1989 REVIEW OF ACTIVITIES

TELECOM RESEARCH LABORATORIES

Telecom Australia

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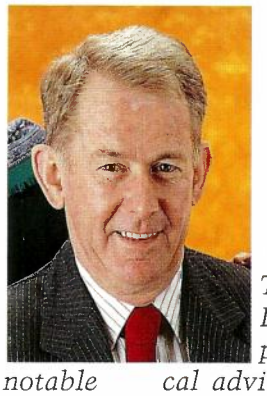
FOREWORD



The introduction of the primary rate Integrated Services Digital Network (ISDN) by Telecom Australia this year was a notable milestone in the history of Australian telecommunications. This initial ISDN will enable Telecom to provide its business customers with enhanced services, whilst containing their costs and harnessing telecommunications to improve business efficiency. However, this marks only the first step along the path to significant technological change in the network infrastructure, which will continue into the next century.

In the next few years, ISDN services will be gradually extended to smaller business and residential customers, as Telecom intro duces the basic rate ISDN. In the longer term, as optical fibre replaces copper cables to provide higher transmission capacity between the customer terminal and the network and as faster packet switching systems allow the integration of services in a common digital network, a broadband ISDN will evolve. This will provide a vehicle for the introduction of a wide range of new services.

Over the last decade, the Telecom Research Laboratories have provided valuable technical advice to Telecom's services and network planners to assist the recent introduction of the ISDN. They have also provided significant contributions to the develop ment of international technical standards, which are essential for the worldwide evolution of compatible ISDN services.

This work is ongoing. This Review of the activities of the Laboratories describes a variety of projects related to new customer services and systems, switching and signalling tech niques, transmission systems and key enabling technologies under lying such systems. Many of the projects are in support of Telecom Australia's ongoing development of the Australian ISDN infrastructure and customer services.

This Review therefore illustrates how Telecom's R&D is directed towards the evolution of a world class broadband ISDN for the provision of new and better telecommunications services for the people of Australia into the next century. It gives me pleasure to commend it to your perusal.

R. K. McKinnon

(R.K. McKinnon)
Chief General Manager

CONTENTS

Telecom Research Laboratories

RESEARCH EXCELLENCE FOR TELECOM'S SUCCESS

MISSION STATEMENT

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

THE TELECOM RESEARCH LABORATORIES

THE LABORATORIES' MISSION

The mission of the Laboratories is to provide Telecom Australia 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 major thrusts:

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

A SHARED RESOURCE UNIT OF TELECOM AUSTRALIA

The Telecom Research Laboratories are a Shared Resource Unit within the Telecom Australia organisation, responsible for performing Telecom Australia's research needs. The Laboratories conduct a Research Programme derived from a corporately endorsed and approved Business Plan. The services of the Laboratories are available to other organisational units of Telecom Australia.

The processes leading to the annual formulation of the Business Plan consider corporate priorities and needs for the performance of R&D projects and related activities - 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 Telecom Australia 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), and
- the management of and participation in Corporate External R&D Programmes on behalf of Telecom Australia.

ROLE OF THE LABORATORIES

The Research Programme

Through the performance of research, development and related activities, the Laboratories provide a strategic resource which is the key to Telecom Australia's technological leadership. The Laboratories:

- provide technological advice regarding the application of new and existing technologies to ensure that Telecom Australia has technological leadership, the most value-effective services and a highly reliable network,
- collaborate with industry to ensure systems and equipment are cost-effective and highly reliable,
- collaborate with universities to ensure that future graduates will have appropriate skills,
- participate in the development of technical standards to ensure that they suit Telecom Australia's requirements to greatest advantage, and
- operate, at a level of excellence, corporate facilities.

In providing technological advice regarding the application of new or existing technologies, the Laboratories strive to:

- provide strategic advice concerning opportunities for exploiting potential new technologies and new generic services,
- transfer technology to other parts of Telecom Australia, industry and academia,
- support existing network technologies to enhance reliability, reduce operational costs and improve performance, and
- increase ownership in Telecom Australia's products, both at system concept levels and through specialised device design.

Participation in the development of national and international standards relating to telecommunications is considered a key element of the role of the Laboratories. In this role, the Laboratories provide delegates to represent Telecom Australia's and Australian interests in national and international fora, able to debate technical issues from a position of in-depth expertise and to influence the development of standards which are in harmony with Australia's telecommunications needs. These fora are also a source of strategic information regarding future trends in service provision and system development. Thus, the Laboratories are able to advise Telecom Australia on the current status of technical standards and the probable directions of evolving standards, assisting Telecom Australia to apply standards in a timely manner and with assurance as regards their credibility and viability. This work often leads the Laboratories to develop tools to optimise the application of new standards by Telecom Australia.

Corporate Facilities

As an adjunct to the performance of the Research Programme, the Laboratories manage and provide several specialised Corporate Facilities for the whole of Telecom Australia. They are:

- the National Information Resource Centre, which provides up-to-date library and information services covering a wide range of topics relevant to Telecom's operations,
- Telecom Australia's Technical Reference Standards for Time Interval and Frequency, with accuracy traceable to national and international standards, and
- Intellectual Property Consultancy, including the management of Telecom Australia's intellectual property portfolio.

Corporate External R&D Programmes

The Laboratories are also responsible for the management and conduct of Corporate External R&D Programmes on behalf of Telecom Australia. These include:

- the management of a portfolio of industry and university research contracts. This programme, presently budgeted at about $2.7 million, complements the intramural Research Programme and seeks to encourage appropriate research in industry and universities. It is currently being expanded in scope to include development of Centres of Expertise in higher education bodies.
- participation in the activities of ATERB, the Australian Telecommunications and Electronics

Research Board, including representation on the ATERB Board. ATERB is a cooperative institution funded by Telecom, OTC, CSIRO and the Department of Defence, making grants to academia to foster research in the telecommunications and electronic sciences.

- representation of Telecom in various scientific and academic bodies.

LABORATORIES MANAGEMENT

The Business Plan is the corner stone of the management of the Research Laboratories. It provides the vehicle for determining which projects will be included in the annual Research Programme and what resources will be allocated for their performance. It also provides a basis for the individual Branches of the Laboratories to derive more detailed Work Programmes and to monitor project progress and associated resource expenditures.

The Business Plan is reviewed and re-formulated annually. Specific research projects must be endorsed and notionally funded either by specific "clients" among the Business Divisions and other Shared Resource Units of Telecom Australia or by the Corporate Centre.

The formal annual consultation processes leading to the endorsement and approval of the Business Plan ensure that:

- the Research Programme derived from the Business Plan is cost-effectively related to corporate needs for research outputs,
- a balance is struck between shorter term projects relating to client needs and longer term projects necessary to maintain the ongoing viability and skill base of the Laboratories,
- accountability for technology and information transfer is a clear responsibility of the Laboratories,
- the Laboratories maintain an up-to-date technical skill base which can be rapidly re-deployed to meet sudden emergent and strategic needs.

FOCUS PROJECTS

The Business Plan and the derived Research Programme are formulated internally in terms of Focus Projects encompassing:

- about 30 major R&D projects, each comprising a number of separately identifiable smaller projects generally grouped in terms of their applicability to Telecom Australia's business and operational activities,
- the Corporate Facilities provided by the Laboratories for Telecom Australia, and
- the Corporate External R&D Programmes managed by the Research Laboratories on behalf of Telecom Australia.

The Programme also encompasses internal and external overhead activities, necessary to the performance of the Focus Projects.

TIERS OF ACTIVITY

Although the Research Programme is determined and listed on a project basis, each project may cover a span of activities. These activities can be considered in four major tiers, each depending on the support of the tiers below it.

The highest tier is concerned with "networks and services" and is most closely related to the essence of Telecom Australia's business and revenue earning capabilities. It encompasses activities such as service delivery, network structures, network management and network serviceability. These activities support Telecom's business-related activities and are directed mainly towards corporate strategic and forward planning operations.

The second tier is concerned with the "system-level elements" from which networks and services are derived, such as transmission, switching, signalling and control systems, and including service definition and reliability at the system level. These activities support the planning, building and operation of Telecom's networks.

The next tier supports those above by activities at the "component and technology" level. In some cases, where the results apply to only one particular system, they may be grouped with and carried out in conjunction with system-level activities. These activities support Telecom's field operations and the industry which supplies equipment to Telecom. There is heavy emphasis on activities such as component reliability, advanced components, energy technology, signal processing and human factors at this level.

The lowest tier is that closest to fundamental R&D, comprising "strategic studies" of new materials, communications needs, traffic theory, etc. These studies constitute the scientific base of other Laboratories' activities and establish Telecom's scientific and intellectual credibility and authority with industry, academia and government. There is considerable interaction with academia at this level, with support given to and received from related activities in other institutions.

RESOURCES

During 1988/89, the Laboratories employed approximately 510 staff. Of the total staff, approximately 230 have professional qualifications in engineering or the applied sciences and 20 in the social and information sciences. A further 190 technical staff supported the professional staff, with administration performed by remaining staff.

The annual operating costs of the Laboratories total approximately $50 million. Of this total, about half is expended on salaries and salary-related costs. Capital expenditures, primarily on laboratory test equipment and facilities, amount to about 13%, and the remaining 37% covers operating expenditures on consumable materials, incidental items (including R&D contracts), and buildings and building services. Laboratory test equipment items number about 15 000, with a depreciated value of approximately $20 million.

FOCUS PROJECTS

Customer-related Projects

- Electronic Data Interchange and Message Handling
- Electronic Directory Systems
- Video and Data Services Delivery
- Geo-Informational Research
- Secure Communications
- Voice Interactive Access and Control of VAS
- Artificial Intelligence

Network-related Projects

- Broadband ISDN
- Data Network Evolution
- ISDN and Common Channel Signalling
- Network Management
- Teletraffic Engineering
- Network Architectures & Planning
- Intelligent Network Services & Systems
- Protocol Engineering
- Inter-exchange Network Evolution
- Mobile Communications Systems
- Optical Customer Access Network
- Mobile Satellite Networks
- Wireless Access Systems
- Metropolitan Area Networks and Customer Access Management
- Caldermeade Antenna Range

Reliability-related Projects

- Electromagnetic Compatibility of Information Technology Equipment
- Bioelectromagnetic Hazards
- Component & Equipment Reliability
- New Cable Technolgy
- ScientificConsultancy
-

Components/Materials-related Projects

- Mid-infrared Optoelectronics
- Energy Conversion and Storage Systems
- Broadband Optoelectronics
- New Communications Fibres
- Mechanical Engineering Consultancy

Physical Standards

- Standards of Electrical and Optical Quantities
- Standards of Time and Frequency

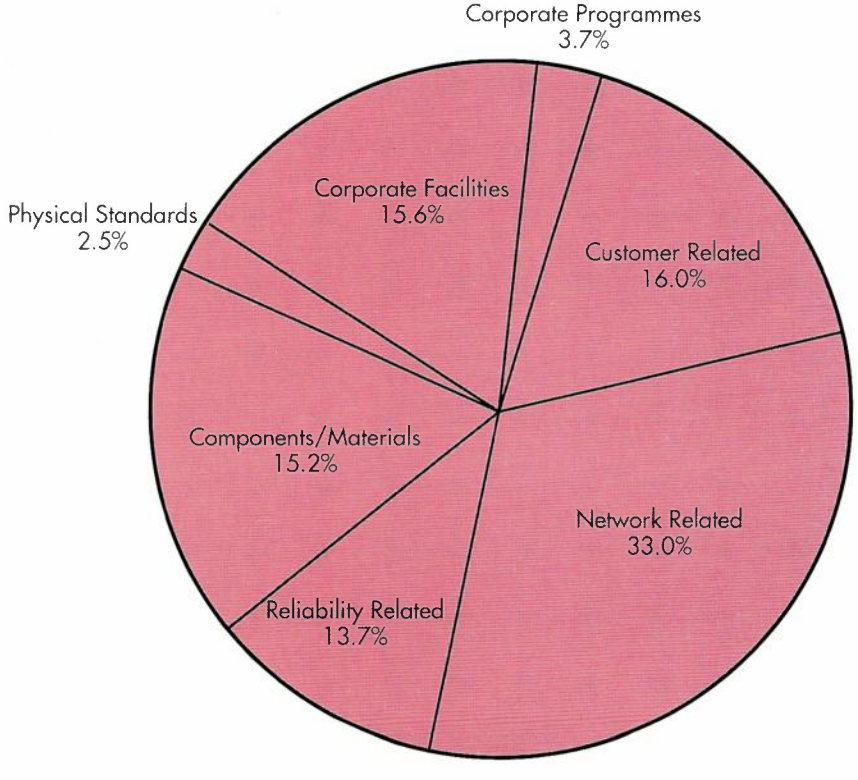
Corporate Facilities

- National Information Resource Centre
- Intellectual Property Consultancy

Corporate Programmes

- ATERB
- Industry & University Contracts
- Sundry Contributions to Outside Organisations
- Centres of Expertise

Table of Focus Projects comprising the Research Programme



Disposition of Laboratories' resources (in total $ terms) against Focus Projects

An aerial view of the Laboratories' campus in Blackburn Road, Clayton

ITEMS OF SPECIAL INTEREST

SEMINAR - "TELECOM'S SERVICES FOR THE 1990s"

In a future of increasing competition in the provision of telecommunications services, Telecom Australia's competitive edge will depend on its ability to understand and apply new technologies in a smarter way than its competitors. This makes it essential for Telecom's senior staff to be adequately briefed on technological futures - on what technologies are about to mature and on what opportunities they offer.

To assist this process, the Laboratories presented a 2-day seminar for management and senior staff in Melbourne during September 1988. The theme of the seminar was "Telecom's Services for the 1990s". Some 200 staff from throughout the Telecom Australia organisation attended.

The seminar was opened by Telecom's Managing Director, Mr. Mel Ward, who outlined the changes occurring in the Australian telecommunications environment, their potential impacts on Telecom Australia and the resultant challenges facing Telecom as it approaches the 1990s.

Dr. Terry Cutler, Director, Corporate Strategy, of Telecom's Corporate Centre further set the scene, as the key-note speaker opening the first day's proceedings. His paper addressed the "Policy and Regulatory Environment" in which Telecom would be operating in the 1990s. The subsequent papers presented by Laboratories' staff covered a range of topics, examining:

- information flows in present and future business communications and their implications for future services needs,
- the application of computer-based geographic information systems in the planning of future services and networks,
- emerging technical standards for new telecommunications services,
- electronic messaging and document interchange services,
- future roles for personal computers in terminal equipment and the realisation of new services,
- the evolution of electronic directory services, and
- communications security for future services and networks.

On the second day, Mr. John Harrison, National General Manager, Business Communication Services, of Telecom's Metropolitan Division opened proceedings with a key-note address on the topic, "The Commercial Environment for The New Telecom". In subsequent papers, Laboratories' staff outlined possible future applications and implications of:

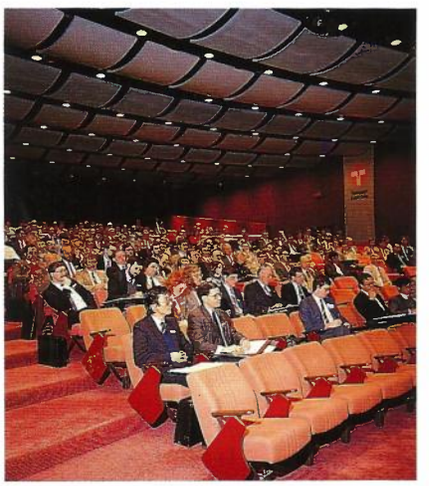
- voice-interactive value-added services,
- video services,
- intelligent networks and derived services,
- human factors aspects of man-machine interfaces and their influence on the success of new services, and
- potential applications of artificial intelligence techniques to improve the customer-service interface and automated network management systems.

The seminar was rounded off by Dr. Fred Symons, whose thought-provoking paper described some of the paradoxes looming in the development and application of new telecommunications services and drew some novel conclusions about the new skills which will be required to ensure the future prosperity of Telecom in the next decade.

The seminar dinner, held at the conclusion of the first day's proceedings, provided an opportunity for the delegates and Laboratories' staff to engage in social discourse and to make or renew acquaintances. The guest speaker at the dinner was Mr. Bob McKinnon, Telecom's Chief General Manager, who elaborated on key strategic issues and directions for Telecom as it faces the 1990s.

The success of the seminar was such that it was repeated in abbreviated form, on request, to another Telecom audience in Sydney a few weeks later. It was also presented to representatives of the Australian telecomunications industry and of Telecom's major business customers in both Melbourne and Sydney.

The favourable reception of this 1988 series of seminars reinforced the conclusion drawn from the 1987 seminar on "Future Networks" that the Laboratories should arrange similar seminars each year. A seminar is now being planned for October 1989. It will cover R&D topics relating to the materials, components and technologies which will be applied in future systems and networks, with particular regard to their implications for improved performance and reliability and/or reduced costs.



Above
An interested Telecom Audience listens to a TRL speaker at the Seminar - "Telecom's Services for the 1990s"

CCITT PLENARY ASSEMBLY MEETING - MELBOURNE, 1988

The International Consultative Committee on Telegraphy and Telephony (CCITT) held its IXth Plenary Assembly in Melbourne from 14 to 25 November, 1988. The Plenary Assembly is held every fourth year, its tasks being to receive reports on the activities of various Study Groups and Committees over the previous four years, approve new and modified recommendations, and approve the study programme for the next study period. In addition, it appoints office-holders and adopts a variety of resolutions relating to the CCITT's mode of operation for the next four-year study period.

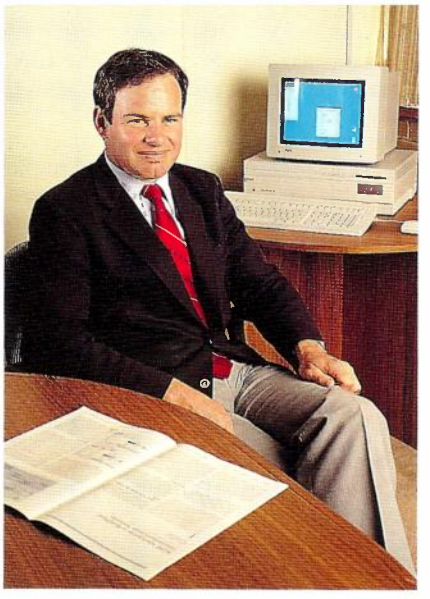
CCITT recommendations are of fundamental importance to telecommunications network operators and service providers, as well as to users and equipment manufacturers. They are the basis of international technical standards which ensure worldwide interconnectivity of networks and interworking of telecommunications services. Among other matters, they cover system and network interface specifications, performance objectives, interworking arrangements and service specifications. Hence, the activities and outcomes of a Plenary Assembly are viewed with world interest and are very relevant to the future development of Australia's public networks and customer services.

The IXth Plenary Assembly approved almost 700 new and amended recommendations, covering all aspects of telephony, ISDN, text and data communications. These will be published in the CCITT "Blue Book".

A major task of the meeting was to explore and develop ways in which the CCITT can respond more readily to the quickening pace of technological development in telecommunications. To this end, several important resolutions covering the mode of operation and accelerated approval of recommendations were the subject of substantial discussion and modification.

The Australian delegation to the Plenary Assembly was led by Telecom's Managing Director, Mr Mel Ward, who subsequently served as its Chairman. The Telecom Research Laboratories contributed to the preparation of the Australian Brief, which was co-ordinated by the Forward Network Planning Unit of Telecom's Corporate Customer Division. The Laboratories' contributions arose from active participation in the work of several of the major Study Groups. Mr. Jim Park, General Manager, Switched Networks Research, of the Laboratories was a member of the Australian delegation.

Three Australians were elected to positions of Study Group Vice-Chairmen by the Plenary Assembly. Alan Cabrera of the Overseas Telecommunications Commission (Australia) was re-elected a Vice-Chairman of CCITT Study Group I - "Definition, Operation and Quality of Service Aspects of Telegraph, Data Transmission and Telematic Services". Andrew Day, of Telecom's Forward Network Planning Unit, was elected a Vice-Chairman of CCITT Study Group XVIII - "Digital Networks, including ISDN". Jim Park was elected a Vice-Chairman of CCITT Study Group VII - "Data Communications Networks". During the previous 4-year study period, Jim had held the position of Special Rapporteur for this Study Group, responsible for the study of the application of formal description techniques to data communications protocols.



Jim Park, Vice-Chairman, CCITT Study Group VII

RESEARCH DIRECTORS MEET AT TRL - NOVEMBER 1988

As the 1988 Plenary meeting of the CCITT (the International Consultative Committee on Telephony and Telegraphy of the International Telecommunication Union) was to be held in Melbourne during November 1988, an invitation was extended by the management of the Laboratories to the Directors of the Research Establishments of the member administrations to meet at TRL to discuss a number of topics of interest to research managers. These included discussion of the ambiguous role of a PTT's research establishment as a unit of the PTT on one hand and as an engine of the national economy on the other. Other topics were the ways by which a research oganisation establishes its value to the parent organisation and what will be the important research topics in five to ten years time.

Participants in the discussions included:

- Mr. D. Merlo, Head of the British Telecom Research Laboratories,
- Dr. Nic Knudtzon, Head of the Norwegian Telecommunications Authority Research Laboratories,
- Dr. Laurie Halme, General Manager, Telecommunications Laboratories of the PTT of Finland, and Mr. J. Jokinen, Managing Director, Telecon (Telecommunication Consulting Services), Finland,
- Dr. S. Tomita, Executive Manager, Switching Technology Laboratory, NTT Communication Switching Laboratories, Japan,
- Dr. Phil Richards from Bell Northern Research, and
- Dr. V. Ramaswami from Bellcore.

In addition to the previously mentioned topics, the participants exchanged information about their respective establishments, their strategies and their work programmes.

The discussions revealed a wide variety of approaches to strategy and role, depending largely on the stage of deregulation or otherwise in the nation concerned. One point of complete unanimity was the value to the parent of being able to control the software of network systems.

The interchange of ideas on directions of future research were useful, with a general consensus about major topics, even though the details are necessarily vague at present. From TRL's viewpoint, the opportunity to meet with senior research managers from other establishments was particularly valuable, and especially so in an environment in which ideas could be discussed on a group basis.

The management of the Telecom Research Laboratories expresses its appeciation to those who participated and hopes that the benefits that they obtained also far outweighed the additional outlays of time, effort and cost.

