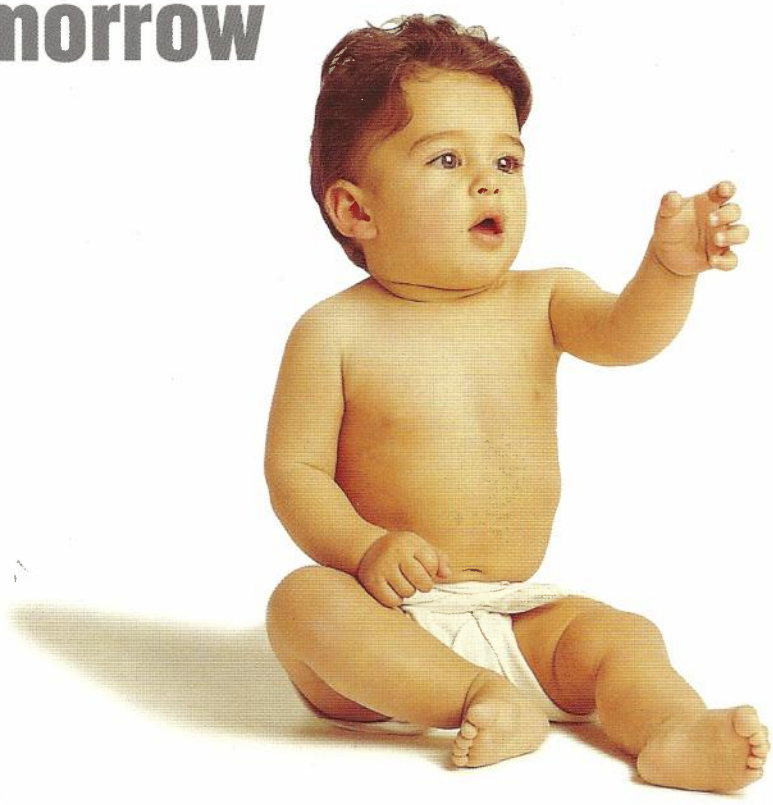
New Horizons

We are developing **initiatives** today
that will **enhance** their world
tomorrow



Telstra
Research
Laboratories

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CURRENT INITIATIVES AND HIGHLIGHTS

1 *TRL is the base for Telstra's field trial of ADSL – a revolutionary system for delivering video images through the telephone network. Another key technology under investigation is the TV 'set-top box' – the 'interface' through which customers will access interactive multimedia services such as tele-learning.*

2 *To deliver multimedia, TRL has been assessing a fast switching technology known as ATM – asynchronous transfer mode – which can support integrated packets of video, voice, data and text. TRL is helping Telstra set up and operate an ATM-based experimental broadband network, Australia's first large-scale test platform for multimedia applications.*

3 *TRL is playing a leading global role in defining TINA – telecommunications information networking architecture – a new 'universal' software architecture that will pave the way for the convergence of computing, communications, broadcasting and advanced network management. TRL was the site of the world's first TINA auxiliary project, PLATyPus, which produced a set of software engineering tools demonstrated to the international TINA community in early 1995.*

4 *TRL has developed one of the world's first corporate electronic directories based on X.500 standards devised by the International Telecommunications Union (ITU). Now being marketed by Testra's National Directory Services, the on-line directory is a major step towards so-called 'intelligent agents' – intuitive visual tools that will select and retrieve information from the world's databases.*

5 *TRL has developed a comprehensive Human Factors Kit – a detailed set of style guidelines for systems designers to use in the development of new software for Telstra, contributing to corporate efficiency and consistency. The Kit is part of TRL's move into investigating the usability of technology and systems as an integral part of services design.*

6 *TRL's expertise in optical amplifier and pre-amplifier equipment enabled it to recommend a radical 'repeater-free' option for Telstra's planned optical fibre link to Tasmania. The recommendation will save Telstra millions of dollars in construction costs and allow it to more easily increase transmission speeds and upgrade the link in future.*

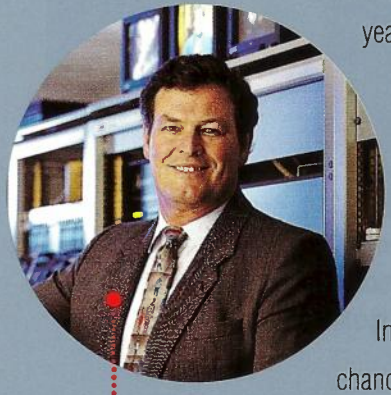
DIRECTOR'S FOREWORD

"The communications network...will enable the consciousness of our grandchildren to flicker like lightning back and forth across the face of this planet. They will be able to go anywhere and meet anyone at any time without stirring from their homes. All the museums and libraries of the world will be extensions of their living rooms."

ARTHUR C. CLARKE, VOICES FROM THE SKY, HARPER & ROW (1965)

The author of *2001: A Space Odyssey* would no doubt be pleased that his vision of a world connected by instantaneous communications – a post-Internet world in which a 12-year old in Melbourne can as easily chat with a friend in the U.S. or browse through an overseas library as he can peruse a textbook – did arrive as predicted.

This leap from vision to reality has been exponential, not gradual. The most sweeping changes in communications over the past three decades have been compressed into the short space of the past few years. Today, technology is changing at a rate that would not have seemed possible 30 years ago, when vacuum tubes were more familiar than transistors, and microelectronics were unheard of.



NOEL TEEDE

Our home and business environments continually remind us of this. Over the past few years, pay TV, open learning, cellular mobile phones, voice-based services and other options have brought home communications to a level of sophistication that was once the preserve of business. Businesses meanwhile are taking advantage of new network services that are slowly collapsing the distance between supplier and customer. The 'virtual enterprise' – based on electronic networks rather than bricks and mortar – is with us.

In today's telecommunications industry, if you think something will happen tomorrow, chances are it will happen this afternoon. And as Australia's pre-eminent telecommunications provider, Telstra is right in the thick of it, making major decisions about future directions within shorter and shorter timeframes. Never in its history has Telstra had to develop so fast, with such an intense focus on so many fronts simultaneously.

Apart from forging alliances and partnerships with the world's top media and information technology players, Telstra is meeting the challenge of change by making significant

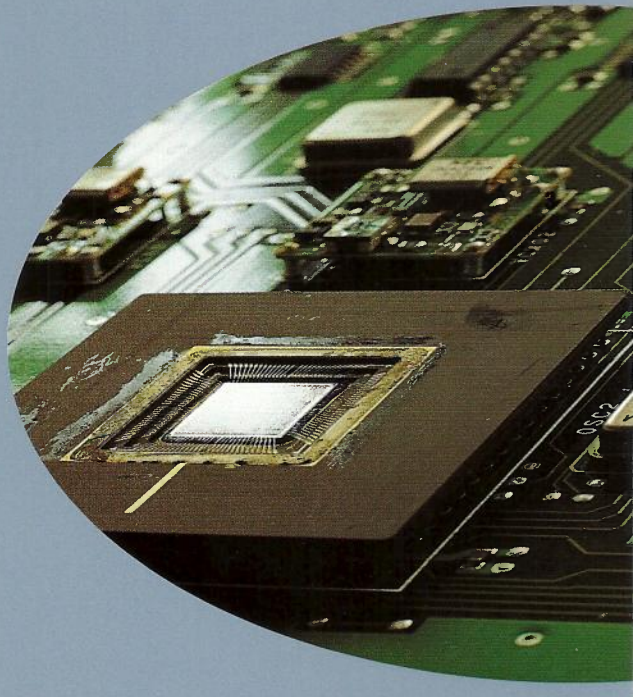
investments in technology, taking the information superhighway to the doorstep of Australian homes and businesses.

This is why the knowledge base at TRL (Telstra Research Laboratories) is so vital to Telstra's success. TRL brings world-class technological expertise to bear on Telstra's investment decisions, making sure those decisions are leading us down a logical evolutionary path. Increasingly TRL is being asked to evaluate alternative network architectures and weigh up the respective risks. Increasingly, TRL is being tied to Telstra's business to extend new strategic initiatives.

Customers won't have to wait 30 years for the next quantum leap in communications. TRL is showcasing emerging technologies to Telstra's business units through its research trials, many of them among the most advanced of their kind. Through such trials, feasibility studies and demonstrations, Telstra can preview new technologies to get a better feel for their potential and limitations. These include the technologies that will allow Telstra to deliver future full integrated interactive multimedia services.

Showcasing technologies is only a part of our job. TRL acts as a strategic resource to Telstra, providing technological advice, collaborating with industry and universities, developing technical standards and operating corporate resources such as NIRC (Telstra's National Information Resource Centre).

Through its vision of the future, its technological expertise, its selective development of technology and its leadership in national and international standards activities, TRL is continuing to help drive Telstra's growth and build its competitive advantage in the marketplace.



NOEL TEEDE
DIRECTOR, TELSTRA RESEARCH LABORATORIES (TRL)


Roast Chicken
at $4.99/Kg
Quantity: 1 Kg
Ordered
Total: $4.99
NEXT ITEM

WHAT IS TRL?

TRL—Telstra Research Laboratories—is the corporate research and development arm of Telstra Corporation Limited, Australia's largest telecommunications carrier. TRL is regarded by many as Australia's foremost centre for telecommunications research and engineering.

TRL researchers and engineers work in partnership with Telstra business units to critically evaluate new communications technologies and standards emerging globally, selecting only those best suited to the needs of Telstra's customers.

This application-focused research enables Telstra to get some way up the 'learning curve' before it actually introduces a new technology or standard. This means a higher return on investment for the organisation and better quality service for users.

For instance, Telstra is spending billions of dollars to modernise its network—taking optical fibre closer to homes and businesses, digitalising the network (now more than 50 percent digitalised), adding multimedia 'muscle' to the network and introducing higher levels of artificial intelligence and control. Proper testing and development of equipment and systems will ensure that this is money well spent.

In some strategic areas of technology—such as security of electronic information—overseas developments may be protected by export restrictions. In cases like these, TRL's strength as a research resource is critical, enabling Telstra to remain competitive within a deregulated global market.

Technical standards are playing an increasingly important role in the convergence of telecommunications, computing and broadcasting, ensuring that all parts of the future full service network will be compatible. Universal standards pave the way for a seamless, integrated and open environment for electronic communication: customers can be reassured they won't be 'locked in' by competing proprietary standards.

TRL represents Telstra on a number of key international standards bodies that formulate specifications for video compression, end-to-end operability, electronic directories, optical fibre transmission and broadband delivery.

What will new technologies do for Telstra's customers?

Teams of engineers, scientists, software and artificial intelligence experts, mathematicians, psychologists and technical officers collaborate with internal corporate Telstra 'customers' in planning new products and services. They test new technologies in the laboratory. They adapt selected technologies to the unique conditions under which they need to operate in the Telstra network and in the Australian environment. They initiate exploratory research trials that enable Telstra business units to assess the potential and limitations of new developments. They provide technical support to Telstra's field trials.

TRL also plays a major role in assisting Telstra to manage its huge investment in infrastructure—from standard telephone handsets to the most advanced optical fibre networks and optoelectronic switches. Without a reliable network to deliver it, even the most advanced service will fail to win customers.

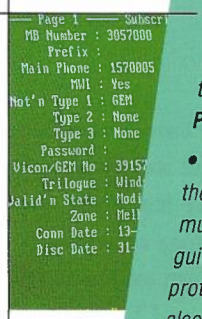
Throughout 1994, TRL continued to initiate research trials and participate in field trials designed to test the performance of emerging technologies and standards that will enable Telstra to deliver future visual and interactive services like teleshopping and video-on-demand.

Now part of Telstra's Research and Information Technology area, TRL works closely with the organisation's

Information Technology Group, which is responsible for designing the operating support systems that add intelligence and power to the network 'hardware' and to customer support functions. About 70 percent of TRL's research is funded by Telstra business units. The remaining 30 percent is supported by discretionary funding allocated for longer-term strategic research.

TRL has been restructured to reflect Telstra's focus on maintaining shareholder value over the next few critical years up to and following full market deregulation.

The Laboratories now organise research programs and skills through a matrix structure designed to retain the strengths of skill-based sections, yet promote a greater multidisciplinary research effort, providing more scope for collaboration with Telstra business units. With research skills now concentrated on fewer strategic corporate



TEST THE PERFORMANCE OF EMERGING TECHNOLOGIES

areas and with liaison to be enhanced by the appointment of business managers, TRL can better focus on corporate needs.

NIRC, Telstra's National Information Resource Centre, is located at TRL. Using sophisticated database management and information retrieval programs, NIRC staff can efficiently locate and compile timely reports on changes within the industry, on new technologies and on activities of other companies and competitors.

Throughout the past year, TRL continued to fund research and fellowships within Australian universities. This helps strengthen Telstra's current and future skills base in telecommunications, which will become more important as development cycles for new products and services become simpler and faster.

BETTER BUSINESS FOR TELSTRA

TRL has been a major force behind a number of Telstra successes over recent years.

*• TRL delivered the original demonstration system of the **Priority One3™** service to Telstra's Advanced Network Products group within six weeks. The **Priority One3™** service is a Telstra single-number service that can be used by customers anywhere in Australia to connect to a company's nearest branch or outlet. TRL's prompt response not only allowed Telstra to get the new service to the original customer, it also opened the market for subsequent **Priority One3™** applications.*

• TRL helped Telstra introduce SDH (synchronous digital hierarchy) to the network, an ehancement that allows for better management and much higher network reliability. Researchers at TRL developed guidelines for implementation of SDH that result in better network protection at a lower cost, making significant savings for Telstra. They also developed a more accurate system for locating faults, saving on maintenance effort and ensuring minimal effect on customers.

• TRL pioneered the use of an optical fibre network architecture that will provide cost-effective access to future visual and interactive services for customers. Researchers have been providing technical support to a number of residential video pilots that will allow Telstra to offer better network delivery for pay TV and the next generation of visual services.

TRL has continued to add significant value to Telstra's network through its tradition of excellence in research.

*Researchers are working with Telstra's Platforms and Capacity Planning group to further develop the **Priority One3™** platform. To test the platform to the limit in the laboratory, they have been simulating every conceivable customer traffic pattern. This will strengthen the platform's stability and performance, no matter how heavy the communications traffic.*

Telstra's customers will soon benefit from a new customer support feature – a help-desk with artificial intelligence support to provide rapid, accurate responses to queries – developed by TRL in collaboration with a major Telstra business unit.

And the suite of new technologies that need to be put in place to deliver the visual services of the future are currently being tested and evaluated at TRL or being refined through customer field trials.

What are these technologies? What will they do for customers? How will they enhance Telstra's performance in 1995 and beyond? What is in store for the future? These are some of the many questions that TRL has tried to address for readers in this issue of 'New Horizons'.

Just as the telephone service became the universal standard for telecommunications this century, video-based services will become the core business of network providers within the next decade.

VISUAL SERVICES

Pay TV, video-on-demand, multimedia, videoconferencing, 'virtual reality' in the home – the image imperative is not only a powerful driver, but a powerful challenge in the race to build future networks that will pave the way for the convergence of computers, communications, information and entertainment.

Multimedia communications in the workplace have the potential to not only improve business performance, they could fundamentally change the way business is done. Videoconferencing, electronic document exchange, telecommuting, on-line market information, and virtual trade and display environments – such services will pave the way for the virtual organisation, which will be flexible and adaptable enough to rapidly mobilise global resources, and capture market opportunities.

Interactive video technology is set to transform the home into a global communications hub. People will use it to get two-way access to a full range of new services – education and training, personalised news services, current movies, community TV and information, pay TV, interactive computer games, home banking, home shopping. Not too far into the future, you might be part of a virtual classroom that spans continents or you might stroll through a virtual shopping mall in another country, making purchases 'on the spot'.

TRL is helping position Telstra at the forefront of video-based service delivery in Australia by developing and evaluating new network technologies, systems and standards that will be critical to the success and quality of future services.

Before a national information superhighway can emerge, the 'roads' must be widened and the 'freight' – text, data, images, voice or video signals – must be digitalised, packaged and tagged so that it can be bussed speedily and accurately from end to end.

Video is the hard part of multimedia delivery – it is more demanding of the network than voice, text or data.

Telstra will spend billions of dollars to provide the full broadband capacity required for multimedia.

TRL's technological insight will ensure that Telstra makes the right strategic choices. For example, instead of simply 'adding on' a pay TV delivery system to the current network, TRL researchers have been trialling a demonstration home entertainment delivery system that incorporates an intelligent communications layer between the Telstra network and the home.

Researchers adapted the model from networked computer systems, in which information servers mediate between users and information sources. The system is suited to video-on-demand, as it provides for sophisticated two-way communication between the user and service provider.

Through TRL, Telstra is participating in a global trial of Microsoft's new Broadband Network Operating System (BNOS) which could help make Australia a world leader in interactive multi-media services.

Video images consume large amounts of transmission capacity, and through their research on video compression – transmitting only the 'differences' within and between video images – TRL researchers are helping develop global standards for picture compression that will ensure all users get the required picture quality, from lower-end (for example, videotelephones) to higher-end (a good example is HDTV: high definition television).

Through its participation in key international standards bodies, TRL is helping shape global standards for future visual services technology, including the pay TV 'set-top box' for the home, and the information storage devices to be used by service providers.

This means that Telstra's customers can expect fast, high-quality, video-based services, regardless of who provides the information, or whether signals travel over optical fibre, coaxial cable or conventional telephone lines.

PROGRAMMING THE BOX

TRL has been trialling a prototype interactive video system for pay TV and other home 'infotainment' services. Artificial intelligence and software engineering experts are working with human behaviour specialists to create remote control, screen graphics and electronic directory systems that will help viewers find what they want, when they want it.

TRL's trial of this system – comprising an intelligent TV 'set-top box' in the home, a central 'mediator' and remote service suppliers, such as video libraries – will enable researchers to develop an easy-to-use customer interface. (The set-top box is an intelligent communications unit that will connect the TV set to a cable link and manage user interactions with the outside world.)

Artificial intelligence incorporated into the system may take the form of intelligent agents or navigators that will protect users from information overload. These virtual personal assistants will build profiles of users to sift through global databanks, selecting only those services and information compatible with users' tastes and needs.

DAD AND DAVE GO DIGITAL

TRL is collaborating with the State Film Centre of Victoria to investigate on-line access to digitalised compressed video material from one of the country's largest audio-visual lending collections – 30,000 films and 10,000 videos as well as many CD-ROM titles.

Some of the Centre's older films are on formats involving projection systems that are no longer available. A multimedia user interface and digital storage technology should improve archiving and access, as well as bring these national treasures 'on line' to a much wider audience.

