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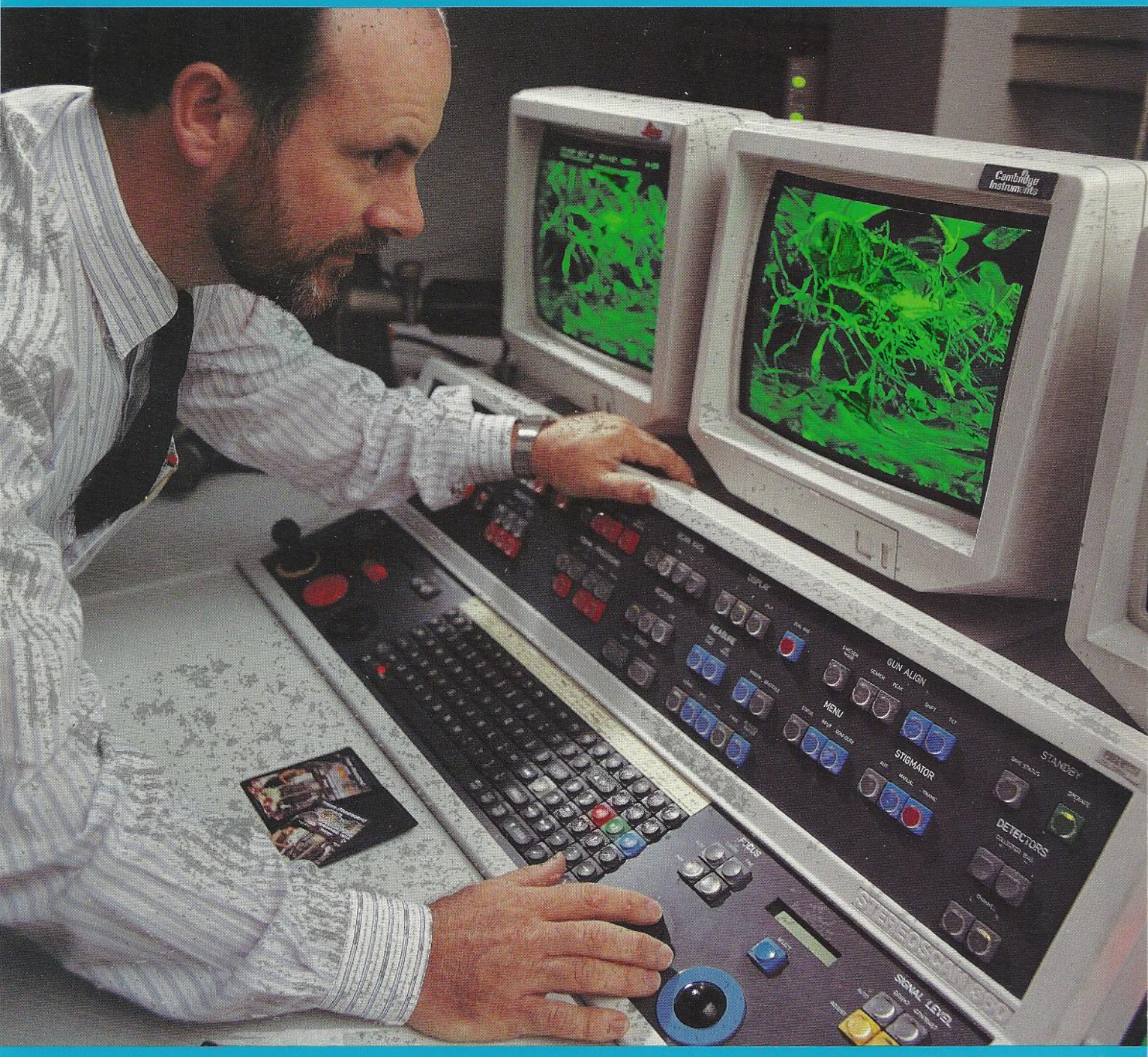
QUARTERLY 80



A RESEARCH UPDATE FOR TELSTRA STAFF ONLY

July, August, September 1995

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July, August, September 1995

FOREWORD

This quarterly publication provides brief insights into recent project activities and achievements of the Telstra Research Laboratories (TRL) that might be of wider interest or assistance to Telstra staff in the performance of their work. Information is provided under a number of headings including:

- The Telstra Research Laboratories – A Brief Overview
- Customer Services and Systems
- Switched Networks
- Transmission Networks and Standards
- Telecommunication Science and Technology
- Research Laboratories Information Transfer – includes reports, papers, talks and Standards Contributions.
- Visitors to TRL
- Staff contacts

The names and telephone numbers of appropriate TRL personnel are included throughout this booklet. If you would like to get further information on a particular topic, please call the contact person nominated.

A.K. Mitchell
for the Director Telstra Research Laboratories

Our cover:

Chris Kelly, Principal Scientist Network Reliability, using the scanning electron microscope.

The Research Quarterly has been printed on 100% Australian made Recycled paper.

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THE TELSTRA RESEARCH LABORATORIES – A BRIEF OVERVIEW

Mission Statement

To provide Telstra with technological and scientific leadership, knowledge and expertise so that it can be the best provider of telecommunications and information services.

The Mission

Telstra Research Laboratories' (TRLs') mission is to provide Telstra with technological and scientific leadership, knowledge and expertise so that it can be the best provider of telecommunications and information services.

The mission is being achieved through seven key areas:

- provision of strategic advice and expert consultancy;
- value adding to Telstra's products and services;
- cost reduction of Telstra's equipment, systems and networks;
- technical support of Telstra's existing plant and equipment;
- transfer of technology to other parts of Telstra;
- increased ownership of Telstra's products through system and component design;
- maintenance of a highly skilled, expert and motivated workforce.

