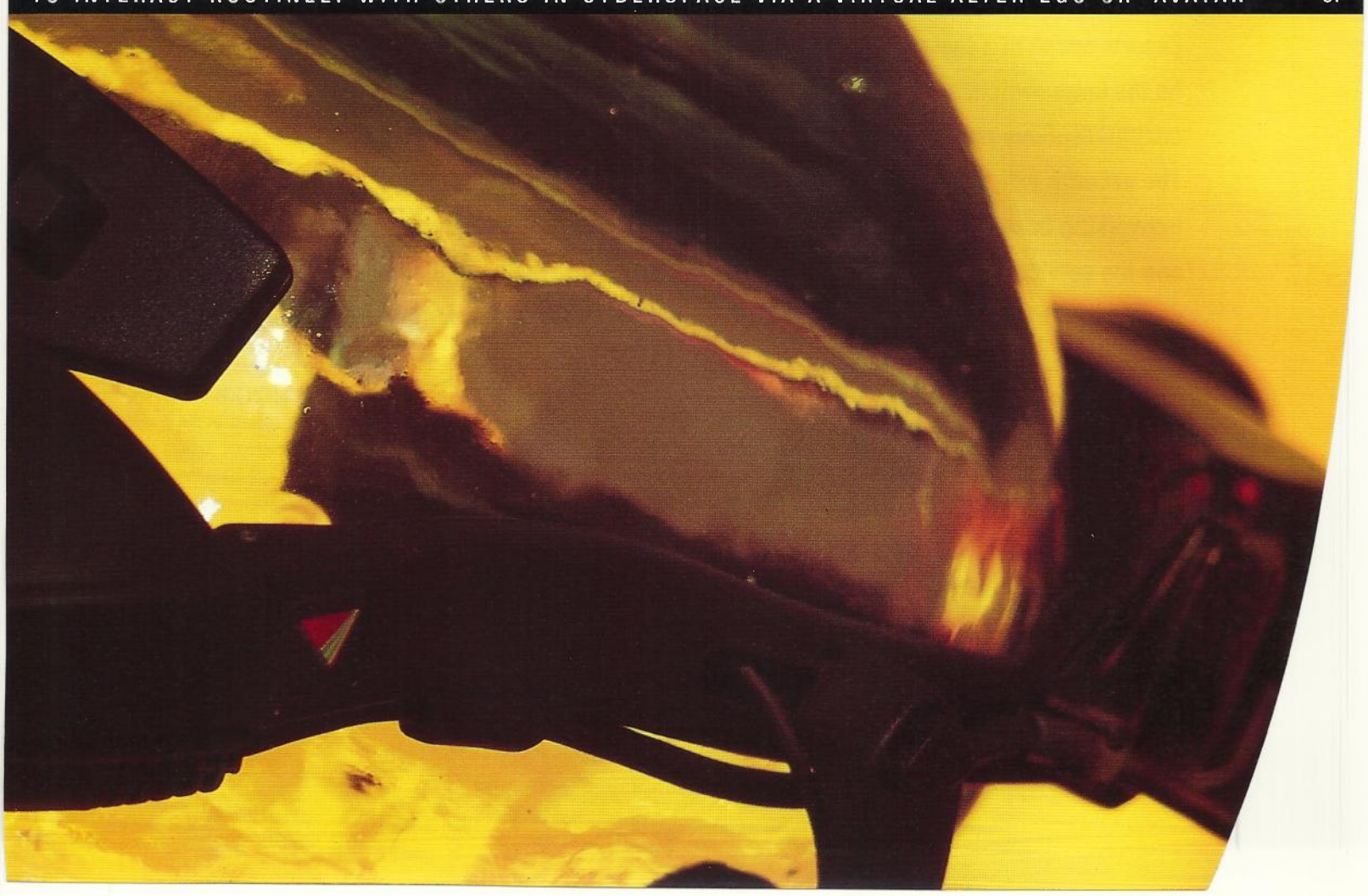
TAKING COMMUNICATIONS INTO THE 21st CENTURY