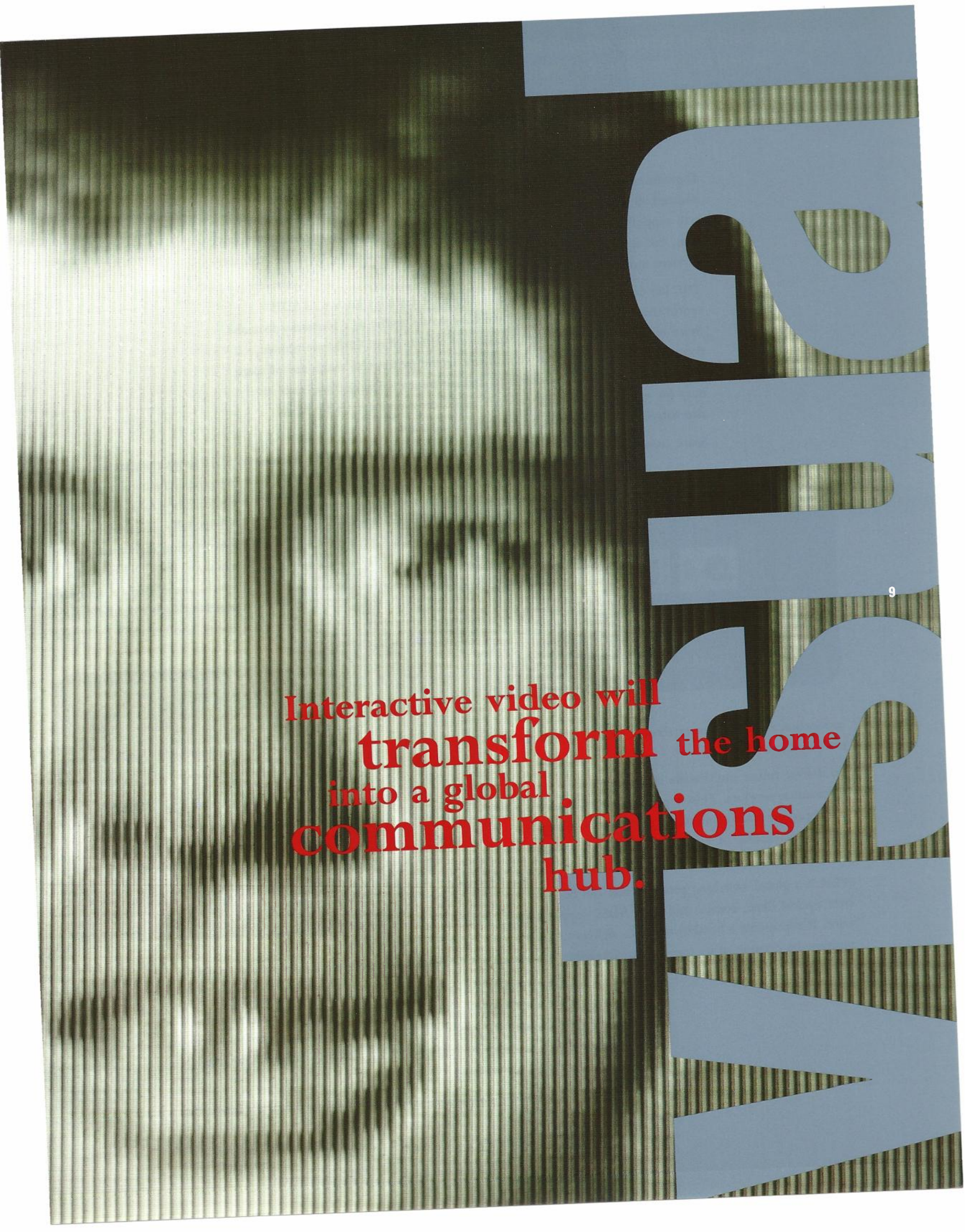
The project will give researchers an insight into the potential for a 'digital development bank', which may manage the movement and copyright of digitalised intellectual property.

RULES FOR CONVERGENCE

With the prospect of widespread multimedia services ahead, network operators and suppliers will have to look more closely at how their products will interwork as telecommunications, computing and entertainment converge.

DAVIC – Digital Audio Visual Council – will be a great help. DAVIC is an international industry forum that aims to standardise the interfaces and protocols for the components of digital audio-visual systems, pay TV, and interactive video services. All of these systems will involve transmission protocols, distributed databases and a set-top box or multimedia control terminal for the TV set.

DAVIC covers complete multimedia communications from end-to-end, prescribing standards for all interfaces and interoperability. Telstra, through TRL, was a founding member of DAVIC, whose members constitute an international 'who's who' of multimedia.


Vision
Interactive video will
transform the home
into a global
communications
hub.

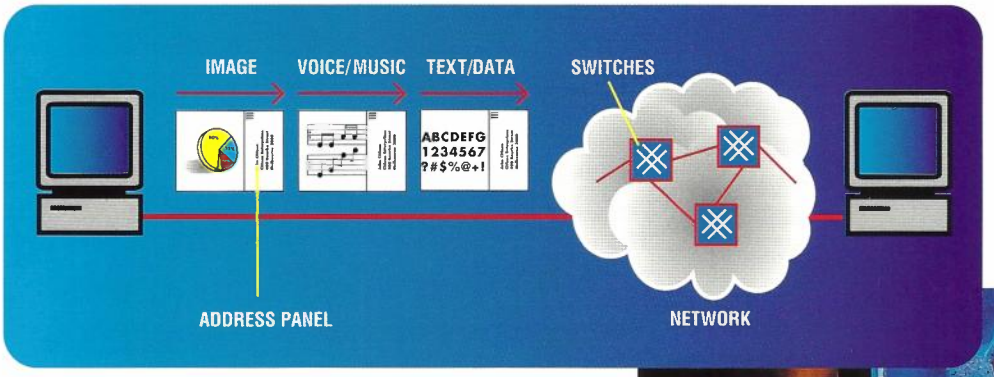
The fully digitalised, full service network will handle information at almost any speed – millions of bits per. second for video transfer, thousands of bits for voice, between a few and millions of bits for data ... and all the possible combinations of these.

DELIVERING MULTIMEDIA

Digitalising the network is a key to value-added communication. Telstra's planned all-digital network – at the moment, it's just over 50 percent digitalised – will support sophisticated information processing in the form of video compression, call security, integrated billing and network monitoring to make customer services more versatile, secure and convenient.

TRL has continued its research on a digital technology known as SDH – synchronous digital hierarchy – which organises traffic in a hierarchy to make more efficient use of the high capacity of optical fibre. Under computer control, SDH networks can reconfigure traffic patterns to make use of spare capacity. If the main Melbourne to Sydney transmission line was excessively busy for example, the SDH network could cross-connect traffic to an alternative, less busy route to minimise congestion.

Spare capacity, intelligent re-routing and duplicated paths are the features of SDH networks that make them extremely fault-tolerant. If an optical fibre cable was to be accidentally damaged by construction equipment for example, the SDH network would immediately respond by switching signals on the damaged line to another cable, with the connection remaining intact throughout the instantaneous handover.



To deliver future multimedia and interactive information services, Telstra plans to use ATM – asynchronous transfer mode – a new fast switching technology capable of supporting integrated packets of video, voice, data and text.

ATM is a global switching protocol that can be used over optical fibre, coaxial cable and ADSL-copper wire. It represents a breakthrough for delivery of multimedia because of its tremendous flexibility in delivering information of any type, at almost any speed.

You could think of ATM as being like an automated postal service designed to handle only standard, post-office approved envelopes, the contents of which can vary (images, text, etc.). Because the envelopes are the same size (a single switching system), they can be sorted at high speed for rapid forwarding.

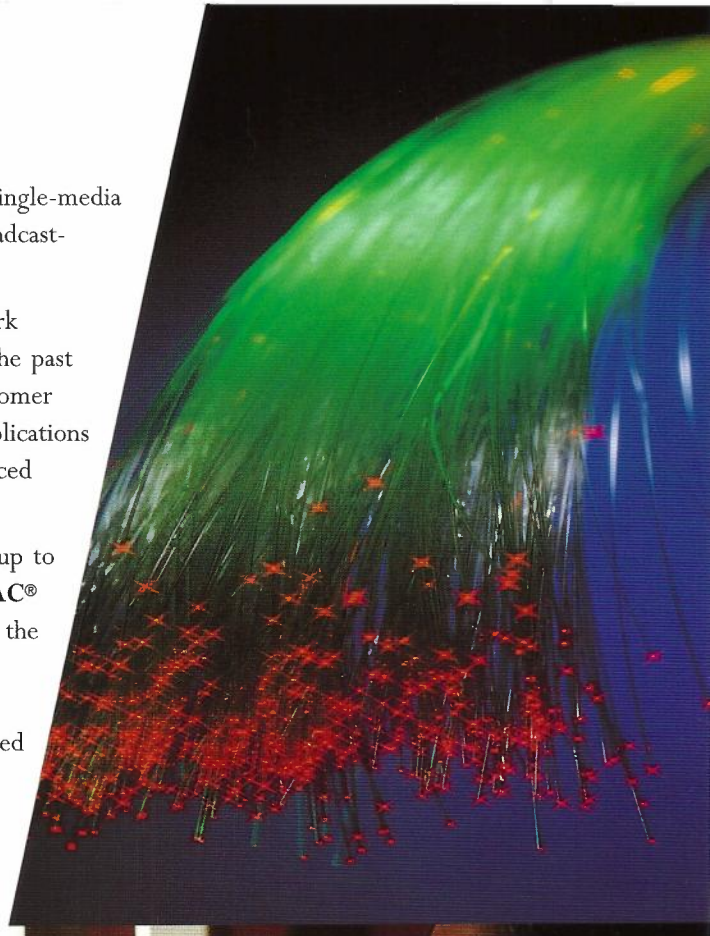
An ATM system can handle any rate of information transfer – hence the

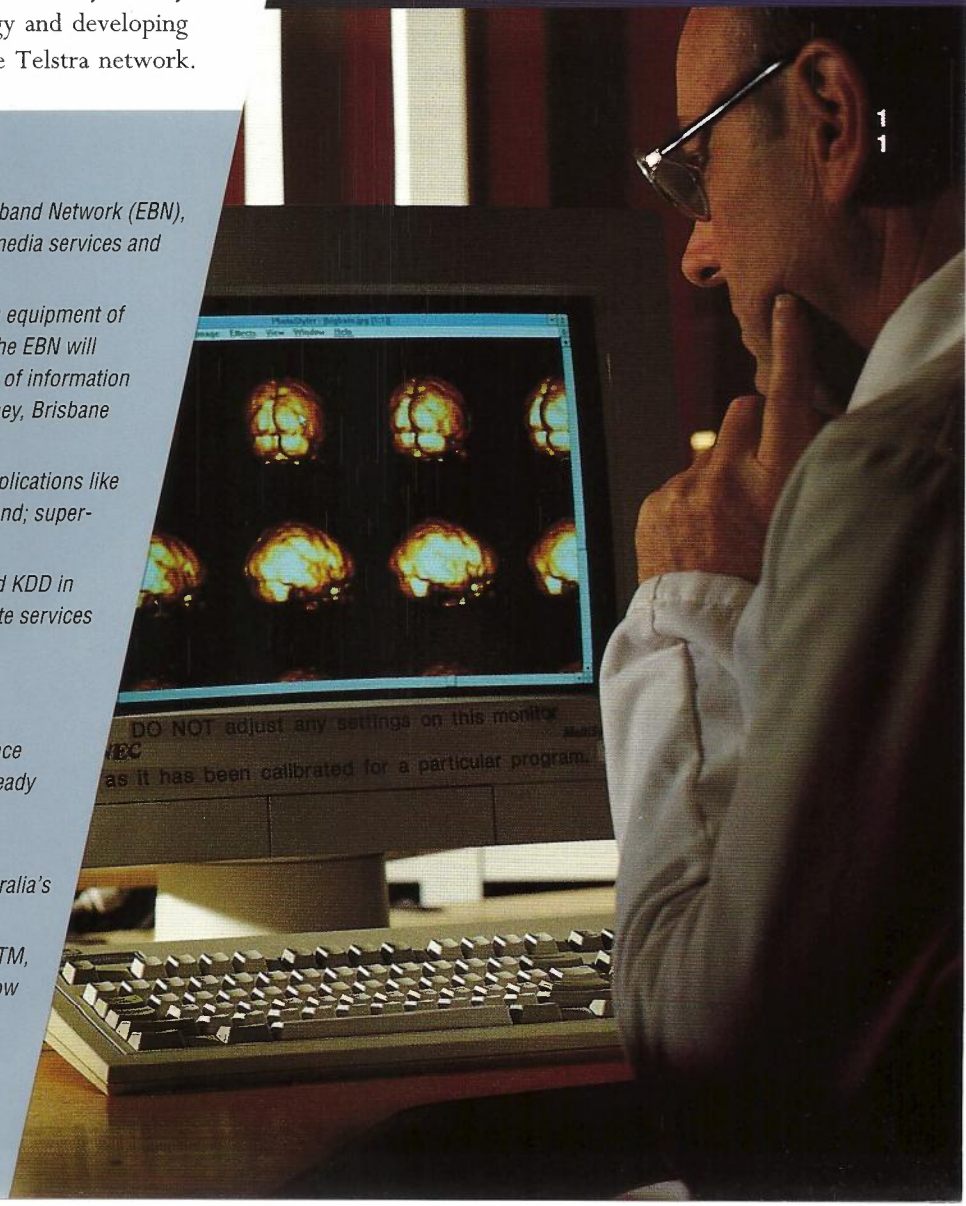
term 'asynchronous'–from a relatively small number of packets per second for single-media communications like data transfer or e-mail, to the high speeds required for broadcast-quality video.

ATM networks can scale bandwidth to demand. This makes better use of network capacity, allowing networks to carry much more information than they have in the past and, of course, to carry value-added multimedia information. With ATM, a customer could use the same connection to handle the full range of future video-based applications – from a videophone call (requiring a lower image quality) to the videoconferenced editing of a TV commercial (which would require much higher image quality).

In related research, TRL has been working with Telstra's Network Products group to develop frame relay as an interface to existing business services like the **FASTPAC®** service–Telstra's high-speed data networking service that geographically extends the local area networks (LANs) of business customers via the public network. (Most PCs in business are connected to other PCs, printers, databases and controllers through LANs. A frame is the basic package of information that can be transmitted over a LAN.)

Like ATM, frame relay is a high-speed, bandwidth-on-demand packet switching system. Frame relay is already used in the United States, allowing business colleagues around the country to share bandwidth in the same way as they do on an office LAN. TRL has been evaluating the technology and developing equipment and financial models for its introduction to the Telstra network.





PUBLIC PREVIEW OF BANDWIDTH-ON-DEMAND

Telstra is about to launch ATM publicly through its Experimental Broadband Network (EBN), which will give Australian users their first real taste of advanced multimedia services and applications.

Through the EBN, Telstra will gain experience operating ATM switching equipment of the type that would be widely used in the future full service network. The EBN will comprise four large switches–each operating at 155 Mbit/s (megabits of information per second)–to provide access to users in Melbourne, Canberra, Sydney, Brisbane and Adelaide.

Participants in the EBN trial will use the network to experiment with applications like local and wide area networking; videoconferencing and video-on-demand; super-computing networking; and ATM services delivery.

Telstra is involved in an international ATM trial with AT&T in the US and KDD in Japan. It plans to connect the Australian EBN network to this to evaluate services delivery across the two networks.

FIRST TASTE OF ATM

Through its Research ATM Network established in 1993 with the Defence Science and Technology Organisation (DSTO) in Adelaide, TRL has already gained experience in ATM transmission and video delivery.

This network – comprising links running at 34 Mbit/s connecting two switches with a capacity of 1.6 Gbit/s (gigabits per second)–was Australia's first ATM connection between capital cities.

Apart from allowing Telstra to assess the limitations and potential of ATM, the research network led to the development of new circuit designs, now being commercialised by Telstra Technologies. The Research ATM network is being incorporated into the larger EBN.

"Can you keep a secret?" is a question more and more customers are asking of communications networks as they expose highly sensitive commercial and personal information to public cyberspace.

SECURITY AND MESSAGE INTEGRITY

Your credit card number and PIN (personal identification number), details of personal finances, bills, tax information, personal taste in movies and video games, political affiliations, buying habits – if you plan to plug into the full service network and manage your life electronically, sooner or later you will have to expose a lot of personal information.

Fraud and the rise of computer crime add a note of urgency to the issue of electronic security. How will your identity be verified for charging and billing in a world dependent on on-line services? How will a supplier know that it was indeed you who ordered a particular service? Experts predict that new and existing information services such as EDI (electronic data interchange) will live or die on the strength of the public's trust in communication networks.

To brace Telstra's network against attempted fraud and electronic eavesdropping, Telstra is developing 'future proof' security systems based on the latest global standards developed by the ITU (International Telecommunication Union) and other influential standards bodies.

TRL is playing a major role in Telstra's endeavour by capitalising on its long experience and expertise in cryptography – the enciphering and deciphering of

electronic messages. Researchers here are developing security systems that can:

- verify the identity of the caller or sender, via an electronic digital 'signature' (to prevent fraud);
- protect the integrity of the message from end-to-end (to protect against unauthorised interference); and
- screen the message from prying eyes in its path from caller to receiver through a type of electronic 'envelope' (to ensure information privacy).

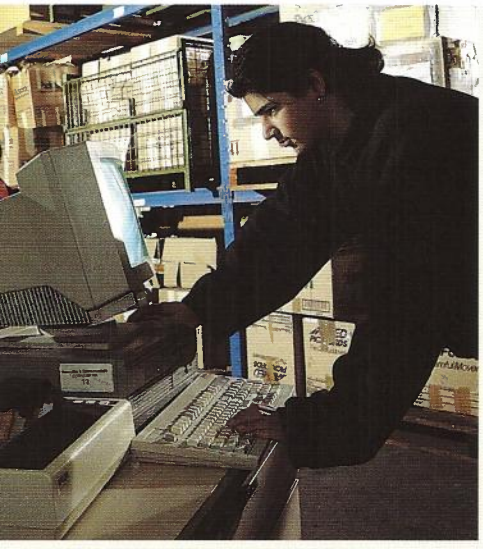
When in place, these super-smart security systems will issue each customer with a unique electronic identification mechanism – the digital signature – to safeguard access to services such as electronic banking and shopping, e-mail, EDI, pay TV, video-on-demand, and mobile phone equipment.

TRL's security systems are based on a mode known as public key cryptography. This involves issuing every user with two unique 'digital' keys, one private, one public. The public key, as its name suggests, can be made known publicly. It can allow the caller to encode a message that only the intended receiver is able to read by using their secret, private key.

The real attraction of public key cryptography is that the private key cannot be discovered from either the message or the public key. It resides at the receiver's end in the form of a smart card, which is read by an electronic card reader. Knowing the correct PIN is the only way to access the functions encoded on the card.

Telstra is developing 'future proof' security systems

Public key cryptography was invented in the United States which, like many other countries, places export restrictions on cryptographic hardware and software. If an overseas buyer purchases equipment from the US, suppliers remove or weaken the cryptographic algorithms. This makes TRL's independent research critical to the security of future networks.



X.509 READY FOR TAKE-OFF

Telstra has piloted TRL's X.509-based security system for e-mail as an enhancement to its internal corporate directory. The X.509 standard is one of the ITU's X.500 series of international standards for electronic directories. When implemented globally, such standards will facilitate safe and hassle-free communication between users and networks anywhere.

TRL is negotiating to develop a public key-based security architecture for commercial distributed systems, beginning with a product developed for Telstra's networks. Researchers here are also developing higher levels of security for ***FASTPAC®*** *customers.*

ELECTRONIC 'PASSPORT OFFICE'

Telstra's National Directory Services are now marketing products based on TRL's corporate electronic directory software, one of the world's first products that fully comply with the international X.500 series of standards for electronic directories.

Three-way authentication – a standard that may include a 'third-party' certification authority, in addition to senders and receivers – is being built into new electronic directory products. The certification authority will act as an electronic 'passport office', issuing certificates that can be used to verify each user's digital signature. This will help ensure that public key information – to be incorporated into future directories – will be current, correct and unforgeable.

A VIRTUAL WORLD IN YOUR WALLET

Smart cards that will carry your private key to 'unlock' public key-enciphered messages have tiny, powerful microprocessors on board that perform complex mathematical functions as well as securely store data to protect against unauthorised use of the card.

TRL researchers are thinking ahead to the next step beyond the experimental public key system established at Telstra, in which a smart card, card reader and PIN will be used to protect information travelling to and from computers in its networks.

Not too far into the future, a personal communications smart card could store large volumes of information about a user's preferences. It could provide each user with access to mobile services, advanced information services, pay TV, home shopping and home banking.

Smart card readers would be built into each household's TV set-top box, not only acting as a security gate to home communications, but offering sophisticated user control. Parents for example could 'lock out' movies they may regard as inappropriate for children.