Right
TRL scientist, Peter Kemeny (left), outlines work on GaAs devices to (l to r) Nic Knudtzon (Norwegian Telecom), Harry Wragge (TRL) and David Merlo (British Telecom)

TRL RESEARCHER, DOUG KUHN, UNDERTAKES UNESCAP ASSIGNMENT

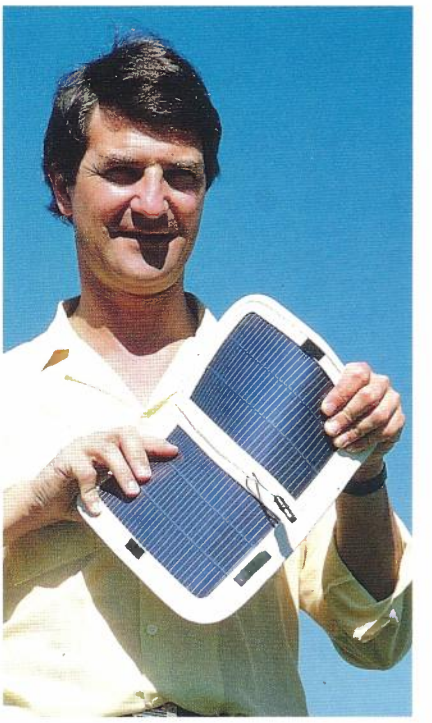
In late 1987, two Telecom representatives joined three other technical experts in the solar energy field in a United Nations sponsored visit to China, Vietnam and Laos. The Telecom representatives were Doug Kuhn of the Energy Technology Section of the Research Laboratories and Michael Mack of the Telepower Section of Telecom's Network Engineering SRU. The other experts in the visiting party were from Japan and Thailand.

The objective of the three week excursion was to conduct training courses under the auspices of the United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP). The courses aimed to assist the countries visited to investigate, develop and harness solar energy resources, particularly for telecommunications applications. The courses covered solar photo-voltaic technologies and systems and their use in telecommunications, particularly in remote areas. The expertise and engineering experience of both Doug Kuhn and Michael Mack, gained from their investigation and application of photo-voltaic technology in Telecom Australia's outback networks, was very relevant to the needs of the countries visited, and especially to their developing communications networks.

The visitors presented a six-day course in Hangzhou (near Shanghai) in China to 25 participants drawn from all areas of the country. A four-day course was presented in Hanoi, Vietnam, for 48 participants, and a five-day course was also presented to a similar number of participants in Vientianne, Laos. All courses provided for friendly two-way exchanges of technical information and experiences in the use of solar power for telecommunications purposes.

Upon his return, Doug Kuhn reported that "At all times we tried to adapt the presentations to suit the host country. Similarities between problems facing Australia and the the host country were highlighted, such as the large distances and diverse climates in China and the tropical conditions in Laos."

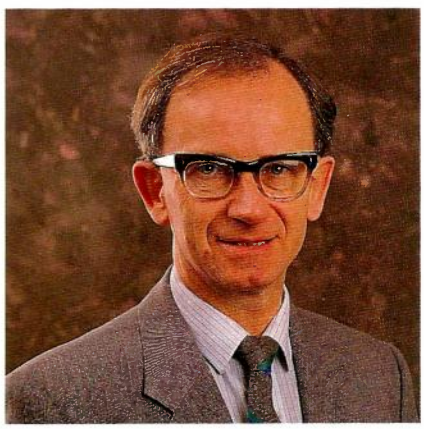
Doug was very impressed by the expertise of his fellow visitors and by the response of the training course attendees. "It was a challenging, demanding and yet enjoyable three weeks," he said. "The personal rewards were endless - often as direct expressions of appreciation, but at other times just a smile that showed understanding. It was a priviledge to have been a part of the UNESCAP team and the co-operation and support of my Telecom colleague, Michael Mack, was much appreciated."



Above
Doug Kuhn solar energy researcher

TELECOM CHAIR AT MONASH UNIVERSITY

In the latter months of 1988, a new Chair of Telecommunications and Information Engineering was established at Monash University. The Chair was endowed by Telecom Australia, with annual funding of $100 000 (indexed annually) provided by Telecom for an initial period of five years. The establishment of the Chair was the successful outcome of discussions with the University during 1988, and it is the first to be endowed by Telecom Australia.



Professor Fred Symons, BE(Hons), PhD, DIC, MIEAust, AIEE, MACS

The Laboratories' management and staff were pleased to learn of the subsequent appointment of one of their colleagues, Dr. Fred Symons, to the Chair in October 1988. Fred had had a distinguished career in the Laboratories in the field of switching and signalling systems, and was Assistant Director, Strategy Development, in the Laboratories at the time of his appointment to his new professorial position. Fred's appointment was also welcomed by Professor Peter Darvall, Dean of Engineering, when the appointment was announced. He said that the University was pleased to have Telecom's assistance in developing a centre of learning with an orientation towards telecommunications and information technologies, which were viewed as important and growing specialties among the fields of engineering.

The new Chair was created in response to the rapid developments taking place in telecommunications and computer science fields. It will provide Telecom and the Australian telecommunications industry with access to a source of competent and telecommunications-oriented graduates and research capability.

Professor Symons is well equipped to head this new initiative by the University and Telecom. Born in Adelaide and a graduate of Adelaide University, Fred subsequently undertook postgraduate studies in communications and electronics at the Imperial College of Science and Technology in England. He later gained his PhD at the University of Essex. His research in protocol engineering established a practical methodology for the graphical modelling and performance analysis of communications systems. This research later found application in Fred's work in the Laboratories and acclaim in international standards forums, when it became the basis of a number of Telecom contributions to the development of technical standards for switching and signalling systems.

While at the Laboratories, Fred initiated, guided and fostered research into common channel signalling, packet switching data networks, formal specification and description techniques for communications systems, Open Systems Interconnection and the Integrated Services Digital Network.

The management and staff of the Laboratories wish Fred well in his new position and look forward to continuing interactions with him in research activities. They are sure that Fred will be able to create opportunities to promote fruitful cooperation between the University, Australian telecommunications authorities and industry, and that he will also play a key role in ensuring a steady flow of competent graduates to advance Australian telecommunications into the Information Age.

NEW CENTRES OF EXPERTISE

The Telecom Research Laboratories have sponsored the establishment of two new Centres of Expertise in Australian universities during 1988/89 through the medium of two substantial R&D contracts. The new Centres will focus on research work in the fields of distributed information systems and communications security respectively.

The Telecom-funded "Centre of Expertise in Distributed Information Systems" is part of the University of Queensland's Centre for Information Technology Research, which has strong links with the University's Computer Science Department. Guided by the Research Laboratories on key areas of R&D interest, the Centre will undertake fundamental research into the software technology of databases and distributed database systems for those applications where computers in different locations must effectively divide their computing workload and share data. For example, the Centre will study software technologies which will allow new public information services based upon textual, image and graphical databases to be presented to the user as a single, integrated package. The user will not need to be aware that the information has been derived from several separate and remote databases. This software technology will also be applicable to the integration of the many databases which are required to control and monitor the telecommunications network.

The "Centre of Communications Security Research" has been established at the Australian Defence Force Academy in Canberra. The Academy is part of the University of New South Wales. This Centre will augment the Telecom Research Laboratories' investigations of methods for providing secure communications services to protect sensitive commercial or personal information and for securing the telecommunications infrastructure which supports such services. The work will include the application of cryptographic and computer security techniques to both new and existing telecommunications services and network management systems. The major initial applications of the work to be performed by the Centre will be directed at Telecom's data and information services and mobile telephone systems. The research studies will provide techniques and systems which will ensure that Telecom can provide the highest levels of com-

munication integrity for its government, business and private customers.

These two new Centres have joined the existing Teletraffic Research Centre at the University of Adelaide and the Telecom Research Laboratories in a co-operative network which seeks to match Telecom's needs for research on important telecommunications topics with academic skills in the tertiary education sector. The three Centres sponsored to date by the Laboratories have demonstrated a recognised research eminence in their particular topic areas, together with a commitment and capability to perform world class research, apply the skills and knowledge generated to telecommunications projects, and to transfer these skills to undergraduate and postgraduate students seeking careers in Australian telecommunications. The Laboratories plan to fund further Centres of Expertise in other tertiary institutions in future years.

Above
At the formal signing of the contract for the establishment of the Centre for Communications Security Research were (from left) Mr. B. Rosenberg, General Manager of Unisearch Limited, Prof. G. Wilson, Rector of University College, ADFA, Mr. H.S. Wragge, EGM of Telecom Research Laboratories, Prof. J. Ronayne, Vice-Chancellor of the University of NSW, Mr. J.L. Snare, Telecom Technical Liaison Officer, and Mr. A. Quaine, Acting Head of the Department of Computer Science, University College

Below
Prof. Brian Wilson, Vice-Chancellor of the University of Queensland, pictured with Mr. Harry Wragge (at left) at the ceremony marking the establishment of the Centre of Expertise in Distributed Information Systems at the University

HONOURS FOR LABORATORIES' STAFF

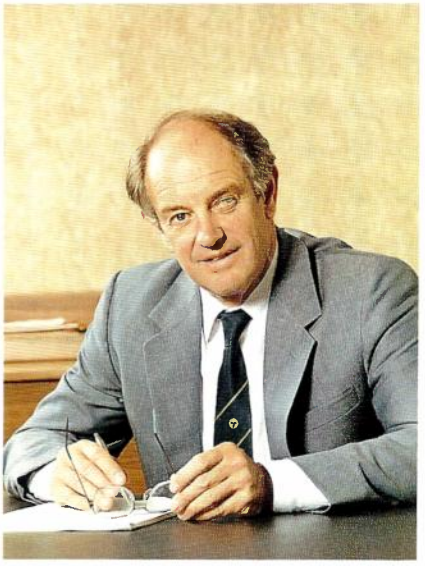
During the past year, several members of the staff of the Laboratories received honours in recognition of their professional contributions and dedication to Australian telecommunications, sustained over many years in their employment with Telecom Australia.

Mr. Harry S. Wragge

Harry Wragge, Executive General Manager of the Laboratories, received two honours.

In October 1988, the Institution of Radio and Electronics Engineers (Australia) honoured Harry by admitting him to corporate membership in the Institution in the grade of "Fellow".

Several months later, in the annual award of honours on Australia Day to Australian citizens who have personally distinguished themselves in a particular field of activity of importance to the Australian community, Harry was admitted to Membership of the Order of Australia on the recommendation of the Governor-General of Australia to Her Majesty, Queen Elizabeth. In the citation accompanying the award of this honour, reference was made to Harry's eminent contributions to the service of telecommunications technology during a career spanning four decades, mostly in the Telecom Research Laboratories.



Harry S. Wragge, AM, BEE(Hons), MEngSc(Hons), FTS, FIEAust, FIREE

Dr. Hec J. Ruddell

Hec Ruddell, who retired from the position of Head of the Polymer Section of the Laboratories during 1988, received the first ever Telecom Award for Outstanding Achievement at a function held in his honour at the Laboratories on 22 July 1988.

The award was presented to Hec by the Honorable Senator Gareth Evans, then Minister for Transport and Communications. In the speeches leading up to the presentation, Mr. Bob McKinnon, Chief General Manager, Mr. Mel Ward, Managing Director, and Senator Evans referred to Hec's distinguished career over 32 years in the Laboratories, during which he had attained international recognition as a polymer scientist and had applied his expertise to lead the introduction of plastics materials in Australian telecommunications equipment and line plant.

They applauded Hec as an excellent first recipient of the award, which had been created to acknowledge outstanding achievement by Telecom staff who had contributed in a significant way to Telecom's vision and values, innovating and surmounting barriers in achieving work goals, and who had demonstrated a high level of personal commitment in their field of work.

Two hundred guests, representing industry, academia and Telecom Australia, attended the presentation function, giving tangible expression of the high regard in which Hec is held by the many people with whom he had made professional contact during his distinguished career as Telecom's foremost expert in polymer science.

Above
Retired Laboratories' polymer scientist, Hec Ruddell (at right), receives Telecom's first ever Award for Outstanding Achievement from Senator Gareth Evans, then Minister for Transport and Communications, whilst Hec's wife, Maida, looks on

EDUCATIONAL FELLOWSHIP WINNERS, 1988

Each year, Telecom Australia, through the Research Laboratories, assists a select number of outstanding undergraduate students to complete the final year of a course of tertiary study leading to a Bachelor Degree in a telecommunications-oriented field of engineering or science at an Australian University or Institute of Technology. The scheme is called the Telecom Australia Educational Fellowship Scheme and it is intended to encourage promising undergraduates to consider a career in telecommunications, whilst lending them positive financial assistance to complete their studies. The scheme is a practical demonstration of Telecom's desire to inject an awareness of telecommunications topics into the processes of tertiary course development, so that Australian centres of higher education will continue to develop capable telecommunications engineers and scientists in the future.

The Educational Fellowship Scheme supplements Telecom's support of postgraduate research on telecommunications topics in Australian centres of higher education through its R&D contract programme and its active support of the R&D grants scheme operated by the Australian Telecommunications and Electronics Research Board.

Nine Fellowships were awarded by Telecom in December 1988 to four Victorians, one Queenslander, one Tasmanian, one Western Australian and two South Australians, all of whom will complete their Bachelor degree studies in 1989. The recipients were:

- Adam Dickson, completing his science/engineering degree at Monash University,
- Rohan Baxter, completing his science degree at Monash University,
- Andrew Herbert, completing his science degree at Monash University,
- Mark Summerfield, completing his engineering degree at the University of Melbourne,
- Homer Wong, completing his engineering/computer science degree at the University of Queensland,
- Peter Campbell, completing his science degree at the University of Tasmania,
- Timothy Boykett, completing his science degree at the University of Western Australia,
- Jonathan Baxter, completing his science degree at Adelaide University, and
- Matthew Leditschke, also completing his science degree at Adelaide University.

The Fellowship Awards were presented by Bob McKinnon, acting Managing Director, at a ceremony held at the Laboratories on 19 December 1988. Deans and professorial representatives from both Melbourne and Monash Universities attended the ceremony, as did the parents of the award winners and management and staff of the Laboratories. In bestowing the awards, Mr. McKinnon spoke of his hopes that the recipients would obtain their degrees with distinction and choose to follow rewarding and challenging careers in Australian telecommunications, since this was the force motivating Telecom to award the Fellowships to young students who had already demonstrated a capacity to succeed.

The Fellows subsequently joined the staff of the Laboratories from December 1988 to February 1989, where they undertook a variety of R&D projects. At the conclusion of this period of employment in the university vacation, it seemed that they had found the experience both interesting and rewarding. For its part, Telecom wishes the Fellows success in their studies and hopes that they are stimulated to seek careers in Australian telecommunications.

Below
Telecom Fellowship winners for 1988

Back (from left): Peter Campbell, Mark Summerfield, Timothy Boykett, Jonathan Baxter, Matthew Leditschke

Front: Adam Dickson, Andrew Herbert, Rohan Baxter, Homer Wong, Harry Wragge (EGM, Research), Bob McKinnon (acting MD, Telecom) and Roger Smith (DEGM, Research)

NATIONAL INFORMATION RESOURCE CENTRE

Strategic information is a vital element in the commercial success of any large scale business enterprise. Information needs to be available in the right place, in the appropriate format, at the right time. Information can be a vital strategic resource, but to be truly useful, it must be effectively collected, managed, analysed, packaged and delivered.

Recently, there have been far-reaching changes in the management of information resources, both published and unpublished, within Telecom Australia. These changes have been made in response to Telecom's evolving role as a competitive commercial enterprise.

The National Information Resource Centre, which is the focus for the provision of information services within Telecom Australia, is attached to the Research Laboratories. Subsidiary Information Resource Centres are located in major metropolitan areas throughout Australia, to assist Telecom personnel with their information requirements.

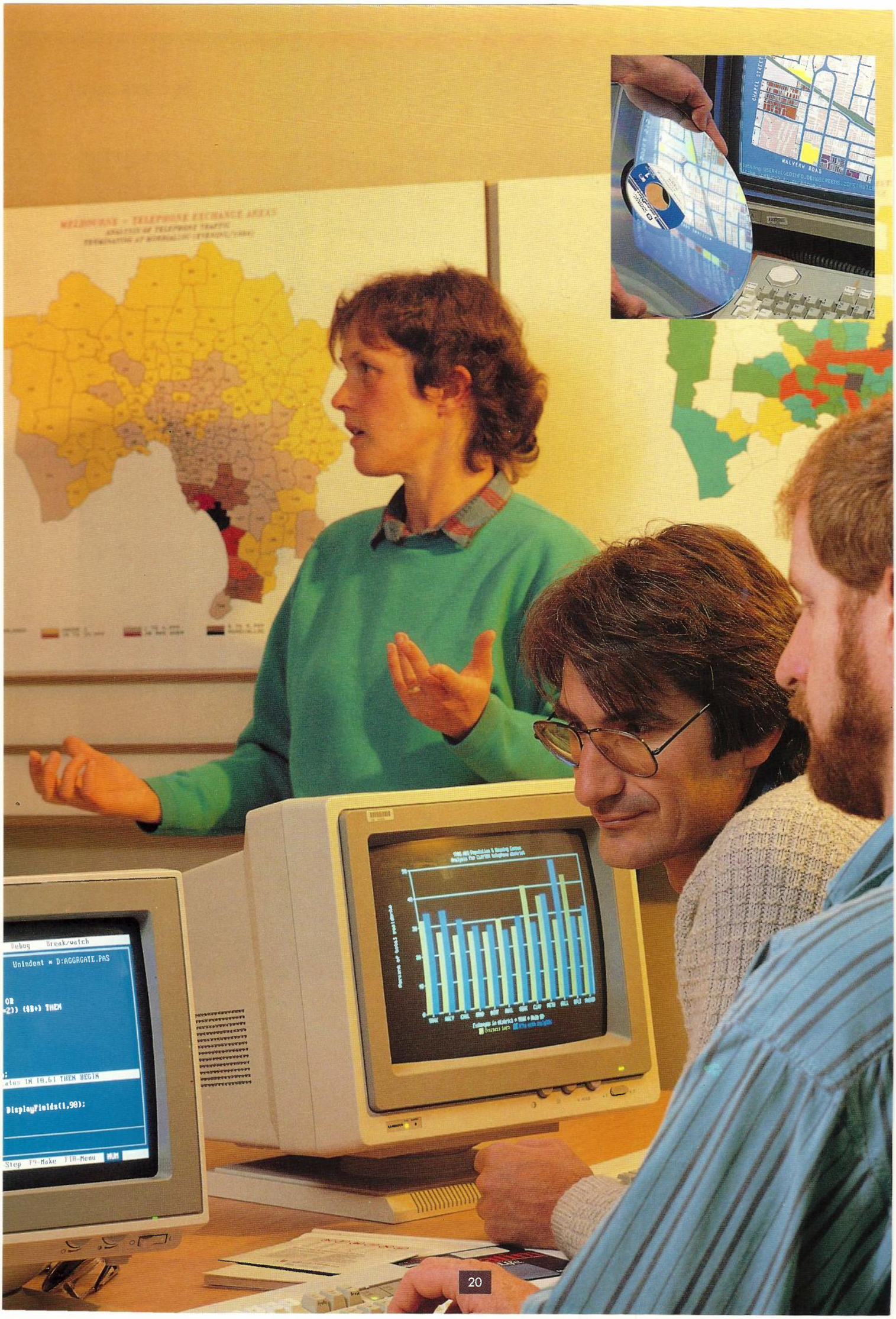
The National Information Resource Centre aims to provide an information service of a very high quality, which is tailored to the specific needs of particular client groups within Telecom Australia. Features of this service include:

- an exceptionally wide access to on-line information sources, including bibliographic and statistical records, and many full text services,
- access to business information through contractural arrangements with organisations such as Arthur D. Little, the Yankee Group, and S.R.I. International,
- access to technological information and research services through membership of organisations such as ERA Technology,
- an extensive resource of printed materials of specific relevance to the diverse technological, scientific, business and personnel management, and commercial activities of Telecom Australia, the collection of which has been developed over many years and reflects both the traditional and new interests of Telecom Australia,
- strong reference collections, comprehensive displays of current journals, audio/video preview facilities and microform viewing equipment - facilities which are available at all Information Resource Centres,
- in-house databases providing access to a wide range of information held by Telecom, for example:
  - Telecom Australia publications,
  - annual reports from an extensive range of organisations, both Australian and overseas,
  - market research reports commissioned by Telecom,
  - items of interest to Telecom from the daily press,
  - details of forthcoming conferences, both Australian and international, in the fields of science, technology, management and marketing,
  - current journal articles,
- a staff of information professionals who are skilled at searching and delivering information, and who have an understanding of Telecom as an organisation.

The National Information Resource Centre is being developed to meet Telecom Australia's needs for published information now and through the 1990s. It is developing as a streamlined high-tech unit, relying heavily on computer-based facilities to support its services and modern telecommunications facilities to deliver its products speedily to its clients throughout Telecom Australia. It aims to provide enhanced and value-added information services to assist Telecom to compete more effectively in the market place.

Left
Librarians draw upon a wide range of technical and scientific journals to provide comprehensive information services to Telecom staff

Staff using the facilities of the National Information Resource Centre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MALVERN ROAD

CUSTOMER SERVICES AND SYSTEMS

Telecommunications users of the future will be confronted by an increasing range of service options. The more sophisticated the services become, the more difficult it will be, for even the discerning user, to utilise them effectively. The successful penetration of many new services will depend not only on the functional needs which they satisfy but also on of effective user interfaces.

Recognising this need, the Laboratories have increased research and development activity in the field of customer services and systems over recent years. Current work focusses on service delivery from the customer's perspective, that is, looking from the customer terminal into the network interface. A broad range of software development projects aim at creating new or improved services. Much of the work is directed towards the non-reserved services market and is essentially market driven. Some 90% of the work is directed at the needs of Telecom Business Divisions.

The R&D programme in the customer services and systems field includes studies of the fundamental processes of human communications, such as who communicates with whom, what are their information exchange needs, and where are they located geographically. This information is translatable into service specifications and systems that satisfy those needs.

Other projects relate to the experimental development of new services. Key projects include electronic messaging, data interchange between computers, information retrieval value added services, video services, voice-interactive electronic services, directory services and a range of potential services founded in artificial intelligence technology and natural language understanding.

As business customers become increasingly dependent on communications and computer services, communications security is an important functional attribute. Current Laboratories' projects concerned with developments in cryptography will ensure that business services offered by Telecom Australia can be made highly secure, with individual source authentication and confirmation of receipt being possible additional services.

Standards are important in the development of communications services. Adherence to standards ensures uniformity and interoperability between like services, nationally and internationally. The development of a detailed knowledge of evolving international standards and the contribution of technical inputs to the processes of international standards development are important in services applications development in the Laboratories.

Future services will require the development of integrated, multifunctional terminals for their effective delivery. These terminals will require adaptive interfaces through which people can comfortably interact with the electronic world in a way which is natural to the human user. Herein lies one of the more challenging tasks in communications services development today.

The following items outline some recent projects undertaken in the Laboratories in the customer services and systems field.