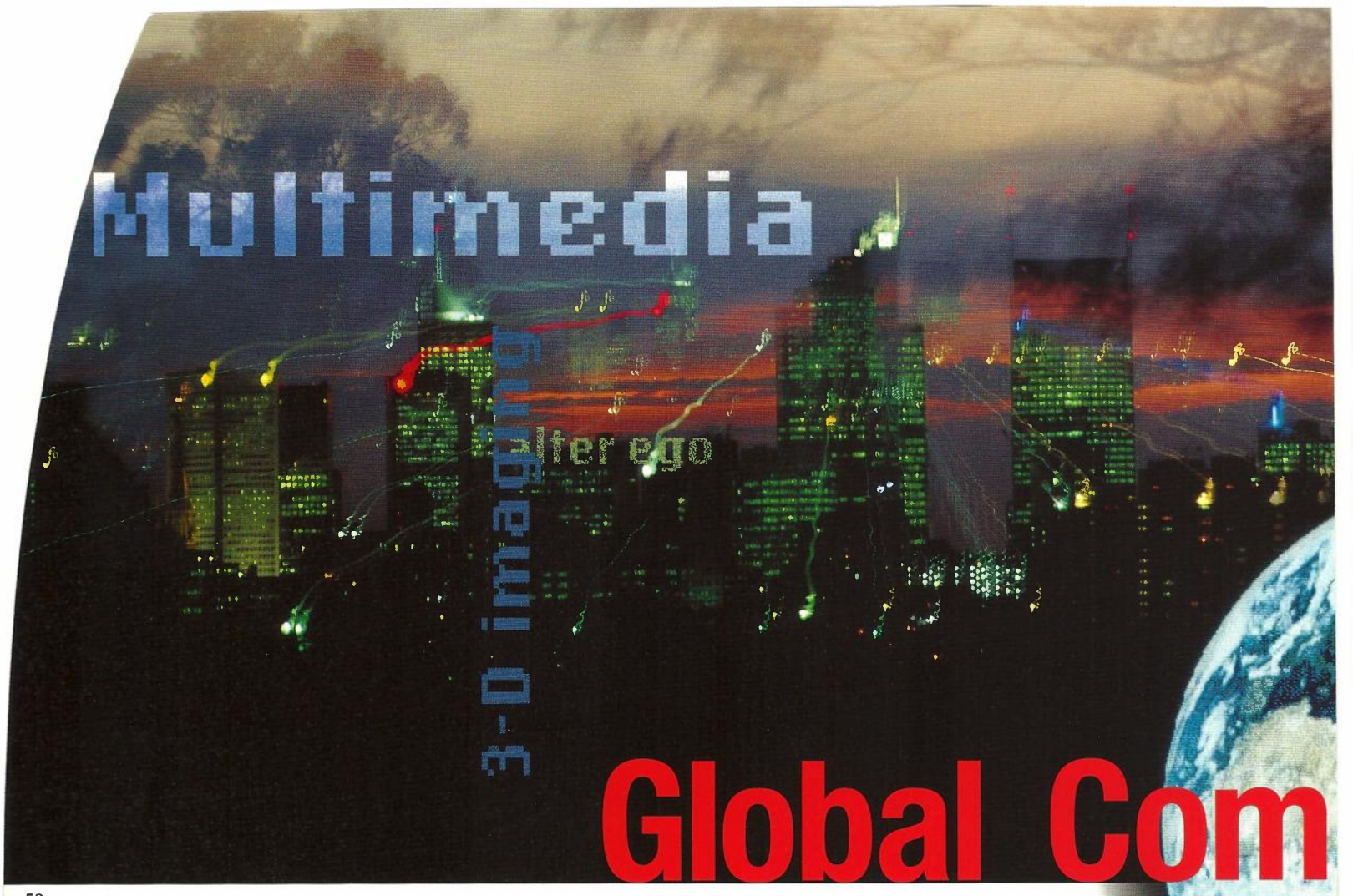
On the verge of a new millennium, it's hard not to be excited at the prospect of what lies ahead in telecommunications. The Internet has brought data communications into the home and the world's communications infrastructure is converging – and moving information faster than ever before.

DEVELOPMENTS IN VIRTUAL REALITY MAY SOON MAKE IT POSSIBLE FOR A COMPUTER USER

> Traditional boundaries between the telephone system, computers, TV and radio have been banished by the Internet, by wireless technologies, by pay TV, by cable modems, by ADSL broadband-over-copper and by intelligence – in the form of advanced software – integrated into the network.