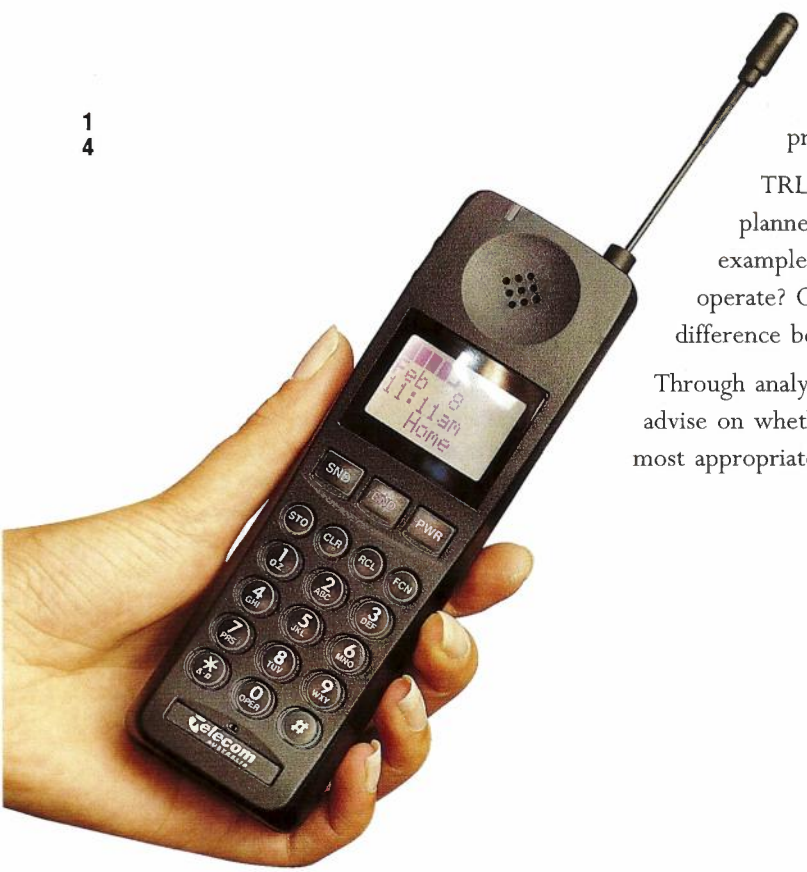
Human behaviour does not follow machine logic. Humans hesitate, have different levels of competence, think and speak differently, get distracted, take short cuts, get bored, switch off. The solution? Design for 'the human factor'.

DESIGN FOR PEOPLE

Computer users know about it, and anyone who has struggled to program a video cassette recorder or even a microwave oven will certainly know about it. It's the 'user-friendliness' or usability of new products. Often more important than the technology, the right 'look and feel' can determine whether consumers will take to a new product or service, or look for an easier alternative.

Usability can encompass consistent design and function: for example, hash keys on different telephone handsets having the same function; or different computer software programs having standard screens and manuals. It can also refer to the way people look up information, or how they respond to pre-recorded visual and voice prompts in automated transactions.

At TRL, human behaviour experts have focused their skills in decision theory, linguistics, human-computer interaction and applied psychology on the job of making systems and products easier to use for a range of Telstra business units. These include Occupational Health, Safety and Environment; Mobile Communications Services; Corporate and Government communications; Network Products; and the Information Technology Group.



Who wants the new service? Why do they want it? How will they use it? What are their expectations? Human factors design begins with an understanding of the range of possible human behaviour and expectations, to determine how Telstra can best target and develop products.

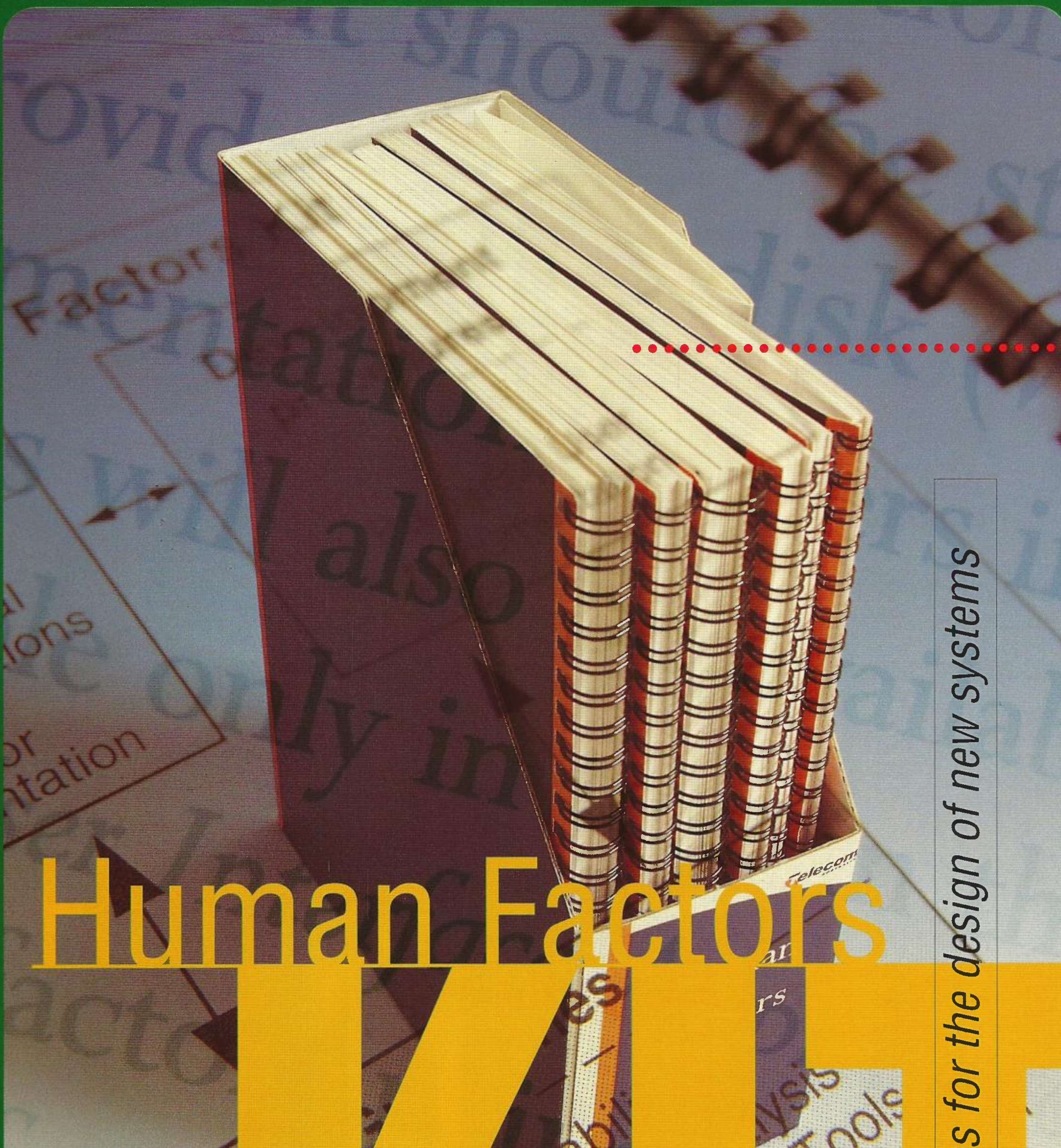
TRL psychologists examine critical assumptions made by designers and planners. Will all users immediately associate the colour red with 'stop', for example? Will all users have the same expectations about how 'HELP' menus operate? Often overlooked in the design process, such factors can mean the difference between success and failure.

Through analysing the information flow of a Telstra client's business, TRL can also advise on whether or not a technology – like interactive voice response – may be the most appropriate for a particular application.

A good example of the team's work is its Human Factors Kit. The Kit – a set of detailed style guides and guidelines for the design of new systems including interactive voice systems – means that all Telstra software now under development will have a unified, corporate 'look and feel'.

No matter where it may have originated, every Telstra computer program will behave predictably. Users will be able to readily adapt their prior computer experience, without the need to start learning a new system from scratch. TRL's Human Factors Kit is a big first step towards a distinctive corporate Telstra 'look and feel'.

The right 'look and feel' can determine whether consumers will take to a new product or service, or look for an easier alternative.

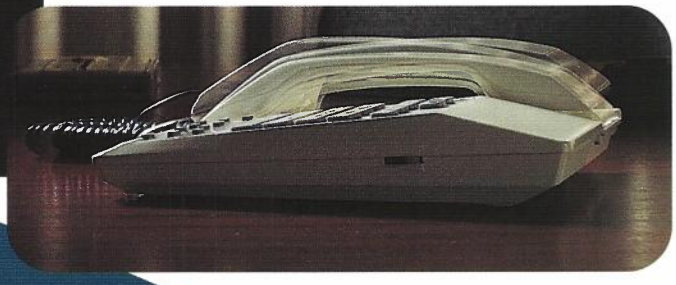


Human Factors KIT

Guidelines for the design of new systems

For Telstra customers, the integration of human factors with product development should translate into complete confidence in new products and services. When they buy a product in future, it should work the way they expect it to. When they subscribe to a service, it should be easy to access and use. When they dial service staff, they should get an accurate, immediate response from someone able to navigate rapidly through the relevant records and databases.

TRL Human Factors researchers will continue to work with engineers and software designers to develop 'intuitive', easy-to-use interfaces for pay TV, electronic directories, interactive information and entertainment services and new mobile communications services.



TRL'S HUMAN FACTORS KIT

Telstra currently runs more than 800 different software applications on many different computer platforms. TRL's Human Factors Kit was designed to help reduce the significant development time and effort involved, the lack of integration, and the constant training requirements due to the lack of consistent program operation.

The Kit consists of two style guides, five sets of guidelines and a separate set of guidelines for interactive voice systems. For systems designers, the Kit takes much of the hard work out of the software development process – they simply follow clear-cut, well-tested procedures and templates for producing screens, menus, icons and terminology.

Now an integral part of the design process for all systems development within Telstra, the Human Factors Kit will help reduce software development time through standardisation of elements such as screen design and printed manual layout, cut training and maintenance costs, and reduce data error rates through making systems easier and faster to use for operators. The Kit is now on-line and updated regularly.

SAYING IT RIGHT FIRST-UP

*TRL's Human Factors Group collaborated with Telstra's Network Products business unit in the design and evaluation of the new **MessageBank**™ service for residential customers. Similar to the **MobileNet MessageBank**™, the service provides customers with a mailbox to which calls can be diverted if a line is busy or unattended.*

Human factors experts advised on the wording and flow of scripts, network access mechanisms and user documentation. Evaluation included intensive usability testing by potential customers. TRL presented Network Products with detailed recommendations, and helped prepare the interface for its commercial implementation in 1994.

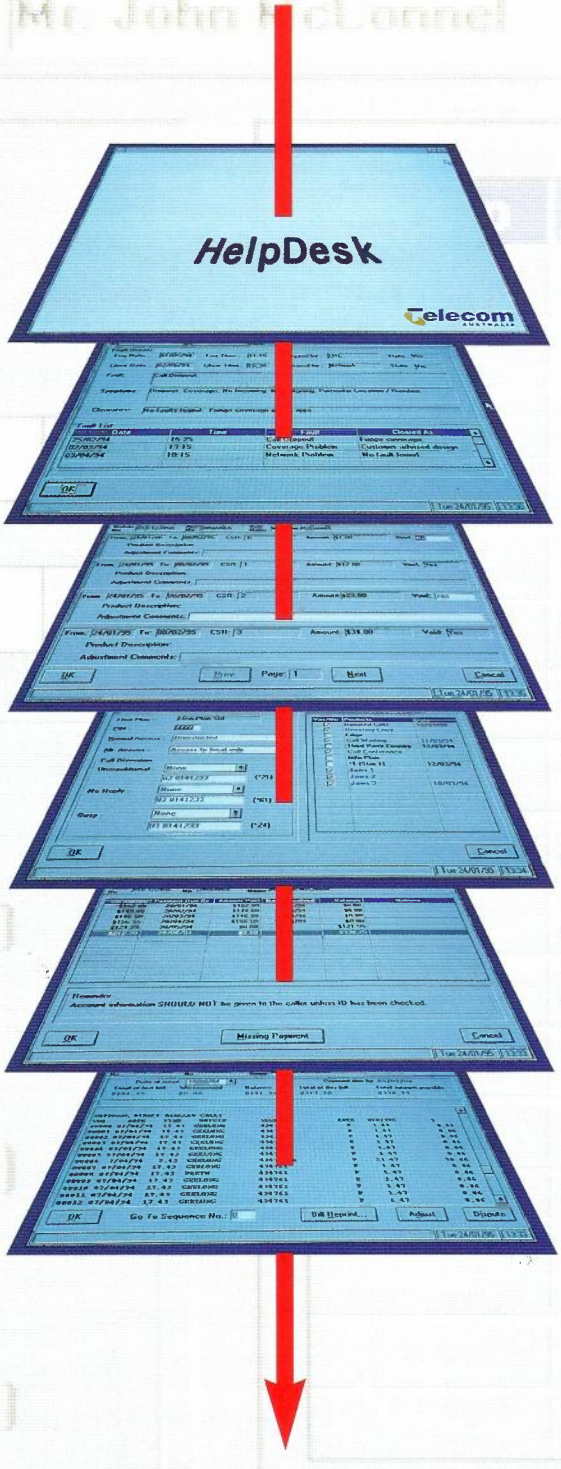
In a deregulated market, service will be as important as price in winning customers. Telstra is developing customer support systems that can deal with the full range of customer queries, new service requests and fault reporting.

INTELLIGENT CUSTOMER SUPPORT SYSTEMS

How many times have you phoned a large company or utility to report a problem and, instead of an answer, you get the run-around?

Providing an immediate, effective response to every customer call is the key to success in services industries. It is not surprising that the help-desk system – a one-stop shop for all queries – is fast becoming a vital frontline operation in customer-focused businesses like Telstra's.

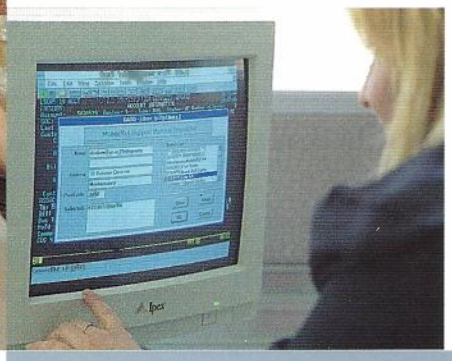
The biggest constraint to any help-desk operation is that every customer service operator has to know almost everything about an organisation's products and processes to be able to answer every possible customer query. This is why customers in the past have had to make further calls to another part of an organisation, or have had to wait for an operator to return a call.



TRL's solution to the help-desk 'knowledge gap' is an inherently smart system based on its expertise in artificial intelligence and human factors design. At the front-end of the help-desk system are user-friendly graphics interfaces that enable operators to 'drill down' through a series of large databases that may be spread throughout the organisation. The result? An accurate and prompt response to the customer, along with advice on how to get better value from the relevant Telstra product.

The key to the success of the new help-desk is its ease-of-use and coverage. It can simultaneously access a range of large and complex databases and retrieve the appropriate information by communicating with the operator through simple graphics or conversationally-worded prompts.

The TRL-designed help-desk system should provide Telstra operators with the information they need to become 'instant experts'. Operators should not only be able to handle routine queries, they should also be able to advise customers on how to get added value from Telstra's services –



suggesting a customer change to a more effective **Flexi-plan™**, for example. Information from customers could be fed back into the network to enhance quality control, management, performance and maintenance.

The help-desk system has the potential to integrate sales functions other than follow-up service. The next step may be a computer-aided sales system that selects a customised mix of Telstra products and services tailored to a user's communication needs and access patterns. The system could keep track of customers' communication requirements such as access to **EasyCall™** services, modifying them on demand if required.

Apart from streamlining customer enquiries and delivering higher levels of service, TRL's extremely powerful and user-friendly help-desk system should dramatically reduce operator training and response time, increase productivity and eliminate the need for major system upgrades.

Providing an immediate, *effective response to every customer is the key to success* in services industries.

EXPERT ADVICE FOR TELSTRA CUSTOMERS

The help-desk developed by TRL for a major Telstra business unit began as a project to locate reported faults in the network. Subsequently, the Telstra operation saw an opportunity to make the new help-desk the focus of a comprehensive upgrade of customer support services, which included a complete systems redesign and feedback from operators and users.

When implemented later this year the new help-desk will offer a single front-end service to handle the full range of customer calls, from billing to tariffs and network information. Help-desk staff will be able to advise customers on the full range of related Telstra services and products – in fact, the system should make customer service operators experts in dealing with customer queries.

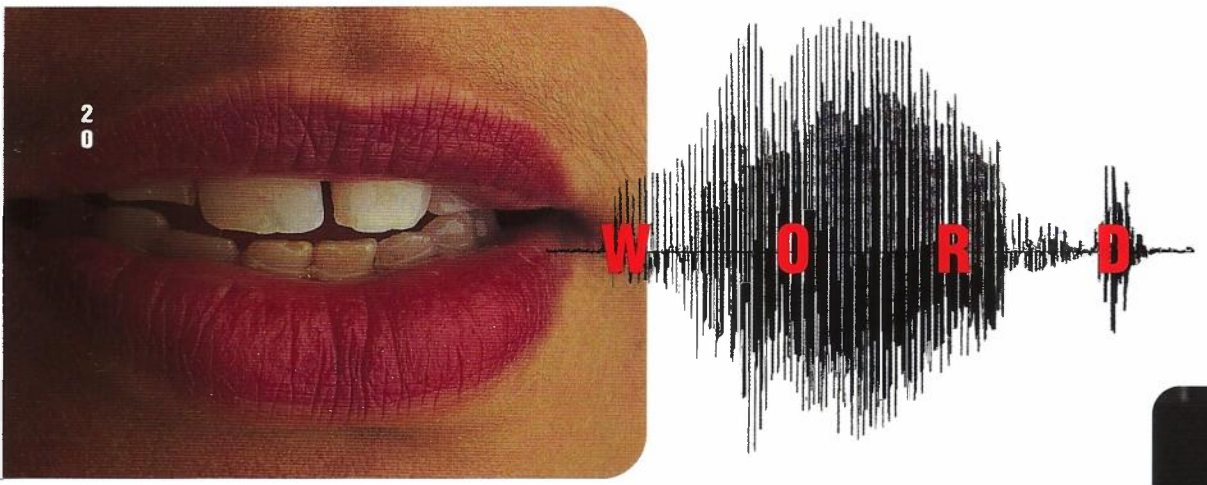
"Look – no keyboard!"...The most promising, and least developed, user-friendly interface between people and machines is the one we use every day, our vocal cords.

VOICE-ACTIVATED SERVICES

Future voice-activated technologies will allow customers to access and control automated services and retrieve information without the need for a keyboard. Instead, customers could choose to converse with computers directly or over the phone, using natural speech patterns and a normal, comprehensive vocabulary.

The voice-mailbox is set to become a standard tool for sending and retrieving voice messages and faxes; for accessing information from databases; and for automated transaction processing. Already voicemail is replacing the written memo in many large companies. Experts forecast the rapid growth and development of new voice-based applications, such as multimedia messaging and automated media conversion of information—for example, from fax to voice.

For mobile phone users overseas, voice-activated dialling is already being used to bypass manual dialling. In future, such services might be integrated with smart electronic directories. Customers would simply instruct intelligent navigational 'agents' within the network to locate and retrieve information, without needing to lift a finger.



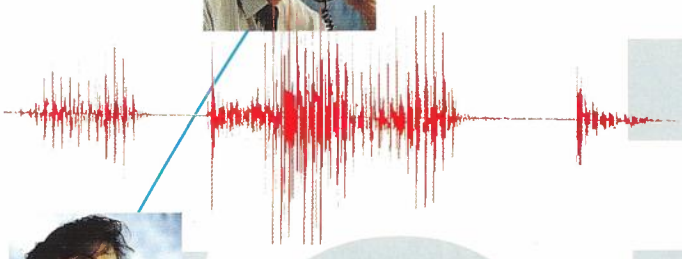
A unique strength of TRL's program is its large database of voice samples.

Australians are already familiar with simple voice-activated systems—for bill payment, flight information and banking transactions, for example. To record a transaction or access information, the user presses keys on a telephone handset in response to standard prompts pre-recorded by a human operator. Desktop computers that respond to simple spoken commands are also readily available.

Despite these early developments, speech-recognition systems under development internationally are still limited by the large variation in pronunciation, sound transmission quality and background noise that characterise phone calls on the public network.

TRL's investigation of speech-recognition technology involves researchers with skills in software and engineering, mathematical modelling, signal processing, linguistics and psychology. Through the research, TRL plans to take artificial speech recognition beyond the constraints of current voice-activated technology.

A unique strength of TRL's program is its large database of voice samples. This database – a microcosm of the different speech patterns heard daily all over Australia – is used to 'train' new speech-recognition systems to accurately recognise widely variable pronunciations of the same word.



LIMITED VOCABULARY, BIG FUTURE

Most current speech recognition systems have limited vocabularies. TRL has developed a customer-service system with a limited vocabulary of 16 words. The system has been trained on part of TRL's database containing speech samples from 5000 people, making it more flexible in its response to different speakers than any other Australian speech recognition system.

In 1994, the researchers transferred the system from its original computer base to specialised digital signal processors, which can process a request almost instantaneously. The development of this speech recognition 'hardware' is a significant step towards commercial application.