COMMUNICATIONS NEEDS STUDIES

The people of any typical large Australian country town are industrious and want to sell their products to Australia and the world. They are also social creatures who want to talk among themselves and keep contact with friends and loved ones who live elsewhere. Thus, they have a strong need for communications facilities to access the world's markets and to maintain social cohesion.

Telecom Australia, the national operator, provides telecommunications services that aim to meet the communication needs of the people here and in every other town, city and remote outpost of Australia. As the "Information Society" evolves in the future, the problem confronting the Telecom people who plan and operate these services will be one of identifying the diversifying communications needs of Telecom's customers, wherever they live or go about their daily business.

In past decades, experience, common sense and the relative stability of communications needs enabled Telecom to identify the needs and match them with a network of service. In the present day world, experience and common sense goes only part of the way. Communications needs are now too varied and complex to be readily identified. However, systematic scientific methods from the social and behavioural research disciplines can be enlisted to bring the communications needs of Telecom's customers into better focus.

In the Laboratories, human communication researchers are engaged in the task of understanding communication needs through Information Flow Analysis, Geographic Information Studies and Human Factors Research.

Information Flows

The Information Flow team is investigating the information content of business and social activities, that is, the way information is generated, who uses it and for what purposes, and with whom and where they communicate. The techniques used are derived from the disciplines of urban anthropology and sociology.

During the past year, the studies have developed a good picture of the information flows in the Health Care Sector and are now directed at the characterisation of customers outside the metropolitan area. To date, the latter studies have examined and characterised the profiles of customers in and around larger country towns (like Toowoomba, Bendigo or Dubbo), and what makes up the information content of their business and social activities. Careful analysis of the data from the field research has helped identify some communications gaps and deficiencies that inhibit customers making the best use of their business and social networks. The analyses also show the attitudes that customers have towards Telecom Australia as a provider of telecommunications services. The products of these analyses are being used by the operating divisions to develop strategies, plans and products aimed at satisfying customers needs.

Geographic Studies

Knowing the characteristics of customers in terms of their communications needs is one thing. Knowing the way in which different classes of customers are distributed in a town or between towns, and why they are distributed in that way, is another matter. This is the province of Geographical Information Studies.

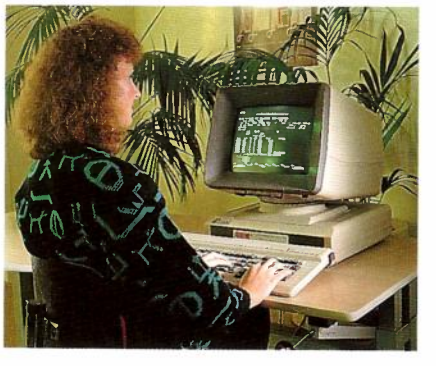
The difficulty with geographical information studies is (and has been) handling and analysing large masses of geographical data and presenting the results on maps. Over the years, geographers have invented various methods of analysis to cope with this problem. These methods have enabled geographers to develop some understanding of how locational characteristics affect the spatial distribution of social and economic activity. However, the sheer mass of data to be handled has often precluded extensive, detailed analysis. Fortunately, new tools are becoming available to help in geographic analysis.

The Geographic Information Studies team of the Laboratories is using computer-based techniques for locational analysis and presentation. The power of the computer systems enables data to be extracted from large complex databases, amalgamated and analysed, and then displayed on computer-generated maps. It is a complex computer task requiring, in itself, significant research effort. The team has developed pilot systems which demonstrate the power of the new computerised geographical information systems (GIS) to aid social and economic analysis for telecommunications planning at all levels. As a consequence of this research, Telecom's operating divisions are being assisted to develop specific GIS applications in their areas of responsibility.

Geographic information analysis depends on the availability of data, such as that from Telecom's operational databases and public databases like those of the Australian Bureau of Statistics. A valuable synthesis can be made by incorporating customer characteristic data obtained from information flow analysis into the GIS database and this is being done for a trial area known as the Melbourne Knowledge Precinct.

Human Factors Research

An expression of a communications need has a number of components, one of which is for telecommunications products that can be readily used by people. Researchers in the Human Factors Research team of the Laboratories are applying the results of experimental research to this end. They are engaged in the evaluation and design of communications systems used by customers and Telecom's own staff to improve usability.



Above
An operator accesses Telecom's Distributed Customer Record Information System (DCRIS)

One important effort has been an investigation of the user interface and operating environment of Telecom's Distributed Customer Record Information System (DCRIS), a database containing a mass of data about the telephone facilities of Telecom's seven million customers, service orders and fault reports, etc. The database is accessed by Telecom staff throughout Australia.

The Laboratories' investigation was carried out jointly with the Occupational Health and Safety Branch of Telecom's Network and Consumer Services Sub-Division. The study resulted in an improved user interface that assists Telecom's operators to attend to customers more efficiently and with less stress.

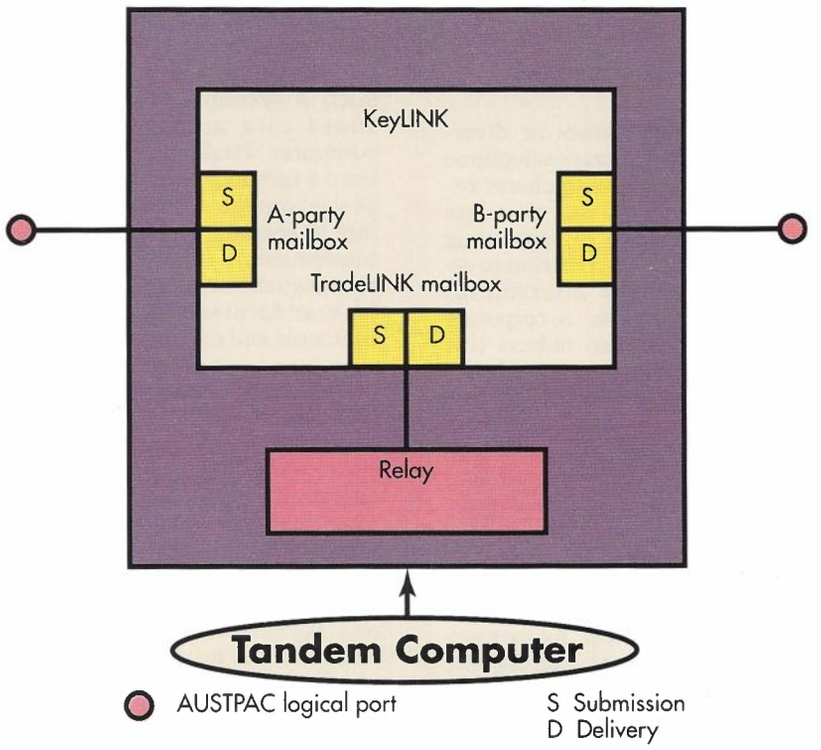
EVOLUTION OF TELECOM'S EDI SERVICE

Telecom Australia recently launched a new service known as TradeLINK, which is targeted at business customers who wish to commence trading electronically using the new technique known as Electronic Data Interchange (EDI). EDI provides for the electronic exchange of information normally contained in trading documents, such as orders and invoices, between the computers of the two trading partners. This new computer-based method of doing business provides a number of advantages over traditional paper-based business practices, particularly with regard to the elimination of errors and the ability to reduce inventory levels by adoption of reliable "just-in-time" inventory control techniques.

The initial TradeLINK service provides message switching and access control. As customers find new applications for EDI techniques beyond handling simple orders and invoices, the need for enhanced service features will arise.

The Laboratories have been contributing to the ongoing evolution of Telecom's EDI service by activities related to both product planning and product development as outlined hereafter.

It is important that TradeLINK has a flexible architecture which allows for the timely introduction of the new service features which are identified by the planning process. The Laboratories have designed a software system which provides for feature enhancement of the TradeLINK service.



Above
The TradeLINK EDI Relay process environment

The first stage of this software development has been completed and is undergoing trials.

The software was developed in the C programming language, with fault-tolerant hardware as the target environment. The complexity of the software and the unfriendliness of the target operating system as a software development environment led to a decision to do most of the software development work in a UNIX environment, rather than by using the native operating system of the target machine. While this approach was unusual, it was found that the adoption of this cross-development technique was both productive and led to a more portable software system.

Another important aspect of the planning of EDI services is the monitoring of relevant international and national standards development activity. Over a number of years, the Laboratories have developed a high level of expertise in the international X.400 Message Handling standards. Recently, the CCITT commenced work on a new study question concerned with the provision of EDI services using the X.400 framework. There are a number of issues still to be resolved, including the internal structure of the messages and the definition of a new EDI-specific communications protocol.

The ANSI X12 committee, which developed the EDI document standards used in Australia today, is also developing guidelines for the transmission of EDI documents over communications networks which are based on the CCITT X.400 standard. On the national scene, the Laboratories contribute to the Standards Australia IT/11 Committee, which is responsible for setting standards for EDI in Australia.

CORPORATE ELECTRONIC DIRECTORIES

As an organisation grows or diversifies, its printed corporate telephone directory and organisation charts become outdated rapidly and thus less dependable as means for providing staff with corporate information to assist their day-to-day interactions within the organisation. A corporate electronic directory can redress this problem by providing staff with on-line access to up-to-date computer-based directory information. Such a directory can provide additional useful facilities, such as automated searching based on a set of keywords. Moreover, it can provide much more information other than simply a telephone number and location. For example, it can include the relevant title of each staff member, his/her section or department, its address, the name of the head of the department, its office hours or other information. It can allow the organisational structure to be explored or corporate subdirectories to be developed, assisting users to determine the particular person, section or department which can help with a particular problem.

Corporate electronic directories can also link a company's PABX facilities with its office automation or central computing equipment. If the company is dispersed geographically, then its different sites will typically have separate and different PABXs, associated PABX management systems and office automation equipment. These incompatibilities complicate the development of corporate electronic directories, and recognised standards are needed to overcome this difficulty.

The major international standards bodies have recently defined standards for distributed directory systems. Such a system allows information stored on a number of distributed computer databases to be accessed from a terminal connected to any one of the computers in the system, with inbuilt access control provisions. The implementation of a distributed directory system therefore requires the use of standardised interconnection protocols and database schema.

The Laboratories have been active participants in the work of the international standards bodies developing these standards. Currently, the Laboratories are implementing a high performance distributed directory system based on these standards. The implementation is one of the first in the world, and it is contributing to the ongoing standardisation process. On one hand, it is testing and demonstrating the practical utility of the developing standards, and on the other, it is helping to uncover some technical deficiencies that must be remedied by amending the standards. Work is in train to apply the Laboratories' implementation to the development of a corporate electronic directory system.

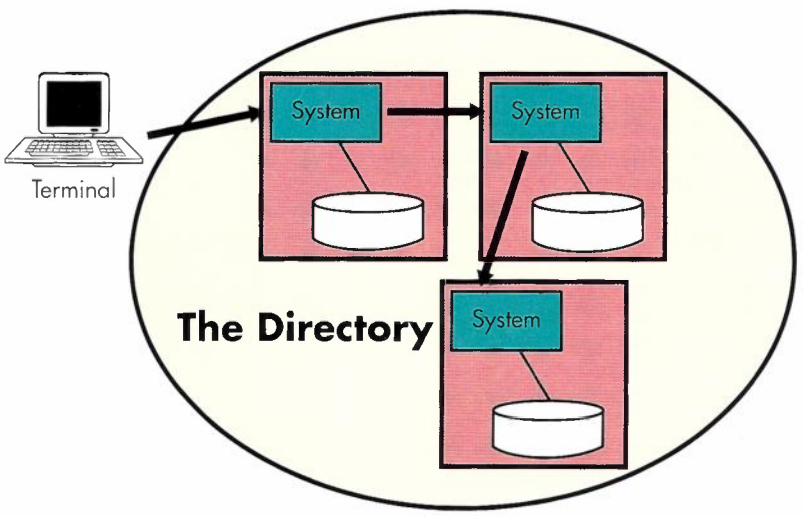
Because of the generic nature of an electronic directory, other applications of the Laboratories' software are possible. These are also being explored. One such Laboratories' investigation concerns the application of the software to the development of directories for network management, with the ultimate objective of assisting the automation of such operations.

VOICE INTERACTIVE ACCESS AND CONTROL OF VALUE ADDED SERVICES

The Laboratories' R&D activities in this broad project area are aimed at the study of voice value added services architectures and related speech processing technologies and techniques. At fundamental level, several activities are being undertaken since they are prerequisite to any successful application of speech processing to new and enhanced telecommunication services. Of particular importance for the interactive access to and control of such services is the work in the fields of speaker-independent speech recognition and high quality text-to-speech synthesis.

As well as identifying and studying these key technologies, the Laboratories are examining potential areas of their telecommunications application, paying due regard to the current limitations of these technologies, especially speech recognition. However, with the current emergence of interactive services which make use of telephone keypad input (ie. dual tone multi-frequency signals) and the maturation of speaker-independent speech recognition technology, these types of service become prime candidates for the application of speech processing technologies.

For speech recognition devices to be used successfully for access or control purposes in a telecommunications service environment, an appropriate vocabulary must be defined. The spoken digits comprise one such vocabulary. Speech recognisers must be trained to understand such a vocabulary by the presentation of an appropriate number of representative speech samples. The speech samples must be representative not only of the speakers intending to use the service but also of the types of telecommunications network conditions likely to be encountered.



Left
A distributed directory allows information stored in any one computer system to be accessed transparently from a terminal connected to any computer system

In the Laboratories, a speech database editing facility has been developed which facilitates the editing of recorded speech, both by the audition of speech segments and by examination of a graphically displayed speech waveform. The recording of speech samples for this database is continuing.

A technique has also been developed for the time varying analysis of speech signals. It is anticipated that this will have application to the generation of high quality text-to-speech synthesis. To date, results have shown that the time varying analysis technique can represent the rapidly varying spectral information in a speech signal better than can more conventional analysis techniques.

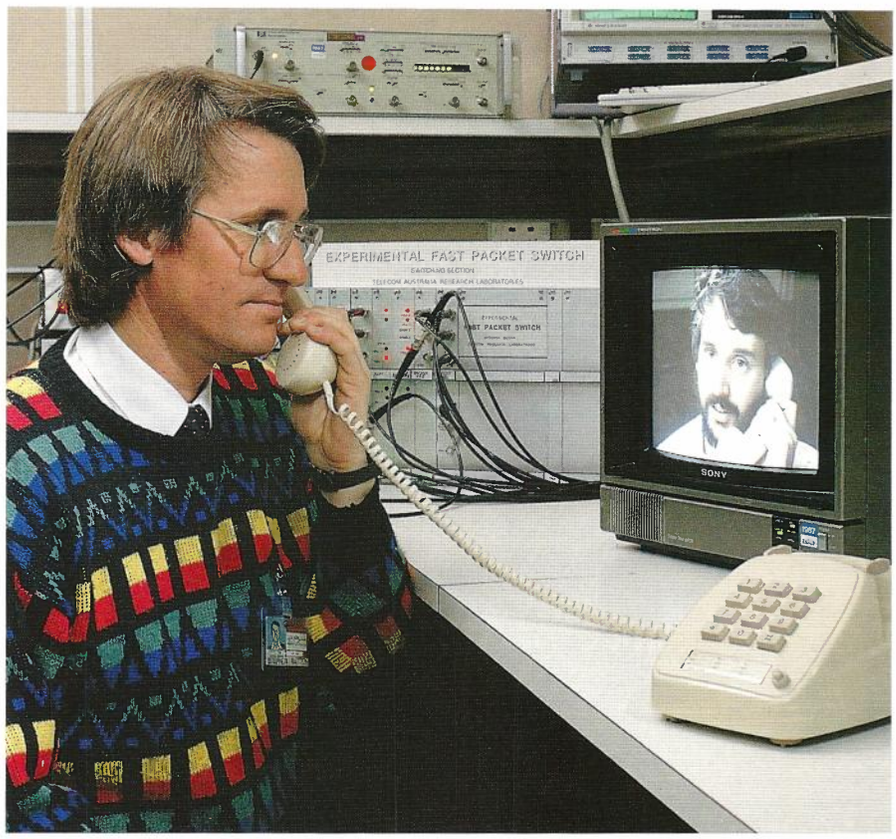
In the area of service modelling, an interactive service demonstration test-bed has been developed. This system is based on the "intelligent peripheral" concept of the intelligent network architecture. It is being used to develop appropriate service descriptions and definitions and to develop appropriate user/service interfaces.

The abovementioned generic tools have been developed as a foundation for future investigations of the application of speech recognition and synthesis techniques in enhanced or new telecommunications services. Applications which can be expected in the next 5-10 years comprise general information retrieval services (such as directory information services) and remote business transaction services (such as order entry, "pay by phone", ticket reservation, etc). Indeed, any such application which involves a dialogue over the telephone, where one end of the conversation can be automated is a prime candidate for applying speech recognition and speech output technology.

VIDEO AND DATA SERVICES DELIVERY

Each year, Telecom offers an increasing variety of voice, video and data services to its customers. However, the trends towards more customised services and the growing range of more complex telecommunications networks presents a promising but often bewildering set of choices to these customers.

The Laboratories are tackling the challenge of optimising telecommunications solutions offered to customers by applying advanced technology. In one specific project, artificial intelligence tools are being applied to the design of private data networks. In another project, video services are being integrated with data and voice services on metropolitan area networks.



Private Networks from Public Services

While some large companies are able to afford communications managers or consultants to plan and optimise their total communications usage, most customers face these difficult decisions with little or no help. Even Telecom's sales consultants are not able to become expert in all facets of all communications services in these times of rapid change.

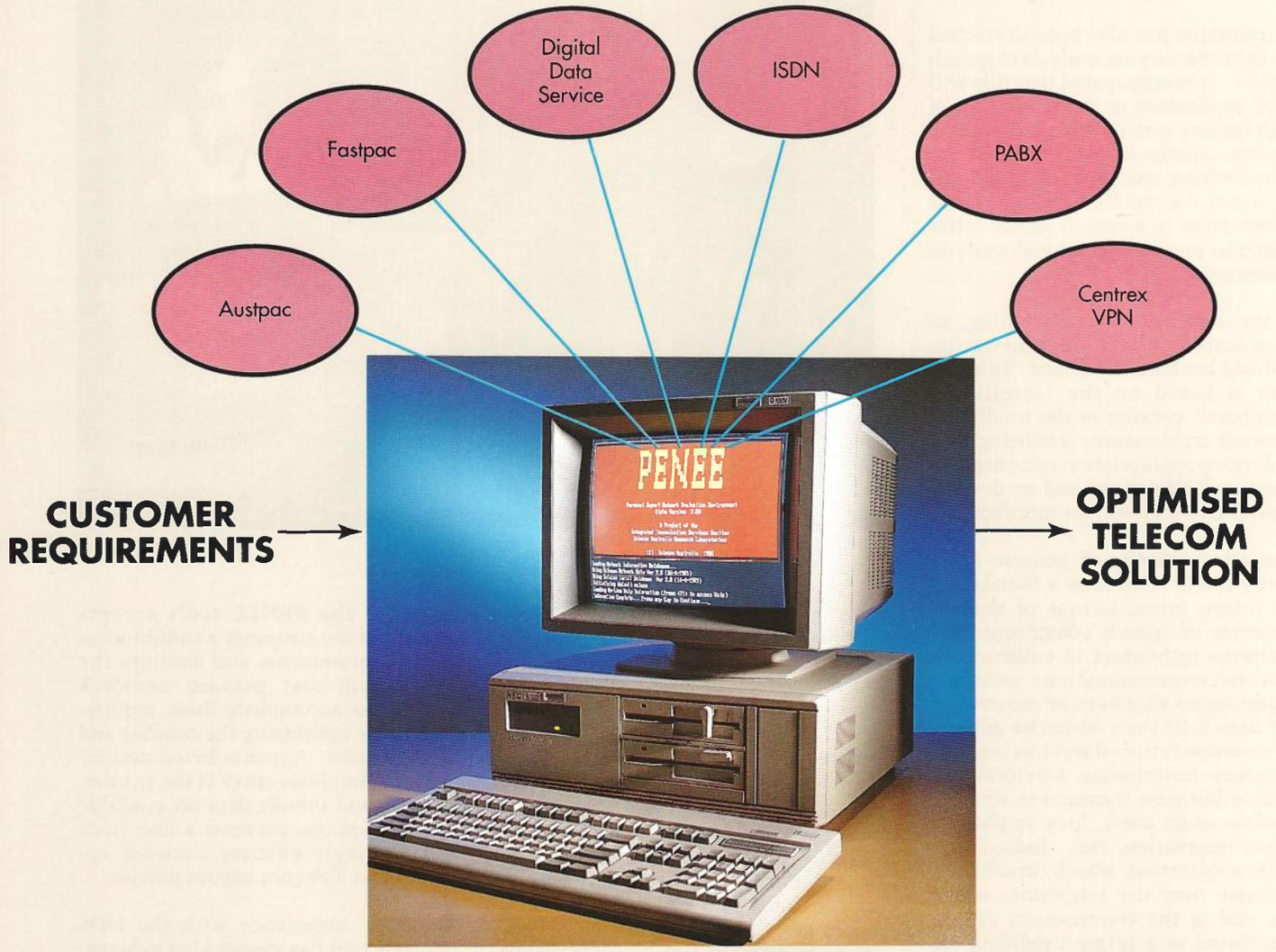
To help solve this problem, a number of expert systems software tools, collectively known as PENEE, have been created by the Laboratories. The tools capture knowledge of network designs, tariffs and service features and use this data to develop customised network solutions matched to a particular customer's requirements. Each of the tools is capable of optimising the design of a customer's private network based upon one of Telecom's services. At present, tools for the Digital Data Service (DDS), AUSTPAC, ISDN and PABX networks are under trial within Telecom.

Each of the PENEE tools accepts details of the customer's communications requirements and develops the minimum-cost private network design to accomplish these requirements by optimising the number and size of links. A menu-driven user interface simplifies entry of the requirements, and inbuilt data on available service options prevents a user from unknowingly entering network options that Telecom cannot provide.

To date, experience with the DDS PENEE tool has shown that substantial time savings can be made in network design and that relative novices can use the tool effectively to demonstrate alternative solutions to, and quotations for, customers. The tools have also been used to assist tariff setting by providing rapid cost comparisons between alternative communications services.

Further research will integrate the various PENEE tools to enable optimisation over more than one type of service. This will enable Telecom to satisfy the total communications requirements of individual customers more easily.

Above
A laboratory demonstration of video telephony over a fast packet switched network



PENEE analyses Telecom alternatives to optimise private customer network solutions

Video Services - A View to the Future

The current high costs of video equipment and video communications channels limit the demand for, and popularity of, video-telephony and video-conferencing services. However, Metropolitan Area Networks (MANs) will offer, for the first time, relatively cheap and widespread video services combined with voice and data services. To advance this pending development, the Laboratories are experimenting with video-telephony services on a pilot metropolitan area network. The pilot network will be a Queued Packet and Synchronous Switching (QPSX) network, which uses a new world standard protocol to provide very high speed digital communications over optical fibres around an entire metropolitan area.