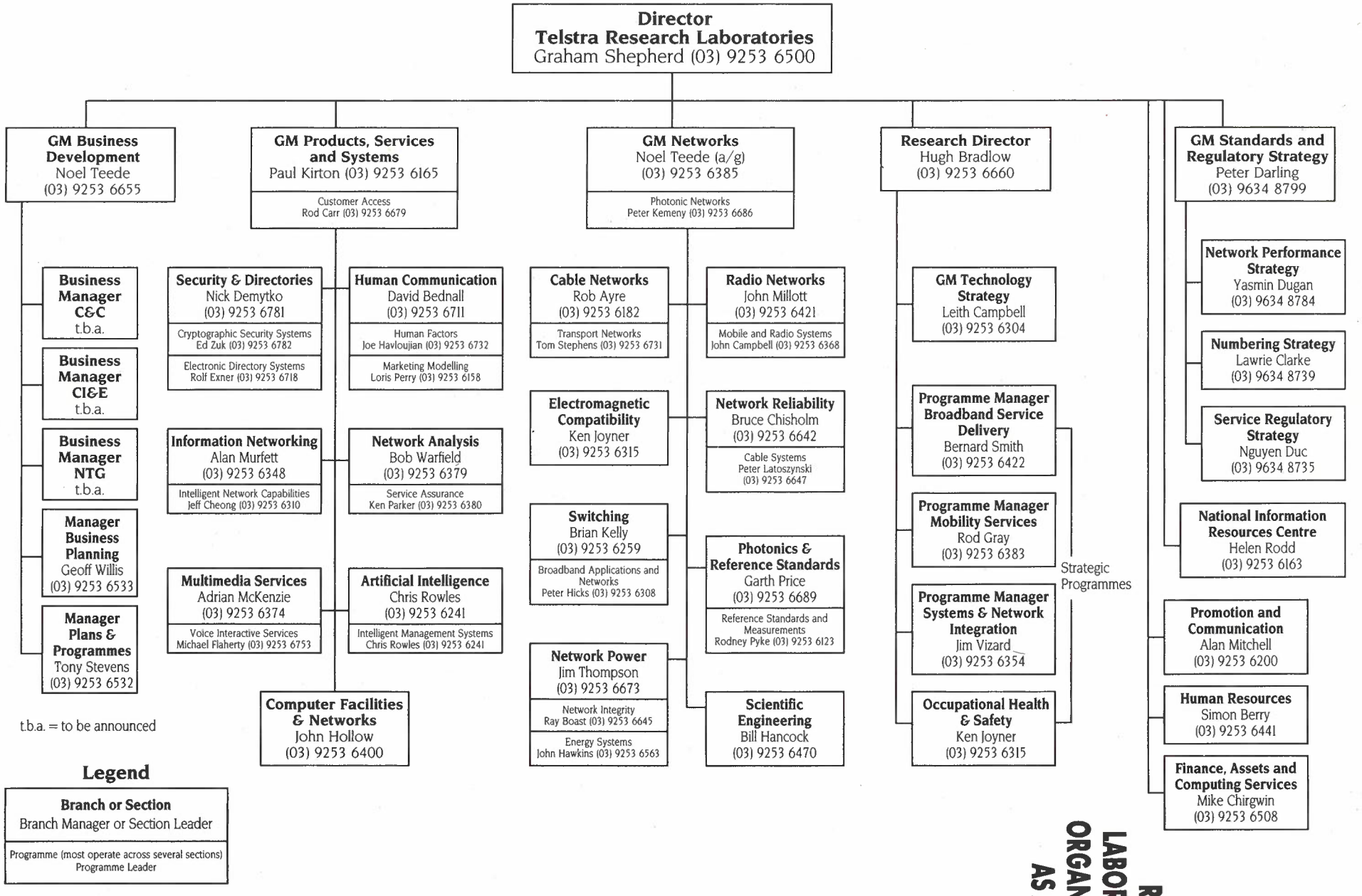
A Resource for Telstra

TRL is responsible for performing Telstra's research needs. TRL conducts a Research Programme derived from a corporately endorsed and approved business plan. The services that TRL provides are available to all other organisational units of Telstra.

The annual formulation of the business plan requires the consideration of corporate priorities and performance needs of R&D projects and related activities. This is in terms of the required deliverables, and the resources needed to ensure their timely delivery. These processes require that specific projects are either funded by a particular client unit in Telstra or on a corporate basis.

Deliverables include:

- the conduct of the Research Programme in accordance with the approved business plan;
- the operation of corporate facilities (National Information Resource Centre, Intellectual Property Consultancy, and Time and Frequency Standards);
- the management of and participation in corporate external R&D Programmes on behalf of Telstra.



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TELSTRA RESEARCH LABORATORIES ORGANISATION AS AT 1.7.95

PRODUCTS, SERVICES AND SYSTEMS

Major Shift in Health Sector Communication Patterns

Socio-technical researchers from the Human Communication Section at TRL have recently completed an evaluation of a small but highly significant trial in Adelaide. The study was commissioned by the South Australian Government account team and was focussed on the use of electronic messaging between a large public hospital and a selected group of local doctors. Telstra supported the trial financially in terms of supplying free lines, transmission costs and personnel to help set up and evaluate the trial. A local software house supplied the necessary software and the project had the enthusiastic support of hospital administration and the local Division of General Practice. The co-ordination of all of these parties was critical to the success of the trial.

A small network was installed using Telstra's X.400 electronic mail network and an encryption code to guarantee security of the data the doctors wished to transmit. The hospital supplied the practices with computers, modems and a range of software and the Emergency Department put in two additional computers to service the GP trial. These were connected to the Department's internal patient tracking system and registrars began downloading data from their system to compile a Discharge Summary which was immediately sent to the post boxes of the participating GPs.

'The Medical Data Exchange Trial, did not employ particularly sophisticated technology but the cultural change which it signals in this sector is extremely important. Doctors as a group, and GPs in particular have been notoriously slow to adopt new communications technologies. This trial is one of the first indicators of a major change in this attitude. The study also offers important insights into the forces which are pushing change within the sector. The hospital recognised that it was losing beds and having to share service provision with a range of primary health care providers who work in its community. There was a clear and critical need to improve connections with these practitioners, and GPs were identified as the first group with whom they should be working much more closely. What is signalled here is a complete transformation of health sector communication patterns and information requirements.

Despite minor difficulties in getting started, Emergency registrars and GPs were generally pleased with the outcome of the exercise and saw it as a useful first step in a direction which they all needed to pursue further. Within the hospital, managers of other departments were already looking to link their own offerings into the trial network. Broader discussion within the sector of trials such as this seems likely to have a strong influence on the viability and future development of much larger and more complex communications networks.

(Contact: Lyn Kennedy, (03) 9253 6437)

A Computerised Tool for Capacity Planning Units Placed in Netscape

NAS staff working in the Service Assurance Program have developed for their clients in Capacity Planning a computerised tool for evaluating traffic loss figures of the various traffic streams connecting the Local Access Switches (LASs) and the Transit Network Switches (TNSs) in the FMO switched network. The tool is accessible to the clients via Netscape and can therefore easily be used by planning people at the different locations with no special arrangements for computing facilities or other technical considerations.

An immediate benefit from the tool relates to the derivation of an effective Trunk-Reservation policy, aimed at maintaining acceptable Quality of Service levels following traffic load changes in either the local plane or the national transit plane. Trunk Reservation is one of the means to ensure acceptable network performance levels due to volatile traffic. Traffic volatility is expecting to be a major factor of network planning after 1997, as competition will also be spread to the local plane and mobile communications will reach higher levels of penetration.

(Contact: Meir Herzberg, (03) 9253 6340
Soh Kam Hung, (03) 9253 6467)

Mobile Network Fraud Detection

The fraudulent cloning of mobile phones has the potential to become a large problem in the mobile telephone network. Overseas telecommunications carriers have shown that network fraud can pose a serious threat to revenue and customer confidence. There is no reason why this trend should not spread to the Australian market if preventive measures are not taken.

One method of detecting fraud is to correlate patterns of customer behaviour across the network in order to detect cloned mobile phones. This requires large volumes of call-by-call data to be analysed dynamically. To do this in real time, we distribute the processing between a number of intelligent monitoring systems, called agents. Each such agent gathers call data from the geographic region in which it has been placed. Agents then collaborate with one another in order to identify cases of fraud.

Consider the problem of mobile phone fraud. Each mobile phone has a unique Electronic Serial Number (ESN) associated with it. When a customer makes a call, the mobile phone transmits its ESN in order to establish a connection with the network. Cloning a

mobile phone involves copying someone else's ESN so that your calls will be charged to their account.

So by tracing ESN usages, it is possible to trace caller behaviour, and to use these traces to identify suspect calling patterns on individual ESNs. The most obvious way of detecting fraud is to test for two calls on the same ESN that overlap in time. However, a cloned phone could make a considerable number of fraudulent calls before there was a collision with a genuine call. A more comprehensive approach to fraud detection requires the use of a more sophisticated method of analysing an individual's calling patterns.