TRL researchers plan to build on this small-vocabulary speech recognition system to develop larger-vocabulary applications within the next few years, involving more natural, less restricted speech patterns.

16 word VOCABULARY

5000

SPEECH SAMPLES ON DATABASE

"GET ME THE NEAREST AUTO-MECHANIC!"

Artificial intelligence researchers at TRL have been exploring how customers might access the on-line trade and services directories that will evolve from its work on electronic directories. Voice activation is a strong contender.

While researchers acknowledge that the time when people will be able to ask a directory to locate and dial up a specific service is a long way off, they are keeping these applications in mind in designing new systems.

This goal is part of Telstra's vision of universal personal communications, in which intelligent, neural networks will keep track of and anticipate customer movements and communication needs and deliver them through flexible access technologies.

Intuitive, screen-based, electronic directories will navigate customers easily and quickly through the maze of future on-line visual and information services.

ELECTRONIC DIRECTORIES

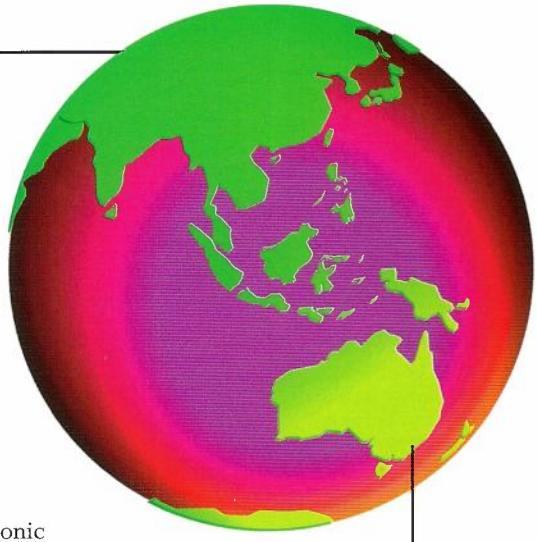
In today's overloaded information environment, the question facing people is not 'What's available?' but 'What do I really need right now and how quickly can I get it?'.

Printed directories are not able to keep up with current rates of information production and change. Telephone directories for example create a huge demand for paper, with obvious environmental and recycling consequences.

Admittedly, life without telephone directories would be chaotic. But with the prospect of the Sydney **White Pages™** directory becoming three volumes instead of two, customers will soon be looking for more convenient ways of finding a number.

May 6, 1996
02.00am
United Kingdom
London

Person requires a number in Sydney. Electronic Directory has been automatically updated. No need to refer to out of date telephone books or international operators.



A new generation of smart electronic directories will find the right information for customers the moment they need it, without the need for time-wasting paper shuffling. Well-designed menus and more advanced interfaces will alert people to service possibilities they may have had difficulty knowing about in the past.

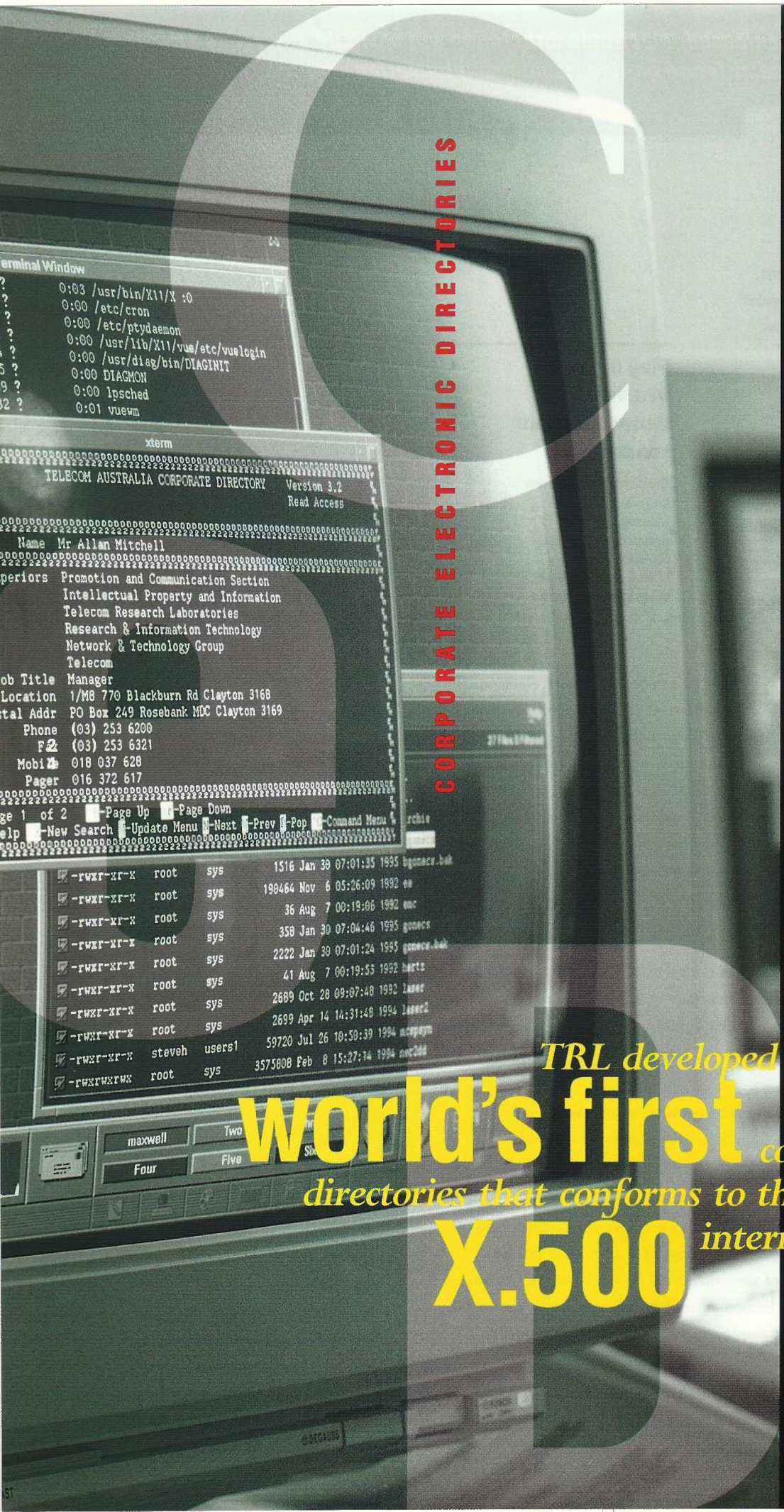
May 6, 1996
12.00pm
Australia
Sydney

Family has moved and has had their telephone connected. Electronic Directory has updated their new number automatically.

TRL has developed one of the world's first electronic directories that fully conforms to the latest set of X.500 international electronic directory standards devised by the Geneva-based ITU (International Telecommunications Union). The X.500 series incorporates security provisions designed to protect the public network against fraud and unauthorised entry.

TRL researchers have represented Telstra on the international teams that developed the X.500 standards, regarded as an essential foundation for a truly global public network. This participation allowed TRL researchers to develop its directory using the most up-to-date guidelines.

TRL's electronic directory software – initially developed as a corporate directory for use by all Telstra staff – will be applied to the development of commercial on-line public and trades directories, and to a range of new directory services for fax, e-mail and mobile phones. Also planned is the introduction of multimedia corporate electronic directories – photographs of employees, for example, would offer obvious security benefits.



TELSTRA THROUGH THE 'VIEWFINDER'

Telstra was the proving ground for TRL's corporate electronic directory, one of the world's first on-line directories that fully complies with the latest set of X.500 electronic directory standards.

With a staff of 65 000 divided into thousands of organisational units nationwide, Telstra offered a tough challenge. But the directory's accuracy, speed, user-friendly screens and powerful cross-referencing capability made it a success. The electronic directory routinely handles about 300 queries from different areas at any one time. Apart from being easier to update than printed corporate directories, it requires little training for new users.

Now operating in a number of large organisations nationally, the corporate electronic directory is being marketed as ***ViewFinder*** *™ through Telstra's National Directory Services division.*

TRL developed one of the

world's first

corporate electronic directories that conforms to the latest

X.500

international standards.

Electronic directories will

allow people to browse

the world's multimedia services.

X.500 GOES GOLD

A G P S

The commercial debut of TRL's X.500 directory software was at the Canberra-based Australian Government Publishing Service (AGPS).

AGPS editors used to spend months sourcing and collating entries from around the country for the Commonwealth Government Directory. Inevitably, some entries would be out of date by the time the directory had been printed.

Through its Government On-Line Directories Service (GOLD) developed using the TRL-designed software, AGPS has dramatically streamlined the process. All government departments are using the on-line service and maintain their own records. AGPS simply extracts data from the database, and formats it for printing. The system has made significant savings for the public sector through increased productivity.

SURFING THE FUTURE NETWORK

Visual electronic directories will be the tool people use to browse through the multimedia services like movies-on-demand planned for Telstra's future high-capacity, high-speed network.

With the prospect of thousands of broadband services coming on-line in future, it would take people days just to click through the possible choices! The services must be easy to get to – or people simply won't use them. User access will need to be as intuitive and easy-to-use as a phone or a TV set.

Finding the right destination will be made easier by smart screen-based electronic directories that will link the user to databases via intelligent 'assistants' or 'agents' located within the network. These smart navigational systems will respond to or anticipate requests by building up user behaviour profiles, carrying out complex transactions such as sifting through video libraries to find the most likely title to delight the user.

WHAT will a 'normal' telephone look like FIVE or SIX years from now?

You'll choose from menus of advanced communication services, you'll use your computer like a phone, you'll videoconference from your home TV-set. That could be your phone in the year 2000.

NEXT-GENERATION PHONES

At TRL, researchers are looking at a full range of possibilities, from a screen-phone for the home, to a combined computer and telephone for the office, to a TV-phone for videoconferencing and interactive access to advanced network services.

The focus here is not so much on what the actual handset or terminal will look like. Rather researchers are investigating the type of new services that will be compatible with screen-phones – or mobile screen-based units – and how customers could best access these services and existing call control options offered by Telstra.

The screen-phone will give customers far more control over the way they communicate than they have ever had in the past. Add a decent-sized screen to a fixed phone or mobile terminal and immediately you open a window to a wider range of service options not feasible through keypad combinations. Users will no longer have to memorise codes like '#1' or '*3#'!

Screens can display prompts, menus and sub-menus, meaning that the screen-phone will bring to the home the sort

At TRL, researchers are looking at a full range of possibilities.

of information management traditionally associated with computers. Screen-phone prompts will guide customers step-by-step through complex transactions or help them track down information. They will connect customers to electronic telephone directories, voicemail, home banking and home shopping, and will increase the power of mobile communications as an information management tool.

Further into the future, computer telephone integration (CTI) will offer the individual even greater control of network services, changing the way organisations communicate and even the way they do business.

In most large organisations, employees already have access to desk-top computer terminals connected via LANs or modems to other users and destinations. With screen-based telephony integrated with powerful PC capabilities, business users will be able to routinely access advanced network services, communicate via voice, text, data and images, and

videoconference on their desktop computers. CTI would allow users to call up and customise intelligent network services for their individual needs. Smart-card readers built into the unit would check each user's identity and authorisation status.

Of course, with the prospect of interactive communications to the home, TRL is looking at the possibility of making a smart TV-set the focal point for integrated communications with the larger world outside.

A computer-like TV may be the consumer appliance that will deliver home entertainment, home banking, home shopping, education and perhaps videotelephony. Researchers here are forging ahead in identifying the most appropriate video compression standards and information storage technologies for future video-based communications across the network.

Just as important, however, is the 'human factors' component of TRL's research which is producing answers to questions like: What's the most 'natural' sequence in which people look things up? What's the most effective menu structure for a home TV-user? What sort of video communication services will people really want?

ADSI MEANS 'EASIER TO USE'

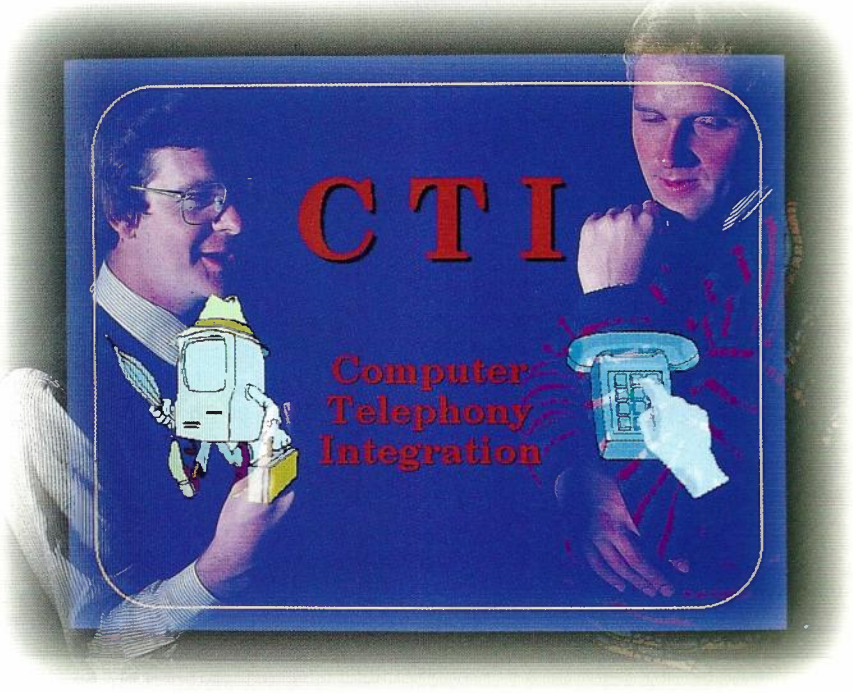
The screen-based telephony standard being tested at TRL is ADSI – analog display services interface. TRL has set up a demonstration system for Telstra clients to test how the standard will work with existing and planned network services.

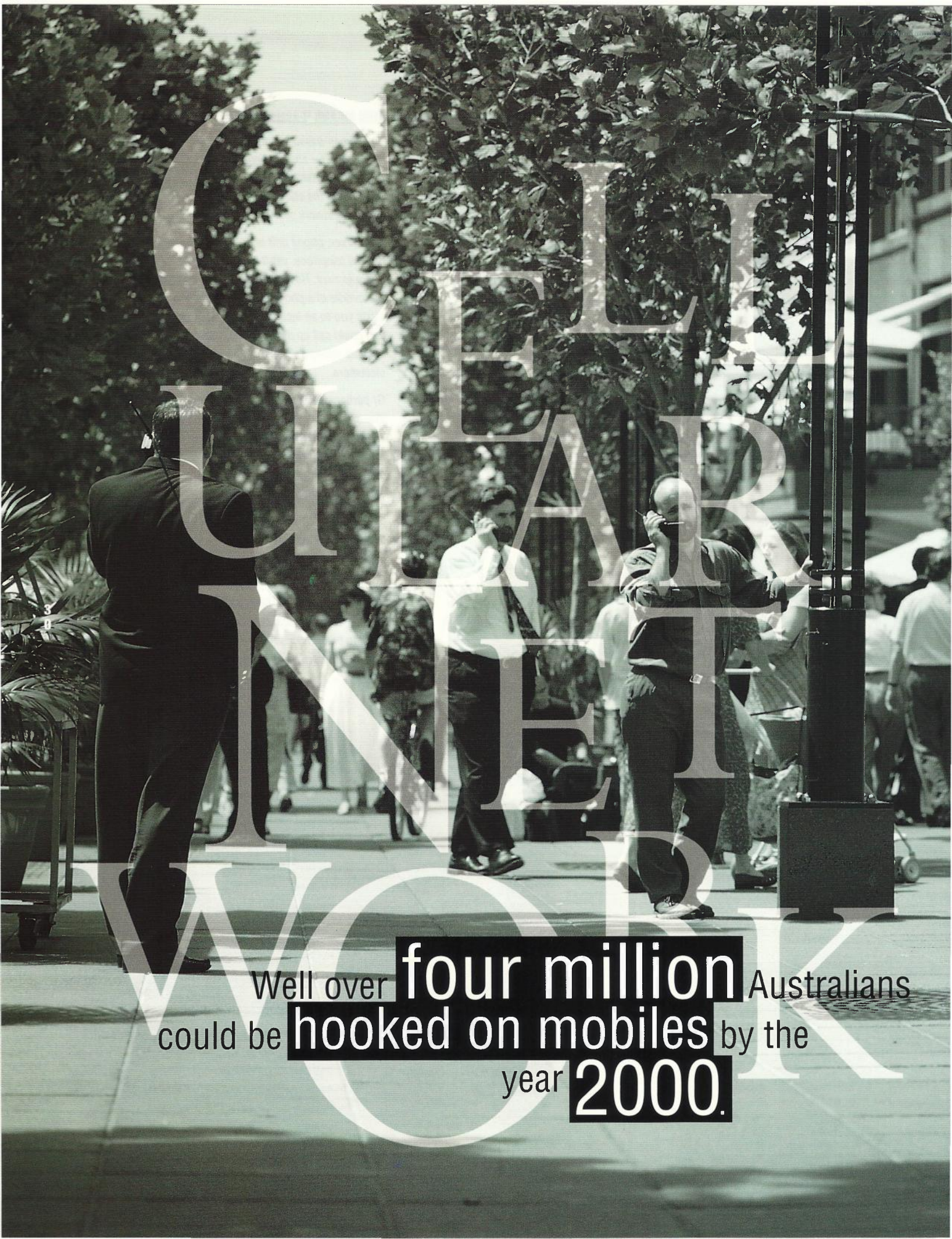
The screen-phone unit is not much larger than a normal telephone, yet it is a far more powerful piece of equipment. How does it work? Let's say you're in the middle of a phone call and you hear a signal that alerts you to an incoming call. With the screen-phone, you could call up a menu of call-handling possibilities, such as taking a voice message or diverting the call elsewhere.

Or perhaps you're doing some banking from home. You call your bank, a customer greeting appears on the screen and moments later, a menu of possible transactions appears, similar to the displays on automatic teller machines.

With screen-phones making it easier for customers to access new network features, Telstra forecasts a significant increase in use of the network.

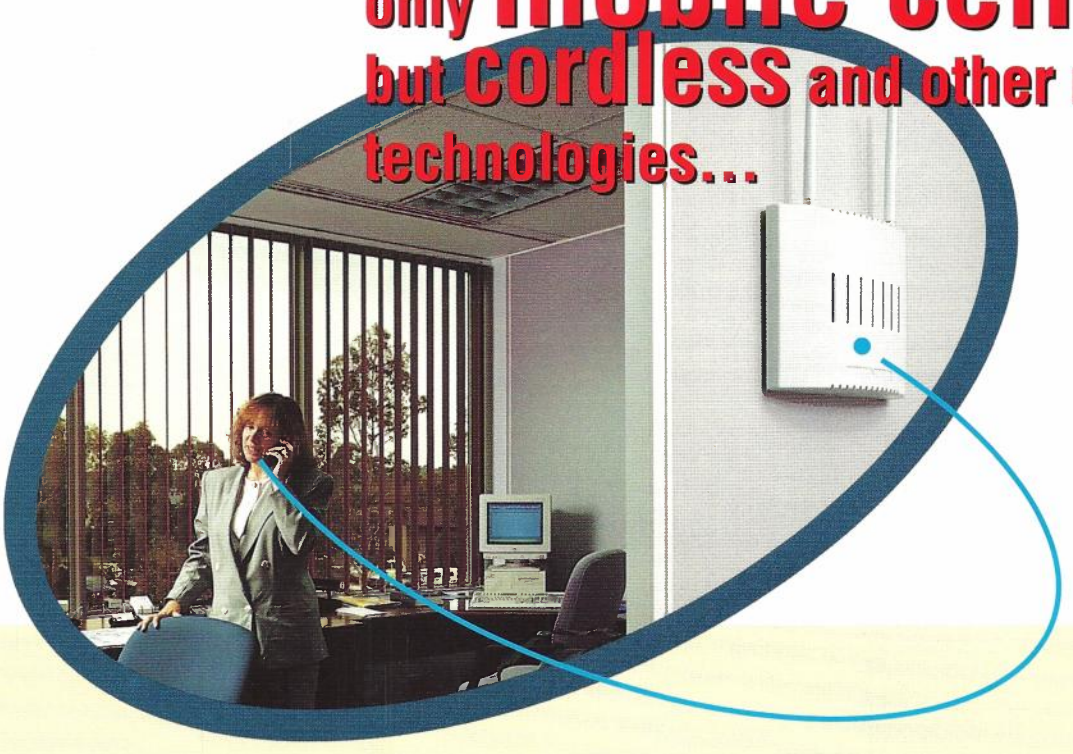
*In the meantime, work continues on enhancements to a new standard keypad phone – the next step beyond the **Touchfone® 200**. TRL has helped produce a more reliable, high-performance handset designed to provide better access to advanced network services for customers. The new phone will be introduced in mid-1995.*




CELL
CLEAR
NET
WORK
Well over four million Australians
could be hooked on mobiles by the
year 2000.