Initially, 2 Mbit/s synchronous video codecs (coder/decoders) are being used. A device has been developed to packetise the video data from the codecs and transmit it over the QPSX optical fibres located at the Laboratories' Clayton site. Experiments with this approach will determine the effects of packet loss on video quality and will lead to the development of true packet-mode codecs which can interface directly to metropolitan area networks and, later, to the Broadband ISDN.

Hopefully, commercial equipment arising from this research will enable Telecom to offer video services in the early 1990s, placing Telecom at the forefront of world developments in metropolitan area networks.

ARTIFICIAL INTELLIGENCE IN TELECOMMUNICATIONS

Artificial intelligence (AI) is the area of research concerned with making a computer mimic human reasoning and intelligence. While such research has the long term aim of building reasoning machines, it has many more practical and immediate applications in telecommunications. The Laboratories are investigating the application of AI techniques in several areas of importance to Telecom Australia. In the EXPRES project, AI is being used for the maintenance of external plant, providing more efficient ways of detecting and repairing cable faults. In the MEDICI project, AI is being used to investigate means of enhancing business services.

The EXPRES Project

EXPRES is an expert system developed in the Laboratories for improved preventative maintenance of Telecom's external cable plant. It has been developed and trialled with the collaboration of operations staff in the Dandenong and Ballarat Districts of the Metropolitan Division.

Faults in cable plant are detectable by several means. Automatic test equipment such as Telecom's SULTAN looks for degraded pairs within a particular cable, providing an early indication of potential faults. The recorded fault history of a cable also gives an indication of which cable pairs are the faulty ones.

The EXPRES system analyses both sets of information to determine the more exact location of faults. Thus, EXPRES can assist fault repair staff to locate and fix cable faults, quickly and with more economic use of resources. Recent trials of EXPRES in the Ballarat district have shown that the widespread use of EXPRES could significantly reduce Telecom's cable maintenance costs in coming years.

The MEDICI Project

At present, there is a bewildering array of services available to Telecom's customers. For example, they can use electronic mail, electronic directories, facsimile and, in the future, photovideotex services. However, all of these services are currently provided via separate terminals and often, lines. Providing these services via simple combinations of existing terminals does not meet the long term need. In the not too distant future, customers will require multi-services terminals based on standard computer hardware which provide the services via a user-friendly transparent user interface. In addition, to make the services most useful, the terminals will need to be customised to suit the needs of particular groups of customers in business or industry.

MEDICI is an experimental software system developed by the Laboratories for computers using the Unix operating system. It uses using AI techniques and networking standards to bring together a package of services in one terminal. By using MEDICI, users need not grapple with the intricacies of individual services. They are assisted to interact with the terminal to obtain a required service via sophisticated screen displays or by using natural language. For example, to enquire about suppliers of engines for a Honda car, the customer might simply type "I need an engine for a Honda". MEDICI takes this request and, using intention analysis, determines that this means that the customer is interested in car engines. It then sends a request via the telecommunications network to the suppliers of car parts and subsequently relays responses to the customer. He may then decide to purchase an engine from a particular supplier and complete the transaction via MEDICI.

In the preceding example, the customer was interested in achieving the end result, rather than knowing the detail of how the networking was achieved. MEDICI looked after the networking aspect to get the desired result for the customer.

MEDICI is an experimental development at the frontiers of a number of areas of computer software research, accomplishing a natural dialogue with the customer through the use of state-of-the -art artificial intelligence software techniques. The MEDICI project was started in 1987 and is scheduled to deliver a completed experimental prototype product in 1990.

SECURITY FOR BROADBAND NETWORKS AND SERVICES

New telecommunications services are becoming increasingly complex. Because their value to business customers is correspondingly increasing, significant improvements in reliability and associated security are also being demanded.

The Laboratories are investigating approaches to the provision of wide-scale commercial-grade security based on the application of newly developed cryptographic techniques. These investigations are aimed at satisfying the security requirements of customer services and their supporting networks, particularly in the areas of transaction, data and text services, mobile services, ISDN privacy and authentication services, and security for future broadband networks and services.

Telecom is currently investigating new services such as video conferencing, high-speed data transfer and Local Area Network (LAN) interconnection. These services can be provided through the introduction of several new broadband (140 Mbit/s) networks. One such network of immediate interest is FASTPAC, a Metropolitan Area Network (MAN) based on IEEE 802.6 standards. In the longer term, the Broadband Integrated Services Digital Network (B-ISDN) will make such services more widely available.

The provision of security features in these new high-speed networks involves the development of new cryptographic algorithms. This is necessary because traditional block cipher techniques based, for example, on the US Data Encryption Standard (DES) algorithm (which is currently widely used in the banking industry) or the Rivest, Shamir and Adleman (RSA) public key algorithm, have speed limitations which make them unusable in these networks.

The Laboratories are investigating stream ciphers as a means of providing security services at the bit rates at which future high-speed networks will operate. The hardware required to perform stream encipherment is relatively simple and can be made to operate at the speeds required.

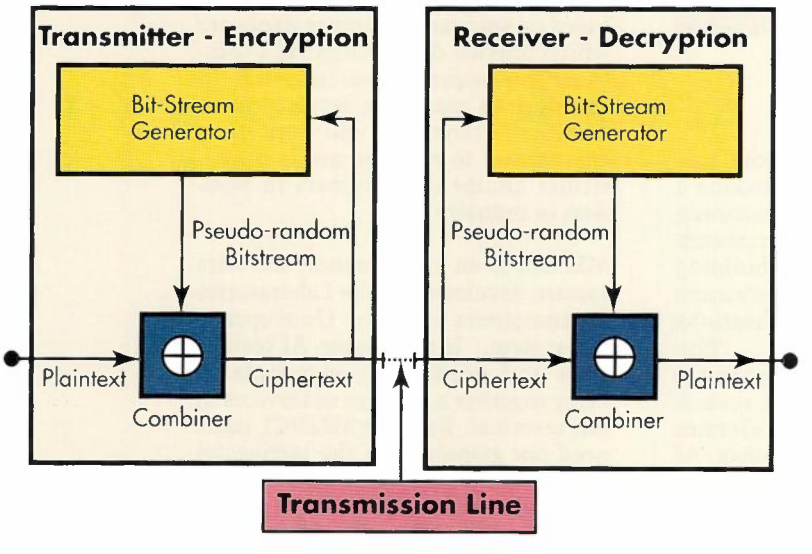
A stream cipher works by combining, in an exclusive-OR logical operation, a pseudo-random bitstream with the information bitstream before transmission in order to encode the data. Decoding is then accomplished by removing the pseudo-random bitstream at the receiver by means of another exclusive-OR operation.

Practical high-speed digital networks suffer from both packet loss and corruption. Any cipher system developed for such a network must therefore be able to cope with these phenomena. Unfortunately, a stream cipher operating in standard configuration will malfunction after packet loss, because this causes the pseudo-random bitstream generators at the transmitter and receiver to lose alignment. This problem can be overcome by operating the cipher in "cipher feedback mode", where the encrypted data is also used at the receiver as an input to the pseudo-random bitstream generator. The Laboratories are currently investigating the security implications of this option.

A computer program has been developed to demonstrate stream cipher techniques to Laboratories' client areas within Telecom Australia and also to Telecom's major business customers. The experience gained by demonstrating this program has provided valuable insights which will help clarify the issues involved in the design of cipher systems suitable for network applications.

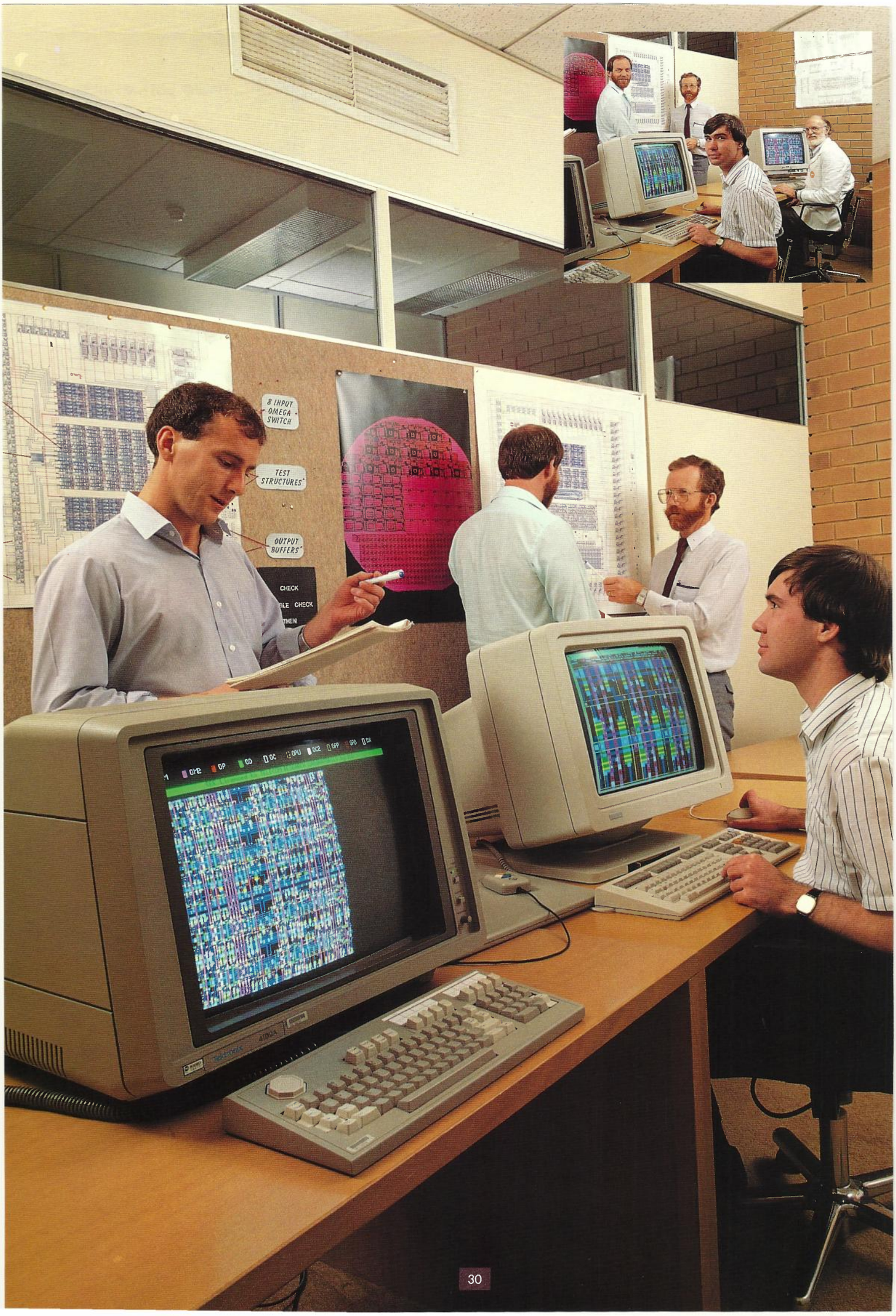
Whilst the best known security-related service is that of data confidentiality (encryption), a number of other services can also be provided using similar cryptographic techniques. Services such as the authentication of one user to another, access control, guaranteed data integrity (which prevents the fabrication, altering, replaying or mis-ordering of information), proof of authorship and proof of receipt of information fall within the general scope of "security services". The Laboratories have been active in attempting to define which of these security services customers will require in new broadband networks such as FASTPAC.

Below
A stream cipher system, showing ciphertext feedback



In order to provide these security services to the broadest possible range of its customers, it is important that Telecom should comply with national and international standards where practicable and applicable. The Laboratories are monitoring the security standardisation process, and have contributed to the IEEE 802 working group's efforts in the fields of MAN standards and security for interoperable LAN systems. This activity not only ensures that Telecom has a comprehensive and up-to-date understanding of relevant standards, but also helps to ensure that points of contention are resolved in Australia's interests.

Above
As computer-to-computer communications becomes the basis of value added business services, network and data security will be a paramount requirement


8 INPUT OMEGA SWITCH
TEST STRUCTURES
OUTPUT BUFFERS
CHECK

SWITCHED NETWORKS

During 1988/89, a number of significant developments have occurred in the field of switched networks.

In November 1988, the CCITT Plenary Assembly approved about 700 Recommendations, many of which cover switching aspects of telephony, ISDN and data networks. A point of particular interest was the inclusion of several Recommendations covering the Broadband ISDN, a topic that first became active midway through the preceding 4-year study period. The surge of interest in this activity within CCITT Study Group XVIII was indicative of the worldwide interest in broadband communications technology and services which can use it to advantage. In a remarkably short time, broadband switched networks have become a prime topic of many of the world's major conferences and of interest to many potential users.

Equally, the separation of the basic switching function and the provision of more sophisticated services (such as more personalized services) in the Intelligent Network Service architecture has seen a great deal of activity. This area is also very dependent upon good standards and makes use of the very capable common channel signalling systems now becoming an integral part of major switching systems. This field has been sufficiently active to have seen the establishment of conferences devoted to it alone.

The need for more sophisticated network management capabilities has not been ignored. It is expected that new technology can add a great deal in this area, particularly with the application of such things as Open System Interconnection protocols and Expert Systems. As in the other areas mentioned above, there has been sufficient international activity in this topic area to warrant the establishment of groups of major network and equipment suppliers to investigate specific means of taking advantage of the new technology.

Hence, the end of the 1980s is proving to be a time of great activity in the switched network research field. We can expect this to continue, certainly in the near future, with the expectation that the early to mid 1990s will see significantly wider bandwidth switched services, more sophisticated services, more powerful network control capabilities and ever more dependence upon standards, clever signalling systems and software techniques.

The next few pages illustrate how the Laboratories are addressing these research issues in order to provide Telecom Australia with timely advice and assistance relating to the future adoption of new technologies and operational practices in Australia's public switched networks.

PROTOCOL TESTING AND THE ISDN

The introduction of the Primary Rate (2 Mbit/s) Integrated Services Digital Network (ISDN) by Telecom Australia in mid-1989 was a significant event in Australian telecommunications. With the planned introduction of the Basic Rate (160 kbit/s) ISDN in the near future, Telecom's network infrastructure will be positioned to make available a wide range of new and enhanced services. Initially, the Primary Rate ISDN will cater for the services needs of business customers, and the later introduction of the Basic Rate ISDN will enable new services to be extended eventually to all Telecom customers, thereby providing a foundation for Australian communications into the next century.

ISDN provides integrated digital access for a wide variety of new services. This has been made possible by the provision of sophisticated protocols for access signalling, so that a variety of service requirements can be transmitted to the network. These new access protocols represent, in a very direct sense, the major step forward in enhancing network intelligence to enable a multitude of services to be provided by the ISDN.

Quite a large step forward in Telecom's operational capabilities has also been needed to allow the successful introduction of ISDN. To assist this process over the past few years, the Laboratories have developed new tools and techniques for protocol testing and remote test access to allow efficient testing and fault diagnosis in the ISDN. These new operational tools were delivered on time to the Telecom groups concerned with ISDN introduction. The tools will play a major role in ongoing ISDN introduction and maintenance.

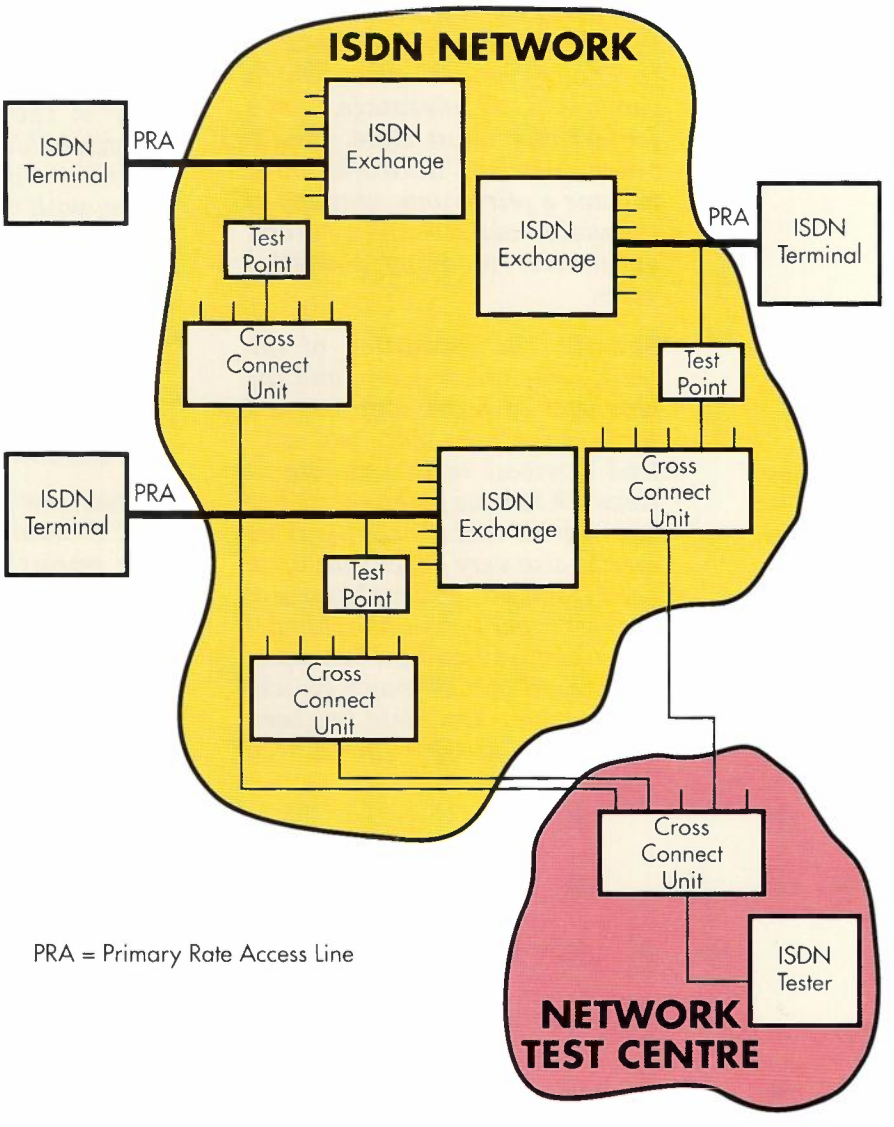
In the work undertaken by the Laboratories, protocol tester development was carried out jointly with Siemens AG, to provide test capabilities tailored to Australian ISDN access standards. This project has provided comprehensive test facilities for Telecom's ISDN support centres.

However, effective diagnosis and rectification of customer protocol difficulties demands that test access is provided to a point as close as possible to the customer's terminal equipment. Since several different locations may be interacting in a given fault situation, simultaneous observation at different parts of a connection is desirable. Technical solutions to allow remote test access have been developed by the Laboratories to allow resolution of these problems.

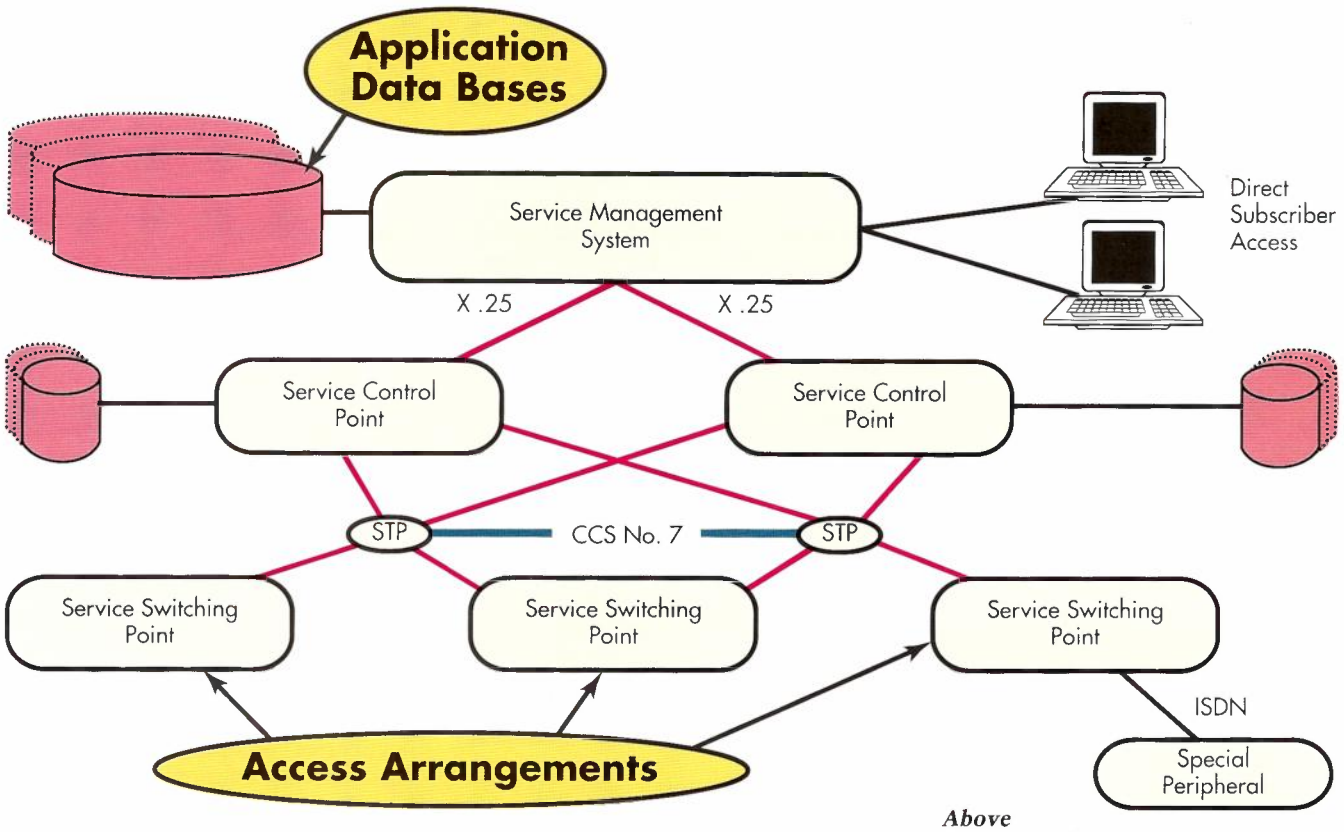
With the ISDN remote test access, a customer's ISDN signalling channel (the "D-channel") can be placed under diagnostic test routines from test centres located elsewhere in the network. The technology provided by the Laboratories to allow this consists of small modular cross connect units for monitoring or intercepting the signalling channels of the 2 Mbit/s Primary Rate ISDN access lines. Network-wide remote control is provided to allow the cross connect units to be switched to other ISDN access lines or to be re-configured for different test purposes.