A more elaborate method is to detect non-overlapping calls that are close in time, but take place in distant parts of the network. Such fraud detection generally requires the communication of data between agents. Therefore the agents must have a sensible policy for determining what data they should or should not communicate.

The aim of our work has been to develop and test suitable policies for communication between agents for fraud detection. In particular we have:

- designed agents which are as reliable as possible in detecting fraudulent use of the mobile network, without the burden of excessive inter-agent communication,
- tested our agent design by simulation in order to determine its
- effectiveness,
- and determined how the agents may be customised according to the properties of the network and the statistics of the call data, in order to optimise performance.

Using simulation studies on a small test network with artificially generated call data we have shown that it is possible to detect a large proportion of network fraud with relatively low volumes of inter-agent communication. In future work we will attempt to scale these results up to a more realistically sized network with more realistic call data.

(Contact: A. Herschtal (03) 9253 6448,
C. Leckie (03) 9253 6245)

Trends in Intelligent Management Systems

Intelligent Management Systems make use of Artificial Intelligence (AI) and other advanced software techniques to improve business efficiency. Tasks such as network management, fraud detection and market analysis are typical applications. They require intelligent tools that can quickly analyse and react to changing trends in large volumes of data. At the recent International Joint Conference on AI (IJCAI) held in Montreal, there were several important trends of direct relevance to Telstra in this area.

Network Monitoring

Network monitoring is an important process in managing the network. It includes tasks such as performance monitoring, alarm correlation and fault diagnosis. This was one of the topics of a workshop at IJCAI on AI in network management and services, which included participants from Telstra, AT&T, BT and Swiss PTT. There was a strong consensus at the workshop that AI was usually more effective for network monitoring than in other areas such as network control and reconfiguration. Network monitoring is usually tedious and labour-intensive, due to the large volume of data that needs to be analysed quickly. This makes it an ideal candidate for automation using AI techniques. An example of such a system is IMAS (Intelligent Monitoring and Analysis System), which was developed in the AI Systems Section for performance monitoring and fault diagnosis.

Data Mining

The field of data mining aims to extract knowledge from large corporate databases, such as billing, customer and fault databases. Data mining can combine machine learning techniques with data visualisation tools to help identify significant patterns in large volumes of data. For example, at AT&T, machine learning is being used to generate rules that can identify cases of calling card fraud. At NYNEX, machine learning is being used to refine diagnostic rules that are used in an expert system for localising faults in their customer access network. In the AI Systems Section, we have developed neural network tools that are used in similar data mining applications within Telstra.

Customer Profiling

With the rapid growth of the Internet and broadband networks, there are enormous opportunities for new types of information services. This raises issues such as which services will customers want, how will they use them, and how will they find them? Customer profiling helps to address these issues by analysing patterns of customer behaviour to model their likes and dislikes. This can be used as a tool for service personalisation, as well as market segmentation. For example, the German AI Centre has developed a sophisticated system for automatically generating documentation of a product to suit the user's goals, interests and preferred media (i.e. text or diagrams). Xerox PARC has developed tools for automatically compiling indexes for databases of documents to suit a user's interests. In the AI Systems Section, we have developed customer profiling tools that help users make service selections, as well as characterising the types of users who prefer a given service.

Intelligent Agents

Intelligent agents are autonomous, intelligent software systems that can act on a user's behalf to interact with other information

services. For example, agents can be used for distributed fault diagnosis, where each agent is responsible for monitoring a particular part of the network. Agents can then cooperate using distributed AI techniques to diagnose problems that span network boundaries. Another approach is to use mobile agents, who can move through the network, gathering information and performing tasks on behalf of their users. While numerous agent languages are starting to appear, a major topic at IJCAI was how to develop flexible and scalable agent designs. This is currently an active area of research in the AI Systems Section.

(Contact: C. Leckie (03) 9253 6245)

10th DAVIC Meeting – Impacts on Multimedia Services

The September DAVIC (Digital AudioVIsual Council) meeting has been characterised by particularly interesting issues concerning content, application authoring, STUs and profiles. In the following there is a summary of the points of major interest for Telstra, including information collected at associated events like a joint DAVIC-IMA (Interactive Multimedia Association) workshop:

1. Many authoritative content providers (BBC, Hollywood producers, etc.) have stressed how essential it is for them to be assured that content produced once can be run successfully on any platform (nationally and internationally) without further customisation from the content provider. This highlights how availability of content will become more and more dependent on the ability of the delivery platform to manage standard representation of information, such as DAVIC is defining in its specifications (e.g. requiring MPEG-2 Main Profile @ Main Level for the compression of video material).
2. It appears clear that the production industry will not adopt wide electronic distribution until a safe system to avoid unauthorised copies (or, even better, a way of making people pay for copies) is available. A mix of technology and law is needed and, in particular, international co-ordinated policies are necessary against electronic piracy.
3. Some demonstrations of multimedia applications made by Apple and HP have clearly underlined the importance that virtual reality, integration with Internet and wireless multimedia communications will assume very quickly in this area.
4. DAVIC will publish the first specifications (DAVIC 1.0) in December 1995, and at the same December meeting the answers to the new Call for Proposal (CFP3) will be received and analysed to start the work on DAVIC 1.1, due to be published in June 1996. Among the many items included in the call, there are also those whose inclusion was requested by Telstra: Internet access, data ports for STUs and high capacity two-way HFC systems. Home network and enhanced quality for video (HDTV), whose inclusion had also been requested by Telstra, have been recognised as important, but deferred to the CFP4 (December 1995) for DAVIC 1.2 (December 1996 completion), because they were considered major items that need more time to be dealt with.
5. After long and very heated discussions, MHEG-5 has been agreed as a normative part of the DAVIC specifications to enable application cross-platform portability. The request to be MHEG-5 compliant is on the application, not on the STU (which means that the run time engine necessary to run an MHEG application can be downloaded to the STU; it does not need to be resident). The advantages for Telstra in having defined by DAVIC a unique application API are in the possibilities that it opens to use different authoring tools (provided they can generate in MHEG-5 objects), in the possibility of being able to use on our platform applications not specifically developed for it, in making simpler the definition to the multimedia industry of what they can use to produce applications for our platform and in giving protection for investments in application development.
6. The Board of Directors of DAVIC is strongly requesting that the DAVIC specifications explicitly state that the STU shall provide an output that preserves the original video format (a single STU for either NTSC or PAL signals). Such a decision (that finds strong opposition from the consumer electronics industry and that is likely to be a very hot issue at the next meeting) would be of great advantage for a PAL country like Australia, setting the basis to avoid in the future problems experienced until now with video equipment which is always designed and made available first for NTSC and then for PAL, and with the PAL versions experiencing considerable bugs and failures.
7. According to its aim to specify interoperability, but not the technology design, DAVIC is going to create a Reference Decoder Model for the specification of conformance of content coding format.
8. DAVIC agreed on the definition of three profiles (distribution, retrieval and conference) that are not organised in a hierarchical scheme ("onion" scheme), but defined with sets of functionalities that make the profiles not necessarily contained one in the other ("garlic" scheme). Detailed analysis of the functionalities sets is now necessary to ensure that there are no major problems in combining delivery of broadcast and interactive services on the

same platform (for instance, having a single STU that is both a "retrieval" DAVIC compliant STU and a "distribution" DAVIC compliant STU).

The next DAVIC meeting, in December 1995, will be an important and controversial one as many issues must be resolved for the final release of the DAVIC 1.0 specifications.