Ten thousand new customers every week – that's the rate at which Telstra's mobile phone business is growing. Well over four million Australians could be hooked on mobiles by the year 2000.

Future 'go-anywhere' communications may incorporate not only mobile cellular but cordless and other radio technologies...



Australians are among the world's most enthusiastic supporters of mobile phones. Telstra operates one of the fastest growing cellular networks in the world, well ahead of growth rates in most OECD countries.

With the recent addition of the **MobileNet Digital**™ cellular mobile network and the **MobileData**™ network to Telstra's earlier **MobileNet**™ analogue network, Telstra is now able to offer advanced services like voicemail, call security, messaging and mobile computer data transfer.

What's the next step? TRL researchers are already planning for the new era of universal and personal communications in which mobile and wireless technologies will play a major role, along with personal numbering, smarter terminal equipment and intelligent call routing within the network.

Picture this. You fly to Melbourne from Sydney on business. You find yourself in an unfamiliar office in front of an unfamiliar terminal screen. You activate the terminal with a smart card encoded with your unique identity (your 'phone number for life'), along with details of all the information services you subscribe to.

In an instant, the network will recognise you and treat the foreign terminal exactly as if it was your own. It will redirect information and carry out pre-programmed instructions, like allocating billing to either you or to the equipment. A wireless personal digital assistant – a combined mobile phone, fax, pager, personal organiser and computer – will provide added 'electronic office' mobility.

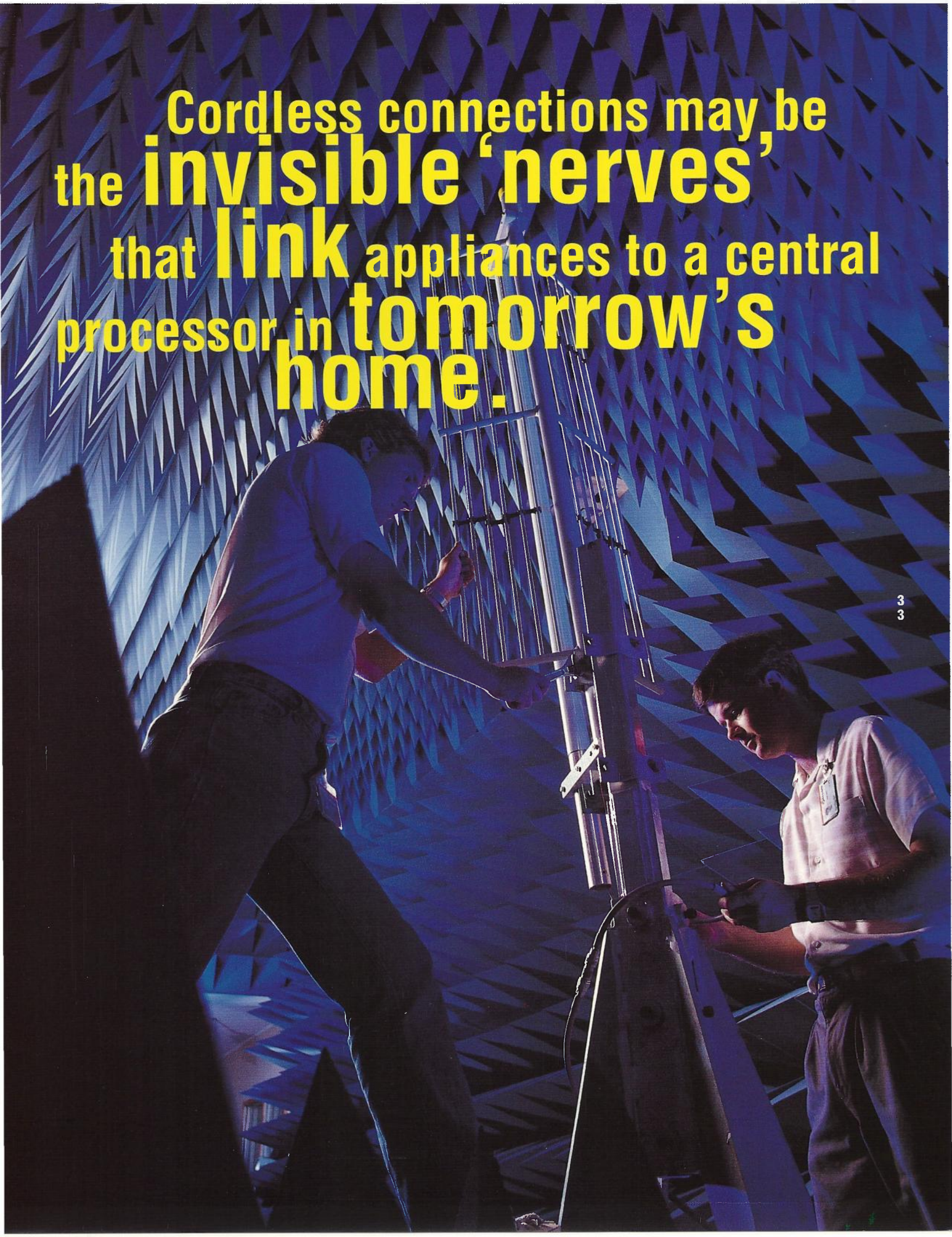
The elements critical to delivering true anytime, anywhere, any-media communications are rapidly being put in place. Wireless and radio technologies will be among the most obvious at the customer end.

TRL's mobile communications team carries out detailed engineering analysis and testing of emerging wireless technologies and systems. It also investigates strategic technologies for delivering future services such as universal personal communications, determining the suitability of such technologies for Telstra's network and market.

Future 'go-anywhere' communications may incorporate not only mobile cellular but cordless and other radio technologies, along with extensive intelligence within the network. (Cordless technologies are referred to as 'access' technologies because they operate at a shorter range than cellular mobile; their main function is to connect the caller to the nearest fixed-network access point.)

ACCESS

TECHNOLOGY


Cordless connections may be the invisible 'nerves' that link appliances to a central processor in tomorrow's home.

Compared to mobile cellular networks, cordless access options offer limited mobility – at the level of the home, a shopping centre, or an office block – at less cost to the customer than cellular. Cordless connections may be the invisible 'nerves' that will link appliances and sensors to a central information processor in future 'intelligent' homes and smart buildings.

TRL's investigation of cordless technologies will enable Telstra to determine optimal operating set-ups for use in business environments and in local neighbourhoods – over how many floors they can audibly transmit in a building for example, or how close to base stations users need to be, or how cordless access systems compare cost-wise to 'wired' alternatives.

TRL has continued to enhance Telstra's mobile cellular network, and is currently evaluating new technologies capable of handling the density of traffic as the mobile user population explodes over the next few years. It plans to use its special strengths in user-friendly design, in electronic directories and in artificial intelligence to add further value and capability to the network.

CORDLESS COMES OF AGE

"Grown-up versions of today's cordless phones" is how one researcher described the emerging cordless communications systems that may soon provide added mobility for customers without the expense of cellular.

TRL has been conducting trials on DECT – digital European cordless telephone technology – to assess its potential as a component of future personal communications services. It may be used to give business people wireless access over a number of floors of an office block to a central PABX, or provide telepoint access in shopping precincts to retail businesses or customers.

TRL's earlier findings on how to optimally configure a DECT network – where to put the base stations, for example, or what types of antennae to use – will facilitate the design of future field trials.

The big promise of cordless technologies is that they may one day be integrated with cellular technologies in the form of a smart dual-mode handset that could automatically switch between the two modes, to provide low-cost, go anywhere communications.

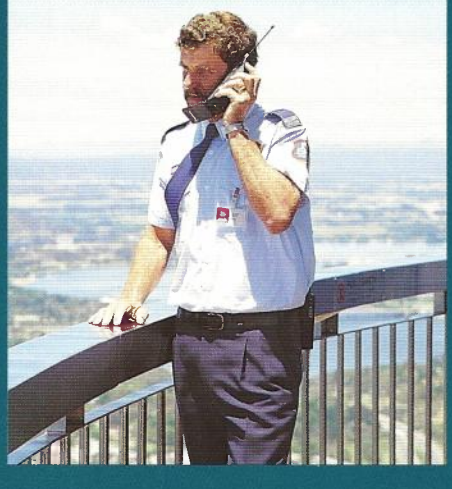
TESTING A WIRELESS OPTION

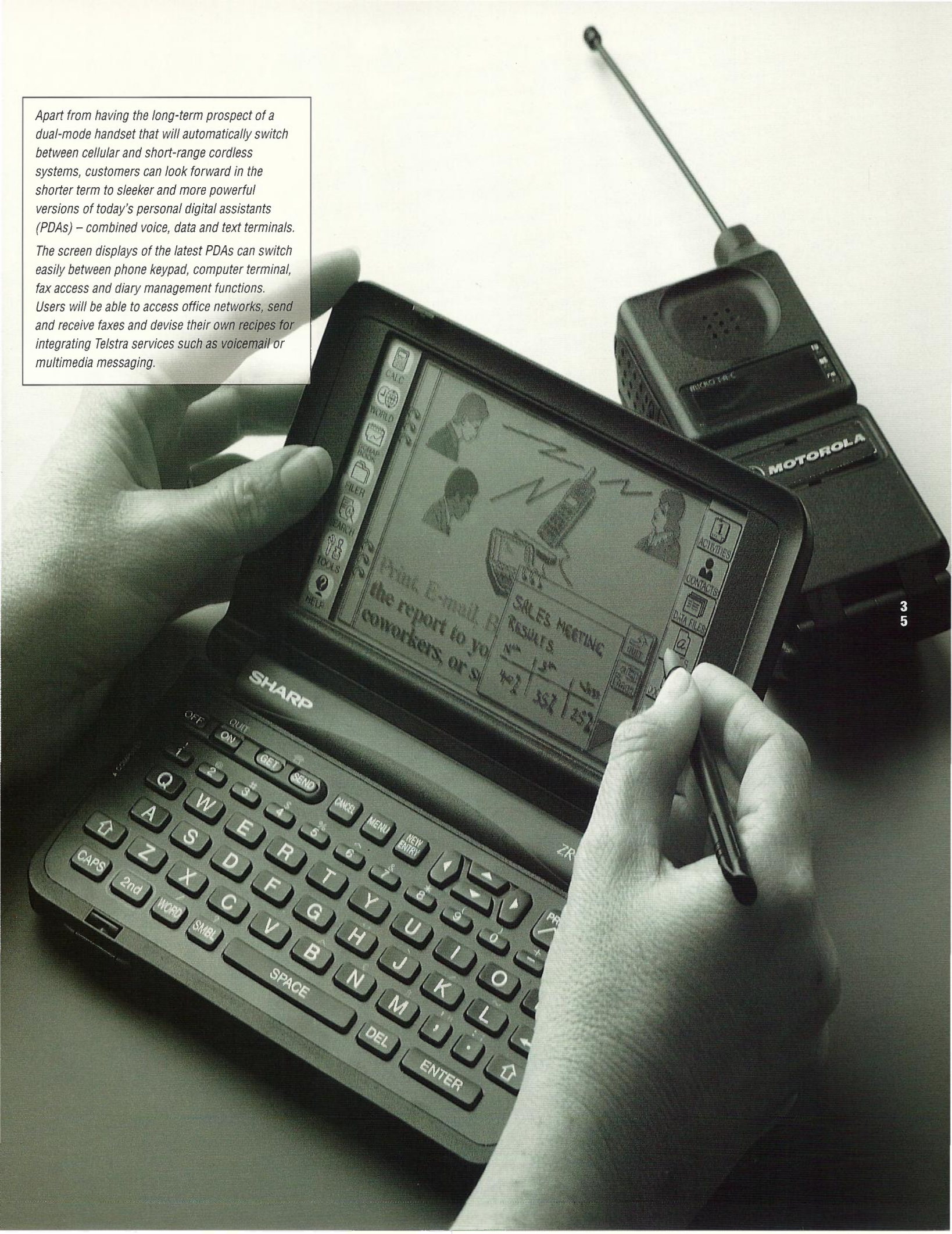
TRL put radio technology to the test in a Queensland community where cables had not yet been laid to customers' homes. This allowed Telstra to provide a residential telephone service and lay cables at a later date, reducing costs.

TRL's aims were to evaluate the quality and customer perception of the service delivered by the radio system and compare the cost against the cost of cabling. Throughout the trial, TRL people worked closely with the local community, giving researchers further insights into the operation of radio technologies at the customer end.

THE FUTURE FOR CELLULAR

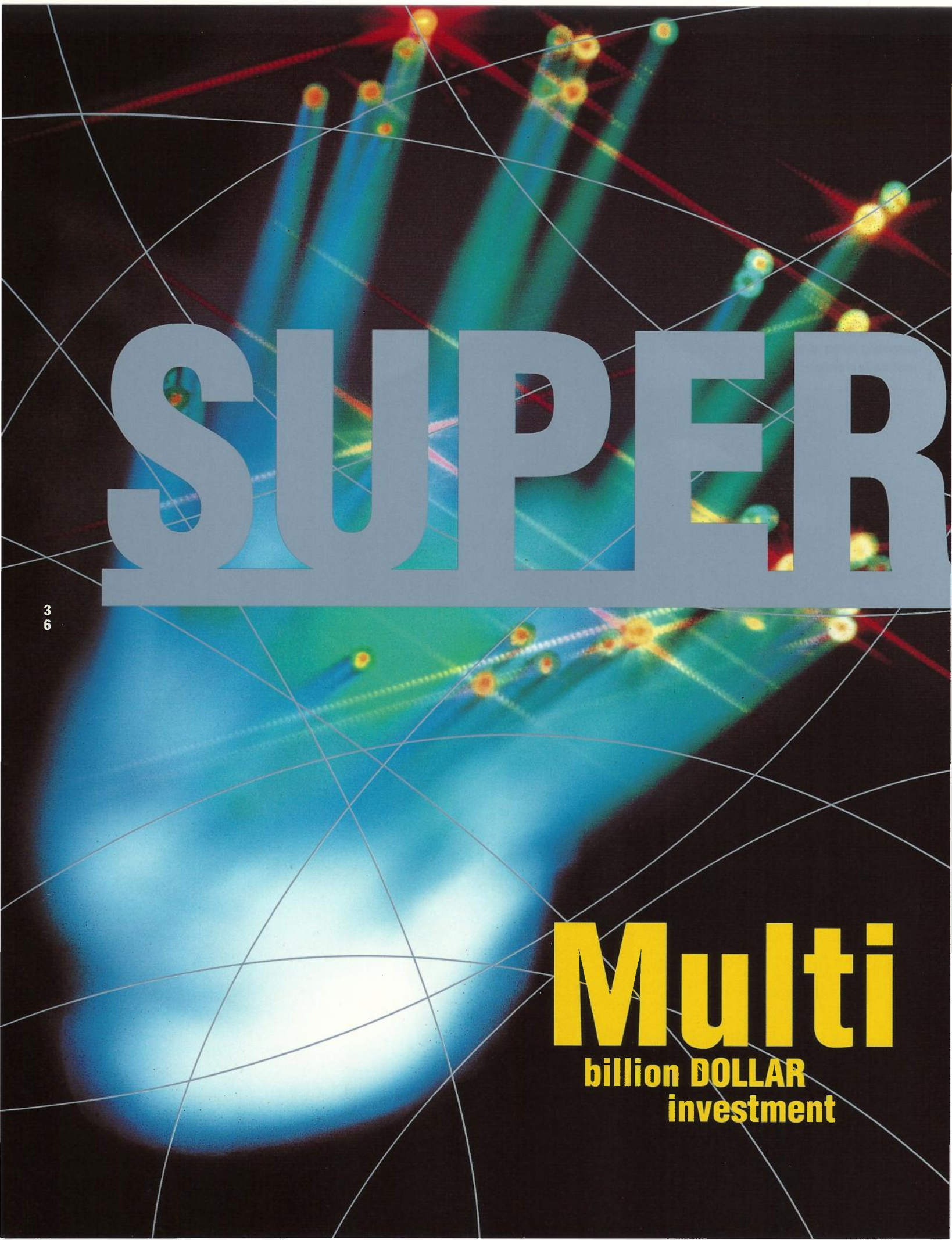
With more than four million mobile phone users forecast for Australia by 2000, Telstra is already planning to increase the capacity of its cellular network. TRL's Radio and Satellite Networks section is investigating emerging overseas standards which can accommodate much higher densities of calls within each cell. Early field trials have allowed Telstra to compare the performance of such networks against existing ones.





Apart from having the long-term prospect of a dual-mode handset that will automatically switch between cellular and short-range cordless systems, customers can look forward in the shorter term to sleeker and more powerful versions of today's personal digital assistants (PDAs) – combined voice, data and text terminals.

The screen displays of the latest PDAs can switch easily between phone keypad, computer terminal, fax access and diary management functions. Users will be able to access office networks, send and receive faxes and devise their own recipes for integrating Telstra services such as voicemail or multimedia messaging.


SUPER
Multi
billion DOLLAR
investment

Telstra has already put much of Australia's information superhighway in place – an extensive network of glass fibres, each one thinner than a human hair yet capable of supporting more than 20 000 studio quality TV channels.

highway

Current optical fibre systems utilise only 0.1 percent of available capacity

Bit by bit, the earth's surface is being criss-crossed by a network of optical fibres, connecting countries across oceans, and connecting cities across vast distances.

The reason for this global push? Optical fibre's unmatched capacity to carry information. Future all-optical fibre networks will carry information-bearing laser-light pulses in dozens of wavelengths – "a sea of colour" as one researcher described it – to create tens of thousands of channels that can be switched and guided by simple glass photonic devices.

The future network will be transparent, light-speed, with few electronic switches, easy to manage and maintain, and robust enough to simultaneously handle massive amounts of information and multimedia traffic.

A single channel within an optical fibre can provide all the transmission capacity a customer would need to interact with the thousands or millions of services offered by the global service network of the future. This spare capacity will also accommodate the machine intelligence and visuals that will be required to make telecommunications services easier to use.