In addition to developing ISDN access signalling test methods, the Laboratories have also been involved with ISDN network signalling. Network signalling is separate from access signalling and uses an ISDN version of Common Channel Signalling System No. 7 (CCS7). A major part of the work undertaken in the Laboratories has been another joint development with Siemens AG, to develop a CCS7 protocol tester which uses the same hardware as the ISDN tester. The tester was designed for the Australian ISDN and telephony CCS7 specifications, but it can be easily modified if changes to the protocols are required in the future.

Below
The Laboratories-designed cross connect unit allows network-wide ISDN access testing from network test centres



PRA = Primary Rate Access Line



Above
Logical architecture of an Intelligent Network

INTELLIGENT NETWORK SERVICES AND SYSTEMS

The intelligent network concept builds on common channel signalling by adding remotely accessible repositories of service data at service control points and imposing network-wide management of this data. A traditional telephone network, by contrast, depends on individual exchanges to provide enhanced services; calls must be routed to an appropriate exchange, and any particular service may not be available throughout the network. New services are introduced into the intelligent network (IN) by adding the new service data to the service management system, downloading real-time versions of this data to one or more service control points, updating address information in signalling transfer points, and possibly, changing trigger tables in service switching points (ie. exchanges). This can all be done centrally.

For many enhanced services, there is a choice of possible implementations, ranging from terminal interactions (as with fax machines talking to one another across analogue telephone lines), through exchange signalling (as in simple call forwarding), to IN centralised control.

The advantages of the IN-based implementations are twofold. Firstly, new services may be introduced quickly across the whole network. In the IN of the future, a high level service language will be developed, allowing the network to be "programmed" like a large distributed computer system, enabling Telecom to develop its own services without reference to exchange suppliers. Secondly, services will be implemented efficiently, sharing the network infrastructure with other services and without the placement of expensive specialised equipment. This will make an IN implementation attractive even for small numbers of customers. Thus, the Intelligent Network is a major step on the road to the universal advanced communications network of the future.

As yet, the IN concept is only partially realised. Many research questions remain open, especially regarding service creation. At the highest level, service creation begins with the writing of a "service script", specifying the actions which make up the service and the proposed treatment of errors and other exceptional conditions. For implementation, the service script is then read by a "service logic interpreter".

Studies at the Laboratories have shown how a service logic interpreter can be constructed and how it depends on the capabilities of common channel signalling. An experimental service logic interpreter is being constructed to demonstrate the rapid prototyping of services from fundamental network capabilities. The same service script should be used for the whole service creation process, from initial experimental prototyping, through simulation for performance evaluation and final service design and testing, to eventual deployment. Object-oriented programming, a new way of looking at software development and re-use of code, is believed to permit this continuity and is being used for all IN experiments in the Laboratories.

Another important area of service creation and implementation is an understanding of all changes which result from the introduction of a new network service. In particular, there will be service database enhancements, and possibly, changed network management actions. An entity-relationship approach is being taken in the Laboratories' studies, with the aim of embedding a machine-readable version of entity-relationship diagrams in a future service creation support system.

The introduction of the ISDN will admit many new opportunities for new or enhanced services. The IN architecture is complementary to that of the ISDN, with the ISDN offering customers uniform connection to the network and the IN providing a uniform service environment across the network. Thus far, the IN has been defined for the ubiquitous provision of services across the multiplicity of access arrangements which currently exist. However, the widespread availability of the ISDN will reduce the diversity of access while adding many new capabilities for service designers. The relationship between the ISDN and the IN is under intensive study in the Laboratories, with a view to understanding, specifying and designing the telecommunications services of the future.

THE BROADBAND ISDN

With the proliferation of optical fibres in the customer access and inter-exchange networks, large bandwidths will eventually be available right to customers' premises. Together with developments in switching technology, this will permit a Broadband Integrated Services Digital Network (B-ISDN) to be developed, capable of supporting video and high speed data services. Important services include personal and group communications, information retrieval, remote computing, education and entertainment. These services will become more pervasive and friendly, taking advantage of new capabilities for video, image, voice, graphics and text communications.

Standards for the B-ISDN are currently being developed by the CCITT. A framework standard was completed in 1988, and detailed standards are expected by 1992. User interface rates will be at 155 and 620 Mbit/s. A packet multiplexing technique, known as "Asynchronous Transfer Mode" (ATM), will be used for information transfer. In this technique, a customer's information is sent to the network in short, fixed length packets or "cells". ATM can support many different services, ranging from low speed data to high definition video at 135 Mbit/s.

The Laboratories are investigating many important aspects of the evolving B-ISDN and are contributing to the development of relevant international standards in the interests of Australia's future communications. Significant topics under investigation include switch architectures, the application of remote switching in the customer access network, congestion control and network resource management.

Switch Architecture

The performance of a network based on ATM will be vital in determining the quality of service perceived by customers. Optical fibres typically provide higher speed and lower error rates than switches. Consequently, network performance will be determined primarily by the switching nodes.

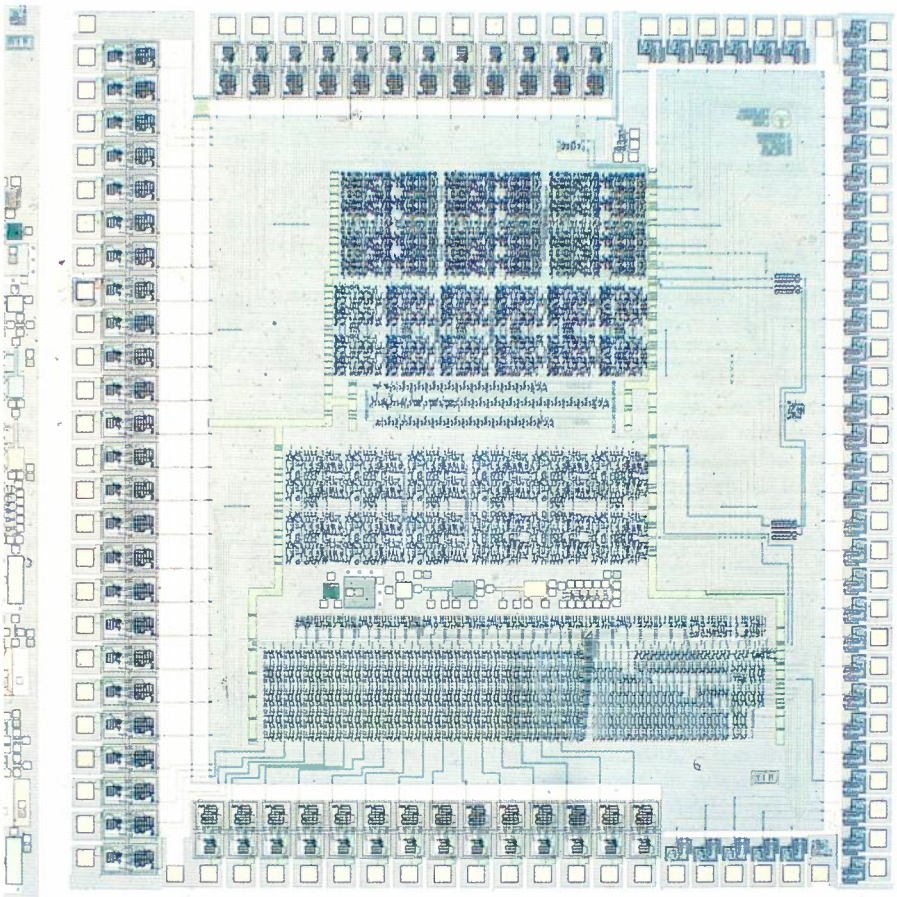
To assess the capabilities of future ATM switches, the Laboratories are investigating switch architectures and functionality. The switch architecture is an important factor in determining the performance that can be achieved. To achieve the performance necessary to support high speed data and video services, self-routing switch structures implemented in dedicated hardware are required.

The Laboratories have been developing an experimental switch based on an architecture which features:

- a sorting network, to order the cells according to their port address,
- parallel switch stages, to handle the simultaneous arrival of multiple cells for an output port,
- a discard function, for discarding cells in excess of the number of parallel switch stages, and
- separate queues on each output, to hold temporary excesses of cells for the output.

An important feature of this switch is the provision of priority mechanisms for servicing cells. During congestion, loss-priority allows cells to be discarded from services least sensitive to loss in favour of services with greater sensitivity. Similarly, delay-priority allows cells for delay-critical services to be serviced first from queues.

The economic realisation of high speed switches is dependent on their implementation in Very Large Scale Integrated (VLSI) device technology, and the Laboratories have been implementing key components required for the experimental switch in VLSI.



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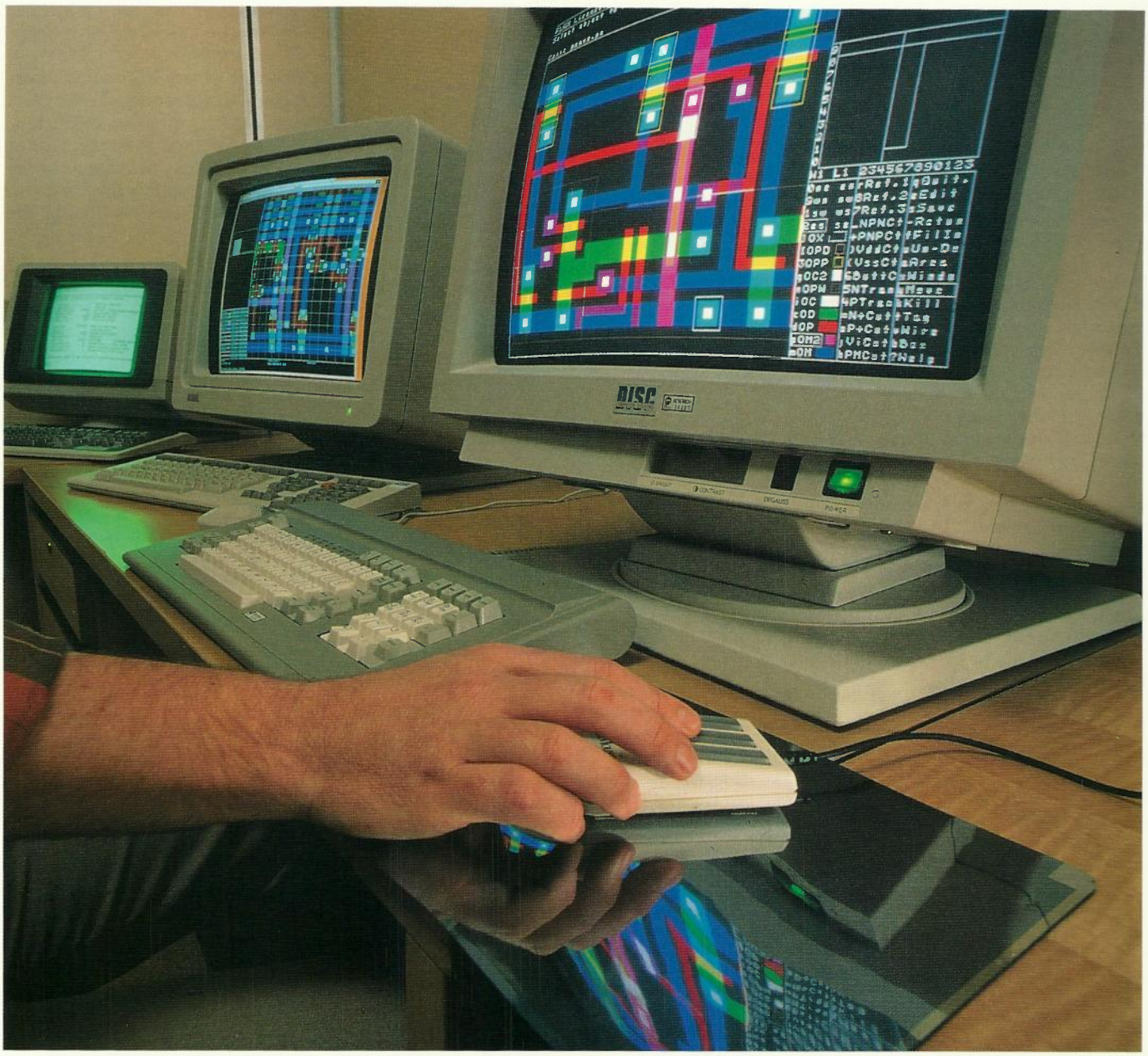
Computer-aided VLSI device techniques are essential to the economic realisation of devices for the Broadband ISDN



Switching in the Customer Access Network

The B-ISDN customer access network (CAN) will use single-mode optical fibre and support all services via a single user - network interface. As also reported elsewhere in this Review, a number of options for the B-ISDN CAN are now under study within the Laboratories. Access arrangements under consideration include simple star networks, passive shared-fibre networks and active switched access techniques.

Passive CAN techniques, such as those embodied in MACNET, involve the sharing of fibre from the exchange to a passive optical splitter located at a distribution point distant from the exchange, close to and serving several tens of customers. The major advantage of this approach is low installation and maintenance costs.

Using active CAN techniques, customer services may be electronically multiplexed, concentrated or switched at the distribution point. The CAN switch acts as a front end which aggregates the traffic before it reaches the exchange switch, taking full advantage of high capacity optical

Above
VLSI implementation of ATM switch elements

fibre links (possibly in the Gbit/s range) between these points and the exchange. A major advantage of active switching is the flexibility of using the fibre capacity. It may also perform the broadcast functions required for some distributive services. Preliminary studies show that the number of customers connected to a single distribution point may be of the order of several hundred.

Other considerations in the Laboratories' studies include network evolution, security of customer data, ability to provide alternative or back-up paths for customers requiring high reliability, ability to support a large number of distribution channels, and rapid response to channel selection requests for distributive services.

No particular option is definitely superior to the others. Technology cost trends, such as laser cost, are critical in comparing future overall costs among the options. Solutions could involve combinations of the techniques to meet the technical and economic needs of specific customer types and service profiles.

Congestion Control

One of the most significant problems for the designers of high speed ATM networks is congestion. Congestion can occur when several users send cells at a rate which is faster than the network can transmit. When this occurs, cells from one or more users must be delayed or discarded. Although this type of congestion could be short-lived, the high transmission speeds mean that the amount of data to be delayed (ie. stored in buffers) or discarded could be large.

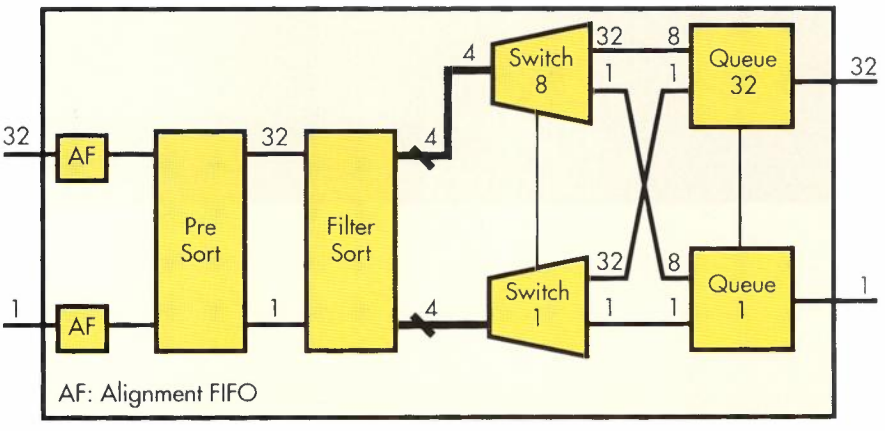
The Laboratories are studying various techniques for controlling congestion.

The effectiveness of congestion control is very sensitive to the allowable quality of service for each traffic type. In the case of ATM, quality of service can be measured in terms of allowable cell delay and cell loss rate. The Laboratories have classified services into five classes which determine relative delay and/or loss priority for cells. The use of five priority levels allows significant improvements in the utilisation of transmission links between switches, while providing the required quality for a range of services. The results of this work have been submitted to CCITT as a contribution towards the development of standards for the B-ISDN.

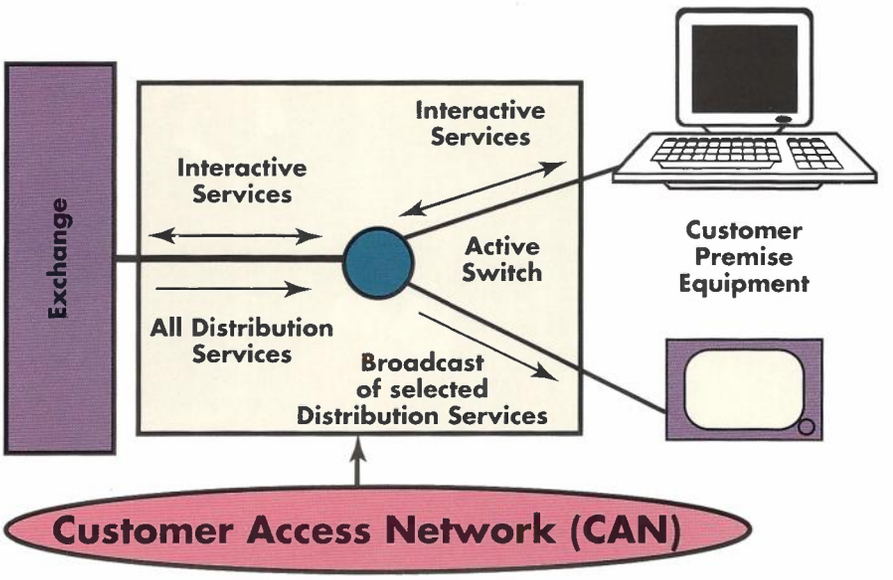
One congestion control technique favoured by the Laboratories is adaptive window flow control. This is a modification of traditional window flow control that reduces the sender's window size if loss is detected. Analysis has shown that the size of network buffers may become extreme with traditional window flow control, but an adaptive window limits the buffer size to an implementable value.

Resource Management

A "virtual path" technique has been developed by the Laboratories to help manage B-ISDN resources. Virtual paths carry a bundle of individual connections as a single manageable group. A fixed amount of transmission and switching capacity can be allocated to a virtual path when it is established. Alternatively, the capacity can be adjusted dynamically as the load distribution changes. The extra control processing required to adjust the capacity must be balanced against the improvement in utilisation of transmission capacity that results. The CCITT has agreed that virtual paths will be included in the B-ISDN standard.



Above
A 32 x 32 self-routing switch fabric with 8 parallel stages



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Active switching in the CAN can perform multiplexing and switching functions for Interactive Services and a broadcast function for Distributed Services

NetCAD - A NETWORK DESIGNER'S WORKSTATION

NetCAD is a software package under development in the Laboratories which is intended to facilitate the specification, analysis and design of Telecom Australia's public networks and also those of Telecom's major corporate customers. It is intended to be an open-ended system, in the sense that additional analysis and design packages can be readily added to the system. Wherever possible, existing tools (which have been developed within Telecom or by software developers outside Telecom) will be used to provide the required functions.

Two central and essential facilities which will be provided in NetCAD are:

- a graphical network specification/display/editing interface, and
- an interface to external sources of network data.

Specific network analysis and design tools are also under development, and some are already available in preliminary form.

One of these tools which has reached a degree of maturity is an algorithm for computing network availabilities. In the evaluation of the performance of a communications network, a fundamental criterion is the network's ability to withstand the failure of some of its elements. With this in mind, computer software has been developed which determines the probability of being able to communicate between (ie. the availability of) an origin-destination pair (O-D pair) of a network from the individual availabilities of the network elements (nodes and links). The algorithm which has been developed is able to compute the end-to-end availabilities for communications through quite large networks (comprising in the order of 100 nodes and links), so long as the link and node availability values are fairly high, typically better than 99%.

ROUTING ALGORITHMS FOR THE DIGITAL SERVICES PROTECTION NETWORK

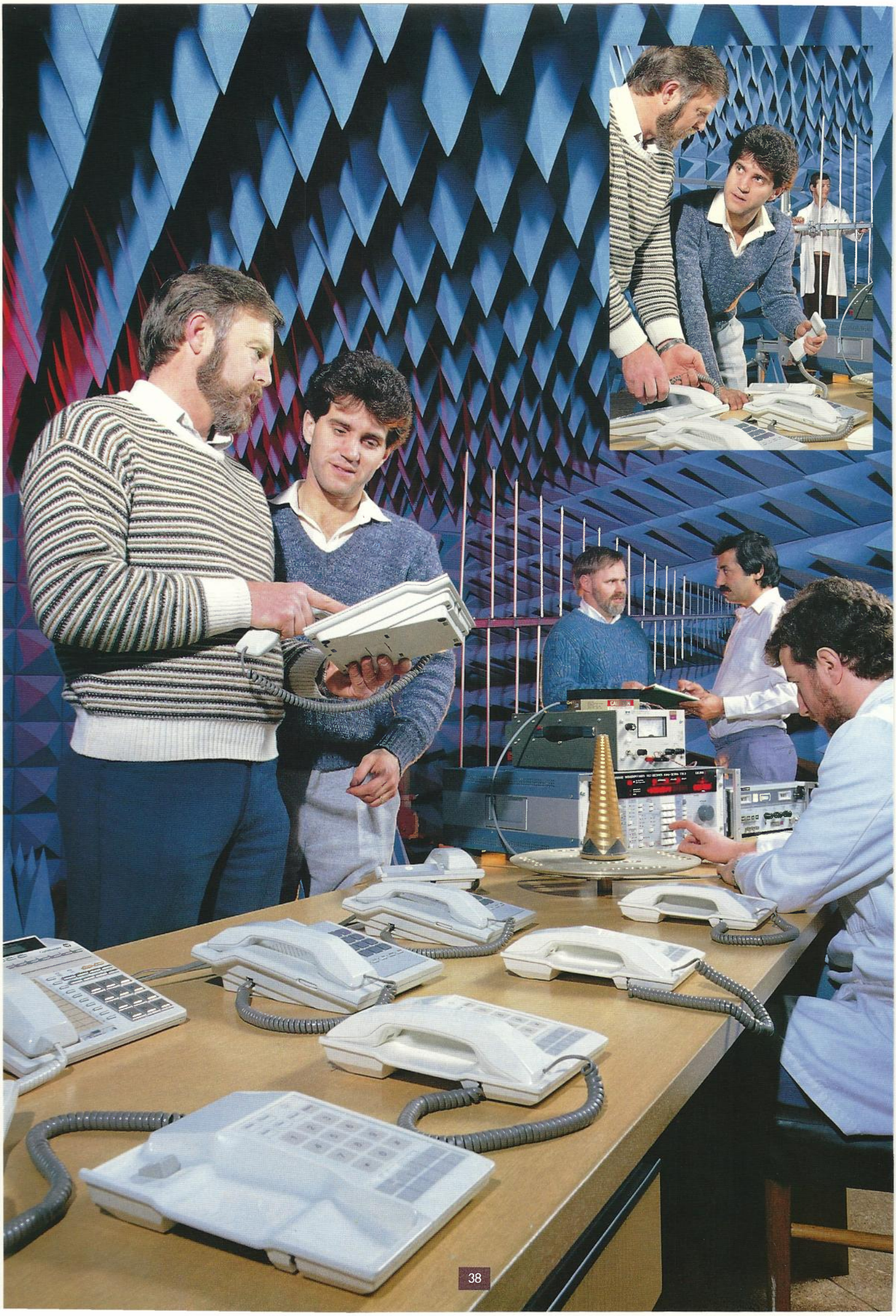
The prime aim of Telecom Australia's Digital Service Protection Network (DSPN) is to provide protection against a single route failure, such as might be caused by a cable being cut or by a common power supply failure which affects all bearers on the route. DSPN nodes operate by determining alternative transmission paths for network services in the event of such failures. Should a DSPN switching node fail, only restricted restoration by the DSPN around that node can be achieved, and any traffic terminating at exchanges off that node cannot be restored by the DSPN system.