(Contact: Luisa Conte, (03) 9253 6282)

Portable ISDN Switch

Telstra has been a world leader in the introduction of ISDN, commencing a Primary Rate Access service ("Macrolink") in 1989, and a Basic Access service ("Microlink") in 1990. ISDN continues to be an important product offering, currently being installed at the rate of 200 services per month for Macrolink, and 1000 per month for Microlink. TRL has for some years been a major contributor to the standardisation process for ISDN signalling protocols in ITU Study Group 11 (previously Study Group XI). Active involvement has included CCS No. 7, ISUP and ISDN Access. To complement and reinforce this work, the Pense project was started in 1989 with the aim of implementing the network side of the ISDN access protocol, Q.931, otherwise known as DSS1. So that the package could be used in the Telstra network environment, the National variant of the Basic Access part of the Q.931 Specification, TPH 1962, was used. The aim was (i) to provide a portable (PC-based) ISDN switch that could be used for demonstrating and evaluating Basic Access services; and (ii) to provide ISDN modules that could be utilised by other TRL projects. In 1992, a subset of the protocol was incorporated into the TRL Intelligent Network Testbed ("INSET"), to prototype a Universal Personal Telecommunication (UPT) service. This version of Pense runs on a PC under DOS for Layers 1 and 2, and a Unix Sun workstation for Layer 3 and Call Control. Switching is performed by a custom-built card providing 8 Basic Access interfaces, corresponding to the S Reference Point.

In 1994, it was decided to extend the functionality of the system using object-oriented methods, in order to provide a more complete implementation and to include Primary Rate Access (TPH 1856). OS/2 was selected as the operating system platform for all three layers, as it provides multi-threading, and supports a sound development environment. Layer 3 and Call Control are incorporated into the PC, enabling the Pense unit to be self-contained. The Primary Rate Access switching function is provided by a Mitel Express card configured with dual CEPT (E1) interfaces.

In August 1995, the completed system was made available to Multimedia Services Section for use as a service testbed. Facilities available are:

- Integrated working of Primary Rate Access and Basic Access circuit switched signalling – Telstra TPH1856/1962.
- Full protocol analysis, message validation and error handling.

The software components have been designed using object-oriented technology, with the view to their reuse in protocol variants and new protocols. The design allows for multiple protocols to coexist within the chosen hardware and operating system platform.

Components of Pense are being used in two TRL project areas:

- Layers 1 and 2 have been modified to operate as the user-side protocol, as part of the Automated Test Platform project.
- The code forms the basis for B-ISDN and B-ISUP developments.

A number of client areas have recognised the potential for capitalising on Pense by identifying custom enhancements to the system.

- Telstra Advanced Technologies wish to add network delays, clock slip and errors, in order to simulate international working.
- Electronic Products and Services intend to use Pense as the basis for the next version of ITerm (an ISDN protocol analyser).
- COMTEST has a potential use as a pre-conformance tester.
- There is a possible application for using a Pense switch as part of a travelling Telstra display of products and services.

With Pense, TRL finishes its narrowband implementation work, but it will retain a consultative role.

(Contact: P. Hormann, (03) 9253 6551,
G. Rochlin, (03) 9253 6355)

Applying Neural Networks to Real-time Control Problems

Many problems of control of telecommunication networks can be solved optimally by matured optimization techniques given sufficient time and computational resources. However, in many practical situations of real-time control and limited computational resources, we are forced to use "suboptimal" heuristics. Such heuristics are classically human generated and available in the limited domains where an adequate understanding of the problems has been achieved. The aim of a series of experiments conducted recently at TRL was to verify practically whether such heuristics can be generated or improved automatically by the use of artificial intelligence techniques applied to a sample of cases for which the optimal algorithmic solutions are precomputed. In other words, the aim was to verify whether the "skills" of the optimization algorithm can be "automatically" encapsulated in a software routine which is much simpler to implement than the original algorithm, both in terms of execution time and computational resources required, and provides results of a satisfying quality.

The particular optimization task selected for experimentation was "real time" capacity allocation in an SDH network environment satisfying bandwidth on demand requirements. This is a known complex non-linear, integer optimization task of obvious relevance to Telstra. Artificial neural networks were chosen as a particular set of machine learning techniques for "heuristic" generation. In our experiments, the state of the system was modelled by 62 numbers (link capacities and offered traffic) and the control (desired output) was expressed by 126 integers (path capacities expressed in terms of 2Mb/s units). For training and testing of neural networks we generated several sets of 2000 instances with random network states (with partial or complete link failures and randomly varying network loads).

The results were much better than expected. We generated a number of very simple neural network architectures achieving 98-99% of throughput when compared to the optimal solution measured in terms of call blocking rates. These results are better than the throughput provided by literature based heuristics (~85%). We also found that our neural networks provide solutions in an order of ms while the original optimization algorithm requires seconds or even minutes to complete the task.

Applications of this approach to other telecommunication network control tasks are currently under investigation.

(Contact: A. Kowalczyk, (03) 9253 6253
M. Herzberg, (03) 9253 6340)

Implementation of MPEG-2 Trick Modes

If video on demand (VOD) services delivered over a broadband network are to offer the same features as customers have come to expect through the use of video tapes, it is important that they offer VCR-like functionality. Work in the Multimedia Services Section is aimed at understanding the different technical solutions available to achieve this, and the trade-offs that follow between cost, performance, complexity and system demands.

The MPEG-2 video coding standard will be used in the provision of VOD services, and while it doesn't specify a particular way in which fast forward and fast reverse are to be implemented, it provides some tools to support their implementation.

When a VOD user requests fast forward or fast reverse, a message is sent to the video server, which then changes the bitstream being sent to the set top unit (STU). The bitstream cannot simply be sent faster to the STU, because of the limited bandwidth between the server and the STU, and the inability of the STU to decode or display this faster bitstream. Thus the video server must select part of the normal-play bitstream to send to the STU when fast forward or fast reverse is requested.

The selection of which part of the bitstream is used for fast forward or fast reverse can be done in one of two ways, each of which places varying demands on the resources of a video server. Actual implementations of fast forward and fast reverse will use either of, or a combination of, these two selection techniques.

- The selection can be performed when required, in response to a user's request. This requires additional processing power in the video server, the amount of which depends on the selection scheme used and the number of simultaneous users invoking fast forward or fast reverse.
- The selection can also be performed once when the bitstream is loaded onto the server, storing the selection in a separate bitstream. This reduces the need for processing power, but increases the storage space required. The additional amount of storage space required is dependent on the number of movies loaded onto the system.

As well as there being choices as to how the fast forward bitstream is selected, there are also choices as to what the fast forward video looks like.

- The fast forward video can appear similar to that of current VCRs, with the picture composed of a number of bands, the faster the speed, the more bands there are. This requires that the normal play bitstream stored on the server is coded with specific MPEG2 video coding parameters.
- Fast forward video can also be achieved by displaying every Nth entire frame, where N is the speed up required. Because the MPEG video coding algorithm makes extensive use of predictive coding between frames, there are restrictions as to which frames can be used if performing the selection when required. This restriction can be reduced by performing the selection once when loading the bitstream, as more time can be dedicated to recoding the bitstream.

If the selection of the fast forward bitstream is performed when required, the way the bitstream is coded limits the appearance of the fast forward video. By performing the selection once when loading the bitstream, greater control of the appearance of the fast forward is possible.