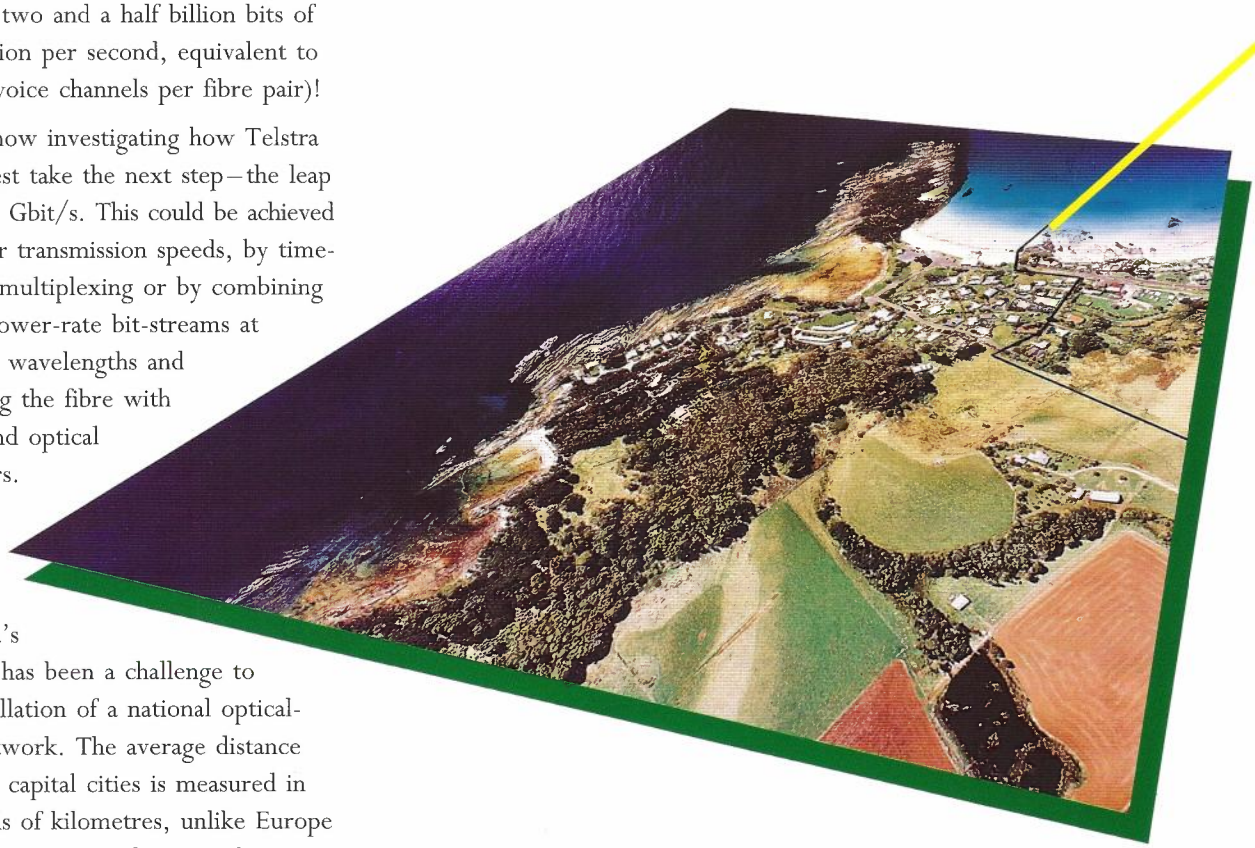
About 50 percent of urban Australian homes are within an average distance of three-quarters of a kilometre from a Telstra optical fibre connection. Telstra is taking great care about how it makes the multi billion dollar investment to shorten this 'home stretch' nationally.

Current optical fibre systems only utilise about 0.1 percent of available capacity. TRL's experience in making and evaluating optical equipment has enabled Telstra to make better use of that potential. TRL's recommendations have taken optical fibre transmission speeds from the original 34 Mbit/s (megabits of information per second) to 2500 Mbit/s (2.5 gigabits per second – two and a half billion bits of information per second, equivalent to 30 000 voice channels per fibre pair)!

TRL is now investigating how Telstra might best take the next step – the leap up to 10 Gbit/s. This could be achieved by higher transmission speeds, by time-division multiplexing or by combining several lower-rate bit-streams at different wavelengths and equipping the fibre with broadband optical amplifiers.

Australia's vastness has been a challenge to the installation of a national optical-fibre network. The average distance between capital cities is measured in thousands of kilometres, unlike Europe where cities are rarely more than 100 km apart. This means that equipment designed for the shorter distances in overseas networks may not be appropriate for use here.

With TRL's help, Telstra has set new global standards for increasing the length of cable between expensive optoelectronic repeaters. In fact, researchers' knowledge of trends in optical-fibre equipment allowed Telstra to plan in 1991 – well before the necessary equipment was available – the forthcoming repeater-free uninterrupted optical cable link to Tasmania.



Telstra has set new global standards for increasing the length of cable between repeaters.

SINGLE HOP TO TASMANIA

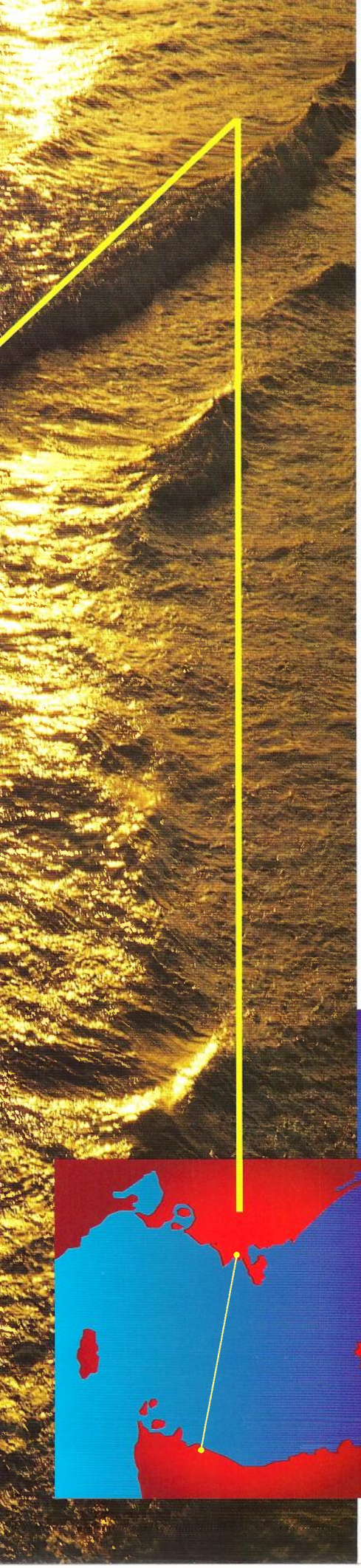
In 1991, Telstra's Capacity Planning group saw a need to install a high-capacity optical fibre link beneath the 250 km stretch of ocean separating the mainland from Tasmania. Through TRL's understanding of the technology, Telstra was able to spend several million dollars less than it might otherwise have spent.

TRL suggested a plan to lay the cable in a single span, without bringing it ashore at King or Flinders Islands, or resorting to the use of submarine repeaters to regenerate weakened signals. The researchers were confident that the single span could be achieved through combining new low-loss optical fibre with optical power amplifiers and extremely sensitive optical pre-amplifiers, eliminating the need for repeaters at intervals along the cable.

There was one hitch – the amplifier and pre-amplifier equipment were still untested ideas, unproven in the field and not even available for trial. However TRL researchers soon managed to design and build a prototype system that demonstrated the feasibility of a long-distance, un-repeatered link beneath Bass Strait.

Said a TRL researcher who worked on the project team, "At the time of Telstra's decision to proceed with a single-hop unrepeatered system, no one elsewhere seemed to be planning spans any longer than 180 km.

"But we knew from our own work and overseas laboratory reports that an amplified system would succeed over the 250 km-long hop.



"The projections we made for the power budget in 1991 are within a few decibels of where the system is now. And we believe we've come close to achieving world-record performance for optical pre-amplifiers."

PHOTONICS REPLACING ELECTRONICS

Telstra plans to lay optical-fibre cable close to most Australian homes and businesses, but the timing of the full roll-out will depend on the economics, which in turn will depend on the strength and speed of the market's response to new information and entertainment services.

Another factor in the roll-out will be the cost of equipment. TRL has been investigating the technology required to make cheap and reliable glass photonic devices such as waveguides and amplifiers which can amplify and process multiple wavelengths simultaneously.

Researchers are also evaluating wavelength division multiplexing and time-division multiplexing for upgrading Telstra's major inter-city optical fibre links from 2.5 Gbit/s to 10 Gbit/s (four lots of 2.5 Gbit/s).

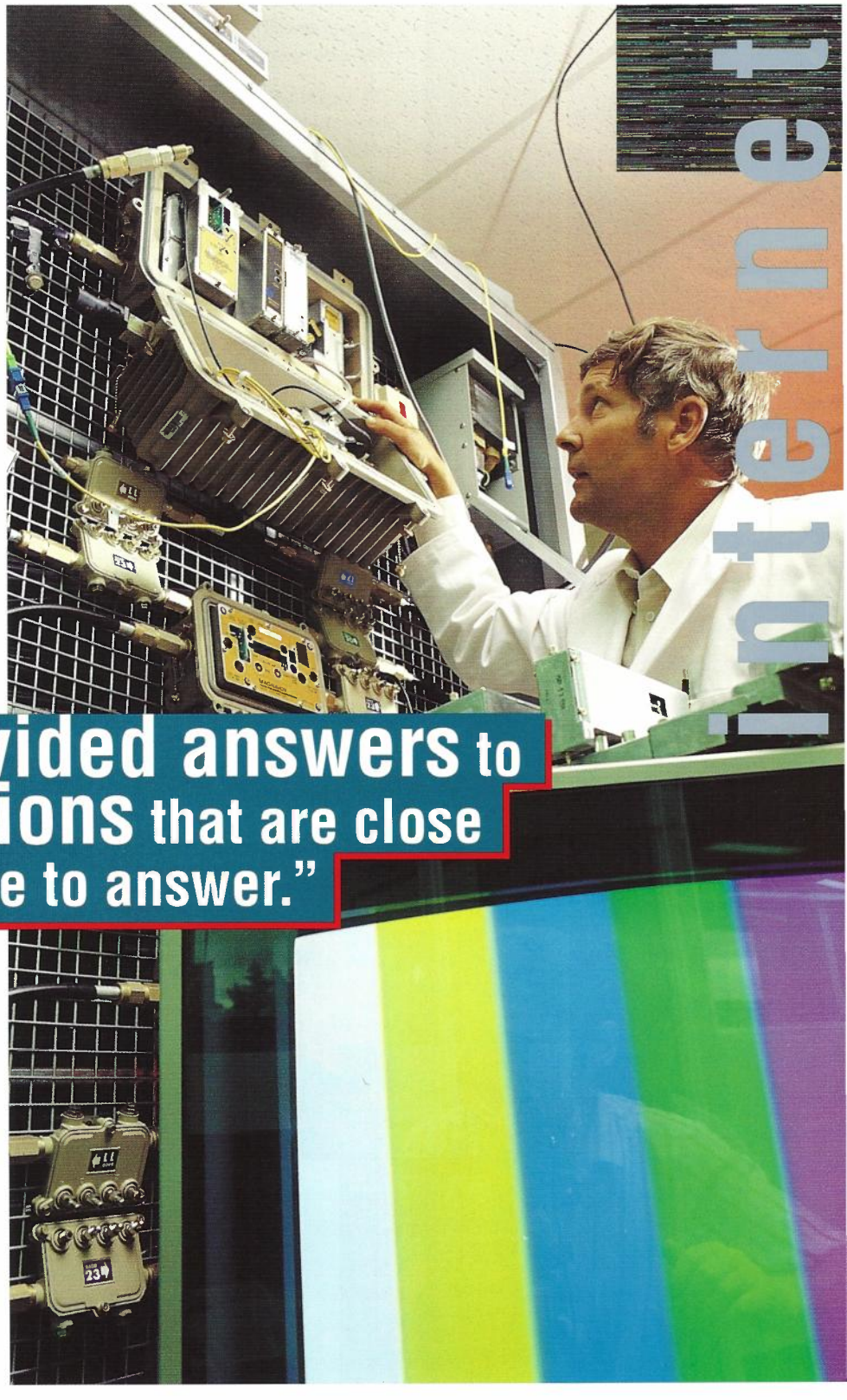
Optical fibres and optical amplifiers should provide more than enough channel capacity to support the large numbers of users and information/ entertainment services planned for next century.

Telstra is investing billions of dollars to 'widen the road' and gear the network for pay TV and interactive video services. It's an investment the organisation is not taking lightly.

COSTING THE SUPERHIGHWAY

Media speculation over the past year about markets for pay TV, tele-shopping, tele-banking and tele-learning has hovered between enthusiastic support to pessimistic predictions of information superhighway 'potholes'.

Whatever the mood of the moment, the deeper reality is that Australia cannot afford to take a back seat and wait for other players to develop new markets for video-based information and entertainment services. Accurately predicting the right timing and mechanisms for introducing such services to customers requires precise analysis and a sound understanding of network architecture.



"TRL has provided answers to questions that are close to impossible to answer."

TRL researchers are combining their expertise in mathematical modelling and network engineering with Telstra's experience in building networks and managing communications traffic to produce and compare cost models for pay TV and new video-based services.

Almost all exchanges in Australia already have optical fibre connections. "It's a significant investment to replace copper telephone wires with a new network capable of delivering the services predicted

for next century," said a TRL engineer. "We have to make sure we make the right decisions at the outset and get the right support systems in place."

A common problem with estimating costs for optical fibre systems is getting reliable cost inputs for components. Even small errors could result in an organisation making a wrong strategic decision. TRL's understanding of emerging technology and global trends means that estimates are based on accurate inputs, and that unit price reductions due to economies of scale can also be factored into cost models.

Associated sections of Telstra – such as the Information Society 2000 (IS2000) project team – are using TRL's results to make strategic decisions about the rollout of pay TV, video-on-demand and other new services. The forecasts are also being used by government policy-making bodies. Said one IS2000 planner, "TRL has provided answers to questions that are close to impossible to answer."

Telstra plans to introduce multimedia services to Australian homes in stages: from digital broadcast, to limited interactivity, to fully interactive digital.

The first stage now underway involves a mix of optical fibre and coaxial cable to deliver pay TV to some areas, while other areas may be served by ADSL (asymmetric digital subscriber line), a new technology for sending compressed and digitalised broadband signals over the existing twisted-pair copper-wire telephone network. As most Australian homes have a phone, an optical fibre-coaxial cable/ADSL roll-out would provide rapid connection to multimedia services.

TRL is investigating how the network will evolve in response to customer demand. For example, if the market responded strongly to 'near video on demand', in which customers might have to wait a few minutes to see the video of their choice, Telstra could save on the additional – and significantly higher – cost of gearing the network for real-time video on demand. It could focus instead on offering better value to customers.

Another driver for the full service network to the home may be Internet. Its success has been phenomenal – it serves approximately 30 million users around the globe, and the volume of traffic it carries has been doubling every year. This growth will be greatly boosted by the expanding population of business users, who will demand much faster rates of information transfer at even lower prices.

video-based information

FINDINGS FROM WOLLONGONG

TRL developed the passive optical fibre delivery and testing system used in a fibre-to-the-kerb technology trial in Wollongong, NSW. When it was first set up, the trial network boasted the world's longest optical fibre customer connection to an exchange and was the world's first passive optical fibre network to integrate video, data and telephone services.

Now that Telstra has completed the trial and surveyed participants, TRL will apply the insights and findings to Telstra's forthcoming ADSL pilot in Melbourne. While participants were more than satisfied with the picture quality delivered over the optical fibre cable, the Wollongong trial revealed two key areas for further development in future high-tech trials: network management and the type of services that could be delivered.

compression technology– squeeze 100 times more information onto a standard telephone line

VIDEO OVER TELEPHONE LINES

During 1994, TRL continued its evaluation of ADSL (asymmetric digital subscriber line), an innovative digital technology that could allow Telstra to transmit bandwidth-hungry video signals over conventional twisted copper pair telephone lines, while still delivering the standard telephone service. New digital compression technology will allow Telstra to squeeze 100 times more information onto a standard telephone line than has been possible to date.

Most Australian homes still receive and deliver communications to and from the local exchange via copper wires. (Optical fibre now connects most Telstra exchanges to the core network.) ADSL will broaden the reach of pay TV, video-on-demand, personalised news and other broadband and interactive services.

A pilot ADSL video-on-demand system is about to be trialled in Melbourne's eastern suburbs. The pilot ADSL network – a larger version of a research network established earlier at TRL – involves 300 homes connected to 50 different movie channels and 10 pay TV channels. The video server that will supply the movies is based at TRL.

VISIONSTREAM

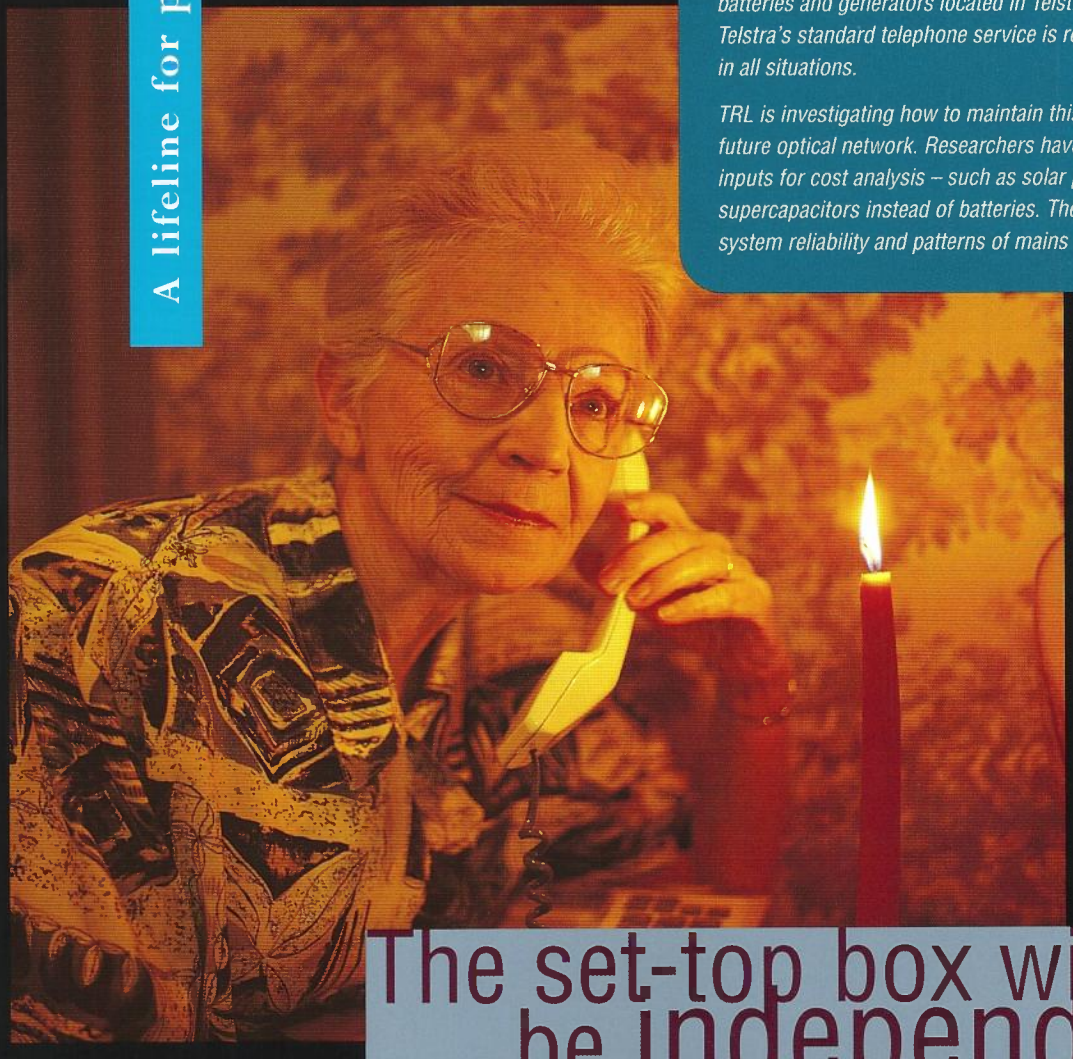
Telstra will deliver pay TV to the home through a combination of fibre, coaxial cable and ADSL/copper.

The optical fibre/coaxial cable architecture was initially trialled on a cable TV pilot network in Centennial Park, Sydney. The trial involved 1000 homes which were provided with video channels, recorded broadcast TV channels, FM radio, community TV and educational programs. TRL provided technical support for the trial, helped train the staff involved and assisted in equipment installation.

Optical fibre/coaxial cable is now being rolled out to four million homes over four years by Visionstream Pty Limited, a fully-owned subsidiary of Telstra. TRL is responsible for particular aspects of the roll-out such as network design, picture quality and testing of equipment.

Even small errors could result in an organisation making a wrong strategic decision.

A lifeline for people in all situations.



