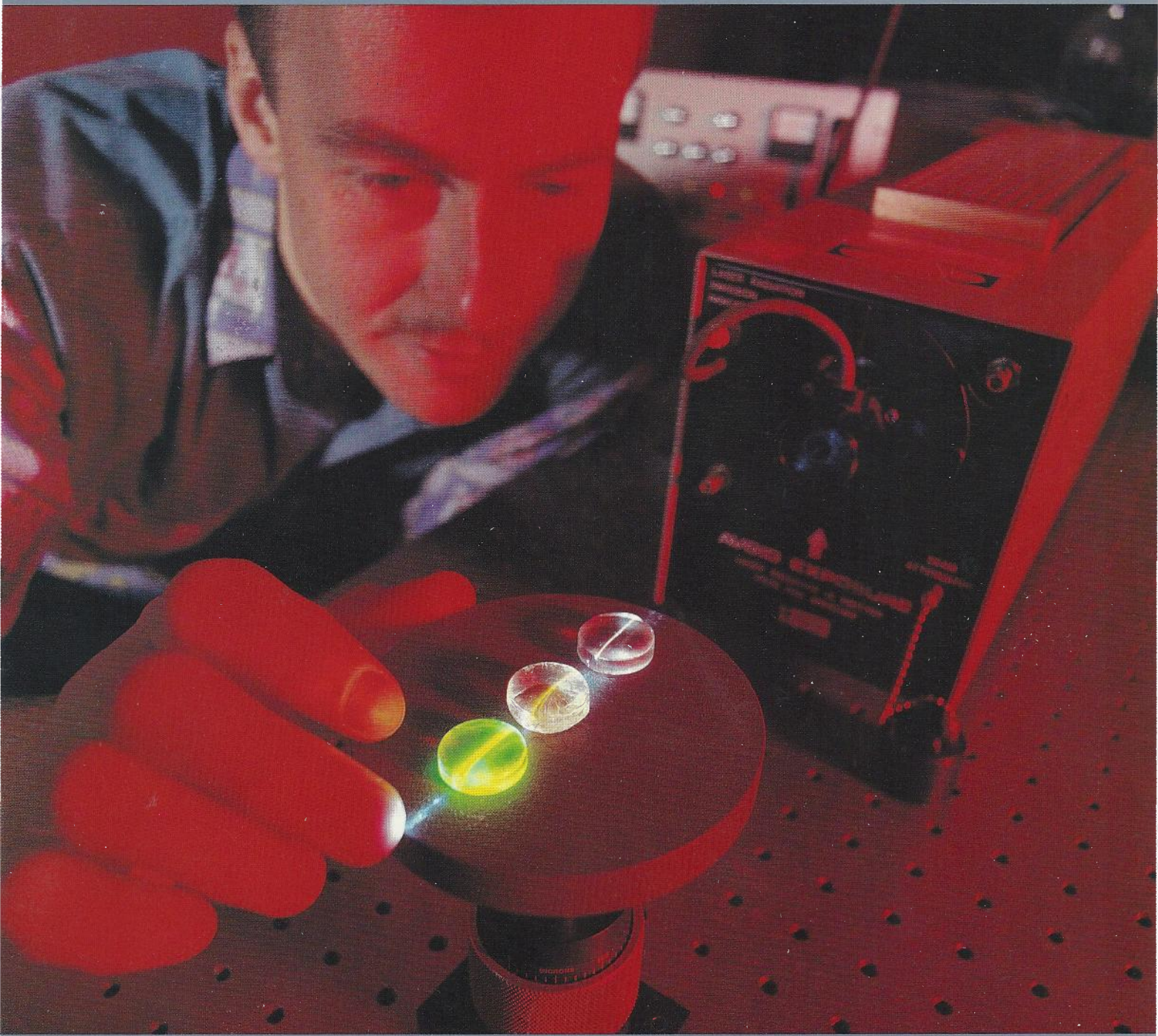


IN CONFIDENCE



# RESEARCH

QUARTERLY 79



**A RESEARCH UPDATE FOR TELSTRA STAFF ONLY**

April, May, June 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 Byrne checks the light transmission through three different doped glass sample optical amplifiers.

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<b>The Telstra Research Laboratories – A Brief Overview</b> .....	4
<b>Customer Service and Systems</b> .....	7
• Distributed Artificial Intelligence .....	7
• Interactive Multi-media Services .....	7
• 9th DAVIC Meeting – Melbourne 5-9 June 1995 .....	9
• DAVIC – Networking Issues .....	9
• Westpac Voice Network Modelling .....	10
• Workflow Technology for Service Management .....	10
• Generic Services Database (GDSB) .....	11
<b>Switched Networks</b> .....	12
• Possible Architectures for the Introduction of ATM over SDH Platforms .....	12
<b>Transmission Networks and Standards</b> .....	13
• The Economics of Long Distance Transmission Using Optical Amplifier Systems .....	13
<b>TRL Information Transfer</b> .....	14
<b>Research Laboratory Reports</b> .....	16
<b>Research Laboratory Branch Papers</b> .....	16
<b>Papers Presented/Published</b> .....	17
• List submitted .....	17
<b>Visitors to TRL</b> .....	18
<b>TRL Business Plan</b> .....	21

**CONTENTS**

## **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 TELSTRA RESEARCH LABORATORIES – A BRIEF OVERVIEW**

### **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.

## A message from the Director

Telstra Research Laboratories (TRL) works together with the various Telstra business units to build Telstra's competitive advantage and achieve company growth.

To better meet the needs of our business unit customers and to increase TRL's efficiency and effectiveness, the Laboratories have recently been restructured.

The new organisational structure at TRL aims to build stronger links to our business unit customers. We are involved in the exciting process of changing the culture at TRL to be more attuned to customer needs.

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

Graham Shepherd  
Director Telstra Research Laboratories

## Why restructure?

The restructuring of TRL has been done to maximise the value that our work adds to Telstra's business.

We believe that our new organisation has a better customer focus, improved strategic focus and improved programme management.

## What's new?

Five key roles have been identified for the new TRL.

- 1. Vision for the future**  
Be the principal source of technological input to Telstra decision making and strategic planning.
- 2. Technological leadership**  
Be the principal resource for management and conduct of technology research and innovation.
- 3. New and differentiated products and services**  
Turn ideas into timely, competitive and sustainable products.
- 4. Standards and Regulatory Strategies**  
Prioritise, lead, influence and communicate on standards and regulatory strategy.
- 5. Telstra Information Services**  
Be customer focussed, service oriented and cost effective.