Using the video simulation facilities in the Multimedia Services Section, the various alternatives have been simulated and compared. As a result, we are in a much better position to assess vendor offerings, their efficiency, processing and storage demands, flexibility and ultimately the cost/performance trade-off that is best to satisfy Telstra's customers.

(Contact: M. Leditschke, (03) 9253 6451
A. Johnson, (03) 9253 6749)

Digital Mobile Interference Into Hearing Aids

A joint investigation undertaken between Telstra Research Laboratories (TRL) and the National Acoustics Laboratories (NAL) confirmed that GSM digital mobile telephones caused interference (a "buzzing" sound) into various types of hearing aids. This preliminary study prompted a more extensive joint investigation by NAL, TRL, the Spectrum Management Authority, AUSTEL – the Australian Telecommunications Industry Regulator, other Mobile Service Providers and representatives from the hearing aid industry and consumer groups including hearing aid user organisations. The primary aims of this study were to:

1. Assess the degree of interference caused by GSM digital mobiles to a wide range of hearing aids;
2. Assess the effectiveness of various treatments and design modifications to hearing aids to reduce interference;
3. Develop a reliable and practical measurement system;
4. Develop hearing aid standards for immunity to digital mobile interference.

The main features arising from this joint study include:

- A highly effective measurement system incorporating a terminated waveguide test chamber and a hearing aid manipulator capable of rotation around 3 perpendicular axis was designed by TRL and NAL for the GSM frequency bands. TRL has recently designed, manufactured, tested and installed a further waveguide transition at NAL to expand their measurement capabilities to include the frequency bands from 1.8GHz to 2.5 GHz.
- The latest model hearing aid mass produced by NAL in a joint venture with industry has been redesigned to be immune to incidental interference (a digital mobile at a distance of 1 metre) but is unusable with a digital mobile at the ear fitted with the aid.
- Four different types of currently available aids have been prototype modified such that they are useable with a digital mobile on the ear fitted with the aid.
- The new Australian standard for hearing aid immunity was published in July, 1995. TRL was a major technical contributor to the Standard. The standard is now being further developed, as a matter of urgency, to permit development of hearing aids which will allow use of a digital mobile by the hearing aid wearer. This further development of the standard will ensure that the hard-of-hearing are not denied access to digital mobile telephony. TRL will again be a major technical contributor.
- The committee of the international standards body (the International Electrotechnical Commission) which is developing an international immunity standard for hearing aids has closely monitored developments in the Australian standards.
- TRL in conjunction with Vodafone and Ericsson have modified existing hands-free attachments and incorporated a hearing aid coupler which enables access to the digital network for a person with an unmodified hearing aid.
- A comprehensive report of all the Australian R&D on GSM digital mobile phone interference to hearing aids has been published by the NAL in conjunction with TRL and AUSTEL.

(Contact: Ken Joyner, Networks Branch, (03) 9253 6315)

Development of a New Frequency Assignment Algorithm for Telstra's Cellular Networks

The tasks involved in designing and operating large cellular radio networks include the selection of base station sites, tower height, antennas, and transmit powers to optimise cell coverage. Once this basic infrastructure is in place, the task then facing network designers is to assign the available radio frequencies to the base stations. This task is critical to both the capacity and quality of the cellular network. Bad frequency assignments will lead to areas with high levels of interference and/or inefficient reuse of the frequencies, leading to loss of capacity, and possibly the need for more base stations and thus increased network costs.

With the current size and growth of Telstra's analogue (AMPS) and digital (GSM) cellular mobile networks, the frequency assignment task has reached the point of being an extremely demanding optimisation problem. This task is further complicated by the number of constraints imposed on the frequency assignments. Notable constraints are the frequency separation requirements imposed by the filter combiners at the base stations and the frequency separation requirements imposed between neighbour cells. Although commercial frequency planning software packages are available, the frequency assignment part is invariably the weak point in such offerings.

With this background it was recognised by TRL back in 1991 that substantial quality and capacity benefits would follow from the development of an algorithm which could provide highly optimised channel assignment solutions. It also recognised that highly specialised skills would be required to develop such an algorithm, and TRL sought the help of CSIRO, Division and Building

Construction and Engineering (DBE) through a R&D contract. Since that time two other R&D contracts have been let with CSIRO, each for the duration of one year, to further advance the algorithm. The present contract expires at the end of the current financial year.

The optimisation "engine" chosen is that of stochastic evolution, and the resulting software product has since been called Frequency Assignment by Stochastic Evolution or FASE. Stochastic evolution is ideally suited to very large optimisation problems which have many constraints applied, and is thus well suited to the task in hand. By working closely with MCS on the specification of features, the resulting software product has been specifically tailored to meet the requirements of Telstra's cellular network designers. The algorithm is also very flexible in its capabilities, and can be applied to both the analogue AMPS and digital GSM networks.

In addition to providing optimised frequency assignments for all radio cells in a network, FASE provides the ability to optimise frequency assignments for a selected number of cells. This feature is essential for the day to day operation where one or more new cells are commissioned.

Early results using FASE on the Melbourne and Sydney AMPS and GSM networks have demonstrated excellent frequency assignment solutions. Version 2 of the FASE software has been delivered to MCS and is now being used by the operating regions of MCS. TRL and CSIRO continue to work closely with MCS on the specification of new and useful features, and are the focus of the current development work.

(Contact: John Campbell, Networks Branch, (03) 9253 6368)

Optical Amplifier Network Pilot – (Brief project activity report)

The Inter-Exchange Network Development project (TN:3) has undertaken extensive studies on optical amplifier systems. Recently particular system architectures and their associated network benefits along with new introduction strategies have been developed to facilitate the economic introduction of these high technology devices into Telstra's trunk optical fiber network (see RQ 79).

These studies culminated in a presentation to Capacity Planning and Transport Technologies in August on suitable strategies for the network deployment of optical amplifiers. This presentation led directly to the preparation of an Expression of Interest (EOI) statement for a network pilot optical amplifier system. The EOI was prepared by a joint taskforce from the SDH Project Group and Capacity Planning with technical advice provided from TRL. The optical amplifier pilot system is intended to be installed between Melbourne and Sydney in a 1+1 configuration during early 1997. The system is planned to operate initially using a single wavelength channel at 2.5 Gbit/s but will be installed fully equipped for WDM operation to allow additional wavelength channels at 2.5 Gbit/s to be deployed as required.

Apart from the system transmission performance, the other important consideration is the management and supervision system. This is currently envisaged to be a standalone system that will fully manage all amplifier sites. It must be able to be integrated seamlessly at the Network Operations Centre in Melbourne and work with the SDH Equipment Management Operations System (EMOS) supplied by Siemens.

Following network testing and acceptance, the initial pilot system will become the Melbourne-Canberra-Sydney XXX cable system within less than 6 months. Thus this network pilot goes far beyond a traditional field trial. Among the key benefits of this type of optical amplifier system are:

1. minimal cost for link capacity upgrades beyond the second wavelength channel,
2. added flexibility using WDM for rapid future link capacity upgrades and
3. reduced maintenance costs as the number of electronic regenrators are reduced.

These key benefits arise as the optical amplifier infrastructure will be fully in place after the initial installation and only a few regenerator sites need to be equipped. The regenerators in the WDM system will need to be equipped with wavelength selected lasers matching the wavelength channels in the 1550nm window that ITU-T is currently standardising for such a WDM system.