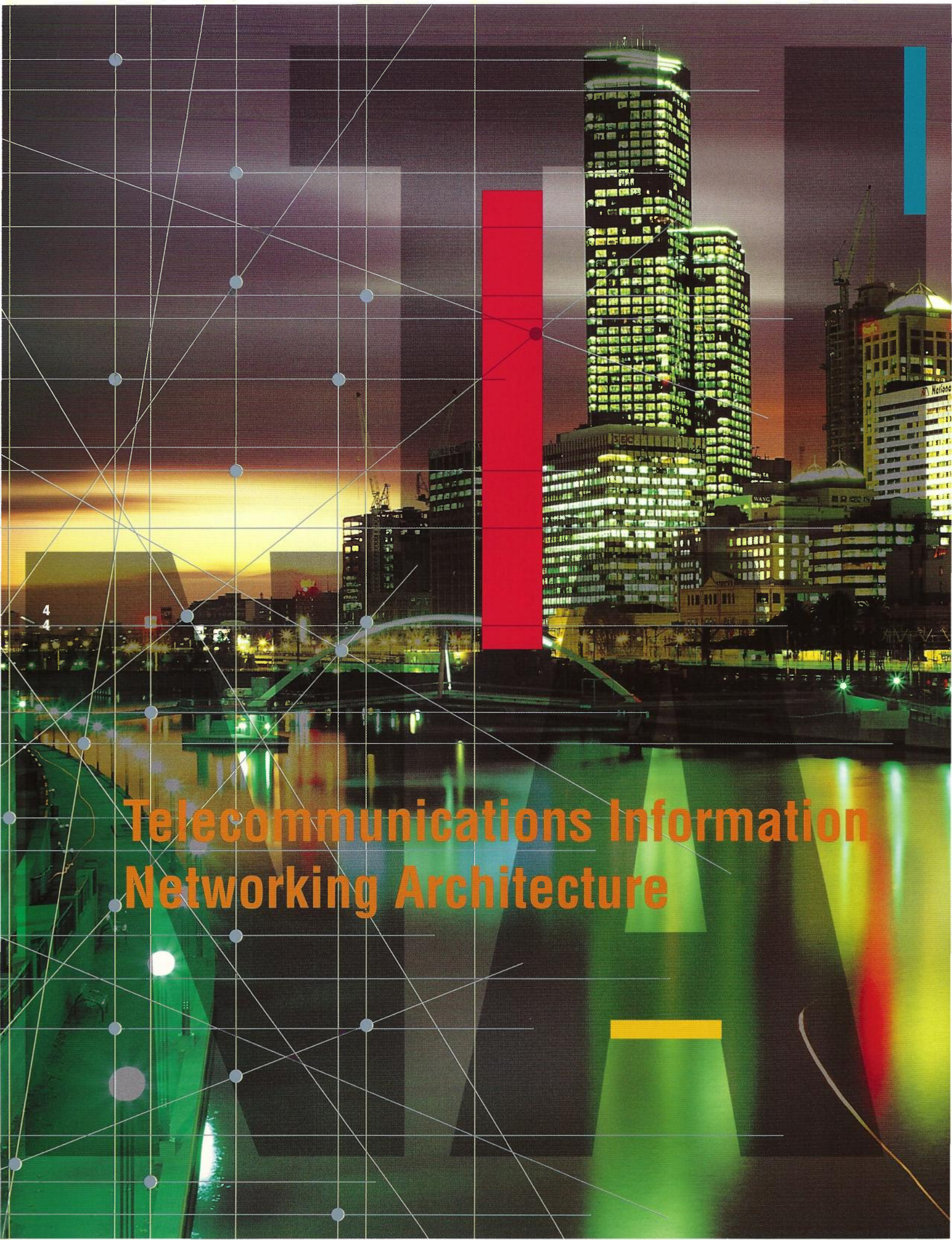
POWER TO THE SET-TOP BOX

To deliver the full range of two-way multimedia services to businesses and homes around Australia, Telstra may need to install an electronic box – a network termination unit – inside each customer's home.

The problem is that the network termination unit will need to be powered to receive signals. At the moment, telephones are powered by electricity delivered over the twisted-pair copper wires in the telephone cable. During blackouts telephones are kept alive by power from batteries and generators located in Telstra exchanges. This is why Telstra's standard telephone service is regarded as a lifeline for people in all situations.

TRL is investigating how to maintain this failsafe, lifeline function in the future optical network. Researchers have been looking at different inputs for cost analysis – such as solar power modules and supercapacitors instead of batteries. They are also assessing power system reliability and patterns of mains power failure.

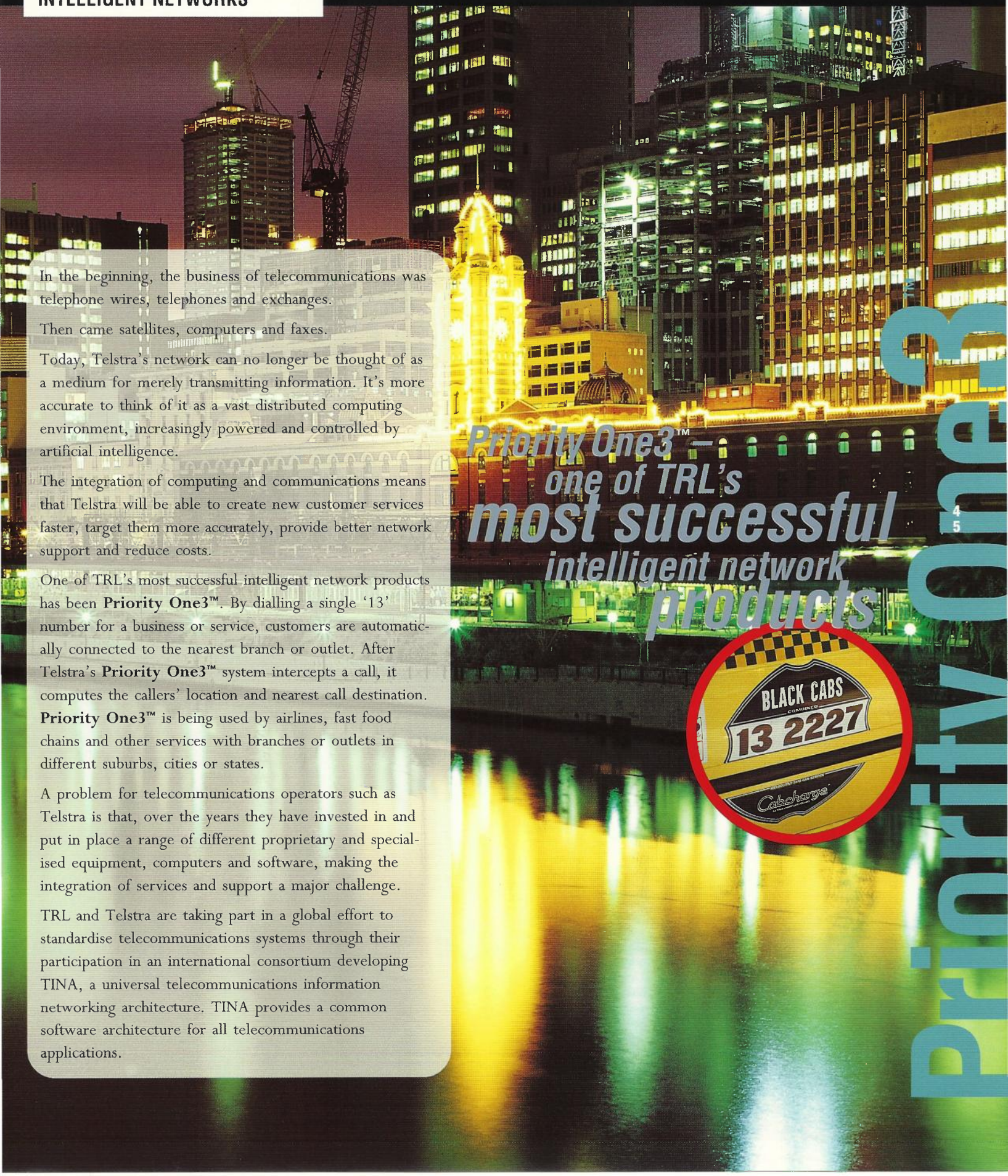
The set-top box will need to be independently powered.



Telecommunications Information Networking Architecture

TRL is helping shape international standards for the convergence of computing, communications and information services.

INTELLIGENT NETWORKS



In the beginning, the business of telecommunications was telephone wires, telephones and exchanges.

Then came satellites, computers and faxes.

Today, Telstra's network can no longer be thought of as a medium for merely transmitting information. It's more accurate to think of it as a vast distributed computing environment, increasingly powered and controlled by artificial intelligence.

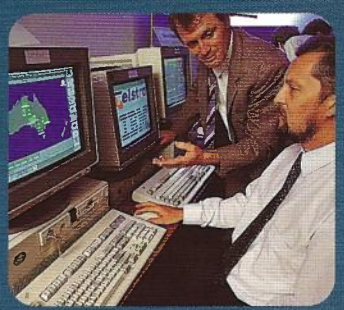
The integration of computing and communications means that Telstra will be able to create new customer services faster, target them more accurately, provide better network support and reduce costs.

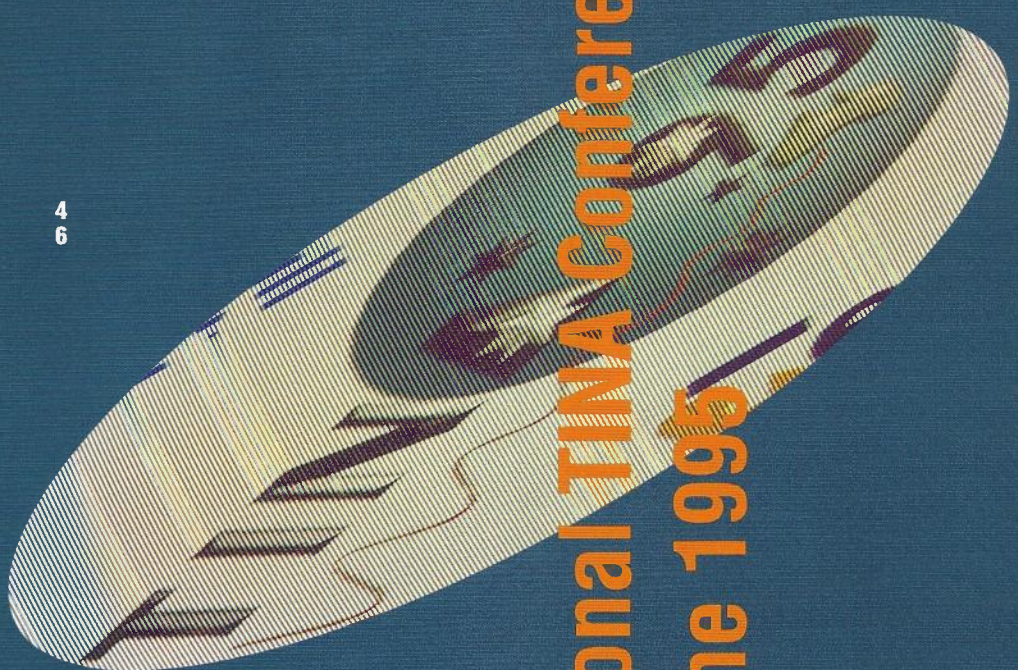
One of TRL's most successful intelligent network products has been **Priority One3™**. By dialling a single '13' number for a business or service, customers are automatically connected to the nearest branch or outlet. After Telstra's **Priority One3™** system intercepts a call, it computes the callers' location and nearest call destination. **Priority One3™** is being used by airlines, fast food chains and other services with branches or outlets in different suburbs, cities or states.

A problem for telecommunications operators such as Telstra is that, over the years they have invested in and put in place a range of different proprietary and specialised equipment, computers and software, making the integration of services and support a major challenge.

TRL and Telstra are taking part in a global effort to standardise telecommunications systems through their participation in an international consortium developing TINA, a universal telecommunications information networking architecture. TINA provides a common software architecture for all telecommunications applications.

TINA bridges the gap between telecommunications and computing



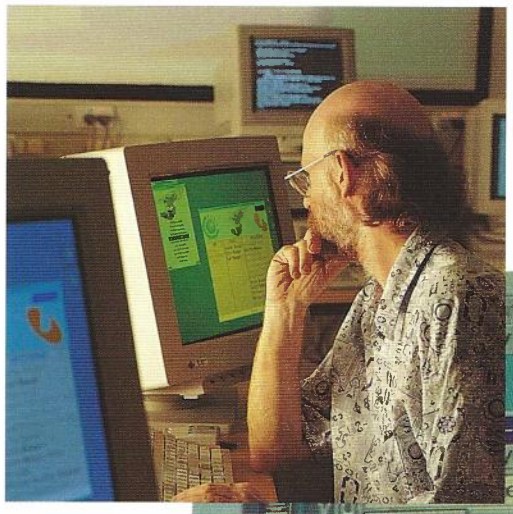


TINA represents a fundamental shift in the way telecommunications services will be packaged, delivered and maintained. "TINA paves the way for convergence," said one TRL software engineer. "Soon you won't be able to tell the difference between computers and telecommunications – you'll make phone calls from your computer. You'll move from one service to another easily and painlessly."

Telstra is a member of the TINA consortium (TINA-C) and was selected to host the Fifth International TINA Conference in Melbourne in 1995.

TRL has one of the world's most active TINA validation projects, and was a key player in the development of two of the systems demostrated at TINA'95. One of these – the Multi Service Platform (MSP) – was the result of a collaboration between Telstra's Network and Technology Group and IBM.

In the longer-term Telstra and TRL will use TINA to enhance the next generation of customer products. In fact, these new support systems will change the way customers deal with Telstra – for example, customers could add new services or subscribe to existing ones simply by calling up graphical menus on their PCs.



universal

personal

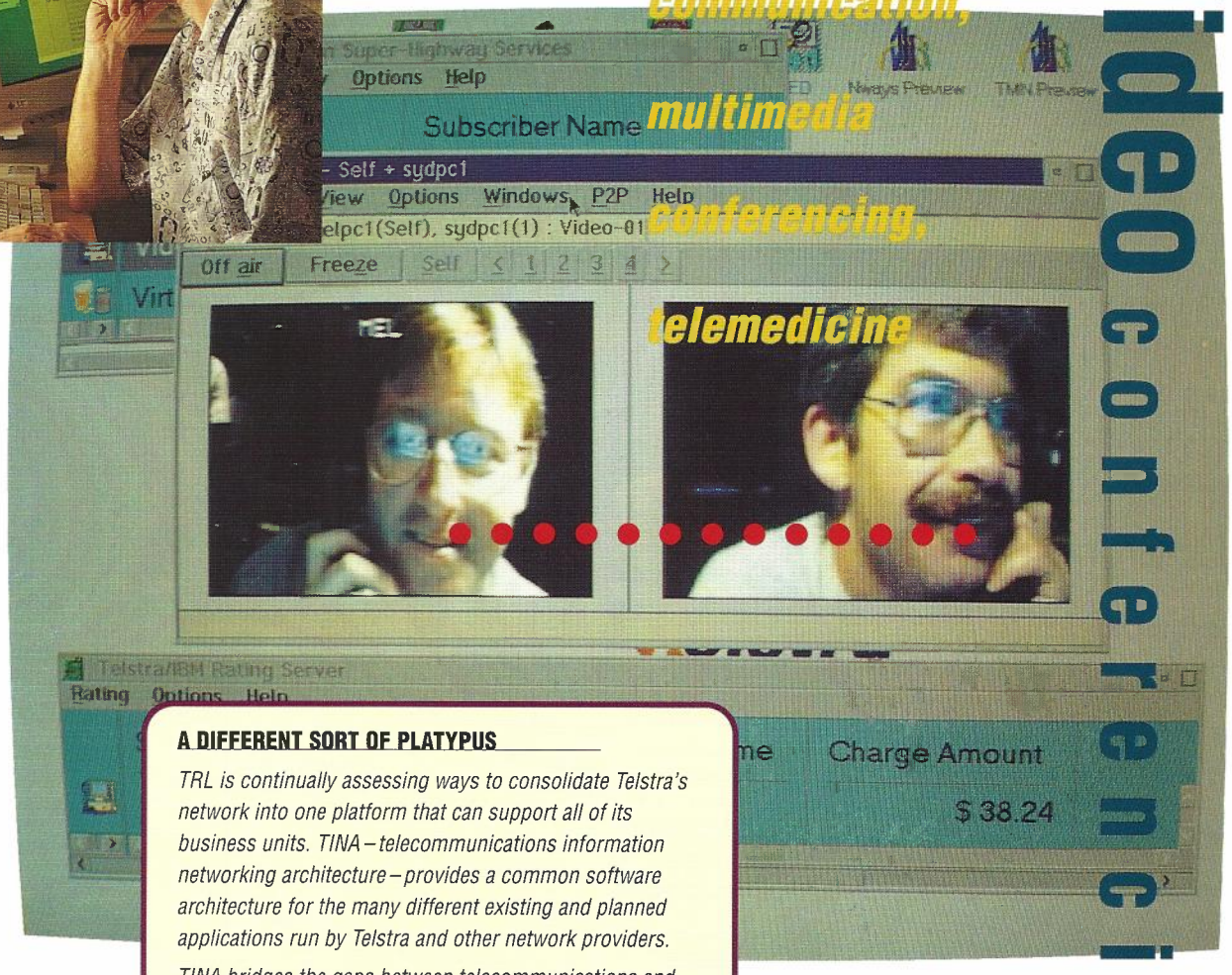
communication,

multimedia

conferencing,

telemedicine

Video conferencing



PLATyPus

A DIFFERENT SORT OF PLATYPUS

TRL is continually assessing ways to consolidate Telstra's network into one platform that can support all of its business units. TINA – telecommunications information networking architecture – provides a common software architecture for the many different existing and planned applications run by Telstra and other network providers.

TINA bridges the gaps between telecommunications and computer processing, paving the way for advanced applications like universal personal communications, multimedia conferencing, telemedicine and broadband virtual private networks.

There are 12 TINA trials in place around the world and Telstra's project based at TRL, PLATyPus – PLATform for TINA Prototyping – was the world's first. It is progressively being copied by companies elsewhere.

PLATyPus has spun off a number of other projects including PLATyTools, a set of software development tools that will automate parts of the development process associated with TINA applications. PLATyTools is being prepared for commercialisation by major computer vendors.

In a related project TRL is working with Telstra's Information and Technology Group to explore the use of TINA for a new generation of operation support systems that will enable Telstra to introduce new services to customers faster and more economically.

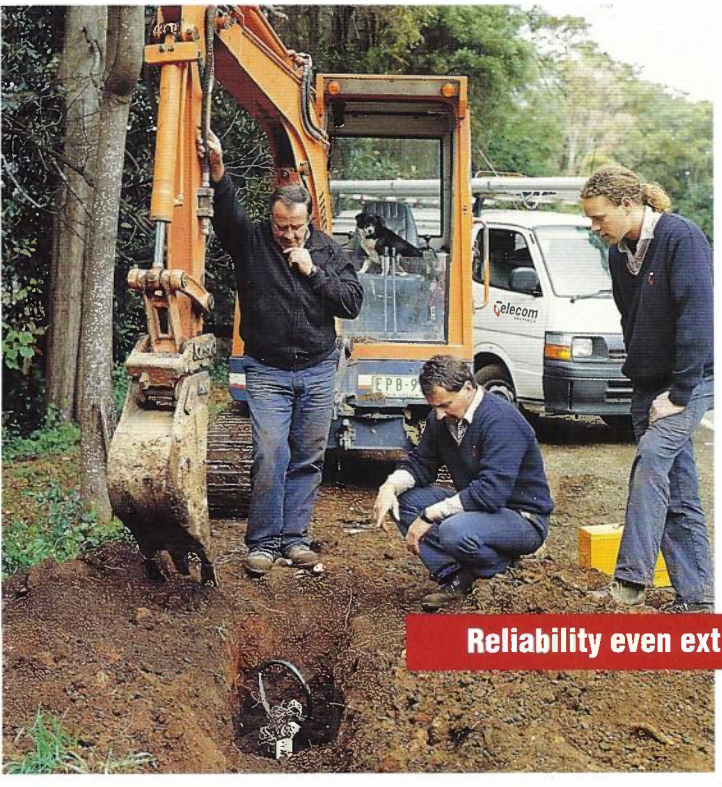
"Success for us is a network that you are not even aware of, that performs flawlessly."

Telstra's reputation for operating a world class network is the result of strategically investing in the right technology, of demanding the best possible quality and of making constant checks and balances across the network.

NETWORK RELIABILITY

Telstra has earned a reputation worldwide for its reliable, high-performance network. The organisation's commitment to network integrity will become more important to customers as the 'value added' factor of electronic information transfer increases.

Business customers especially will demand totally secure, reliable, failsafe communications in the era of the paperless enterprise. Said one TRL network engineer, "If we're doing our job well, the customer should not know we're here. Success for us is a network that you are not even aware of, that performs flawlessly."