TO INTERACT ROUTINELY WITH OTHERS IN CYBERSPACE VIA A VIRTUAL ALTER EGO OR 'AVATAR' 51





Experts speak of a massive paradigm shift within the next 12 years. Gone will be the large switches and transmission lines of the past. In their place – a global communications platform in which computation and storage are ubiquitous. The network will become simpler, with the development of more advanced information networking infrastructure ('middleware') to facilitate interaction between the end-user and the services they access. Telstra, through TRL, has become a national leader in the deployment of intelligent networks, security systems and corporate intranet systems.

> Applications software may also be distributed throughout the network. Just as computer users today can download software applications and upgrades from the Net, network-resident software may become commonplace, requiring less electronic storage space at the desktop.

> With digital TV, video signals will be streamed faster and processed more readily for use in small-screen or wall-sized applications. Once real-time image quality and movement come to resemble 'the real thing', videoconferencing and collaborative online working will become more compelling. Participants will be able to see non-verbal cues and detail as readily as in a face-to-face meeting. People may soon be routinely surfing the Net through their TV set, using a hand-held remote control instead of a keyboard, downloading TV programs, movies and a range of video-based services.

> Interfaces will become more intuitive, continuing current trends in graphical browsers, multimedia information retrieval and virtual reality. Developments in virtual reality and 3D imaging may soon make it possible for a computer user to routinely interact with others in cyberspace via a virtual alter ego or 'avatar'. Early next century, a Year 8 student may explore the relationship between the planets in our solar system by plugging into a simulation that enables them to 'grow' to a height of thousands of kilometres, and 'stride' through the solar system at the speed of light.

> Small Software programs, known as intelligent agents, will roam the internet on our behalf, interacting with each other to negotiate transactions, authorise agreement and package information in a convenient form.

networking infrastructure

> TRL is investigating the use of new high data-rate wireless technologies for mobile multimedia communication (mobile videophones, for example), and for wireless connections to the Internet and office local area networks (LANs). One future scenario – you unpack your new PC or Internet terminal, switch it on, and the latest software applications and operating system are automatically downloaded from the Internet over the airwaves.

> The longer-term prospect is that we will one day be walking around 'online'. Instead of computer screens, we may view information and images via retinal displays, in which a stream of photons from light-emitting diodes is modulated and scanned directly across the retina. Another possibility is a small cylindrical mobile unit with roll-out screen and intelligent agent technology for anywhere, anytime videotelephony.

> Then there is the prospect of auto-navigation. Already, new cars are being fitted with global positioning satellite systems that pinpoint a car's position on an electronic map. With the recent scaling down of microprocessors, the electronics for such systems may soon fit into a single silicon chip, embedded in a cellular mobile phone. This would enable users to query the Internet for information about local weather conditions, banks or restaurants in the immediate vicinity.

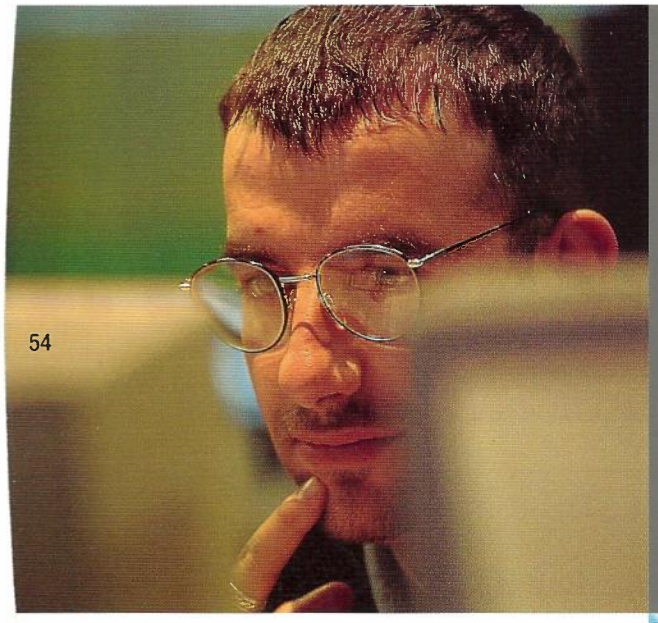
munications Platform

MANAGING VIDEO SERVICES OVER THE INTERNET

> TRL researchers have been working with Telstra Multimedia to develop a content management system for delivering video services over the Internet. The system could work over Big Pond™ Cable (Telstra's cable modem service) or ADSL (Asymmetric Digital Subscriber Loop) platforms.