While preparing the EOI a dicison was taken to replace this with a Request for Tender (RFT). The RFT will be issued at the end of October and a number of companies capable of supplying optical amplifier systems will be invited to submit reponses. If all goes according to plan this pilot system will be the first of a nationwide network of optical amplifier links and Telstra's first step towards the realisation of an all photonic transport network.

(Contact: Frank Rühl (03) 9253 6420 or Tom Stephens (03) 9253 6731, Networks Branch)

Contributions to ITU-T on Optical Amplifier Systems

ITU-T is presently working towards standardising optical fibre communication systems employing optical amplifiers. As part of this process three new standards are being developed: G.scs for single-channel optical amplifier applications, G.mcs for multi-channel applications and G.lon for long unrepeatered optical amplifier links. These standards are

intended to be finalised during the upcoming ITU-T Study Group XV Meeting in November and would then be voted upon at June 1996 by the ITU-T member representatives.

The Inter-Exchange Network Development project (TN:3) submitted two contributions to the ITU-T Experts Meeting in July. The first contribution recommended a maximum optical power level for optical amplifier systems of +17 dBm. Though optical amplifiers can produce transmit powers higher than this value, there are good reasons for limiting the transmit power level. These are the Laser Safety limit for Class 3A lasers at 1550nm, the likelihood of fibre endface or connector damage due to high optical power levels and the impact of optical nonlinearities on the transmission system performance.

The second contribution dealt with the design of cascaded optical line amplifier links. It was argued that the optical line amplifiers are subject to an intrinsic self-regulation effect and hence do not require careful adjustment of their operating point. Provided the line amplifier has a small signal gain exceeding the link loss by more than 3 dB, the line amplifiers will naturally tend to operate into saturation. Self-regulation also means there is the possibility to offer limited self-recovery from small degradations in link loss.

(Contact: Frank Rühl (03) 9253 6420,
Networks Branch)

TRL INFORMATION TRANSFER

During the last quarter, the TRL staff have published or presented details of the progress and noteworthy achievements of various projects and activities. These publications comprise both official Telstra publications (in the form of Research Laboratories Reports and Branch Papers) and papers submitted for external publications in learned journals or presented to outside organisations (including professional institutions and societies).

Some of the listed Research Laboratories Reports and Branch Papers are confidential and restricted to appropriate areas within Telstra. These are indicated by the '*' included in the publication number. Only the titles of such publications are included.

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RESEARCH LABORATORIES REPORTS

7939* – "Guidelines For The Siting Of Telecommunication Installations – Protection Against Radio-Frequency Electromagnetic Interference".
Macfarlane, I.P.

8329* – "Surface Waves And Near Fields Over Ground Planes At Frequencies Above 30 MHz".
Macfarlane, I.P.

8331* – Predictability Of Electromagnetic Radiation in the Vertical Plane Over Real Ground at Frequencies Above 30 MHz.
Macfarlane, I.P.

8347* – Harmonic Fields Radiated At Elevated Angles From 27 MHz ISM Apparatus Over Real Ground.
Macfarlane, I.P.

8348* – Investigation of ATUP/ISUP Flow Controls.
Barnes, L.; McMillan, D. and Tunney, L. (Network Operation)

8353* – Introduction to Distributed Artificial Intelligence.
deBeler, M.; Leckie, C.; Senjen, R.; Ward, B.; Zhao, M.

8355* – Development of a Co-ax to Waveguide Adaptor to Propagate 1800MHz Signals in 900MHz Wageguide.
Rowley, J.

8358* – An Overview of a Security Architecture for Telstra.
Warner, M.

*Reports marked * are classified as 'IN CONFIDENCE – For Telstra Australia Use Only'.*

Research Laboratories Reports Note: In some cases Research Laboratories Reports classified as 'In Confidence – For Telstra Australia Use Only' will only be released to staff when accompanied by their Section Manager's authorisation.

RESEARCH LABORATORIES BRANCH PAPERS

NETWORKS

Component Analysis Report

95/002* – High Voltage Evaluation of Prototype Loading Coil Modules (LCM) And Associated Protection Modules (PM).
Frost, C.R.

95/003* – Evaluation of The Electrical Resistibility of Prototype Alcatel (AUS) System 12 Line-Card Hybrids.
Frost, C.R.

95/004* – Wear on Edge Card Contacts of Line Shield Protection Modules.
Godfrey, J.R.; Scott, K.L.

95/005 – The Reliability of Commonly Used Telstra Cables Terminated to Siemens 71, 2000 & 5000 MDF Termination Modules.
Godfrey, J.R.

Network Power Report

95/04* – Reduced Protection Scheme for the MDF Feasibility Study.
Frost, C.R.; Pengelly, G.

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PRODUCTS, SERVICES AND SYSTEMS

'Flexible Learning in a Training Environment, Flexible Delivery of Training & Education, July 1995, Sydney, NSW.
*Isaacs, D.**

'Methods, Merit and Money: Applying Qualitative Research to the Commercial Environment, Australian & New Zealand Communication Association Conference, July 1995, Perth, WA.
Davis, N.; Jenkins, A**.

'An Efficient Inference Engine for Interactive Fault Diagnosis in A Helpdesk Application, The 8th International Conference on Industrial & Engineering Applications of Artificial Intelligence & Expert Systems, August 1995, Melbourne, Vic.
Zhao, M.; Leckie, C.*; deBeler, M.*; Rowles, C.**

'Robust Natural Language Query Processing Using Key-Centred Phrase Structure Frames, IJCAI '95 – International Joint Conference on Artificial Intelligence, August 1995, Montreal, Canada.
Jiang, J.; Rowles, C.**

'Strong Enhancement of Coulomb Drag in Double Layer Systems Due to Correlations Among Carriers, EP2DSXI – 11th International Conference on Electronic Properties of 2D Systems, August 1995, Nottingham, UK.
Szymanski, J.; Swierkowksi, L.; Gortel, Z.W.*

'Experience & Trends in AI for Network Monitoring & Diagnosis, IJCAI '95 – International Joint Conference on Artificial Intelligence, August 1995, Montreal, Canada.
*Leckie, C.**

'TINA – Applying Distributed Object Computing to Telecommunications, Object World Conference, August 1995, Sydney, NSW.
*Richardson, P.**

NETWORKS

Optical Characterisation of UV-Written Buried Channel Waveguides Abstracts at 1995 Australian Guided Waves Workshop, University of Sydney, NSW, 20 & 21 July 1995.
Faith, M.E.; Leech, P.W.*; Kemeny, P.C.*; Moss, D.; Ouellette, F.; Ibsen, M.; Svalgaard, M.; Leistiko, O.; Poulsen, C.*

Fluoride Fibres: Fabrication for Telecommunications Applications Abstracts at 1995 Australian Guided Waves Workshop, University of Sydney, NSW, 20 & 21 July 1995.
*Stone, G.O.**

Channel Waveguides Formed in Silica by Implantation With Various Ions; Abstracts at 1995 Australian Guided Waves Workshop, University of Sydney, NSW, 20 & 21 July 1995.
Leech, P.W.; Faith, M.E*; Kemeny, P.C.*; Ridgway, M.C.*

Low Loss Channel Waveguides Fabricated in Fused Silica By Germanium Ion Implantation; Electronics Letters, 20 July 1995, Vol.31. , No.15.
Leech, P.W.; Kemeny, P.C.**