Reliability even extends to worst-case scenarios like backhoe damage

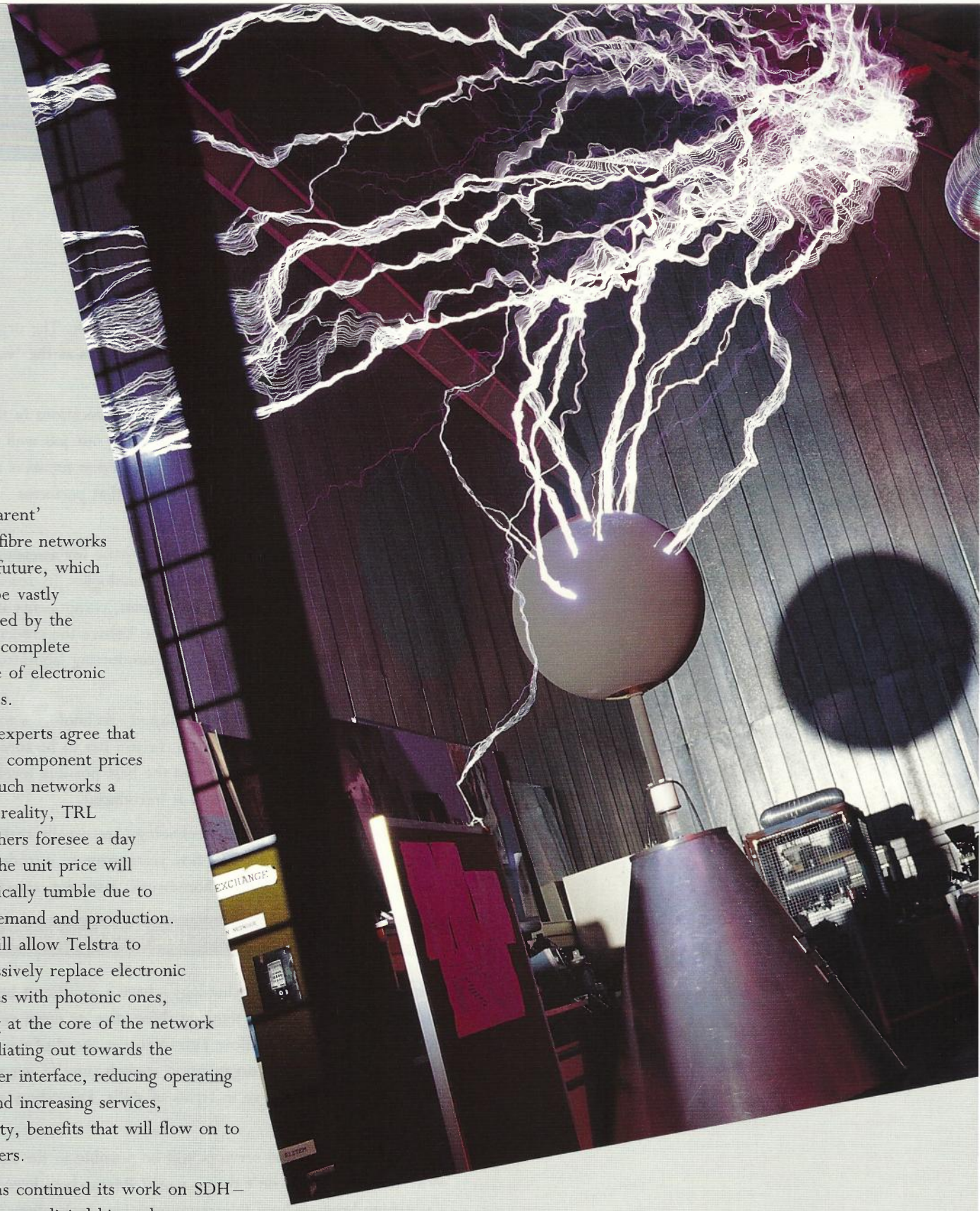
TRL is Telstra's source of technical expertise for assessing, selecting and refining new network technologies. Its researchers test and monitor new network equipment, components and systems to rigorous standards, and give Telstra the credentials to operate new technologies through conducting laboratory trials and building prototypes.

In selecting leading-edge – often untested – technologies to equip its network for future applications, Telstra has to be sure it will achieve reasonable returns and the best possible levels of service soon after the technology is introduced.

The highest returns on a new technology are usually realised within the first few years. The few years prior to introduction – when organisations do their homework, assessing, selecting, testing and adapting the technology – have a significant bearing on early performance. By thinking three, five or more years ahead, TRL researchers allow Telstra to get ahead of new technologies, giving the organisation enough time to get some way up the learning curve in terms of skills, know-how and insights.

What architectures and services will be possible in the future? Why will they – or won't they – work? Researchers here keep a watching brief on how telecommunications technology is advancing globally, and select the most promising and appropriate for laboratory investigation.

Developments in optical planar wave guides, for example, may mean nothing to most people, but to TRL engineers they represent a major step towards the super-capacity, super-fast

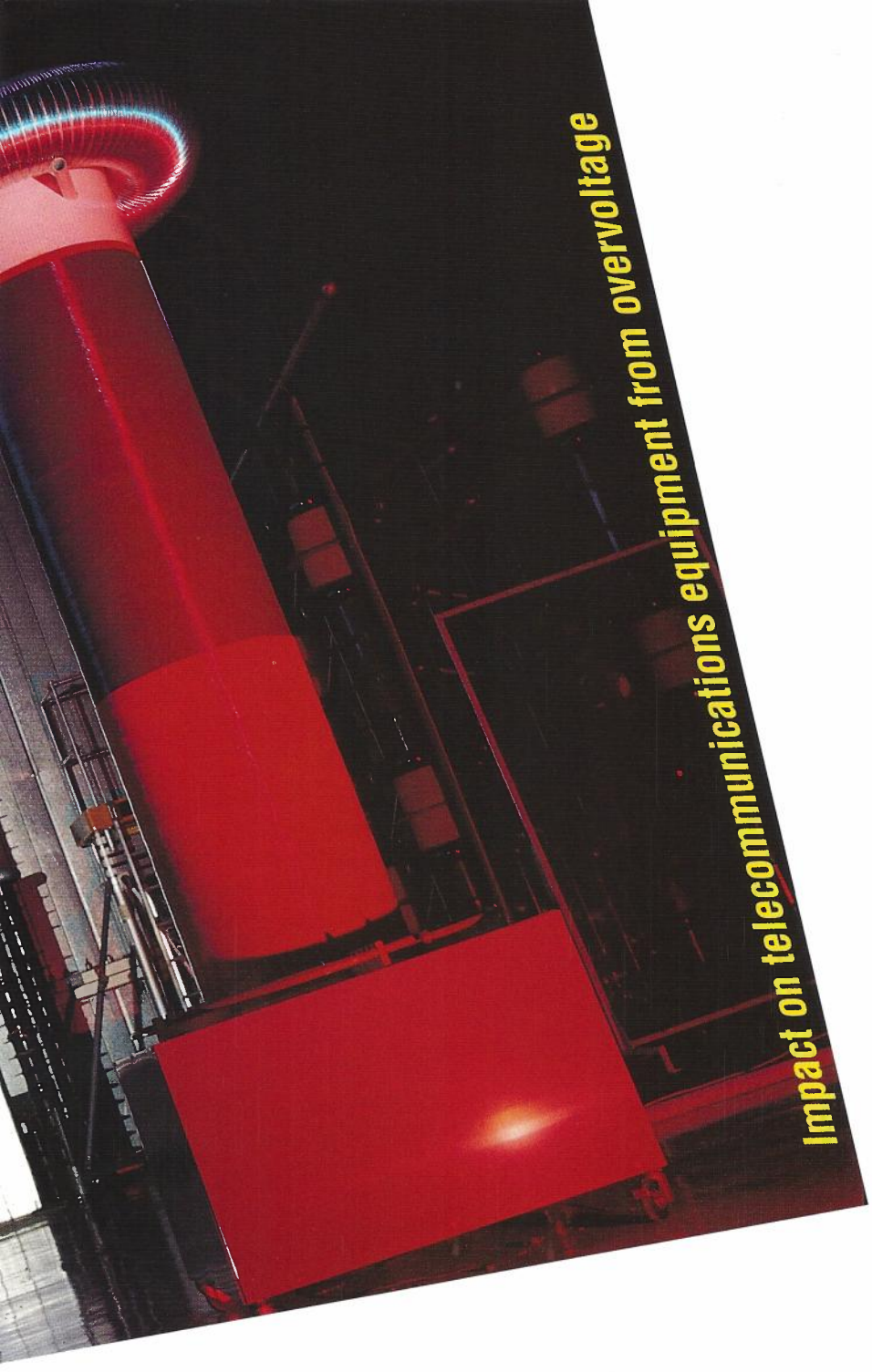


'transparent' optical-fibre networks of the future, which could be vastly simplified by the almost complete absence of electronic switches.

While experts agree that current component prices make such networks a distant reality, TRL researchers foresee a day when the unit price will dramatically tumble due to mass demand and production. This will allow Telstra to progressively replace electronic switches with photonic ones, starting at the core of the network and radiating out towards the customer interface, reducing operating costs and increasing services, flexibility, benefits that will flow on to customers.

TRL has continued its work on SDH – synchronous digital hierarchy – an advanced network-management tool that can automatically mobilise spare capacity to prevent 'outages' due to accident or overload.

And work continues on the assessment of network components against stringent performance standards, encouraging Australian electronics and components suppliers to aim for higher quality levels. Indeed, because of Telstra's reputation, its endorsement of Australian products enhances their export value overseas.



This same redundancy will protect the network from accident – the worst-case scenario often cited is that of a backhoe digging through a cable. A sophisticated SDH network management system would respond within milliseconds by re-routing signals on the damaged line to the pre-determined alternative path. The network would barely miss a beat.

SHOCK-PROOFING THE NETWORK

TRL has continued its research on the impact on telecommunications equipment of overvoltage from electrical stress and lightning damage.

Every year in Australia about 15 million lightning bolts hit the ground. TRL collects data on power surges and transients that occur on Telstra's cables, particularly those located in high-risk areas. This enables Telstra to determine the appropriate level of protection for equipment.

Although optical fibre cables are less susceptible to lightning damage than copper transmission lines, the sophisticated switching and exchange equipment in place today is more susceptible to surges than its predecessors and is also more susceptible to static electricity damage from human handling.

SPOT-ON STRESS MONITORING

No matter how carefully it's installed, optical-fibre cable needs to be constantly monitored because of its sensitivity to stress. Stress – due to pressure from an overlying rock, for example – impairs the light-guiding ability of the optical-fibre core.

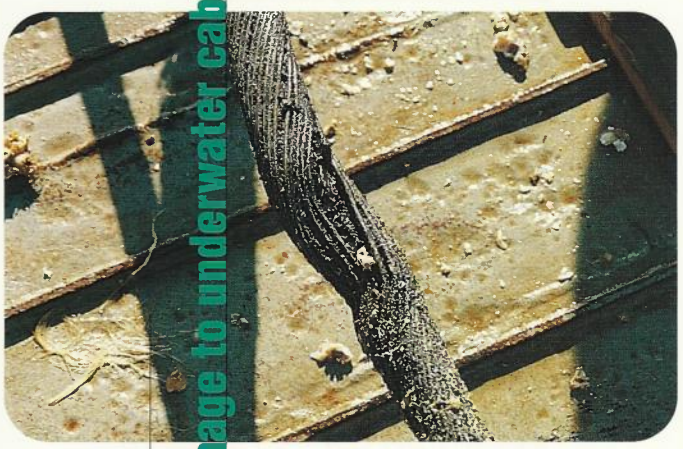
Predicting where stress will occur and pinpointing its location is the key to preventing breakdowns in optical-fibre transmission. TRL has developed a highly sensitive optical radar instrument designed to pick up light reflected from faults along the length of a fibre.

SDH AND 'SELF-HEALING'

Optical fibre and ATM will allow Telstra to provide such versatile and convenient service that both domestic and business users will find themselves relying more and more on the public network to manage their businesses and their lives. Networks will need to be failsafe and extremely fault-tolerant to maintain the trust of customers.

TRL has been developing 'self-healing' network management systems based on SDH – synchronised digital hierarchy. SDH makes use of an optical-fibre network's extremely high capacity by making available alternative paths along which traffic can be re-directed according to demand. This feature will enable Telstra to efficiently manage traffic on major routes during periods of heavy congestion.

Using optical radar to pinpoint damage to underwater cable



The device has been successfully used to pinpoint and estimate the extent of damage on an undersea optical fibre cable that had been accidentally snagged by a ship's anchor in Darwin Harbour.

Apart from testing the cable for strain, TRL's optical fibre probe was able to test for sea-water seepage into the cable, something that traditional devices are not able to measure. As a result of the tests, Telstra's Fibre and Radio Applications Group were persuaded to replace a one-kilometre length of the moisture- and strain-damaged fibre, fully restoring the cable's capacity and performance.

The longer wavelength used in TRL's instrument makes it more sensitive than traditional instruments. It can detect even slight stresses on optical fibre cable weeks before they result in transmission problems, enabling repair crews to take preventative action. TRL has commissioned a commercial model for use by Telstra's line-maintenance crews.

QUALITY THROUGH AND THROUGH

Service quality begins with reliability – reliability of the largest network systems, down to the smallest components. Microelectronic components in particular may be small, but their function is often quite important to network integrity.

The best time to assess the reliability of components is before installation, to prevent expensive maintenance problems and equipment failure once the components are in place.

One example is application specific integrated circuits (ASICs), semiconductor devices that carry out highly specialised functions. Because they are developed for specific purposes, ASICs are manufactured in small volumes and may not be subjected to the rigorous quality controls of more common integrated circuits. Consequently their reliability can vary between batches and between manufacturers.

TRL has the only team in the country able to fully test the reliability of semiconductors.

ASIC chip

...the only team in Australia able to fully test semiconductor reliability

Compared to Europe or the United States, Australia's telecommunications market is small. Yet the rest of the world takes notice when Telstra talks technical standards.

...the first laboratory in the world to achieve interworking between Japanese and American fax machines.

If an information superhighway was to be built in the same fashion as Australia's early railway lines – with tracks of different sizes in each state – imagine how difficult information transfer would be across 'borders'. You'd have to constantly change 'trains' to enter each new technical environment. At worst, you'd be unable to reach your destination.

Global standards ensure that the emerging information superhighway is accessible to everyone, providers and users alike. Standards reassure customers that they will not be 'locked in' by proprietary boundaries through their choice of equipment, service or provider, in the way that computer users have been in the past. Standards also provide a foundation for the smooth end-to-end flow of information, without intervening technical barriers.

TRL's Standards and Regulatory group has continued co-ordinating Telstra's participation in national and international standards bodies such as the ITU (International Telecommunication Union).

For example, the TRL group provided advice to the AUSTEL committee responsible for planning Australia's new national numbering system. In future, services providers requiring systematic, recognisable numbering systems for new products, like FreeCall™ 1-800, will benefit from this work – not to mention the customers who use the services.

Telstra's commitment to its customers is reflected in the effort it is now putting in to safeguard their future interests. TRL's Standards and Regulatory group helped AUSTEL devise an end-to-end minimum service standard for Australian telecommunications post-1997, when the market will be fully deregulated.

Without an agreed standard, customers would have no guarantee in a competitive market that the basic telephone service would be available at a fixed cost, or would be readily available across different carriers.

TRL's input was vital to the development of a basic service standard. "If not for Telstra, that technical standard would not have happened. No one else had the technical expertise to do it," commented one expert. The standard is worded in Plain English so that customers will have a clear idea of what, and what not, to expect.

Telstra was also a founding member of DAVIC – an international standards forum that is assessing all of the possible elements involved in the delivery of future multimedia communications, such as information storage and retrieval systems, and the TV 'set-top box'.

X.500

phonewords

FOLLOWING AUSTRALIA'S LEAD

Although the Australian telecommunications market is much smaller than those of the United States or Europe, Telstra has made Australia a highly respected player in the United Nations-like world of international telecommunications standards.

- *In the early days of faxes, Telstra recognised that customers would become increasingly disadvantaged by competing proprietary systems. So it strongly supported the development and refinement of international fax standards.*

TRL was the first laboratory in the world to achieve inter-working between Japanese and American fax machines. This eventually led to the early adoption of the 'Group 3' fax standard which has accelerated the worldwide growth of the fax market – and has since made life easier for a generation of fax users.

- *Early standards for optical-fibre transmission lines were devised in Europe where distances between towns are relatively short. Telstra and TRL were able to demonstrate that expensive signal repeaters could successfully be placed at longer intervals along an optical-fibre cable, reducing equipment and maintenance costs.*
- *Without Telstra's and TRL's input to standards for SDH – synchronised digital hierarchy, a network-wide system that protects against 'outages' – telecommunications operators globally would have had difficulty connecting SDH to SONET architecture (SONET is used instead of SDH in the United States).*
- *TRL researchers helped the ITU formulate the X.500 set of international standards for electronic directory software and then developed one of the world's first corporate electronic directories for Telstra.*
- *Services definition for ISDN (integrated services digital network) has been enhanced for customers through Telstra's participation in the ITU. Telstra was the first network provider in the world to offer customers primary rate ISDN access nationally.*
- *Telstra has played a key role in getting international agreement on a common keypad design standard for PHONEWORDS, an intelligent network service in which users key in words – like 'doctor' or 'pizza' – rather than numbers for service access. Telstra prepared a submission to a major European standards group, ETSI, on standard keypad layout. ETSI has since adopted the recommendation.*

GLOSSARY

ADSI
Analog display services interface. A screen-phone technology that will enable users to access and control network features and interactive services via screen menus

ADSL
Asymmetric digital subscriber line. A technology that enables digitally compressed video signals to be carried over the conventional telephone network

ATM
Asynchronous transfer mode. A fast packet switching protocol that allows voice, text and data to be transmitted simultaneously across optical fibre, coaxial cable or copper networks

Broadband
Communications technology that has a data transmission capacity of more than one Mbit/s. Broadband is essential to the transmission of video images

Computer telephone integration (CTI)
A technology that will allow users to carry out voice communications through a computer interface

Convergence
The integration of computing, communications and content

EBN
Experimental broadband network. A Telstra non-commercial broadband test network that utilises ATM technology to support a range of broadband multimedia and narrowband information transfer

Frame relay
A high-speed, bandwidth on demand packet switching technique that provides cost-effective connectivity for remote personal computers and LANs

Full service network (FSN)
A Telstra term for the information superhighway. A full service network will have the capacity to provide telephone services as well as pay TV and interactive broadband services

Gbit/s – see Mbit/s

Intelligent agents/navigators
Advanced electronic information retrieval systems that will locate appropriate online information with minimum input from the user

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 standard control

Mbit/s (or Gbit/s)
Megabits or gigabits per second. Units for measuring the rate of digital information transfer – a megabit per second is a rate of a million bits per second, a gigabit a billion bits

Multimedia
Involves the use of two or more modes of communication (voice, data, text, graphics, video) simultaneously

Narrowband
Communication technology that has a data transmission capacity of under one Mbit/s. Narrowband includes on-line interactive services such as Internet

Optical amplifier
A small section of specially doped optical fibre that, when pumped by another laser, amplifies a multiple wavelength signal. New power amplifiers and pre-amplifiers can boost a signal strongly enough for it to travel over long distances without the need for intervening signal regenerators

PDA
Personal digital assistant. A single mobile terminal that combines a number of functions – phone, fax, pager, personal organiser and computer

PLATyPus
A TINA project carried out by TRL through which researchers have produced a set of software engineering tools that can streamline the task of building TINA applications

Priority One3™
A Telstra intelligent network service that provides call delivery on the basis of origin-dependent call routing

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

SDH
Synchronous digital hierarchy. A transmission standard that organises communications traffic in a hierarchy to achieve more efficient use of network capacity

Set-top box
An intelligent communications unit that will link a user's TV set to an external cable socket, providing sophisticated control, security and delivery of online services

Smart cards
Plastic cards equipped with tiny microprocessors that allow them to store and process information as well as provide secure user access to services

TINA
Telecommunications information networking architecture. A software architecture that will allow for the convergence of telecommunications, computing and broadcasting and advanced network management

Universal personal communications
A model for future networks in which wireless access and network intelligence will provide integrated personal and business communications mobility

Video compression
A technique whereby 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

Video on demand
A service through which people could access large databanks of movies, educational programs and information through a multimedia interface, then control program viewing using pause, rewind, etc. Near video on demand would involve commencing the broadcast of programs at short, regular intervals without user control.

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