> The project involves the development of a video-program indexing and management system – known as VISTA (Video Integration with Stored Text Access) – and streaming of video over IP (Internet Protocol) networks. An example of how the system could work is a prospective home-buyer inspecting houses remotely over the Internet. The buyer would access a server holding video footage of houses for sale, and 'inspect' selected homes while accessing relevant text and audio information. The system would have VCR-type controls (pause, rewind, etc.) and interface with standard Internet browsers.

> Both customers and advertisers would benefit from a personalisation function, which delivers information on local services in the caller's area. The system could be used for accessing archived programs, and for training, distance education and travel services.



DIRECTORY THAT SPELLS IT OUT FOR YOU

> TRL researchers are collaborating with Telstra business units to introduce speech recognition interfaces to Telstra services that respond to simple directory queries from the general public. TRL developed one of these systems using its own speech-recognisor algorithm and a database of recordings – of numbers, letters and basic control words – spoken over the phone by a sample group of 2,000 Australians.

> Researchers have tested the speech recognition system as an interface to Telstra's White Pages™ and Yellow Pages® directories. Callers simply spell a surname. An automated interactive voice response (IVR) system confirms the name, or, in the case of matching entries, prompts the caller for further details. When the system locates the name, it reads out the phone number or connects the caller.

> TRL is also evaluating a spoken name – as distinct from spelt-name – speech recognition system. The aim is to include a speech interface in the next release of TRL's successful View500™ corporate electronic directory. Apart from mobile phone users, the many Australians who still use rotary dial telephones will be among those to benefit from the new speech interfaces.

HARD ROCK MAKES RIPPLES IN BIG POND

>'Streaming' audio and video means that content can be accessed while a file is being downloaded. This ensures a continuous, rapid supply of images and sound. TRL has developed and demonstrated the delivery of live 'broadcasts' via Telstra's Big Pond™ Internet service. The first broadcast in late 1997 – in collaboration with FOX FM's 'net@nite' program – was a live concert at Melbourne's Hard Rock Cafe. This was simulcast throughout Australia on FM radio and throughout the world on the Internet. While Telstra's Retail Products and Marketing unit managed the project, TRL implemented it for the first broadcast.

SHARING VIRTUAL WORLDS

> The term 'virtual reality' refers to technologies that enable humans to visualise, manipulate and interact with computers and extremely complex data. This is usually via a computer-generated 3D environment. Virtual worlds offer visual, auditory and other sensual outputs to users, and allow for input and interaction from the user. The user's 'view' of the virtual world is updated in real-time in response to each input.

> For networked computers, distributed, multi-user, virtual environments are a possibility. TRL has been investigating and evaluating developments in this area. This technology has enormous potential for a range of applications – education and training, tourism, medicine – particularly over high-bandwidth networks.

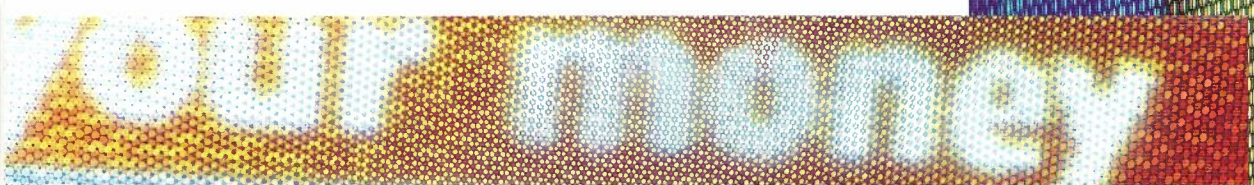
> However, before such applications become a commercial reality, research is needed into a number of issues. These include suitable protocols, navigation and interaction in 3D, 'useability' aspects of virtual environments and multi-party audio communication. TRL plans to investigate these areas in order to develop a prototype, multi-user, virtual environment that would form the basis of future applications delivered over Telstra's network.

BRINGING THE FUTURE INTO FOCUS

Where will the communications industry be in the year 2002? No-one can say for sure. This makes planning for the future difficult, particularly when companies such as Telstra must invest large sums of money in projects with long lead times.