## New matrix structure

A new matrix structure has been designed with programmes operating across sections. Programmes are the "output delivery mechanism" providing total solutions to customers while sections maintain the depth of technical expertise.

All research work is now carried out in the 21 programmes which range in size from 5 to 72 staff years. Some programmes are focussed around a single customer while others support major business developments such as the introduction of broadband services and serve several customers. Programme leaders are expected to co-ordinate research across discipline boundaries, deliver results needed by the customer and provide vision for the programme that enhances Telstra's business opportunities.

## Strategic programmes

Because of their importance to Telstra, four of the programmes have been identified as being strategic. The four strategic programmes are:

- Broadband Service Delivery
- Mobility Services
- Systems and Network Integration
- Occupational Health and Safety

and they account for about 40% of the research effort at TRL.

## Stronger Customer Links

A new Business Development Group has been established as a seamless interface with our customers. Together with customers this unit will identify growth opportunities for Telstra. The Business Managers will work closely with business units to understand their R&D needs and ensure that the programmes achieve maximum benefit to the business units and Telstra.

TRL will also have a strengthened role in strategy and will have prime responsibility for providing Telstra with a vision for, and influencing the shape of, future telecommunications networks and services. This function will liaise closely with the Telstra R&D company.

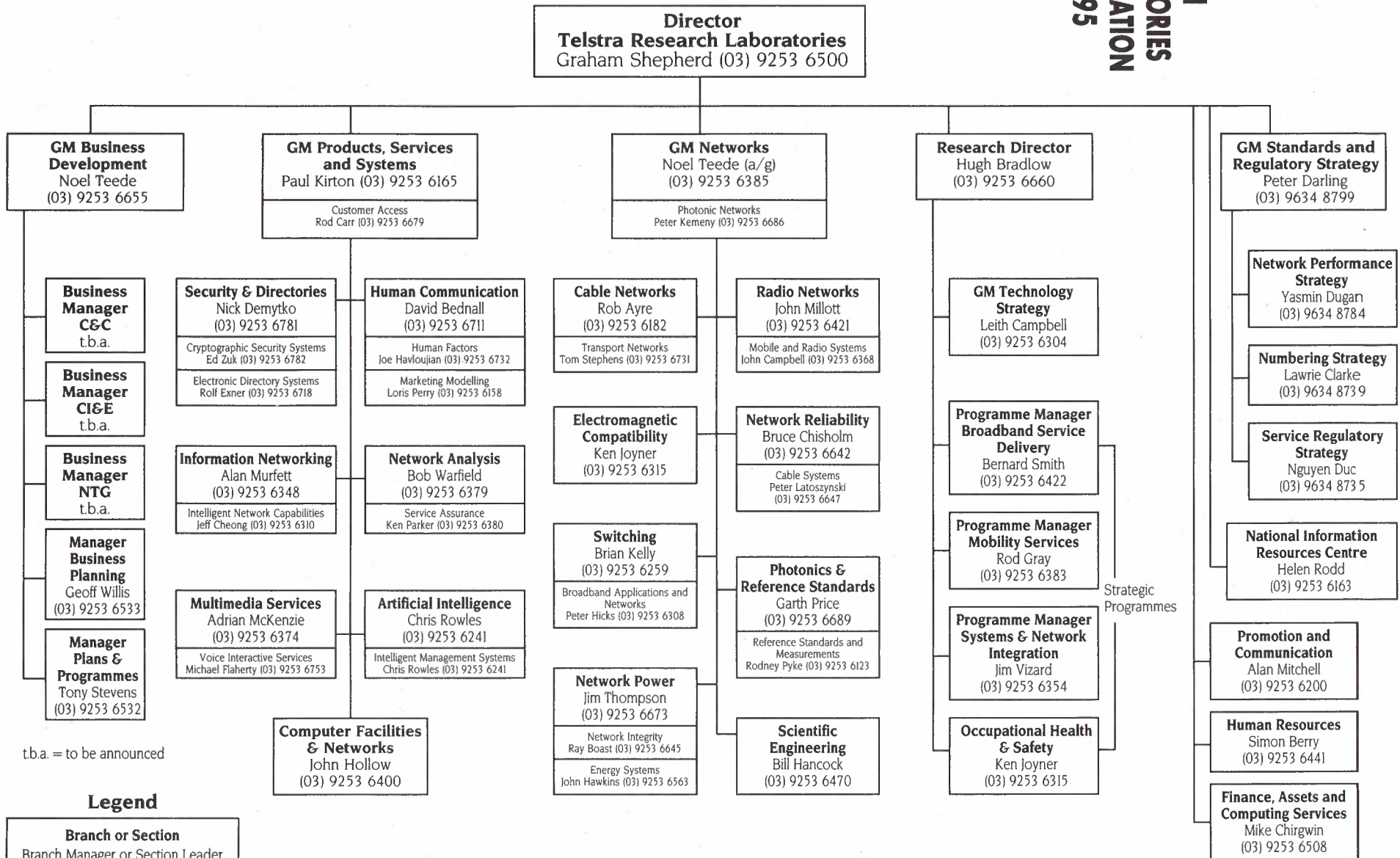
## New Organisation Chart

A new organisation chart showing names, positions and phone numbers is given over the page.

## Any Questions?

If you have any questions please contact Doug Kuhn, Transition Manager, Telstra Research Laboratories on (03) 9253 6655.

## RESTRUCTURE OF THE TELSTRA RESEARCH LABORATORIES



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t.b.a. = to be announced

**Legend**

**Branch or Section**  
Branch Manager or Section Leader

Programme (most operate across several sections)  
Programme Leader

## Distributed Artificial Intelligence

Distributed Artificial Intelligence (DAI) is a rapidly emerging field in AI. It combines multiple knowledge-based systems to solve problems in a co-operative manner.

Experience from overseas highlights the important role of DAI in developing new services and operational support systems, e.g., helping to schedule meetings, or diagnosing faults in a WAN. This project is aimed at developing Telstra's technological capability in this important new area.