In some instances, a transmission system which has failed can be quickly recovered by switching, almost instantaneously, to a protection bearer system. In other cases, telecommunications traffic must be re-routed around the failed system using alternative physical paths, although it must be noted that this requires some computer processing of the network state.

For the latter situation, algorithms must be developed to determine an optimal re-routing strategy for traffic and to ensure that any high priority traffic receives adequate protection. In particular circumstances, it may be desirable to drop lower priority traffic streams in order to protect the higher priority streams during the re-routing procedure, in accordance with predetermined guidelines.

Recently, the Laboratories developed a mathematical model and algorithm for identifying new service restoration paths under network failure conditions and under various priority constraints. A prototype system has been developed, in both IBM PC and UNIX environments, based upon a linear programming model.

A feature of the model is its ability to have priority weightings assigned to traffic streams. The ratings can be based upon criteria such as service, revenue or reliability. In the model, the computer program recommends assignments of the traffic flows to the network so that these requirements can be met - to within the limits of available network resources. In certain circumstances, the model produces multiple solutions to the problem. In these cases, the user is able to select an appropriate solution to meet other (possibly) more subjective factors.



TRANSMISSION NETWORKS

Optical fibre and mobile radio technologies will dominate transmission networks in the 1990s, as telecommunications networks evolve to support increasing demand for broadband services and personal communications. Broadband networks will be optical fibre based and employ predominantly digital transmission techniques, with Gbit/s rates. Personal communications will make increasing use of small hand-held personal terminals, together with more widespread custom-design of access to the fixed network. These scenarios imply more customer control, supported by increasing network intelligence for rapid service definition and delivery.

Optical fibre is now well established in the inter-capital and inter-exchange networks, with transmission systems operating at up to 565 Mbit/s. The increasing demand for broadband services highlights the need to exploit further the capacity of already installed optical fibre, in the nearer term future, by moving to 2.4 Gbit/s direct detection systems on inter-capital routes. Further capacity increases will later follow through the application of multi-carrier coherent optical systems in the mid-1990s.

High speed data transmission services, local area network interconnection and video services will be carried initially on the QPSX Metropolitan Area Network, which will evolve towards the Broadband ISDN. Finally, in the later 1990s, optical fibre will achieve sufficient penetration in the customer access network to enable the delivery of telecommunications and television services to both business and residential customers.

The current spectacular growth in demand for mobile communications services illustrates the value which many customers place on being able to communicate wherever and whenever they choose. A number of technical developments will mature in the next few years to help satisfy this demand. Digital cellular mobile systems will be available in the early 1990s, promising better quality and a wider range of services. L-band satellite mobile systems will come on stream soon after 1992. Telepoint services and combined Telepoint/Paging services will expand network access economically for the mobile customer, and wireless PABXs and radio local area networks will enhance office communications systems and reduce their capital and operating costs, enabling advances in telecommunications technology to increase business productivity. All of these developments will lead to mobile services becoming a significant part of Telecom's business in the 1990s and beyond, adding a further degree of reality to what was once regarded as sheer speculation that the hand-held personal communicator will become as ubiquitous as the transistor radio.

These developments in broadband networks and personal communications are discussed in more detail in the following pages of this Review.

MOBILE COMMUNICATIONS SERVICES

About three years ago, Telecom Australia introduced a cellular mobile telephony network in Australia. In that short space of time, customer demand for mobile communications services has experienced remarkable growth, far exceeding original estimates. In turn, this has required Telecom to expedite the extension of its network. Current indications are that this growth will continue and that mobile communications could potentially become a significant part of Telecom's business.

A variety of work is in progress in the Laboratories to investigate the means by which the future extension of Telecom's mobile radio communications network can be achieved. Related studies are concerned with enhancing the performance and service features of the existing network.

The current cellular network is based on analogue techniques for the transmission of voice and is not immediately suited for the transmission of data. In the terrestrial network, voice-band modems are widely used for data transmission over conventional telephone lines. A similar approach can be adopted for cellular radio systems, except that specialised modems must be used to overcome the effects of the signal fading which is usually present on a mobile radio channel. Following Laboratories' evaluations of commercially available modems, one has been selected and is now included in Telecom's product range. By integrating these modems into the network, the mobile user can be provided with access to the full range of Telecom's data networks and services, such as the AUSTPAC public packet switching network and Viatel and Keylink services. A field trial is now underway to assess the value of this service.

As the use of the cellular network grows, it becomes increasingly difficult to provide the required standard of service within a fixed amount of spectrum. As a result, several Laboratories' studies are concerned with improving cell design methodologies so that better spectrum utilisation is achieved. A complementary approach is being taken in other studies of means of improving the base station antenna. In the latter case, a multi-sectored antenna is being investigated. Such an antenna should allow more frequent re-use of frequencies in the cellular network. A novel lens-fed approach is used in the antenna so that the required degree of sectorisation can be achieved economically.

Spectrum utilisation in cellular networks is often increased by reducing the size of the cells. The current Telecom network is designed for a minimum cell size of 2 km. Future mobile networks will have much greater user densities and a much greater component of personal portable ("hand-held") terminals, requiring the adoption of smaller cells ("micro-cells"). Studies have been conducted into the propagation characteristics of such micro-cells, and the results are being used to explore possible network architectures for micro-cellular systems.

The next, and future, generations of cellular systems will utilise digital transmission techniques. With such systems, better spectrum utilisation is achievable and a greater range of services can be made available. However, the use of these techniques may require cell design approaches which differ from those for the current analogue system. This issue is being studied in the Laboratories by a combination of field measurements, detailed analysis and computer simulation. A contract is also current with Philips Radio Communications Systems Ltd for further studies in specific areas of digital cellular systems.

The results of this work will enable the Laboratories to provide timely advice to Telecom's Special Business Products Division on the performance of various digital cellular systems as they become available and on design rules for their application in the Australian network.

SATELLITE NETWORKS

Over recent years, there has been a general trend in domestic satellite communications systems to provide customer-oriented services using small earth terminals. Telecom is interested in providing services such as telephony, messaging and data transfer by the use of transportable and mobile terminals, primarily for applications in rural and remote areas. Small terminal applications in such networks have been the subject of Laboratories' studies since the mid-1980s.

In the Laboratories' studies, the main emphasis has been on satellite-based land-mobile systems which will come into effect at the end of 1992, when Aussat launches its second-generation satellite system. The second-generation satellites will contain a special L-band (1.5/1.6 GHz) transponder dedicated to providing mobile-satellite services. A collaborative effort between Telecom and Aussat is presently underway to implement these services.

In addition, Telecom has been examining the possibility of providing low-bit-rate data and messaging services using a portable "suitcase" terminal operating at Ku-band frequencies (12/14 GHz) with the present Aussat satellite system. As reported elsewhere in this Review, a special "test-bed" terminal has been designed and prototyped under contract to the Laboratories by Mitec Ltd., a subsidiary of the University of Queensland, for these specific studies.

The main propagation effect on radio transmission from a moving vehicle to a geostationary satellite is the shadowing effect of roadside foliage or other obstructions. The results of past measurements of these effects are now being used to evaluate the performance of mobile terminal equipment. Specifically, the studies are centred upon the capability of the modems used in this equipment to obtain optimal use of power and frequency in the available land-mobile satellite spectrum. The construction of a laboratory-based satellite-link simulator has been completed. This equipment allows the user to simulate quantitatively the effects of multipath and shadowing on transmitted speech. The resulting recordings are then used to obtain a subjective evaluation of the speech quality for the specific equipment being tested. In this way, different modems can be compared to

Above
The Laboratories' satellite simulator

determine which one is optimum from a performance/cost point of view.

The testing of land-mobile satellite terminal equipment is also being done in collaboration with Aussat, using the Japanese ETS-V satellite. While not as well controlled and highly repeatable as laboratory-based conditions, these further tests will allow qualitative evaluation of equipment under actual operating conditions.

The outcomes of all of these studies will enable Telecom to be well-informed on matters relating to the economic and technical feasibility of providing a land-mobile satellite service. When the occasion arises, the work will also assist the preparation of a well-founded technical specification for mobile terminals.

WIRELESS ACCESS SYSTEMS

Future offices and business premises will be highly automated, with a considerable amount of data communications between large numbers of computer terminals, office machines and external networks. When integrated with voice communications, this will require flexible and cost-effective networks in customer premises. Portability of the terminals and ease of re-configuration will also be highly desirable features of these networks.

Wireless in-building networks achieve these features, allowing users to be mobile and providing flexibility in the installation and re-location of terminals, eliminating fixed wiring and re-wiring delays and costs. Given the rising costs of cabled alternatives for in-building distribution networks, the wireless alternative could become the more cost-effective option. Already, several indoor wireless products, such as advanced cordless phones with data transfer capabilities and short range transaction systems, are commercially available or will soon appear in the market. In future, wireless PABXs, high speed radio local area networks (LANs) and universal personal portable phones will form the basis of many customer premises networks.

Research is required to assess the capabilities and applications of these products, as well as to specify the performance requirements and to establish design rules for such radio networks to ensure their adequate application in any given office. Recognising this, studies are being conducted by the Laboratories in relation to indoor propagation, network architectures, radio LAN protocols and radio technologies for indoor wireless systems. Studies are also being undertaken to evaluate the performance of terminal products which are likely to be in the market within a year or so.

One recent study concerned the advanced digital cordless phones, known as CT2, which allow for in-communications channel switching to counter excessive interference. The usual advantages of digital speech are also available. A variation of these digital cordless phones, known as Telepoint systems, can be used as a wireless phone in public places, such as shopping centres, hospitals, railway stations and sports grounds. The area capacity of the Telepoint system has been evaluated using propagation

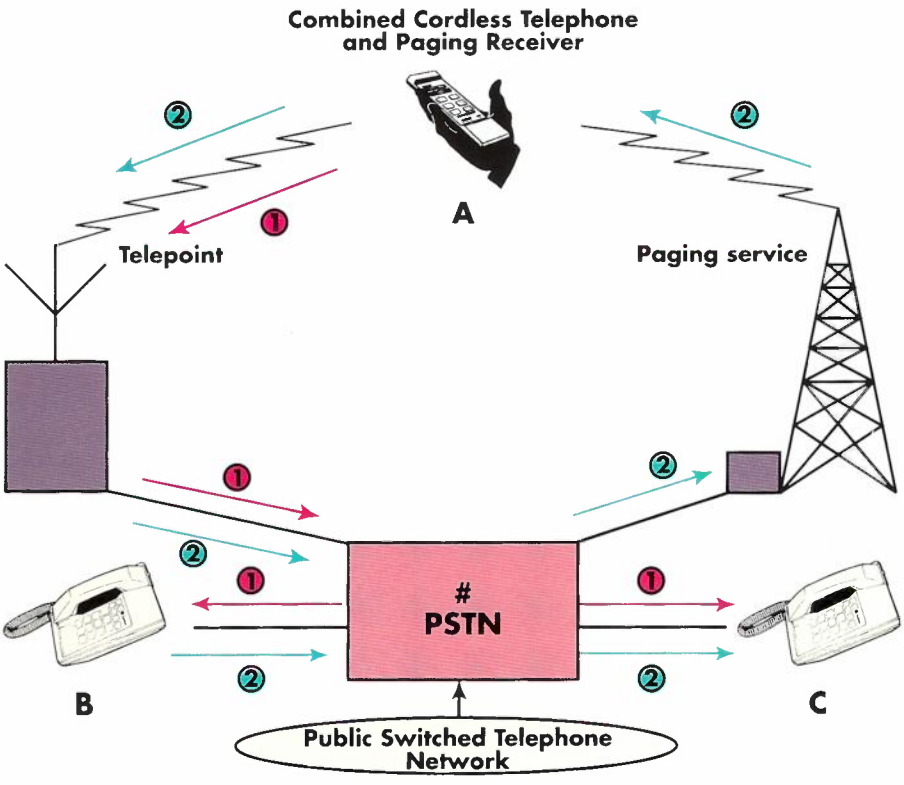
models developed by the Laboratories and the effect of new protocols on call blocking and call cutoff have also been assessed. Currently, technical support for an initial trial of these Telepoint systems is being provided by the Laboratories to Telecom's Special Business Products Division.

Studies have also been conducted to evaluate radio LAN access protocols for providing integrated voice and data communications. In this context, packet radio access techniques have been analysed and compared with circuit switched techniques such as time division multiple access (TDMA). This work has shown that packet access techniques are particularly efficient when the proportion of data traffic in the integrated voice and data situation is high, a case typical of an automated office. A high speed indoor transmission experiment to verify the above ideas is currently being designed.

Below
Schematic arrangement of a combined cordless telephone/paging receiver in a basic Telepoint service with public network access, showing service capabilities:

1. Party A can use personal portable (wireless) telephone to dial B or C, via Telepoint base station, from a public place,

2. Party B can page A with a message to telephone C, and A can subsequently call C.



OPTICAL CUSTOMER ACCESS NETWORK ARCHITECTURES

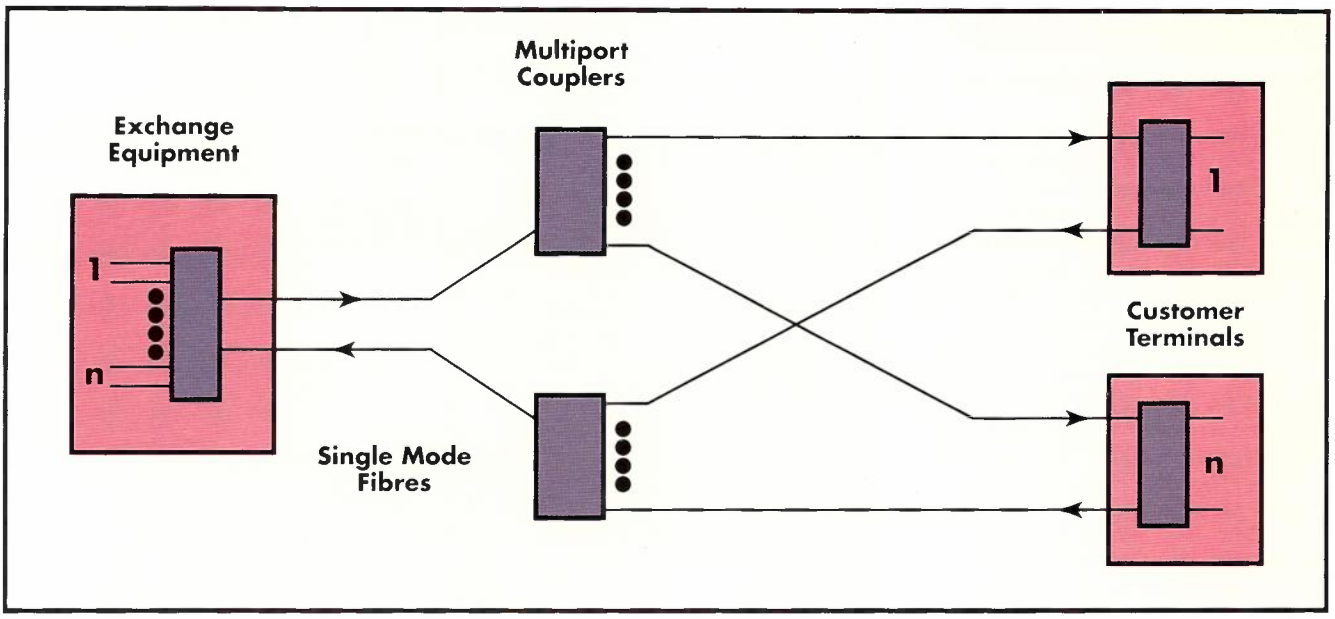
Telecom Australia is presently conducting pilot trials, in Sydney and Melbourne, of providing telephone services over single mode optical fibres to residential customers. A small number of these customers are also being provided with video services. The pilot trials are giving experience in the application of optical fibres in the customer access network, particularly as regards external plant aspects. However, the transmission approach used in the trials is based on the provision of a dedicated optical fibre from the exchange to each customer, an approach which is not generally cost-effective for residential and business customers.

The Laboratories have been examining alternative, less costly optical fibre network architectures for the customer access network. For residential and business customers in urban areas, the two major options are an "active" or "passive" network.

An active network is based on a double star topology from the exchange, with the use of active electronics at a distribution point located near the customers' premises, possibly about where today's cabinet or pillar is sited. The function of the electronics equipment is to multiplex the customer services onto fewer optical fibres between the distribution point and the exchange, so reducing the costs of this segment of the external plant.

A passive network architecture is based on a double or triple star topology, with the use of passive optical fibre couplers at the distribution point as the combining/splitting elements. The optical fibre couplers could be located, for example, at the present cabinet or pillar sites, in the street near the premises of a number of customers. The customer services could be multiplexed together using time division multiplexing, sub-carrier multiplexing or wavelength division multiplexing.

The Laboratories have been investigating the use of passive networks and have developed an experimental system as a test bed, with the assistance, under contract, of Alcatel-STC Pty Ltd and Australian Optical Fibre Research Pty Ltd. The system, known as MACNET, provides a range of narrowband digital services using time division multiplexing.

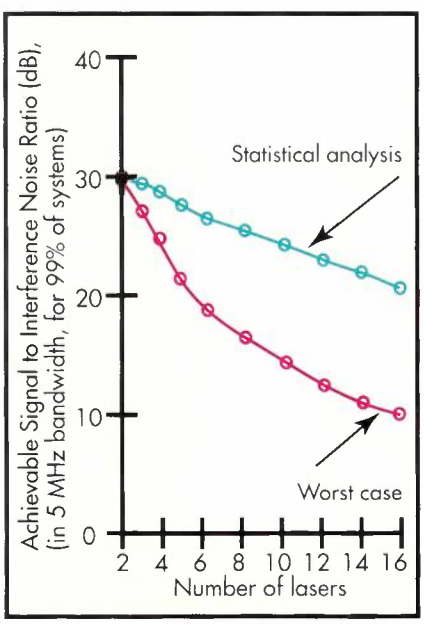


Above
Schematic of a passive optical network for customer access

The preferred choice between an active and passive network architecture is, as yet, unclear. The choice depends on many factors. It is important that each network should be capable of supporting a wide range of services, including video-based services and, in the longer term, Broadband ISDN services. One of the key features of a passive network, in contrast to an active network, is that other services can be overlaid at a later date without the need to alter any of the external plant.

Video services can be readily provided on a passive network using analogue modulation techniques and electrical sub-carriers to modulate the laser diode. This approach is well suited to the distribution of a large number of PAL TV channels to customers, as in an interactive video service. Transmission in the upstream direction from the customers to the exchange can be limited by optical interference noise, which occurs when the optical signals from the individual lasers at each customer end are combined through the optical fibre couplers. Studies at the Laboratories have established that between four and eight TV channels can be transmitted upstream in a passive network using frequency modulation and typical laser diodes (chosen without wavelength selection).

Another transmission approach with passive networks is the use of wavelength division multiplexing with, for example, separate wavelengths for different services and/or customers. However, the spectrum of typical Fabry-Perot laser diodes precludes close channel spacing, due to the effects of mode partition noise with narrow optical filtering. The Laboratories have developed a theoretical model, which has been verified by experimental tests, to estimate appropriate channel spacings. Preliminary results suggest optical channel spacings of 15-20 nm can be achieved with typical laser diodes in a wavelength division multiplexed network. It is expected that, in the longer term, advanced laser diodes with narrow optical spectrums will allow much closer channel spacings.



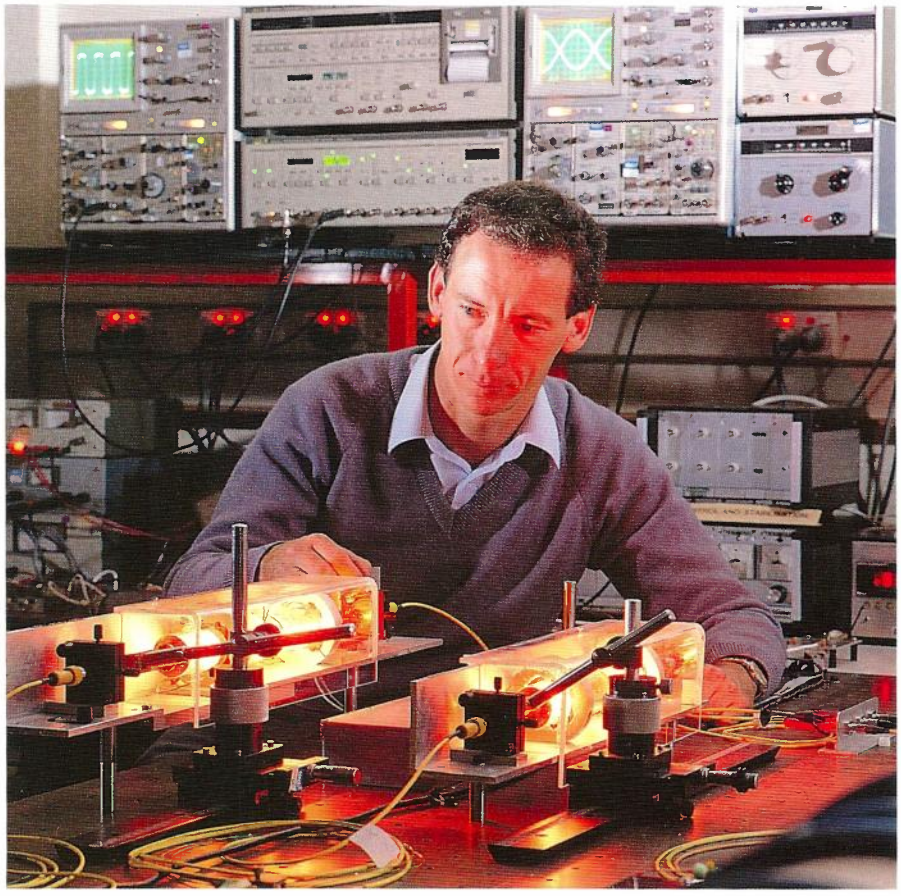
Left
Upstream transmission performance with sub-carrier multiplexing in a passive optical network

INTER-EXCHANGE NETWORK EVOLUTION

Telecom Australia is currently installing an extensive single-mode optical fibre transmission network linking Australia's major cities and provincial centres. This is complemented by a network of single-mode optical fibre cables within those cities. Although transmission systems operating over these fibres at rates of 140 and 565 Mbit/s meet present requirements, the real capacity of the fibres is much greater, and there is scope for enhancing the value of this optical network in the future through the use of higher capacity transmission systems. Thus, the presently evolving network will provide the transmission capacity needed to serve Telecom's customers far into the 1990s and beyond.