> TRL researchers have attempted to identify the most important forces – economic, market, regulatory and technological – that will influence the global communications industry up to the year 2002. They came up with four principal business 'scenarios' for the future. Each is determined by a unique combination of different factors, such as whether the future industry will be open or closed, and whether the market will demand basic (e.g. telephony) or sophisticated (e.g. multimedia) services.

> Scenarios are stories that describe possible futures. They enable Telstra to confirm that its business plans are robust and to develop contingency plans for improbable, but significant, events. Telstra has integrated scenario planning into its corporate planning cycle.



GOING DIGITAL

> One way to enhance the current pay TV service is by making it digital. Digital TV has a sharper picture quality – being less sensitive to electromagnetic interference – than the conventional analogue TV used in today's pay TV services. Further, through video compression and digital processing, a single digital TV channel can squeeze into a bandwidth one-seventh the size normally required for an analogue channel. This frees up capacity in a cable TV network for new services such as near-video-on-demand and virtual shopping malls.

> Digital TV is still an emerging technology, and TRL has been investigating the network requirements to deliver it over the pay TV network. This has included network dimensioning to maintain other services such as Big Pond™ Cable. Other work involves systems integration of telecommunications, video and optical fibre/cable technologies to guarantee high transmission quality. Transmission quality is a more important factor in video-based services than in broadband Internet services.

Glossary

> ACA (Australian Communications Authority)
National regulatory authority for Australian telecommunications and radio communications, responsible for adherence to technical standards and use of radio-frequency spectrum. (ACA incorporates the former AUSTEL and Spectrum Management Agency.)

> ADSL (Asymmetric Digital Subscriber Loop)
A technology that enables the copper telephone network to carry datastreams of up to 6 Mbit/s eg video signals.

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

> Big Pond Cable™
Trademark name of Telstra's broadband Internet service delivered over the hybrid optical fibre/coaxial cable pay TV network via a cable modem at the customer end.

> Big Pond intranet™
Trademark name of a Telstra service that offers organisations of different sizes a private, cost-effective intranet, secured from the public Internet via a firewall, yet enabling users to communicate via common Internet tools such as e-mail, Web browsers, etc.

> bit
Short for binary digit–the smallest unit of digital information used by information processing, storage and transmission systems. The binary system uses only '0' and '1' to represent all possible quantities. A byte is made up of eight bits and represents the equivalent of one text character.

> broadband
A general term used to describe transmission at bandwidths higher than 2 Mbit/s (eg high-speed data and video services).

> browser
Computer application program offering easy-to-use tools for exploring and retrieving information over the Internet. Microsoft® Internet Explorer and Netscape Navigator™ are the most widely used browsers.

> cable modem
A device used for high-speed connections between PCs and the Internet over the pay TV network. Can deliver data at up to 100 times the speed of standard telephone modems.

> caching/caches
Electronic storage areas that maintain frequently accessed data available for local retrieval. Caches enable faster retrieval of Web pages faster by accessing information stored locally, instead of reloading the page from the original server, which may be on the other side of the globe.

> coaxial cable
Contains 2 to 18 coaxial tubes, each consisting of a copper wire conductor inside an insulated copper tube. This high-capacity cable is used in combination with optical fibre (see HFC) in the Foxtel pay TV network.

> DAVIC (Digital Audio Visual Council)
An international body–comprising the world's major telecommunications, computing, software, cable and consumer electronics organisations–that assesses the architectures, interfaces and protocols required for digital broadband service delivery over an open network environment.

> DECT (Digital Enhanced Cordless Telecommunications)
A European cordless communication standard that may be used in future PCS networks.

> digital
A method of storing, processing and transmitting information through the use of distinct electronic or optical pulses that represent the binary digits (bits) '0' and '1'. Digital technologies employ discrete pulses to represent information, as opposed to the continuously variable signals of analogue technologies.

> DRCS (Digital Radio Concentrator System)
Radio telephone system developed by TRL specifically for rural and remote access in outback Australia. Used radio signals beamed in bursts by solar-powered repeater towers 40 to 50 km apart.

> EBN (Experimental Broadband Network)
A non-commercial Telstra network managed by TRL, that used ATM technology to support a range of new multimedia and data services such as video retrieval, remote medical diagnosis and supercomputing networking.

> firewall
Network security system comprising software and hardware to control the flow of data between a private network and the Internet.