Systems using traditional AI technology have demonstrated their effectiveness at automating the routine, data-intensive tasks of network performance monitoring and fault diagnosis, e.g., in the mobile and customer access networks. The benefit of using AI is that it is possible to capture the reasoning used by human experts. This makes it possible to automate the routine, data-intensive aspects of these tasks. This has the benefits of reducing labour costs, improving service quality, and freeing specialised staff to work on more complex problems.

The cost and importance of these tasks will increase dramatically as network size and traffic levels grow. However, growth in network size and traffic is out-stripping the capacity of centralised management systems. Moreover, other applications such as fraud detection require faster analysis of much larger volumes of data. The volume of data to be processed will make it necessary to distribute the task between multiple distributed systems. In addition, more sophisticated problems will require co-operation between several systems that are each responsible for different aspects of the task, e.g., switch or transmission facilities management.

DAI techniques can potentially slow this cost escalation by allowing the size and complexity of these tasks to be divided between multiple intelligent systems in a co-ordinated manner. Consequently, if Telstra is to be able to monitor the quality of its networks and services in a timely and cost-effective way, then it will need to be able to use DAI technology to scale up its existing AI tools. Also, DAI will build upon emerging distributed platforms such as TINA.

In response to these needs, we are developing a prototype system for diagnosing faults in the cellular mobile telephone network. This distributed expert system will demonstrate how DAI can be used in several representative fault scenarios. In particular, we are investigating three key theoretical issues:

1. communication languages between distributed expert systems,
2. distributed knowledge representation techniques, and

3. control strategies for co-ordinating distributed diagnosis.

Our aim is to develop a set of DAI tools and demonstrate their benefits to Telstra.

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

## Interactive Multi-Media Services

The current focus of telecommunication companies is the rapid introduction of Interactive Broadband Services (IBS), such as Electronic Yellow Pages, Home Shopping, Pay TV and Movies-On-Demand. In order to achieve a rapid startup and sufficient early growth, players in the IBS industry (content, computer and telecommunications companies) have formed alliances – a vertical business model. Internal pressures from content providers, and external pressures from customers and regulatory authorities will result in the opening up of the industry – a horizontal business model.

### Software Architecture

The Artificial Intelligence System Section (AISS) has developed a prototype system for exploring the issues of an IBS delivery software architecture.

This prototype is designed so that the software architecture:

1. Satisfies the short term vertical business model, but supports a future horizontally structured industry.
2. Clearly defines the roles of the Network and Application Providers, and supports the inevitable separation of these roles as the industry matures.
3. Is open, thus enabling the IBS operator to achieve innovation and pricing advantages from competition between producers of IBS software and hardware components.
4. Copes with various technologies, e.g. ADSL and ATM.
5. Provides a framework for Application Providers to implement and provide their services with much flexibility and as little constraint as possible. Imposing artificial restrictions on Application Providers will cause them to look for other distribution means for their services.

Results of the study of various IMMS architectures and our prototype have shown that an IMMS architecture should provide easy customer connection, application directory navigation and application invocation through service directories, and personalised access to information.

**CUSTOMER  
SERVICES AND  
SYSTEMS**

**Distributed Service Directories**

Given that broadband interactive multimedia services will become a reality in this year or next, it will be critical that a service directory of different services is available to the customer. The service directories must have a very user-friendly front user interface, must quickly find the service information the user wants, and must be up-to-date.

It seems that the potential market, and the market value of broadband interactive multimedia services cannot be over-estimated. The same is also true for service directories. With potentially tens of thousands of films, shows, games, documentaries, information services, shopping services, etc., available from broadband interactive multimedia services, there is a potential for revenue from service directories through advertising and/or service charges.

We believe that network providers are the best candidates to run the service directories due to the following:

1. Network providers normally have the detailed up-to-date information to build and update the service information databases.
2. Network providers normally play mediators' roles between the customers and the service providers.
3. It is easy for network providers to conduct inter network service search if the service required by the customer cannot be found locally because gateways of the networks are normally managed by the network providers.

A service directories prototype is currently under development at AISS, TRL under the sponsorship of Strategic Development Unit, Telstra. The service directories prototype under development has the following features:

1. The service directories will be distributed, i.e. the directories will be stored in different computer systems over the network. If the search mechanism cannot find the answer to a customer query on a local service directory, it will continue searching through the network until an answer is found, or the customer interrupts the search process, or certain condition set up beforehand becomes satisfied, or all of the service directories on the network have been searched, exhaustively.
2. A resource discovery method will be required to conduct such kind of distributed search.
3. The service directories will be database system independent, i.e. service directories based on different kinds of database servers will be allowed in the network. The directories and the database servers communicate with each other through standard Open Database Connection (ODBC) interfaces. Currently, two kinds of database servers are planned for the

prototype: Oracle System 7 server (system 8, soon) and Microsoft SQL server. Other database servers, such as DB2, etc. can be connected if required.

**Personalised Access to Information**

The proposed introduction of a large number of Interactive Multi-Media Services (IMMS) on Telstra's broadband network, and the diverse choices open to customers as a result of these services can easily lead to an information overload that dissuades customers from using such services. To alleviate this information overload, it is necessary to provide easy and personalised access to information. Personalised information access tools rely on learning a customer's long-term preferences on the basis of his/her habits regarding the usage of services, and then use these learnt preferences to provide personalised and user-friendly services to customers. A by-product of service personalisation is the provision of accurate information about customer preferences to service providers so that suitable products can be offered to customers.

We believe that network providers, as mediators between customers and service providers, should have a strong presence in providing personalised access since there is potential for revenue from:

1. Increased usage of services with increased customer convenience due to personalisation.
2. Charges to service providers for accurate and online service usage profiles.

Our research indicates that in order to have a high degree of customer acceptance of broadband services it is necessary that these services be personalised.

In order to provide personalised access in the IMMS context, the following design requirements need to be taken into account:

1. Since IMMS users are typically casual users of services, a user's preferences must be learnt from a small number of past selections.
2. In the context of IMMS, information filtering must be done in real time, and hence, the use of computationally intensive assessment of each item in the information source against a complex matching criteria during on-line interactions must be avoided.
3. The benefits gained from providing personalised information access will be useful only if the recurrent cost of incorporation of personalisation tools into a service is kept low by using a portable and modular design.
4. Revenue from service personalisation can be increased if acquired user preferences can be put to dual use both to assist customers by personalising interfaces, and to assist service providers by providing accurate and timely information about service usage profiles.