As demand for increased transmission capacity grows, the first development in the network will be the introduction of higher capacity 2.4 Gbit/s transmission systems. In the long-distance network, where repeater spacings for the current transmission systems have been maximised, there may be problems in operating the new systems over these long spans. In order to resolve these, a research programme and field experiment is underway in the Laboratories, in collaboration with the Telecom Network Engineering Unit of Telecom, to determine the performance achievable in such systems and the origins of the performance limitations in current prototype systems. This work will continue as developments in the technology of optical sources for these systems occur. For urban routes with lengths of up to about 30 km, no special problems are expected to arise.

In the longer term, probably around the mid-1990s, a new generation of optical transmission systems, called coherent optical systems, will become available. These systems are so called because they employ optical sources with very high spectral purity, made possible by the improving performance of semiconductor laser diodes. Coherent optical systems employ heterodyne or homodyne receivers, which are similar in concept with radio technology but which operate at optical frequencies. They achieve greatly improved sensitivity compared to conventional systems because of the signal gain that occurs in the mixing of the incoming signal and the local optical oscillator signal, and the signals occupy a narrow optical bandwidth.



Coherent optical transmission systems offer an improvement in receiver sensitivity over conventional systems of about 10 to 20 dB, depending on the techniques compared. This improvement could be used to achieve either longer transmission spans or increased capacity over the same repeater span. But possibly the greatest advantage over conventional systems arises because the receiver in a coherent system is frequency-selective; it responds only to optical signals within a narrow band of optical frequencies centered on the local optical oscillator frequency. Thus, it becomes possible to combine a large number of optical carriers onto a single fibre, and to choose a particular channel for reception by tuning the local laser oscillator, much as with a radio receiver. In addition, it becomes possible to amplify the combined array of optical carriers in a single optical amplifier, so that, at many repeater stations, only a single multichannel amplifier is required instead of several single-channel amplifiers. Thus, coherent systems offer the potential for providing great increases in the capacity of trunk optical fibre cables, installed or planned, without necessitating a commensurate increase in line equipment.

A number of technological problems must be overcome before these systems can be employed in the Telecom network, and a great deal of work is being directed to resolving these. In the Laboratories, a programme of analytical work is being undertaken to establish the performance achievable from various coherent system options. An experimental system, employing Differential Phase Shift Keyed (DSPK) modulation, is being constructed to test the predicted results and to gain experience in the operation and characterisation of these systems.

Above
The Laboratories' experimental coherent DPSK optical transmission system

NETWORK ARCHITECTURES FOR FUTURE BROADBAND SERVICES

Demand from businesses for high speed data communications between computer mainframes, local area networks (LANs) and other devices is increasing rapidly. The Laboratories have been investigating various network options for the distribution of such broadband services. While it is expected that future systems will be based on optical fibre transmission in the customer access network (CAN), it is also necessary to identify the most suitable network topologies which might be adopted. The more immediate options include the use of:

- synchronous transmission and multiplexing (as in the US SONET standard and the CCITT Recommendations G.707, G.708 and G.709) for transport of continuous bit streams, or
- Metropolitan Area Networks (MANs) such as the QPSX product (based on IEEE Draft Standard P802.6 - Distributed Queue Dual Bus (DQDB)) for high speed packet data.

In the longer term, the Broadband Integrated Services Digital Network (B-ISDN) can be expected to provide a wide range of broadband services over fast packet switched connections.

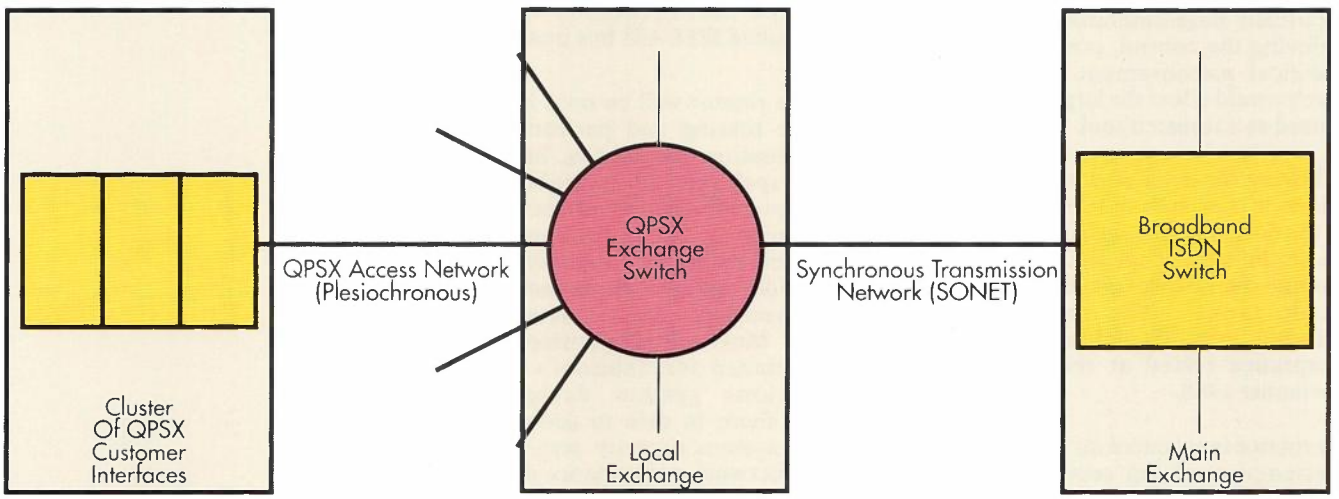
The Laboratories' studies of the possible evolutionary strategies have revealed some important relationships between the network options. Synchronous transmission networks may be used as the fundamental transport for both the QPSX MAN and the future B-ISDN. However, such a strategy would constrain the parameters to be used for cell size and transmission rate within those networks. The QPSX MAN could be used as a distributed access network for the B-ISDN, provided the critical parameters such as cell size and header functionality are compatible. The Laboratories are continuing to study the relevant developing standards and are providing inputs to the international standardisation process as appropriate.

In the Laboratories, more fundamental transmission studies have concentrated on the synchronisation aspects of these network options. The ability to provide synchronous services over the networks depends on the capability to derive a suitable network clock at any customer interface. Detailed analysis of the synchronisation method to be used in Telecom's QPSX Pilot MAN in Melbourne in 1989 has shown that it should be able to provide a standard G.703 2 Mbit/s interface with the specified jitter performance. These studies have also shown that the QPSX network can operate over plesiochronous (unsynchronised) transmission links without the occurrence of slips, even for the largest conceivable number of network nodes.

Other studies of the QPSX media access protocol on very large networks have shown a need for protocol enhancements, in order to guarantee a proportion of the capacity to a particular connection. This is particularly important for real-time services, such as video conference services, in which excessive delays due to network congestion can result in frames arriving at their destination too late. The Laboratories have developed an enhancement which provides guaranteed capacity in a flexible way, with minimal changes to the existing DQDB protocol. Stations using this guaranteed capacity scheme can co-exist in the same network with stations using the existing DQDB protocol. Simulations have demonstrated that the scheme can ensure any desired distribution of capacities, even on very large networks.

The research described above has provided direct support for the QPSX product development by Telecom's subsidiary joint venture company, QPSX Communications Pty Ltd. It has also provided technical inputs to the IEEE 802.6 standards group. Preparations are currently in hand for transmission and access protocol measurements on Telecom's forthcoming trial of a QPSX Pilot MAN in Melbourne in the second half of 1989.

Below
A possible QPSX evolutionary stage



LARGE ANTENNA ROTATOR EXTENDS ANTENNA RESEARCH CAPABILITIES

Late in 1988, a contract for the development and commissioning of a large antenna rotator for the Laboratories' Antenna Test Range was successfully completed. This has resulted in a significant extension of the antenna testing facilities available to Telecom Australia, completing the re-establishment of the antenna test range at Caldermeade, 72 km south-east of Melbourne. The facility is now the best equipped range in Australia, able to test very large antennas under remote control and with fully automated instrumentation.

The project to design, develop and commission the large rotator was commenced in the early 1980s, when a future need to test large diameter parabolic antennas, typically those of satellite earth stations, was identified. A basic specification for a large rotator was prepared and, since no rotator meeting these specifications was available commercially, companies were invited to tender for the first stage of the project. This stage focussed on the detailed development of the design concept for the rotator.

Several different functional areas of the Laboratories, as well as others within Telecom, were involved with the successful prime contractor, C.J. Abell & Co. of Unley, South Australia, in refining the concept and producing the final detailed design specifications for both the large rotator and its associated control and instrumentation systems. The aim was to produce a design which would carry out performance testing of mechanically and electrically large antennas, as well as achieving the control, positional and electrical measurement accuracies which would allow the large rotator to be used as a research tool.

Following the detailed design stage, a follow-on contract was let to C.J. Abell for the development and commissioning of the rotator on the top of the antenna test tower at the Caldermeade range. The rotator was delivered, installed and satisfactorily acceptance tested at the range in November 1988.

The rotator is mounted on the specially strengthened top section of the 30 metre high receive tower at the range. It is attached to the tower by a spherical bearing and two 100-tonne screw jacks, supported by a thrust bearing. This arrangement provides a gimbal mount with an elevation adjustment of plus or minus 5 degrees in any azimuth direction. As well as allowing alignment with the measurement axes of the 2500-metre range, this mounting arrangement permits alternative alignments to achieve longer range lengths to more distant off-range transmit towers.

The rotator is 2.5 metres in diameter and 1 metre high. It weighs 8 tonnes and will support an antenna and its associated mounting hardware weighing up to a total of 8.5 tonnes. It has been designed to withstand 54 m/s (ie. 190 kph) winds at the masthead with a 10-metre diameter antenna in place. The maximum wind speed at which measurements can be carried out within the specified positional accuracy limits is 18 m/s (ie. 65 kph).

The hydraulic drive used by the rotator provides a continuous rotation in either direction over a wide speed range to a maximum of 0.3 rpm. Variations in the rotational speed are within plus or minus 10% of any set speed. As well, the rotator can be driven to a pre-set position with a final positional accuracy of plus or minus 0.02 degrees. The total positional accuracy, taking into account bearing and the control system feedback measurement factors, is plus or minus 0.03 degrees.

The rotator can be either operated manually or integrated with the pre-existing computer-controlled measurement system so that it forms part of a fully automated antenna test range facility. An internal microprocessor provides automated control of the rotator and output of rotator position and status information to the instrumentation system via a standard IEEE-488 bus interface.

The large rotator will be used for acceptance testing and performance characterisation of antennas. In addition, its capabilities allow it to be used for more precise research into new and novel antennas. The much improved facility will enable the Laboratories to test a wider range of antennas with greater precision than was previously possible. Most test programmes will be undertaken for Telecom's communications system designers, enabling them in turn to determine whether system capacity and transmission network performance design goals will be achieved. On occasion, projects will be undertaken for other Australian organisations, where the unique features of the range are essential to their satisfactory performance.

The new rotator can carry solid parabolic reflector antennas up to 10 metres in diameter, and even larger mesh structures. This has significantly extended the capability of the range, since previously, only antennas less than 4.6 metres in diameter could be mounted on the pre-existing smaller rotator because of weight and wind loading limitations.

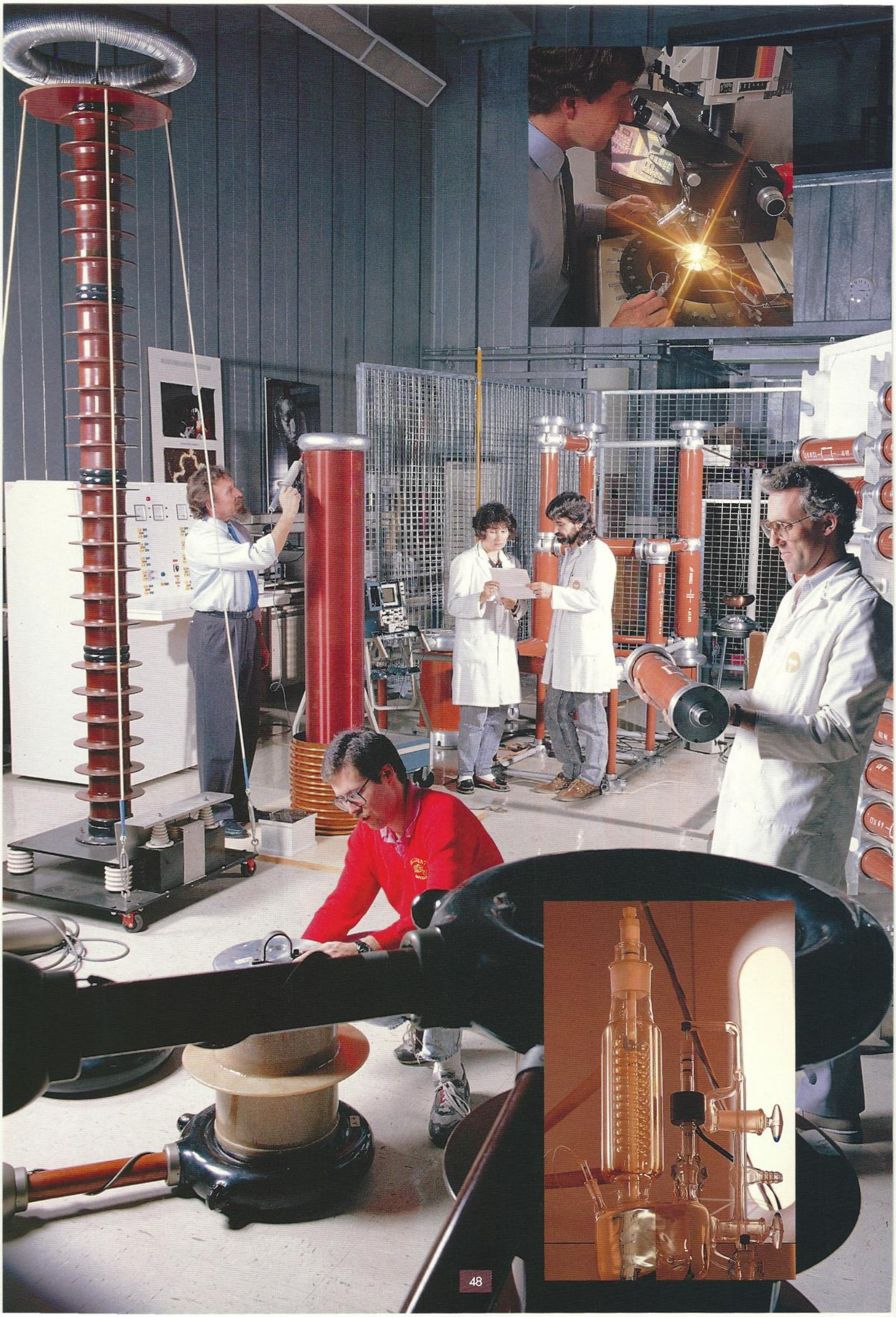
As well as requiring more substantial mounting and rotating mechanisms, the testing of larger antennas requires very accurate positioning. For example, large earth station antennas have very narrow beamwidths, typically 0.3 degrees or less, and their testing requires that the the radiation pattern envelope must be sampled at angular intervals as small as 0.03 degrees. The large rotator is able to meet these requirements.

In an alternative configuration using both the large and small rotators, the large rotator provides a mounting for the small rotator upon which smaller antennas can be set up. With the appropriate software control, this test set-up allows azimuth-over-elevation-over-azimuth control of antenna position, and great circle antenna pattern cuts can then be measured instead of the usual conical cuts obtained when either rotator is used alone.

Right

The large antenna rotator is hoisted to the top of the receive end test tower at the Caldermeade range (Insert: The installed rotator)


WALTER WRIGHT
WRIGHT



NEW TELECOMMUNICATIONS TECHNOLOGIES

Historically, telecommunications have played a major role in the development of the vast, remote island continent of Australia. The dependence of Australians upon communications linkages for business, social and rural activities has driven Telecom Australia to be amongst the first administrations worldwide to utilise many new developments in telecommunications technology. This was the case more than a century ago in the early days of telegraphy and telephony. Today, the technologies have changed dramatically, but the imperatives are as strong as ever.

Generally, it is at the fundamental level of research into new materials, components and techniques that the first indications occur of technology developments that will soon impact on telecommunications equipment, networks and services. The Laboratories undertake such research to maintain Telecom Australia's technological leadership, to generate strategic corporate advice on opportunities for exploiting new technologies, and to establish scientific and intellectual credibility and authority with local and overseas industry, academia and government.

For example, Telecom Australia pioneered the use of solar power systems for remote area telecommunications in 1974. Since then, it has earned an international reputation for the excellence and reliability of its remote area network. Present research encompasses new thin-film solar cell materials, novel battery types for energy storage and better approaches to solar power system design. The results of this work will further improve the reliability and reduce the costs of telecommunications in the remote parts of Australia.

The Laboratories have nearly two decades of experience in optical fibre technology. By 1980, it was obvious that silica glass fibre, now in regular use, had reached a state of near-perfection in terms of low loss transmission of light signals, and that any new breakthrough which might allow a significant extension of the distance between repeater amplifiers on a fibre link could only come from the use of entirely new materials and associated fibre fabrication processes. Over the last four years, the Laboratories have collaborated with university and industry groups to investigate and develop fluoride glass fibre technology for ultra-low loss mid-infrared optical communications. In the last year, the Laboratories have also produced some exciting new developments in active fluoride fibre components.

Further advances in near-infrared fibre systems, whether for future generation inter-exchange networks in the mid 1990s or for the first generation of optical customer access networks in the early 1990s, are largely dependent upon developments in optoelectronic components. These devices will have to be sophisticated and capable of high speed operation, yet available at a price consistent with the application. For the customer access network, they must be inexpensive. In the last year, staff of the Laboratories have invented and produced new components which are capable of integration into single-chip optical transmitter and receiver units.

The selection of research activities described in the next few pages illustrates the continuing commitment of Telecom Australia to harness new technology so that Australia will have a modern, efficient and reliable national telecommunications network in the next decade and beyond.

RADIATION DATA FOR SOLAR POWER SYSTEM DESIGN

Telecom Australia has made extensive use of solar energy over the last fifteen years, principally to power telecommunications equipment in the rural and remote areas of the Australian continent. During this period, the components that comprise a solar power system, such as photovoltaic modules, storage batteries and control electronics, have improved considerably. However, the databases recording solar radiation information are not as extensive as Telecom engineers would like to assist them to design solar power systems for the widely varying conditions of solar radiation which can be encountered at typical locations across the continent.

To design a solar power system that is reliable and yet cost-effective requires a detailed knowledge of the fluctuations in the sun's intensity from day to day, month to month, and even year to year. In Australia, the Bureau of Meteorology regularly measures and records solar radiation in comprehensive detail at less than 20 sites. These are typically located in capital cities or large towns, places where Telecom is least likely to use solar power because of the availability of mains electricity supplies. The Bureau's measurements are of the solar energy incident on a horizontal surface, whereas the solar modules used in typical telecommunications applications are usually mounted on an incline facing the sun to increase the energy collection. Thus, in Telecom's use of this data for design purposes, mathematical transformations containing several approximations and assumptions must be applied to determine the radiation levels actually incident on the solar modules.

In the Laboratories, the accuracy of these transformations is being investigated by using solar radiation data measured by pyranometers mounted horizontally and at a range of different angles of inclination. Radiation measurements are being made every five seconds and then averaged over thirty minute intervals before being stored. The experiment is being run over a complete year to give a range of solar altitude angles and sky conditions from heavy cloud to clear sky.

In an attempt to increase the number of locations for which Telecom's solar power systems can be more accurately sized, the Laboratories are also studying the potential use of the Bureau's more extensive records of sunshine-hours in Australia. This data is merely a daily record of the number of hours during which the sun's intensity is above a certain threshold. While being a less precise record of solar radiation, the records are available for more than 40 widely scattered sites which are more typical of Telecom's applications of solar power systems. The records for many of these sites extend back over thirty-five years. This is advantageous, because a twenty-three year solar cycle has been identified by other researchers, and this would not be apparent in the more accurate pyranometer records, which are generally less than ten years old.

There are a number of locations for which both detailed half-hourly radiation records and sunshine-hours data are available. In the Laboratories' studies, estimates of solar radiation which are based on sunshine-hours data but which use different algorithms have been compared against actual radiation records. Solar power system designs using actual radiation data and sunshine-hours data have also been compared.

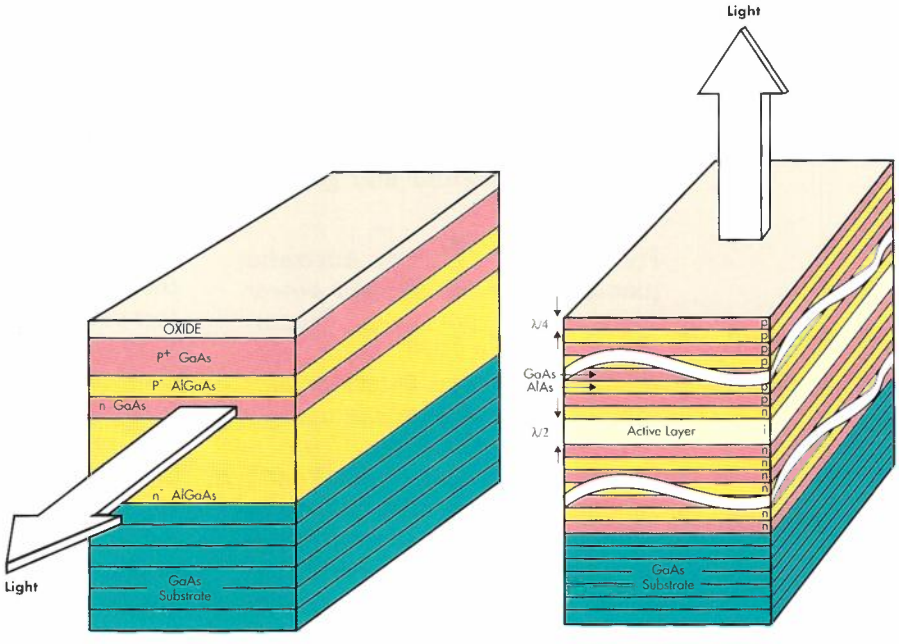
Results to date indicate that the sunshine-hours data can be usefully applied in solar power system design, since it often offers better accuracy than that which would be obtained by extrapolation from that for a site perhaps 1000km away.