Radio Devices and ITE; CISPR/G/WG1 '95, 1 September 1995
**MacFarlane, I.P.*

All Optically Written Planar Germanosilicate Waveguide Gratings, Photosensitivity and Quadratic Nonlinearity in Glass Waveguides; Fundamentals and Applications, 9-11 September 1995, Portland, Oregon, USA.
Moss, D.; Ouellette, F.; Faith, M.E.; Leech, P.W.*; Kemeny, P.C.*; Ibsen, M.; Leistiko, O.; Poulsen, C.V.; Love, J.D and Ladouceur, F.J.*

Dispersion Management of High Capacity 10 Gbit/s Transmission Systems-Modelling and Practical Implications, invited talk presented at the Optical Society of America's Annual General Meeting, 10-15 September 1995, Portland, Oregon, USA.
*Stephens, T.D.**

** Denotes TRL Professional.*

RESEARCH LABORATORIES PAPERS PRESENTED/ PUBLISHED

VISITORS TO TRL

A wide variety of people from within Telstra and from external organisations visit the Laboratories, either as individuals or in groups. The visitors include executives, clients, researchers and officials of government and private organisations, and the purposes of such visits are to facilitate information transfer relating to the management and outcomes of R&D activities of mutual interest. Some notable visitors during the last quarter were:

July

VXL Holdings Malaysia
Mr Lim Chee Wah, President;
Mr Larry Teh, Technical Director.

ITG – National Computer Operations
Sheri Wright, Manager Operations Support Services;
Vatch Vorperian, Operations Support Services;
Les Gray, Shift Manager;
Ami Chand, Operations Support Services;
Linda Cattanazzi;
Roger Banks, Operations Support Services;
Adrianne Green, Operations Support Services;
Julian Cwikla, Operations Support Services.

NTG – Cable & Radio Networks
Two Engineering Students working for six months with Telstra.

IREE
44 Participants.

Laos PDR, Ministry of Communications, Transport, Posts & Construction
Mr Somlith Phoutonesy, Deputy Director.

Doug Campbell.

Southcorp
John Burbridge, General Manager Information Systems;
John Goldrich, Manager Executive Information Systems;
Peter Rogers, Corporate Communication Manager;
Tim Laing, PC Support Manager;
Ken Anulda, IS Manager Gadsden Packaging, Flexible Division;
John Dixon, Account Executive;
Tony Ryan, Regional Account Manager.

Department of Defence
Tony Ayers, Secretary;
Ken Norris, Director Industry Capability & Involvement;
Don McDonald, JORN, Regional Project Manager;
Max Brennan, Director General, Jindalee Project;
Les Morrison, National General Manager and Ron Dicker, General Manager, Wide Area Surveillance – Telstra Applied Technologies,

University of Science, Malaysia
Professor Wan Seng Tan, Director, IT Centre, USM
Dr Shurki Sulaimah, Research Fellow USM;
Phillip Yeoh, Manager Austrade Penang.

Geelong Science & Technology Centre
Phil Emery, Brendan Schmidt and Ivan Colak;
Ray Wursthorn, Account Executive;
Stephen Wheeler, Communictions Consultant.

National Directory Services
Commercial & Consumer
Meredith Corbet, BS Technical Support;
Maxine Lehane, Telstra Shop Manager;
Peter Logie, Services Manager;
Martin Lant, MCS;
Jennifer Hanslip, Office Supplies Serv.
Corporate, International & Enterprises
Cameron Purnell, Consultant;
Ian Keegan, Mobile Networks;
Philip Langenbacher, Technical Specialist;
Paul Nolte, Technical Specialist.
Corporate Centre
Graham Bishop, Senior Consultant;
Andrew Jamison, Management Dev.;
Bruce Stephens, Account Management;
Peter Todd, Management Development.
Network Technology Group
Mario Bernardi, Cell Leader ARE-11;
Patrick Kennedy, Analyst Programmer;
Mark Timmins, Technical Specialist;
John Tucker, Software & Systems;
Ian Wakefield, Customer Operations.

Health Insurance Commission
Peter Hatch, General Manager Information Services Division;
Gill Bertlemier, Manager Office Systems & Networks;
Bernd Schacht, Manager Telecommunications & Network Services;
Kim Hughes, Phil Jacobs, Jim Clarke and Lu Andretta;
Andrew Gunter, Account Executive;
David O'Brien, Communications Consultant;

Age Green Guide
Les Cardilini, Journalist.

United Nations Trade Point Development Centre-RMIT
Carlos Moreira, Director;
Donald Gibbs, Managing Director, Trade Point Australia.

Aichi Delegation – Japan
Mr Minoru Nagase, Manager, Computer & Infirmities System Engineering Headquarters, Nippon Denwa Shisetsy Co Ltd;
Ms Toshiko Yamamoto, Assistant-Director (Design), Commerce & International Trade Division, Department of Commerce & Industry, Aichi Prefectural Government;
Mr Masao Otake, Vice General-Manager, International Division, Nagoya Chamber of Commerce & Industry;

Mr Shunzo Kawabata, Managing Director, Noritake (Australia) Pty Ltd;
1 person from Toyota Motor Corporation Australia;
Mr Katsunobu Nakagawa, Director, Toyoshima Australia Pty Ltd;
Mr Ryo Matsumura, Nagoya Trade Information Centre, JETRO;
Ms Michiko Yashiro, Professor, Nagoya Junior College of Art and Design;
A Government Representative;
Keiko Hirata, Interpreter;
Joanne Brown, Premiers & Cabinet.

August

Department of Industry, Science & Trade
Catherine Higgins, Senior Project Officer, Telecommunications Industry Section;
Brownyn Williams, Assistant Director, Telecommunications Industry Section;
Bob Lansdown, Chairman, Telecommunications Development Authority.

Vietnamese delegation
Mr Do Muoi, General Secretary, Vietnamese Communist Party;
Dr Do Trung Ta, Chairman, VNPT;
12 Government Officials;
35 Business Officials.

QANTAS
Mark Humphreys, Product Development Manager;
David Glover, Strategy & Planning Consultant;
Ross Godwin, Senior Information Architecture Consultant.

Yangtze Optical Fibre & Cable Company
Mr Zhao Molin, Chairman of the Board, Former Director General of the Science & Technology, Dept of MPT China;
Mr Jiang Tinglin, Board Director, President of the Wuhan Research Institute of Post & Telecoms, MPT China;
Mr Lin Chaofan, Board Director, General Manager of the Yangtze Optical Fibre Group;
Mr Bao Griangjin, Board Director, Vice President of the Wuhan Research Institute of Post & Telecoms, MPT China;
Mr Wu Zhiqiang, Secretary to the Board, Associate Professor;
Mrs Li Ming, Board Director.

West Australian Newspaper
Peter Morris, Communications & Computer Technology Writer.

James Hardie Security
Glen Murray, National Operations Manager;
Ross Doonan, General Manager;
John Blyth, Account Executive

Corporate Affairs
Ian McMinn, Senior Media Relations Manager, Electronic Media;
Carole Jaaks, PA for Director Corporate Affairs;
Ken Cavanagh;
Carole Livingstone, PA for Doug Campbell.