Taking into account the above requirements AISS has developed a prototype personalisation system that learns customer preferences in a Video On Demand (VOD) service. The learnt preferences are then used within the VOD user interface to provide suggestions to the user about possible movies for viewing, and to provide easy access to movies typically chosen by the user. Learnt preferences are also used within an administration tool for service providers in order to determine product characteristics preferred by different customer groups, and to tailor products suitable for a particular customer group.

(Contact: P. Sember, (03) 9253 6145, W. Wen, (03) 9253 6273, B. Raskutti, (03) 9253 6196)

## 9th DAVIC Meeting – Melbourne 5-9 June 1995

From June 5-9, Telstra hosted the 9th DAVIC (Digital AudioVisual Council) meeting in Melbourne. DAVIC is the key international industry forum deciding specifications for interfaces and protocols in end-to-end interactive broadband audiovisual or multimedia systems. In particular, the DAVIC specifications look like being those that will dominate systems supporting digital video broadcasting, video-on-demand, home shopping, home banking, etc.

Organisation of the meeting was highly successful and the objective of "freezing" a large set of specifications was achieved. "Freezing" means that there is just one solution for each function required of the system. Tests and review of this first set of specifications will lead to finalisation in December 1995.

By hosting the meeting, Telstra was able to have good representation at all technical committees and gain a thorough understanding of the elements of the DAVIC architecture. Most of Telstra's delegation at the June meeting was drawn from TRL, but it was strengthened through participation of staff from Video Platforms and Telstra Multimedia. Co-ordination of Telstra's DAVIC activities continues to be provided by Multimedia Services Section at TRL, which has provided consistent representation at all the formal DAVIC meetings.

Many key issues emerged from the meeting that Telstra must watch, including:

- (i) the use of ATM and how far towards the Set Top Unit (STU) it should go;
- (ii) implications for a network provider of downloading software to configure an STU for a particular access network;
- (iii) access to internet services (currently the supported data formats are not compatible with many forms used on the Internet);

- (iv) importance of DAVIC's work on Fibre to the Curb (FTTC) (they are the only group looking at the whole system) including accommodation of Australian network characteristics;
- (v) harmonisation of DAVIC specifications with those of Digital Video Broadcasting (DVB);
- (vi) accommodation of network based value added services, harmonisation with B-ISDN directions;
- (vii) match between the DAVIC "profiles" (sets of functions that must be supported by DAVIC systems) and the requirements of our commercial service offerings;
- (viii) and significant problems in reaching agreement on a security system (and risk of departure from the Foxtel approach).

In addition to these specific technical issues, DAVIC's draft long term plan must be scrutinised carefully for alignment with Telstra objectives so that comment and direction can be provided at a time in which it can still be influenced. DAVIC is also beginning to address the issue of copyright with an initial exchange of ideas at their next meeting in September and Telstra would do well to consider participation.

In all, Telstra's hosting of the event has been extremely valuable in highlighting the significance of this group's work within Telstra, and as a means of providing coverage across the many diverse topics under its control. However, many unresolved issues remain which could impact on our business significantly.

Debriefs have been provided to MSAG (Telstra's Multimedia Standards Advisory Group) and TRL staff, an executive summary has been provided for Telstra senior management and further debriefs are planned according to the advice from MSAG.

(Contact: L. Conte, (03) 9253 6282)

## DAVIC – Networking Issues

The 9th Digital Audio-Visual Council (DAVIC) meeting was hosted by Telstra in Melbourne from 5-9 June 1995. DAVIC is a consortium of equipment suppliers, network operators and service providers. DAVIC's aim is to provide an End-to-End Specification of new audiovisual services such as inter-active video, movies on demand (MoD), inter-active games etc. It is an Implementation Specification based on standards from many diverse areas such as MPEG, ISO, ITU.

DAVIC Specifications can be seen as the next step after simple Cable TV, where customers can choose what they want to see and the time they want to see it.

There are many issues resulting from the DAVIC Specification. This article only considers networking.

The networking aspects of DAVIC are developing rapidly from a "Cable TV" view of service broadcasting toward an ATM network – called the Broadband ISDN or B-ISDN – where there is flexible client-server connections and some service control is exercised by the customer. The problem is that many DAVIC people have quite different ideas about what a "network" is and what it is capable of delivering.

Telstra, as one of the few telcos that are permitted by national regulation to operate such services, is keen to see a unified network that is capable of delivering DAVIC services plus the many other telecommunication services. It wants to take advantage of its leadership in Intelligent Network (IN) service delivery and its proposed B-ISDN.

The last few meetings of DAVIC (which are held about every 6-8 weeks) have seen a concerted push by a few telecommunications companies including Telstra to have a B-ISDN service delivery option included in the DAVIC Specification. This was achieved with the DAVIC 1.0 Specification that was "frozen" at the Melbourne meeting and is now available publicly. However, some of the details are still being argued about. This is occurring via email groups and at the next two meetings where extensive "editorial" changes are being made before the Specification will be published in January 1996.

The B-ISDN will be able to deliver calls with many connections per call and to multiple parties and with different bandwidths for each connection. The connections can be uni-directional if required.

The IN can provide services such as a video menu system to customers so that they can navigate their way to the wide range of service providers that may exist on the network. The service selection response from the customer will be detected by the IN and converted into a service provider address. The call will then be diverted to this address.

The combining of B-ISDN and IN will provide a network that provides added-value delivery for interactive services of the near future. It will also allow the same network to provide services that are not defined by DAVIC.

(Contact: B. Dingle, (03) 925 36292)

### **Westpac Voice Network Modelling**

TRL was involved in the modelling of the private (PABX) network of Westpac bank late in 1994. Westpac has more than one thousand branches nationwide networked with PABXs. The major component of the overall network is the Corporate Communications Network (CCN), which covers the large branches in metropolitan cities. The main objective of the above study was to investigate whether it would be economically viable for Westpac to use Telstra's Corporate Virtual Private Network (CVPN) for CCN's

voice communication needs instead of the private network.

The modelling tool used in the above study was Strategic Telecommunication Evaluation Model (STEM) software. STEM allows one to model the relationship of the demand for a particular service to the resources required to meet the demand over a period of time. STEM models can be used to explore scenarios and compare alternatives.