> frame relay
A simplified packet transport protocol used to connect local area networks (LANs) over large distances.

> GSM (Global System for Mobile Communications)
European digital standard for mobile phones based on time division multiple access (TDMA). TDMA allows several conversations to share a single radio channel by each transmitting digitised voice within its allocated timeslot.

> HFC (hybrid fibre coaxial cable)
A shared broadband access architecture using optical fibre between exchanges and hubs in suburban streets, and coaxial cables between the hubs and customers to carry Foxtel pay TV and Big Pond Cable services.

> HTML (HyperText Markup Language)
A computer language used to write and format pages for Web publication. Incorporates Web features such as hyperlinks, frames, headings, etc.

> intelligent agent
An advanced software system that is capable of performing tasks on behalf of a user in accordance with predefined roles. This may include selective information retrieval or easier navigation; problem solving, for example, finding faults in networks; and tailoring information for users through multimedia presentation.

> IN (intelligent network)
A telecommunications network architecture that employs computers to customise telecom services for unique user needs, or to create and implement new types of telecommunications services in response to market demand.

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

> IP (Internet Protocol)
Part of the TCP/IP family of protocols describing software that tracks Internet addresses, directs outgoing messages, and recognises incoming messages. Current version is IPv4; next version will be IPv6. Used in gateways to connect networks at a high level.

> IP address
A unique set of digits (eg 123.123.12.1) identifying a computer connected to a network, and used by communications programs. Human users communicate through more friendly domain names (eg person@company.com.au), which are automatically translated into the IP address.

> ITU (International Telecommunications Union)
An international standards body established by the United Nations which aims to establish standardised communication procedures and practices worldwide.

> IVR (interactive voice response)
Automated customer service or information selection based on pre-recorded voice prompts controlled by a touch-tone telephone or voice-recognition system.

> LAN (Local Area Network)
A short-range (typically within an office or building) high-bandwidth communications network that links computers, printers and other peripheral devices under central control.

> 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 a million bits per second; a gigabit, a thousand million bits.

> multicast
New delivery mode for delay sensitive multimedia services to large user groups (such as video on demand, which requires instant playback, etc). Enabled by new Internet protocols such as RTP.

> 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).

> narrowband
Communication technologies with a data transmission capacity of under 1 Mbit/s. Includes online interactive services (eg 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 contains up to 120 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 switching
On a packet-switched network, data is packaged and routed in 'blocks' or packets, each having a header with the network destination address.

> PCS (personal communication services)
A term used to describe an intelligent, digital, two-way wireless telecommunications system that may make 'one-number, anytime, anywhere' communications possible. The concept includes cordless telephones, cellular mobile phones, paging systems and intelligent 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.

> QPSX (Queued Packet Synchronous Exchange)
Broadband packet switching standard developed by the University of Western Australia (with Telstra/TRL) as an alternative to frame relay, ATM, etc. The basis of Telstra's Fastpac™ product.

> 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.

> repeater

A device used to amplify and equalise an analogue communication signal that has been weakened and distorted through a long circuit. Similar function to a regenerator in digital systems.

> RSVP (Resource Reservation Protocol)

An international signalling scheme that provides network applications with a means of 'asking' routers to reserve bandwidth.

> RTP (Real Time Protocol)

Provides end-to-end network transport suitable for applications transmitting real-time data over multicast networks. RTP leaves resource reservation and quality of service functions to RSVP.

> SDH (Synchronous Digital Hierarchy)

A standard for high-speed digital transmission at a series of transmission rates. Created by the ITU flexibly and efficiently to transport many digital signals at once, and facilitate interworking of transmission products from multiple vendors.

> SIM (Subscriber Identity Module)

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

> SME

Small to medium sized enterprise.

> SOHO

Small office, home office segment of business market.

> SPC (Stored Program Control)

Solid state computer controller for earlier electronic telephone and telex exchanges.

> Usenet

Short for 'users network'. UseNet is the Internet's biggest bulletin board system, networking tens of thousands of newsgroups worldwide, and accessed by millions of Internet users every day.

> video compression

A method of transmitting analogue 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.