Journalists from India
Aruind Padmanabhan, Senior Correspondent, Times of India;
R. Krishnan, Chief of Bureau/Deputy Editor, Hindu Business Line;
Oswald R Pereira, Special Correspondent, Financial Express;
Rajesh Kalra, Senior Special Correspondent, Business Standard;
Naresh Minocha, Chief of Bureau, Indian Express;
Harnek Sinak, Senior Correspondent, Economic Times;

Deutsche Bank, Bankers Trust, Rothschild, National Mutual, Hong Kong Shanghai Bank, JP Morgan
Craig Castle, Michele Russell, Andrew Butterell, Paul Davis, Campbell Boag, Paul Lim, Alistair Francis, Tony Pearce;
Donald Sutherland, Account Executive;
David Holder, Communications Consultant;

CSR
Elmer Wolfenden, Manager Group Communications;
Jeff Apcar, Senior Network Analyst;
Ian Gilroy, Senior Network Analyst;
Darren Broughton, Account Executive;
John Duthie, Communications Consultant;
Alex Veliosi, Account Executive Global;

Prices Surveillance Authority, Trade Practices Commission, Industry Commission
Mr David Webb, Communications/Property Services, PSA;
Gad Ellinson;
Ms Ellen Ward, Director Information Technology, IC;
Ray Linden, IC;
Allan Mickelsen, IC;
Shayne Smith, National Account Executive;
Anna Coates, National Communications Account Assistant;
Ranil Sharma, Regional Sales Executive.

Commonwealth Bank
Dr John Looker, Group Manager, Multimedia;
Ms Sally O'Neill, Chief Manager Strategic Planning;
Terry Raynor, Executive Manager Strategy Planning;
Dennis Nicholson, National Business Manager, C&G;
Phillip Heavener, Industry Marketing Manager, TMG.

Herald Sun
Jane Schulze, Finance Reporter.

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VISITORS TO TRL

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Bambatha Jonas Hlongwane;
Thandekile Josephine Motau;
John Moran, IBU;

Shanghai Camera Crew
Mr Feng Zhengzhi, Deputy Chief Inspector Channel 14;
Ms Du Laizheng, Editor;
Mr Dai Wenhua, Cameraman;
Mr Fang Songxian, Reporter;
Ms Zhang Hualing, Interpreter, Austrade;
Ann Wei and Kriti Colless of IBU.

AMP
Colin Williams, Technical Manager Voice Communications;
Warwick Broxom, Senior Account Executive.

REAME Training Centre
Major Jack Lord
WO Mick Elliott
WO Steve Brown and students
SGT M R Baldwin
SGT T K Gifkins
SGT S J Gould
SGT B T Harrison
SGT S Ibbott
SGT J P Kelly
SGT E Tinning
SGT G Turner

RMIT
Jonathon Alfa, George Carydias, Joshua Cheetham, Narelle Crooks, Nalska Dandeniya, Austin Dark, Linda Di Florio, Lambros Dour, Trang Du, Robert Dvorak, Mark Greenham, Robert Hendry, Ty Ho, Rohan Jackson, Mark Kegel, Mary Loukounakis, Mayckil Mikhail, Andrew Nasarvczyk, Stepehn Oh, Nova Patullo, Michael Pulis, Lisa Reid, Con Syrrakos and Huy Tran.

National Telemarketing Centre
Frances Vinci, Trudi Pilz, Geena di Stefano, Wendy O'Rourke, Sharon Pereira, Adam Crowe, Frank Rivellese, Anna Marsh and Caroline Barratt.

Trinity Grammar
26 students, 1 staff member and 4 parents.

Telecom Thailand
Mrs Tipawan Wuttisam – Vice President of Department of Administration Bureau of General Affairs;
Mr Apisak Narikawit – Senior Executive Manager, Computer System Sector, Customer Services Information System Department;
Mr Thira Phoemas – Senior Executive Manager, Billing System Sector, Customer Services Information System Department;
Miss Rattanaporn Na Songkhla – Executive Manager, Computer System Sector, Customer Services Information System Department;
Mrs Chintana Wirasathien – Deputy Senior Executive Manager of Metropolitan Area 2.2 of Metropolitan Area 2;
Mrs Sununtha Kudeepirom – Specialist 8 of Sector of Administration of Customer Services Information Systems Department;
Mr Manop Thondee – Deputy Senior Manager, Systems Management Division, Technology Information Department;
Mr Polsak Sewamontree – Deputy Senior Manager, Fixed Assets Accounting Systems Division, Technology Information Department;
Mr Suppachai Santihirunpak – Senior Manager of Budgetary Sector of Administration Office of Metropolitan Telephone Area 3.

Coopers & Lybrand Associates
Mr Prasan Chuaphanich – Partner Bangkok Office.

September

Parliament House – Sound & Vision Office
Bruce Sharp, General Manager;
Bert Gonzalez, Director of Engineering;
Michael Lawrence, Director of Technical Services;
Cynthia Law, Director of Production Operations;
Bob Hughes, Senior Sales Professional Telstra.

Channel 7
Craig Woolven, Network Telecommunications Manager;
Phil Ziken, Account Executive.

Communication Authority of Thailand
Mr Damnoen Kaewthawee
Mrs Sutee Nakasuwan
Mr Adisak Chokamnuaychai
Mr Karoon Kalayanalarp
Miss Orapin Pongvaramitchai
Mr Noppadon Mongkonsin
Mr Chaianunt Worakhunt
Mrs Pranatee Kulnitayakom
Mr Sarun Thaibuntao
Mr Kamhaeng Kulkamthorn
Miss Supreya Charoensinsumrit
Mr Supan Leerakomban
Jim Hair, Co-ordinator ITU & Regional Organisations.

Zimtrade and United Nations Trade Point Development Centre
Ma-lord Makaya, Manager Trade Information Centre;
Mike Humphrey, Deputy Chief Executive;
Tom Butterly, Information Services Advisor;
Donald Gibbs, Managing Director, Trade Point Australia.

The Age and Armstrong Audio Visual
Mark Gardiner, Communications Manager, The Age;
Lance Pink, Senior Consultant;
David McKinnon, Building Services Supervisor, Armstrong Audio Visual;
Chris Anderson, Regional Account Executive.

Einhoven University of Technology
26 Undergraduate Students.

2UE, 3AW, A Current Affair
Murray Olds, News Editor, 2UE;
Colin Tyrus, News Editor, 3AW;
Rob Penfold, Executive Producer, A Current Affair;
Andrew Charitou, National Business Manager;
Graeme Brown, National Account Executive.

Telephone Organisation of Thailand
Mr Soonthorn Choopongs, Senior Executive Manager;
Mrs Puangsoi Kesornthiong, Senior Executive Manager;
Mr Narong Supnutsetkul, Executive Manager;
Mrs Chalermkiat Juntanasmit, Supervisor;
Mr Charnnapong Gerawanwong, Supervisor;
Jim Hair, Co-ordinator ITU & Regional Organisations.

Westpac
Trevor Russell, Chief Manager Technology Operations;
Gordon Herriott, Manager Communications Services;
Bob Knight, Manager Strategy Design;
Andrew Charitou, National Business Manager;
Graeme Brown, National Account Executive.

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TRL is managed to a rolling 5-year Business Plan, which is corporately reviewed and approved annually. The Business Plan encompasses agreed 'deliverables' and the resources needed to achieve them. The deliverables include:

- the conduct of the TRL's R&D Programme, comprising a range of investigatory projects performed for and nationally funded by a variety of Telstra Client Divisions, with their endorsement;
- the operation of Corporate Facilities for the whole of Telstra, including the provision of specialised services relating to:
  - library information and translation services,
  - intellectual property consultancy services,
  - academic programme.

The preceding table gives details of TRL activities and appropriate staff contacts.

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