A model of the private network was developed using the network traffic and cost details supplied by Westpac and call charging information from SAMIS database. The model run period was chosen as ten years and the service demand was shown to increase and decrease gradually over that period. The model results provided information about the network costs, call charges and resource costs over a period of ten years.

A second model was developed with CVPN deployed midway through the run period replacing the Flexnet Megalinks of the private network. Comparison of results from first and second models showed the overall network running costs to be higher in the latter case.

While this study showed that migration of CCN branches to CVPN was not as economically attractive as the current private network, it is quite possible that the hundreds of small branches using commander systems may benefit from cost savings offered by the CVPN. Further work on this topic will provide the answers to this question.

(Contact: N. Bharatula, (03) 9253 6482)

### **Workflow Technology for Service Management (Executive Summary from Research Laboratories Report No. 8340, by Sam Stainsby)**

Workflow provides a way of looking at business processes in terms of tasks and data and the conditions under which each task can be performed. The resulting model is in a form that is suitable for automation on workflow management systems (WFMSs). Each task is carefully defined and associated with software applications and user authorities so that appropriate staff have the tools to complete tasks appropriate to their roles. Although apparently similar to many current systems that support data flow and job allocation, WFMSs are far more flexible and tunable, since process models are not 'hard-coded' into a single application. This is especially important for rapid process re-engineering or for developing new processes.

Workflow technology is becoming an increasingly important part of the management of key business processes for a number of large companies. The use of a WFMS significantly accelerates both process

development and process turn-around times, often reducing the number of people needed in a process. So far, most companies appear to be using WFMSs in pilot projects only. However, it will not be long before businesses are differentiated on the basis of the ability of their WFMSs to deliver products efficiently, rapidly and reliably.

This report is an evaluation of the ability of WFMSs to create or improve processes for the activation of complex telecommunication services. IBM's FlowMark workflow management system has been used to manage a simulation of the InfoCall (1900) service activation process. This model is exhibited in the report and recommendations for the future use of workflow technology for service activation and other customer-oriented processes are stated. These recommendations may be found in section 6. Our conclusion is that WFMSs provide good facilities to model, document, manage and audit business processes. Users are presented with a consistent interface, no matter where they are in the process. Data transfer is more reliable than manually managed processes and there is much more control over the consistency of data. However, current commercial WFMS packages are still immature and as yet have little to offer in the way of debugging tools and recovery support. Of particular concern is the lack of facilities for dealing with unanticipated conditions during the execution of a complicated process.

(Contact: J. Keegan, (03) 9253 6536,  
S. Stainsby, (03) 9253 6208)

## Generic Services Database (GSDB)

Telecommunications carriers are rushing to introduce new and sophisticated services into their networks, using Intelligent Network (IN) equipment as the enabling network technology. The IN concept has grown from the desire to reduce the cost and time to market traditionally associated with the introduction of new services, using advanced computer and switching technology to provide greater service customisation and flexibility.

Currently, equipment vendors around the world are developing their own proprietary versions of IN technology, while within the ITU-T and other standards organisations, significant effort is being expended in developing IN standards to allow for interoperability of IN equipment from different vendors. As the standards mature, equipment vendors will move towards standards compliance, while possibly still offering different or enhanced features.

Limitations in vendor IN offerings have resulted in Telstra developing a number of its own IN adjunct systems, which enhance the capabilities of existing exchanges using centralised computer equipment upon which

the IN services operate. The adjunct architecture has allowed Telstra to lead the world in the introduction of services such as Priority One 3.

As part of its research programme into IN technology and architecture, TRL has developed a prototype IN system known as Generic Services DataBase. GSDB is an IN adjunct designed to integrate with the TRL Service Creation Environment and Service Management System to provide a platform for experimentation with IN technology and techniques. The system has been developed to comply with the ITU-T Capability Set I(CS-1) Intelligent Network standards. It also includes advanced capabilities not allowed for within the CS-1 standards. A milestone in the GSDB development work was achieved in May 1995, when multiple services, including a number translation service, a card service and multi-alerting service, were demonstrated in the model exchange network at the Network Test Centre in the Exhibition exchange building.

The development of GSDB has allowed TRL to gain in-depth technical expertise in IN standards and technology. Knowledge gained has been used to provide input into Telstra's IN strategic directions, and to provide advice and technology transfer to the IN development areas within Telstra. It has also allowed for critical evaluation of the IN standards, and for feedback into standards development through the TRL representatives involved in ITU-T Study Group II. The work has also placed TRL in a position to assist in the evaluation of vendor offerings in the IN area, and in evaluating opportunities for vendor interworking.

Experiments with GSDB include performance tests to assess the performance capabilities of various aspects of the IN architecture, including the Call Model, Service Control Point, Service Data Function and interworking interfaces. Results so far have indicated that equipment conforming to the IN standards should be capable of achieving good call handling performance within the Telstra network. The system has also been used to evaluate the service capabilities of a CS-1 adjunct.

Further work in TRL's IN related activities will include enhancement of the Service Creation Environment and Service Management System to provide a capability for rapid service development, simulation and testing in the model environment. This work can be applied towards the development of a customer laboratory for rapid service development and demonstration, with possible application in the Telstra IN Network. Investigation of possible new charging models for application with IN services is also in progress.

(Contact: D. M. Harsant, (03) 9253 6153,  
C. Escobar, (03) 9253 6346)

## **Possible Architectures for Introduction of ATM over SDH Platforms**

The aim of the Future Network Architectures project in Switching Section is to develop proper deployment strategies for multi-service broadband networks, in particular, to address the architectural and topological issues related to introduction of SDH platforms and their subsequent evolution to support ATM-based services.

Simple metrics, such as installation cost, cannot be an appropriate selection criterion for these networks. The deployment strategy must take into account the market uncertainty, accelerated rate of technological changes, and emergence of new services and demands. It should also be able to assess the possibility of future upgrades, as the traffic trends may quickly render the present platform obsolete. A flexible architecture which can, within some reasonable bounds, accommodate the future demand evolution may be more optimal than the one which minimises the current capital outlay.

In this project a robust framework to guide network deployment policy formulation has been developed. The model deals with changes in network topology and architecture, incorporates uncertainty inherent in demand forecasts in a fundamental way into the model and allows the factors associated with competition and market deregulation to be included in the analysis.