> WDM (wavelength division multiplexing)

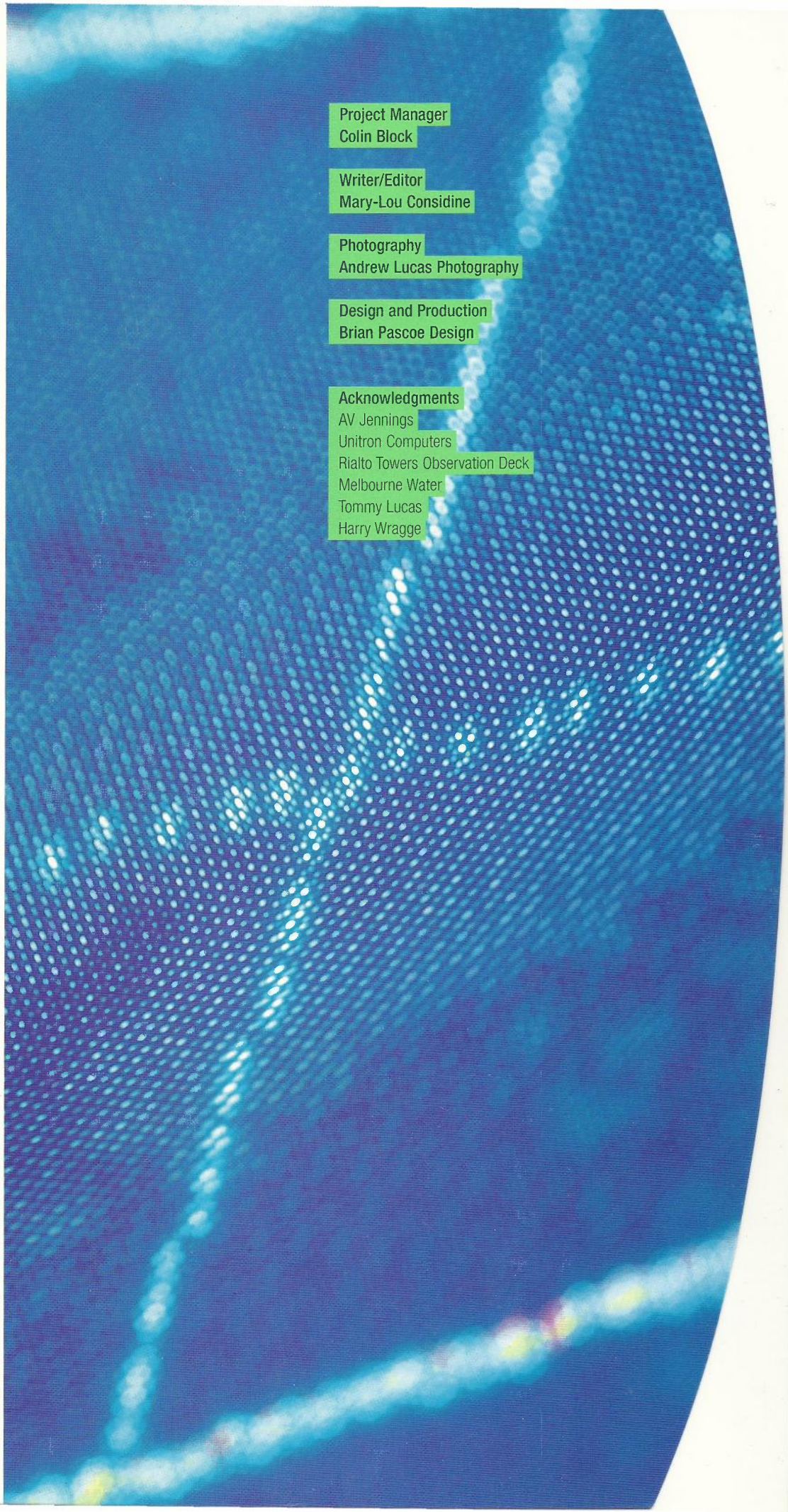
Technique used in optical fibre transmission for using different wavelengths of light to send data, increasing network capacity without the need for laying new cable.

> World Wide Web (WWW or the Web)

A series of interlinked computer sites which display text, graphics, images and sound. Users browse the sites via a graphical user interface. Web sites are like multimedia magazines, with additional interactive features and links to other sites.

> X.500

An ITU standard that governs the user directory structure in e-mail and electronic systems. In theory, any e-mail user directory structured according to the X.500 rules can be consulted by any other standard-compliant e-mail system. The basis of TRL's successful View500™ directory system.



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