The methodology is being applied to a case study of deploying SDH and ATM-based broadband platforms. Several architectural scenarios have been identified and a critical comparison of these attempted. In such a comparison, the interplay between requirements of services, installation and growth cost of each architecture, and the trade-offs between initial capital outlay, flexibility, scalability and management capabilities are being considered.

(Contact: Farzad Safaei, (03) 9253 6115)

## The Economics of Long Distance Transmission using Optical Amplifier Systems

Erbium Doped Fibre Amplifiers (EDFA) have the potential to revolutionise long distance optical fibre transmission systems. With the help of EDFAs it is for instance possible to achieve long-distance unrepeated transmission links such as the 240 km Bass Strait optical fibre link currently being completed. However, so far the current high cost of EDFAs designed for use with transmission systems has prevented their wider deployment through economic considerations.

Following on from a number of previous studies and demonstrations highlighting the performance of optical amplifier transmission systems, the Inter-Exchange Network project in Cable Networks Section has undertaken a study looking at options for the economical deployment of optical amplifier systems. Presently, Telstra's SDH intercapital network, operating at 2.5 Gbit/s per optical fibre (equivalent to 30,000 simultaneous telephone channels), is being rolled out between Australia's capital cities, utilising Telstra's extensive installed single-mode optical fibre base. All new 2.5 Gbit/s transmission links operate at a wavelength near 1550 nm and utilise electronic regenerators at regular intervals of about every 100 km.

With optical amplifiers, the regenerator span could be increased to 150 km by deploying optical booster amplifiers following each regenerator. For the optical amplifier option to become economic with transmission links installed along existing optical fibre routes with established repeater sites would require a major reduction in the cost of optical amplifiers. Obviously, optical amplifier systems, which are virtually bitrate independent, become much more economically viable for future 10 Gbit/s transmission systems due to the increased regenerator costs.

An alternative deployment scenario considered in this study is based on regenerators deployed every 200 km with an intermediate optical line amplifier. These types of optical amplifier systems are much more attractive and will become economically viable when optical amplifier prices drop as expected over the next few years. Moreover, systems based on optical line amplifiers offer the potential of cost effective upgrades to multi-wavelength operation.

TRL has demonstrated that this type of system is technically feasible and offers adequate system performance for network operation on installed fibre routes. The 200 km and 300 km systems were demonstrated on standard single-mode fibre using SDH transmission equipment with externally modulated transmit lasers and optical line amplifiers at 100 km intervals.

(Contact: Frank Ruhl (03) 9253 6420 or Tom Stephens (03) 9253 6731)

**TRANSMISSION  
NETWORKS AND  
STANDARDS**

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.

Reports and Branch Papers 'for general use' are available on request and are also listed with abstracts or summaries of the contents of such publications given after the lists.

If you want to get copies of Research Laboratories Reports or Branch Papers, please telephone (03) 523 6700. Or you can complete a request form (included on the next page) and send it to:

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All requests should indicate clearly:

- The name, position, organisation and telephone number of the person requesting the materials.
- The postal address to which copies should be mailed.
- The number, author and title of each Research Laboratories Report and/or Branch Paper requested, and the number of copies required.



**RESEARCH  
LABORATORIES  
REPORTS**

**8332\*** – The Use of Forward Error Correction Technique in Digital Transmissions Over HFC Networks.  
*Pham, A.*

**8333\*** – Analysis of Clocks and Synchronisation Distribution in Telecom's SDH Network.  
*Taylor, M.; Wells, D.; Zilberg, E.*

**8335\*** – Asynchronous Transfer Mode: Security Issues.  
*Taylor, R.*

**8337\*** – Effects of Mismatched Filters and Adjacent Channel Interferences on Digital Transmission Performance.  
*Pham, A.*

**8339\*** – Network Element Failure Impact on the CCS Network.  
*Neame, T.; McMillan, D.*

**8340\*** – Workflow Technology for Service Management.  
*Stainsby, S.J.*

*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.*

**TELECOMMUNICATION SCIENCE  
AND TECHNOLOGY**

**Energy & Device Technology Report**

**ED95/02\*** – Examination of Lintek Circuit Board Integrating Polymer Thick Film and Printed Circuit Technologies.  
*Scott, K.L.*

*\* Telstra Australia Only*

*The Branch Papers marked \* are classified as 'IN CONFIDENCE – For Telstra Australia Use Only'.*

*Branch Paper Note: In some cases Branch Papers classified as 'IN CONFIDENCE – For Telstra Australia Use Only' will only be released to staff when accompanied by their Section Manager's authorisation.*

**TRANSMISSION NETWORKS AND  
STANDARDS**

**TNS0361\*** – Development of a Wide Dynamic Range Optical Power Standard.  
*Pyke, Rodney W.*

**TNS0365\*** – Calibration of Neutral Density Filters for Optical System Instrumentation.  
*Pyke, Rodney W.; Doney, Tom*

**TNS0368\*** – Far Field Evaluation of a DELTEC MTPA890-8-MEA, 820-960 MHz CMTS Base Panel Antenna.  
*Farr, Doug; Edwards, Brendan*

**TNS0372\*** – Laser Diodes Versus Gas Spectral Lines for Optical Wavelength Calibrations.  
*Pyke, Rodney W.*

**TNS0373** – Draft Australian Standard on Laser Safety.  
*Ayre, Rob*

**RESEARCH  
LABORATORIES  
BRANCH  
PAPERS**



**TELECOMMUNICATION SCIENCE  
AND TECHNOLOGY**

Electrical Properties of (Zn, Mn) Containing Multilayer Metallizations To p-Type InGaAs/InP; Materials Research Society, Spring Meeting, San Francisco, 16-21 April 1995.

*Leech, P.W.\*; Reeves, G.K.; Zhou, Wei.*

Waveguides Fabricated In Fused Silica By Germanium Ion Implantation At Varying Doses; Materials Research Society, Spring Meeting, San Francisco, 16-21 April 1995.

*Leech, P.W.\*; Ridgeway, M.C.*

An Electrical Model for Multilayered n+/n and Heterostructure Planar Ohmic Contacts; Materials Research Society, Spring Meeting, San Francisco, 16-21 April 1995.

*Reeves, G.K.; Leech, P.W.\*; Harrison, H.B.*

A New Window for Understanding UV-induced Reactive Index Changes in Glasses: EXAFS Analysis; OFTC Seminar, University of Sydney, 23 June 1995.

*Stone, G.O.\**

Telstra Research on Optical Fibres in the Photon Factory; RMIT Seminar, Department of Communication & Electronic Engineering, 10 May 1995.

*Warminski, T.\**

**CUSTOMER SERVICES AND  
SYSTEMS**

Neural Networks in Real Time Decision Making, International Workshop on Applications of Neural Networks to Telecommunications, May 1995, Stockholm, Sweden.

*Campbell, P.\*; Ferra, H.\*; Kowalczyk, A.\*; Leckie, C.\*; Sember, P.\**

Examples of Applied and Theoretical Research in Artificial Neural Networks in Telstra Research Laboratories, Siemens AG, Corporate Research & Development Centre, June 1995, Germany.

*Kowalczyk, A.\**

**NORMAN W V HAYES MEMORIAL  
AWARD**

The paper "The Australian Universal Video Codec Project" written by Biggar, M.\*; Pang, K. (Monash Uni); Dunstan, S. (Siemens); Arnold, J. (ADFA); which appeared in Vol 13, No 3 September 1993 issue of the Journal of Electrical and Electronics Engineering, Australia has been selected for the 1993 IREE Norman W V Hayes Memorial Award.

The Norman W V Hayes Memorial Award is the premier award of the Institution, presented no more frequently than once a year to the author(s) who contributed the most meritorious original paper published in the Journal during the preceding calendar year.

*\*Denotes TRL Professional.*

**RESEARCH  
LABORATORIES  
PAPERS  
PRESENTED/  
PUBLISHED**

## IN CONFIDENCE

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:

### April

OTS Plant Performance

8 Participants

ITG Graduates

9 Participants

Viewfinder Publicity and Buchan Communications

Beverley Head, Australian Financial Review and Siobhan Forbes, Buchan Communications

RAAF College, 1/95 ENGOFFELECTRFAM

FLTLT E J Boyd, FLGOFF K R Bowman, FLGOFF E R Myatt, FLGOFF D K Bell, FLGOFF J M Miers, FLGOFF M N Nussio, FLGOFF A J Rogers, PLTOFF A G Grimmer, PLTOFF D S Hurley, PLTOFF M W Rust

Queensland Department of Housing & Local Government and Bay Technologies

Jan Philips, Manager and Ian Ellem, Project Manager, Information Services Division; Alan Gaudin, Bay Technologies accompanied by Telstra's Peter Hogg, Senior Sales Professional – Qld State Government and Alan Jenkins, Telecom Applied Technologies

Defence Industry Study Course

Superintendent Murray Adams, Victoria Police, Displan Officer; Brian Archer, Transfield Shipbuilding Pty Ltd; LTCOL Gary Barkley, DEGP-A, Mat Br-A; Keith Bell, Telecom Australia, NTG; Geoff Buchanan, Finance Director, Skilled Engineering Limited; Warren Canning, Manager Business Development, AMRL, DSTO; Graham Chappell, Global House; EGCDR Russell Cox, SOMPM, HQLC-RAAF; Tony Creedy, ATEA; Ron Dicker, Telecom Applied Technologies, Jorn Project; Eugene Dimitriadis, Montech Pty Ltd; Brian Dixon, Defence Science & Technology; Gordon Edwards, Logistics Manager, Director General Navy Production; Rod Fuller, General Manager, Product Development, ADI Engineering; James Gleeson, Rockwell International; Ian Goodwin, Manager Supply, BHP Manganese; Roger James, Project Manager Defence Sector; David King, Siemens Ltd; Doug Lay, Telecom Australia, NTG; Bev Lyttle, Acquisitions & Logistics Office V/T; Kevin Mosey, KPMG Information Solutions; Peter McNair, Telecom Applied Technologies, Jorn Project; Bob Mulholland, Directorate of Capital Procurement Melb, Material Div, (Army);

Ian Randall, Telecom Australia, Manager, Development Programs; Norm Ridgway, P-3C Refurbishment Project, Airforce Material Division; Ian Rodgers, Senior Business Analyst, Transfield Shipbuilding Vic; Tony Smith, MAT-A, Army Material; Tony Spurling, Manager Technical Services, Army Survey Regiment; Inspector Michael Walker, Metropolitan Fire Brigade Board; EGCDR Jose Zarate, LPMI, HGLC – RAA

Guest Speakers:

Mr Wayne Nowland, Optus Communications Pty Ltd; Dr John Adams, Ferntree Computer Corporation Ltd; GPCAPT David McCarthy – HQ, Australian Defence Force; Mr John Craven, Anderson Consulting; Ms Judy Anderson, Department of Communications and the Arts.

Australian Broadcasting Corporation

Dick Winston, Manager Technology Strategy; Ray Reynolds, National Manager Technical Operations; Jim Toogood, National Manager Communications Unit ABC Radio; Brian Bailey, Manager Operations and Engineering, AIM Pty Ltd accompanied by Telstra's Judi Tucker, Account Executive and Barry Ihle, Communications Consultant, Media & Business Development.

AMP

Frank O'Collins, Program Director Client; Geoff Thompson, Manager Future Projects; Mike Errington, Chief Information Officer accompanied by Telstra's Warwick Broxom, Account Executive and Steve Cronin, Communications Consultant.

Ministry of Posts and Telecommunications, Cambodia

Mr Koy Kim Sea, Undersecretary of State for International Relations accompanied by Paul Donlan of Telstra

Hewlett Packard

Dean Hall, HP Pala Alto; Paul Bankowski, HP Hong Kong; Les Hunter, HP Australia

Regional Collaboration in Mathematics Education 95

100 Participants

Nynex USA

Joe Anderson, Managing Director

Zurich Australian Insurance Group

Geoff Hohnen, Communications Manager; Ian Chatman, Telecommunications Manager; Daryn Apolony, Network Support Manager accompanied by Simon Beresford-Wylie, Account Director and Graeme Brown, Account Executive both of Banking & Financial Institutions Group

May

Tattersalls

John Mortimore, General Manager, Commercial Business; Adrian Nelson, General Manager; Peter Philpot, Marketing Manager On Line Lotteries; David

## IN CONFIDENCE

Brockhoff, Production Systems Manager; Andrew Russell, Communications Manager accompanied by Patrick McGuire, Account Executive.

### ANZ

6 Participants accompanied by Grahame England, Account Executive and Ian Ridge, Communications Consultant

### Celcom Malaysia

Hasim Hj Abdul Hamid, Mazlan Johari, Schuhairy Abdulla, Ahmad Zainuddin Zainal Abidin, Nor Azmi Jamaludin, Hafidza Md. Armin

### Hot Chips

2 Participants

### Visual Arts School, RMIT

Professor Williams

### Corporate & Government

Frank Catena, Manager FMO Implementation; Matthew Coles, FMO Systems; Steve Naskopoulos, Manager FMO Systems; Sam Achi, El, Satellite & Network Management Planning; Jeremy Somers, Austpac Leadhouse; Arnis Gross, P2 Manager, Service Operations Engineering; David Hales, Manager, Service Operations Engineering; Zlatko Lozanovski, TranSend Leadhouse; Denis Ryan and Trang Chau

### Parliament

Glenn Carlos, Advisor to Senator Cook

### State Bank NSW

Tony Singleton, Head of Treasury Systems; Steve Mayhew, Technical Support Manager; Paul Connors, Manager Network Facilities; Tony Gorman, Manager LAN & WAN Networks; Peter McNally, Manager IT Data Security; Ross Cordukes, Computer Systems Manager

### Republic of Indonesia

His Excellency Professor Dr J B Habibie, Minister for Research and Industry

### Indonesian Mission

Makmur Makka, Advisor to the Minister accompanied by Ross Abbott

### Viewfinder Publicity and Buchan Communications

Stan Beer, The Australian; Cathie Connell, Buchan Communications

### First Data Resources

Kent Flury, Managing Director; Peter Wright, Director Network Services; Patricia Schafer, Director of Technical Services; John Healy, Senior Manager Network Engineering accompanied by Warwick Brown, Account Executive and James Mann, Customer Service Manager

### Leongatha Christian School

6 Students and Alvin Johnson, Teacher

### June

### VNPT, Vietnam

Mr Nguyen Van Nghiep, Deputy Director of International Relations, Mr Doan Khoa,

Deputy Director of Telecom Division and John Moran, Telstra

### Telekom Malaysia

Dr Adznan Bin Jantan; Amran Bin Hj. Naemat and Wong Kok Ann all from Research & Development Division

### Corporate Affairs Induction Programme

Peter Shmigel, Kathleen McLennan, Audrey Korsten, Vicki Russell, Rhonda Baker and Warren Smith

### Deutsche Telekom

Gunter Nuchter, Project Manager, ATM Marketing

### National Australia Bank

Marshall Bickford, Project Director; Bryan Bussell, Technical Strategist; Gerald De Hann, Marketing Consultant; John Hadfield, Payments Systems Expert; accompanied by Telstra Account Team – David Simpson, Senior Account Executive; Grant Riddoch, Account Executive; Paul Casbolt, Communications Consultant

### RAAF College, 2/95 ENGOFFELECTRFAM

FLTLTE E J Boyd, PLTOFF S J Tuck, FLGOFF M Grima, FLGOFF B R Doohan, FLGOFF P A Ridley, FLGOFF D A Currie, PLTOFF P R Hodgson, FLGOFF A J Ward, FLGOFF K M Rouhan, FLGOFF A T Nelson, FLGOFF A Scholten

### Telstra Corporation and Telstra Research Laboratories

Rob Cartwright, GMD Employee Relations also Vivienne Gale, Rick Field and Ruth Cameron

### Shanghai Science & Technology Investment Corporation

Mr Liu Zhenyuan, Mr Hu Xiaobao, Mr Gu Peide, Mr Fu Zhigeng, Mr Yu Jian and Ms Zhang Ruxin accompanied by Telstra Mobile Communication Services, Rodney Arambewela, Business Development Manager, Tony Bundrock, National Manager, Arthur Wood, National Manager, International Business, Luci Luciani, Regional Manager – Engineering WA, Tony Coyle, Senior Engineer Development, Kelvin Wong, Business Development Manager North Asia, Theodore Liu and Simon Chang

### ITG – Leadership Development Program

12 Participants

### Commonwealth Bank

Mike Smith, Communications Manager; David Kidd, Senior Manger, Strategic Research & Planning accompanied by Telstra – Dennis Nicholson, National Business Manager; Bob Shaw, Account Executive; Tim Bennett, Communications Consultant

### DSTC

Board Attendees  
David Barbagallo, DSTC; Lois Fordham, DSTC; Bob Gurnett, CITEC; Leith Hayes, DSTC; John Hughes, UTS; Alan Hayman, DBIRD; David Leggett, DEC; Melfyn Lloyd,

**VISITORS TO  
TRL**

IN CONFIDENCE

DSTC; John O'Callaghan, CSIRO; Don Sinnott, DSTO; Noel Teede, TRL; Rodney Topor, Griffith University; Frank Wroe, Chairman, DSTC

Balwyn High School

David Abbott, Jordi Bird, Russell Clarke, Samantha Chui, Cheryl Chiah, Jim Hadjigeorgiou, Raffi Kevoorkian, Amit Khanna, Glen Lin, Chris Margin, Ben McDonald, David McNaught, John Moi, Chi Wai Ng, Nadiah Rengganis, Vinod Sharma, Ronald Szeto, Willie Tang, Glen Throves, Melissa Huan and staff Ian Watkins and Martha Floratas.

**VISITORS TO  
TRL**

## IN CONFIDENCE

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.



**IN CONFIDENCE**

- Are you receiving TRL's RESEARCH QUARTERLY (RQ)? If NO, please tick the "Addition" box and fill out the address form below.
- If you do receive RQ and your present address etc is incorrect, please tick the "Correction" box and fill in your correct address.
- If you wish to nominate others who would benefit by receiving RQ please tick the "Addition" box and fill out the address.
- If you receive RQ now and would like to discontinue receiving it please tick the "Deletion" box and fill out the address form and return it to us.

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Thank you for your co-operation.

Addition

Correction

Deletion

Name (in Capitals) _____
Position _____
Department _____
Address _____ _____
Reference No. on Address Label _____

Please return to:

The Information Officer  
Promotion and Communication Section  
Telstra Research Laboratories (TRL)  
P.O. Box 249  
Rosebank MDC  
Clayton Victoria 3168

Telephone (03) 9253 6700  
Facsimile (03) 9253 6321