NOVEL OPTOELECTRONIC DEVICES

A novel class of optoelectronic devices based on the gallium arsenide family of materials has been invented in the last year in the Laboratories. The devices offer the promise of radically changing the optoelectronics used throughout information and communications technology. The devices are lasers and optical switches, and their novelty lies primarily in their geometry, in that they emit light at right angles to conventional devices. This new feature has immense utility.

Usually, lasers are constructed from a multilayered, single crystal grown on a thin circular wafer. The devices must be cleaved out of this crystal before they can operate because the cleavage faces are the laser mirrors and the light is emitted from these faces.

The new transverse, or surface emitting, lasers invented in the Laboratories have their mirrors constructed during the material growth, during a very complex part of the multilayered growth process. It has been known most of this century that mirrors can be made by alternating layers of high and low refractive index - so called multiple interference filters. But this application calls for single crystal alternating layers of extreme purity and atomic precision in thickness. Such materials can be grown by



Conventional Laser **Laboratories Designed Laser**

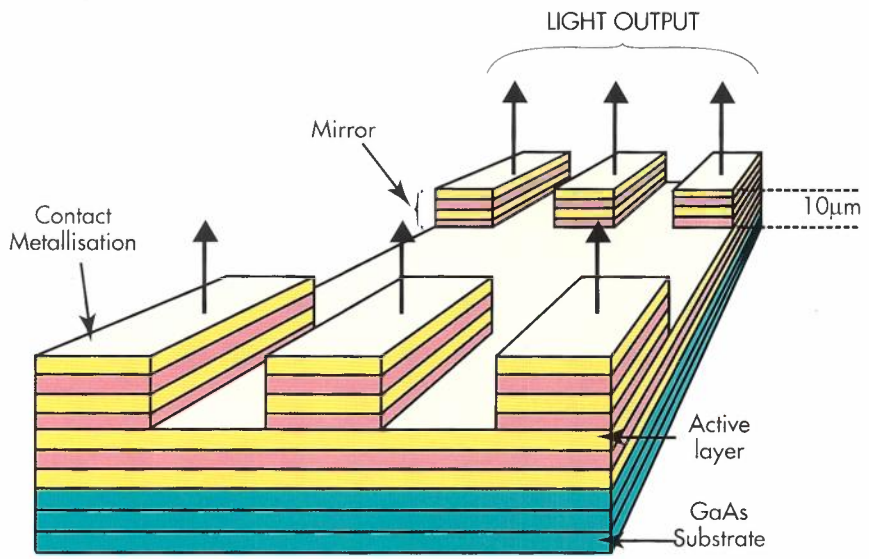
The Laboratories-invented laser structure (right) compared with that of a conventional laser (left)

Molecular Beam Epitaxy, a technique refined over the last eight years in the Laboratories to the point where they are one of the few laboratories in the world where the required precision can be attained. The structure has a narrow active laser region sandwiched between the thick mirrors. After etching back, a whole array of lasers is left pointing up from the surface of the wafer. A metal contact need only be placed on the top of each mirror and the lasers are complete.

The first applications are now evident.

Arrays of these devices offer great possibilities in information manipulation and switching. A 100 x 100 array gives 10,000 times the processing power of a single element. Such parallel processing of information is being researched worldwide in an endeavour to extend the present limits of conventional electronics.

The new devices invented in the Laboratories have an excellent chance of playing a significant role in the future advancement of optical communications.



The whole surface of a wafer (about 75mm in diameter) can be covered with lasers and focussed. Very powerful light sources can be constructed. Because the lasers do not need to be cut out before they are operated, they can be tested and, if found faulty, immediately ignored without any further processing. This will dramatically reduce costs. Further, conventional lasers emit from an extremely small area which does match well with the core of an optical fibre, but transverse lasers can be tailored to match the fibre core and optimise coupling. It will also be possible to etch self-alignment structures such as a rim, to aid this coupling and final packaging of the devices.

A similar structure can be used as an optical switch. It can reflect light of a specific wavelength until current is injected into the active layer, when the mirror property breaks down and the light is transmitted. A single device can also be used as a light modulator to code information in optical communications. Depending on the application, it can either modulate the amplitude or the frequency of the light.

Above
A surface emitting laser array

(Approx Number of GaAs/AlAs layers per device = 70. Operating current per device = 1 to 10 mA)

FLUORIDE FIBRES AND DOPED FLUORIDE FIBRE LASERS AND AMPLIFIERS PRESENT NEW NETWORK OPTIONS

Since 1986, the Laboratories have been actively developing techniques for drawing optical communication fibres from entirely new materials - the so-called heavy metal fluoride glasses. Such fibres could potentially transmit optical signals at mid-infrared wavelengths over 1000 km without the need for amplification. Steady progress has been possible in this work through close collaboration with the Chemistry Department of Monash University, which has undertaken research into the basic glass chemistry and prepared glass samples for drawing into fibres in the Laboratories. The University has been supported in its work through two R&D contracts let by Telecom for this purpose.

These efforts culminated recently in the successful fabrication of the first experimental lengths of multi-mode fluoride fibre to be drawn at the Laboratories' facility, marking a major milestone in the goal to demonstrate low-loss transmission at mid-infrared wavelengths in the laboratory.

However, there is another potential application of fibres which is generally less known, but which is playing a role in shaping future directions of some related work in the Laboratories.

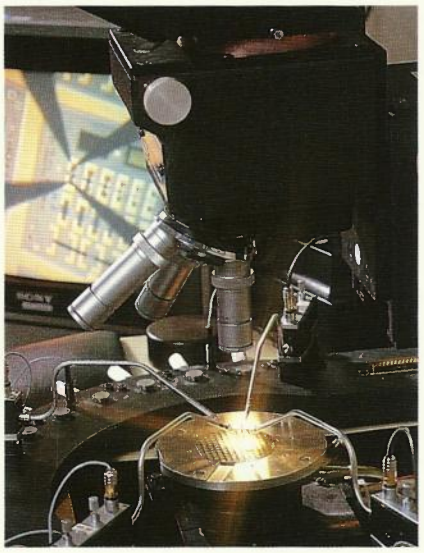
The confinement of light to a small core area less than 10 micrometres in diameter makes optical fibre a good medium for the control of optical signals. In particular, if small quantities of certain rare earth elements (dopants) are added to the core glass during fabrication, the resultant fibre will fluoresce and become "active" on exposure to short wavelengths of light. By appropriate selection of parameters, a short length of such a fibre can be made to amplify optical signals passing through it, or even to become a laser source. Different elements give different wavelengths. For example, neodymium is active at 1050 and 1300 nanometres, erbium at 1500nm and holmium at 2500nm.

Not unexpectedly, fluoride glass makes an excellent host for active fibre components at all wavelengths of interest in telecommunications. Paradoxically, silica glass is quite inappropriate as a host for neodymium at 1300nm, the wavelength at which most systems currently operate. Moreover, erbium-doped fluoride is

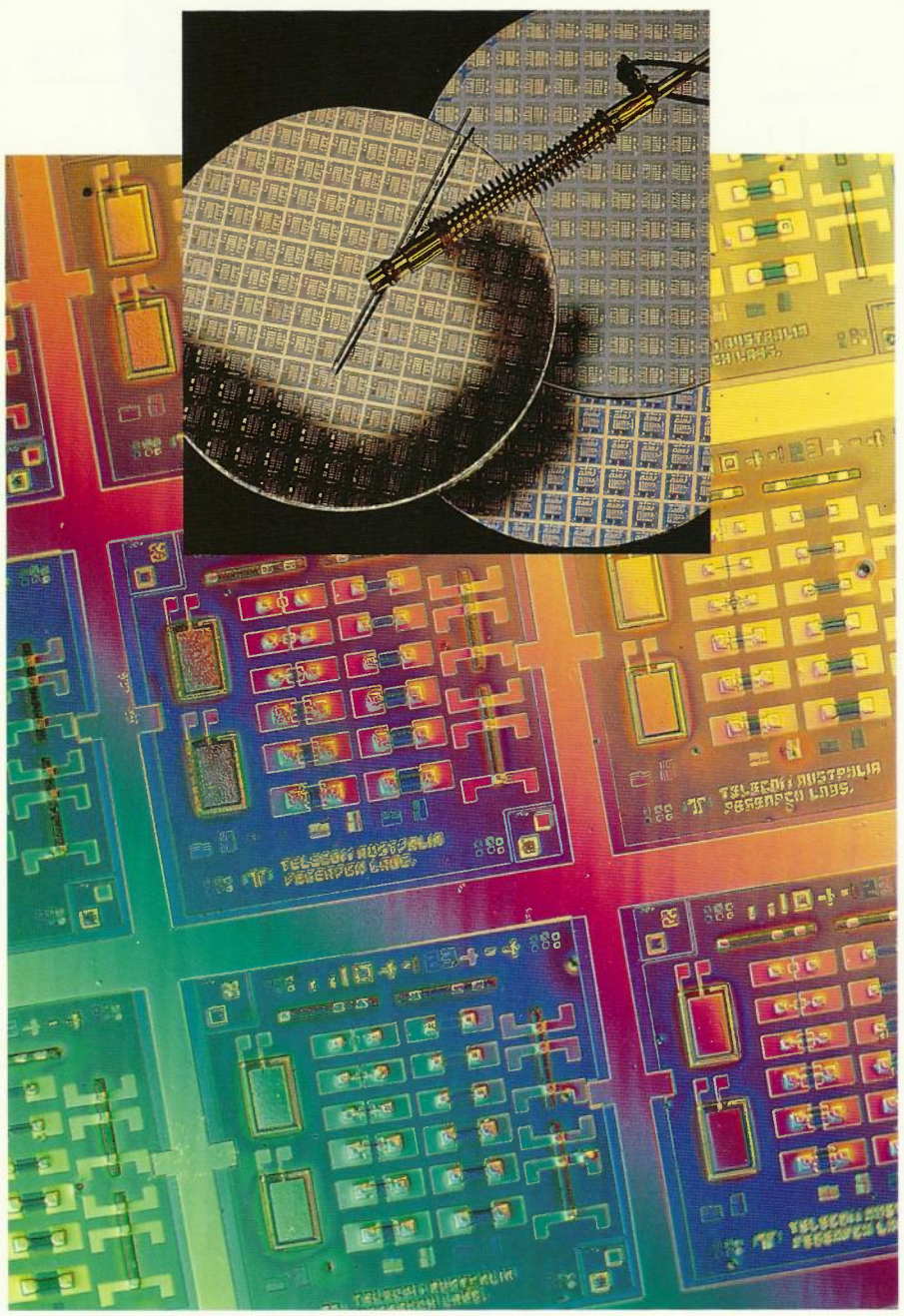
active over a much broader range of wavelengths near 1500nm than erbium-doped silica. Therefore, one of the earliest applications for fluoride glass fibres could well be as lasers and amplifiers operating at near-infrared wavelengths.

Consequently, a glass fabrication facility has been established in the Laboratories to investigate active fluoride fibres and their potential for application as amplifiers and sources in various parts of the future optical telecommunications network. It is clear that the low cost of such devices presents new options for application as repeater amplifiers in the long haul network, as well as lasers in the optical fibre distribution network as it evolves in the 1990s.

Above
Excitation of a fluoride glass rod (centre) with UV light produces fluorescence which is characteristic of the dopants in the glass



Left
Test probing a patterned MCT photoconductor test chip (shown at increasing magnifications)



MID-INFRARED OPTOELECTRONIC DEVICES

For just over 12 months, considerable effort has been devoted in the Laboratories to a new project to develop techniques for the growth of the compound semiconductor material, mercury cadmium telluride (MCT), and to fabricate optoelectronic devices from it. This material shows great promise in optical telecommunications applications because its band gap, and hence the wavelength that it can detect, can be tailored by adjusting its composition. MCT devices could be made for applications right across the infrared band, including the 1.3, 1.55, 2.5 and 3.5 micrometre wavelengths of current and future telecommunications interest. However, MCT is expensive and difficult to obtain, as well as being more difficult to process into devices than materials based on silicon and gallium arsenide.

During the year, about one hundred 5cm wafers of cadmium telluride, mercury telluride and mercury cadmium telluride were grown in the Laboratories using the Metal-Organic Chemical Vapour Deposition (MOCVD) process. Subsequently, the electrical and physical properties of the wafers were comprehensively analysed. Almost all of the wafers used commercially available gallium arsenide as a substrate since this material is strong, relatively cheap and, though not atomically matched, forms a good base for the thin epitaxial layers of MCT in which devices are made. As a result of this development effort, it was concluded that the best process for the growth of MCT is to grow a large number of alternate thin layers of cadmium telluride and mercury telluride to form a multi-layer structure. The band gap can then be tailored by adjusting the relative thicknesses of the layers. Some very good layers with excellent electrical properties, uniformity and surface smoothness have been grown in this way.

Concurrently, a fabrication technology for making optoelectronic detector devices from the grown MCT was being developed in the Laboratories. An initial problem of delineating the MCT into individual device structures was solved by the development of a novel etch solution based on potassium iodide, which rapidly etches the MCT layer but leaves the gallium arsenide substrate material untouched. For device fabrication, a surface passivation layer with insulating properties is also required which is compatible with both the MCT and gallium arsenide substrate as well as with the metal interconnection system. It must also be readily etched without damaging the MCT. Silicon dioxide, polyimide and zinc sulphide are promising candidates which have been investigated to date. After investigation of several alternatives, a double layer of chromium-gold was found to be the most suitable metallisation system.

Using this technology, a number of wafers have been patterned with photoconductive detector devices as well as special test structures for determining electrical properties. Packaged devices fabricated in the Laboratories using this technology have been used to show that they are efficient detectors of laser light at a wavelength of 2.5 micrometres at room temperatures. This work has demonstrated the potential of MCT devices for use in future generations of mid-infrared communications systems.

ADVANCED FACILITIES FOR MATERIALS RESEARCH

The Telecommunication Science and Technology Branch provides expert engineering research and development support to other Laboratories' Branches and other areas of Telecom in the fields of mechanical, electrical and electronic engineering. This support encompasses the design, development, analysis and manufacture of specialised prototype components and equipment relevant to Telecom's research activities and future needs.

Such activity, essentially innovation, relies on a broad knowledge of engineering physics and mechanics, and requires an in-depth knowledge of material properties, stress analysis, heat transfer, fluid mechanics and computer techniques. In the management of particular projects, techniques such as mathematical modelling, simulation and computer-aided design are used to provide valuable insights before prototype manufacture. Prototype manufacturing facilities include conventional and numerically controlled machinine tools, and tools for forming, joining and assembly work.

These skills and facilities has been applied successfuly, over many years, to a wide range of construction projects and also to the solution of a number of difficult field problems.

During recent times, the construction of a Recirculating Inert Atmosphere Chamber (RIAC) system, otherwise describable as a glovebox for handling volatile or sensitive materials, proved to be an interesting, innovative and challenging project.

A successful RIAC system must always maintain within its walls an inert atmosphere which is essentially free of the most reactive components of air, namely oxygen and moisture. This permits expensive, extremely high purity materials to be readily manipulated, processed and stored inside the chamber, with minimal reaction with the chamber's inert atmosphere. Examples of such materials include the very high purity feedstocks used in the production of glass pre-forms from which fluoride glass optical fibres are drawn and the materials used in the fabrication of semiconductor devices by processes such as Metal-Organic Chemical Vapour Deposition (MOCVD).

The decision to design and construct the RIAC system in-house followed visits to overseas research organisations, which highlighted the scarcity of commercially-sourced chambers of suitably advanced specifications. To meet the Laboratories' requirements for an advanced RIAC at a realistic cost, comprehensive design specifications for the system were first developed. These included technical features superior to any known commercial system available in Australia or overseas.

The design, development, manufacture and commissioning of the RIAC system took only eighteen months to complete, providing the Laboratories with a state-of-the-art facility which has the following advanced features:

- dual main chambers, with a common three way ante-chamber (ie. material transfer port) requiring only one re-circulator - thus allowing work to be carried out simultaneously in both main chambers,
- all stainless steel construction - to minimise contamination,
- duplication of key components for added reliability in the event of their failure - with all components accessible, readily serviceable and available at short notice,
- mobile shelves and loading trays for easy access, but which move out of the way when not required,
- an interlock system on all port doors - to prevent contamination of the main chamber's atmosphere by the accidental opening of any door,
- automatic evacuation and re-filling of the ante-chambers,
- eye-level control and display panels - showing system operating status.

The Laboratories' staff involved in the RIAC project were pleased when their skills and efforts were recognised by the Victorian Division of the Institution of Engineers, Australia. The Institution judged RIAC to be the best product submitted in 1989 in the "engineering products" category in its annual process of making Awards for Engineering Excellence in five product categories. This Victorian State Award was made in May 1989, and it also made RIAC eligible for consideration for the Institution's National Award later in 1989. The latter Award is granted to the best of the products which won State Awards.

Above
The award-winning Recirculating Inert Atmosphere Chamber designed and built in the Laboratories

RELIABILITY ASSESSMENT AND STANDARDS

Telecom Australia seeks to provide its customers with economical and reliable telecommunications services. With the ever-increasing sophistication of telecommunications systems and equipment, a high level of quality and reliability in both hardware and software is required, together with efficient maintenance and assured safety of Telecom's personnel and customers. Another necessity is a sound base of technical specifications and standards upon which to build Telecom's networks.

To achieve Telecom's reliability goals, all materials, components and parts in the systems and equipment should perform their specified functions for their entire design life spans in the variety of Australian environments. Degradation of materials or components, causing equipment malfunctions or downtimes, results not only in costly repair or replacement, but also in customer dissatisfaction and losses in revenue. Equipment malfunctions, inadequate equipment specifications or incorrect work practices can also introduce occupational safety and health issues, or in worst cases scenarios, potential causes of personal injury or damage to plant and property.

The Laboratories assist Telecom's Product Managers and Design Engineers with material selection and the assessment of parts, components and assemblies to ensure reliability. Laboratories' investigations involve the measurement of relevant parameters and comparison with specifications, such that all factors affecting reliability or performance in the operational environment are considered.

This work often requires simulation of the stresses and conditions to which a product may be exposed during its service lifetime.

Preferably, reliability assessment should occur in the product design phase, when it can be applied most easily and effectively. Hence, the Laboratories' reliability assessment and failure analysis investigations are often performed in close co-operation with suppliers of materials or equipment to Telecom.

When problems arise in the field, they can be widespread and costly to rectify, and it is imperative that the Laboratories can quickly determine causes and produce remedial measures.

Compatibility and safety of equipment are reliability-related issues investigated by the Laboratories. Electromagnetic compatibility is an increasingly important aspect of equipment performance, as semiconductor-based equipment is often prone to electromagnetic interference. Bioelectromagnetic hazards are also of concern. The work practices which Telecom adopts must be assessed in terms of occupational health and safety requirements.

Telecommunications is dependent on accurate measurement, and the Reference Standards maintained by the Laboratories provide traceability to the Australian National Standards and contribute to the efficient operation of the network. The Laboratories operate, develop and disseminate electrical, optical, time and frequency standards to meet Telecom's needs. This work encompasses the development of measurement techniques, the solution of measurement-related problems, and liaison with national and international standards laboratories and authorities.

The next pages of this Review describe some projects related to reliability assessment and standards which have been performed in the past year.

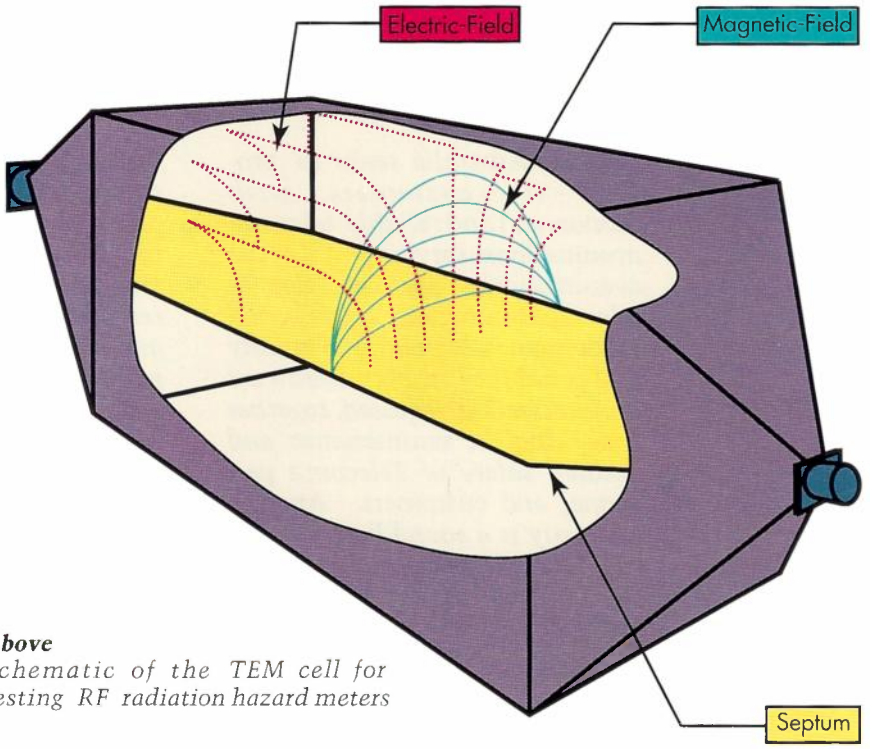
TEM CELLS FOR TESTING RF RADIATION HAZARD METERS

Telecom is committed to ensuring that the working environment is safe from possible hazards to personnel through their exposure to radio frequency (RF) radiation, and that members of the general public are not exposed to excessive levels of RF radiation due to their proximity to radio/TV broadcast and radiocommunications installations owned or operated by Telecom. Australian Standard AS2772-1985 provides guidance on the exposure of persons to RF radiation and sets limits to avoid possible hazardous effects from such exposure.

To demonstrate compliance with the limits contained in the Standard, the levels of RF radiation must be measured, and because of the very large number of Telecom installations emitting significant levels of RF radiation, surveying all of them is a task of considerable magnitude. Survey teams in each state and individual lines teams have been equipped with RF radiation hazard meters, so that routine surveys can be performed and personal exposure levels assessed on a day-to-day basis by the staff most closely involved with RF radiation.

Unfortunately, the failure rate of RF radiation hazard meters purchased by Telecom has been higher than expected. This is generally a consequence of the fragile nature of these instruments and the environments in which they are used. In many cases, the failure mode is such that the fault is difficult for the operator to detect without access to specialised test equipment, and therefore the fault may go undetected for some time.

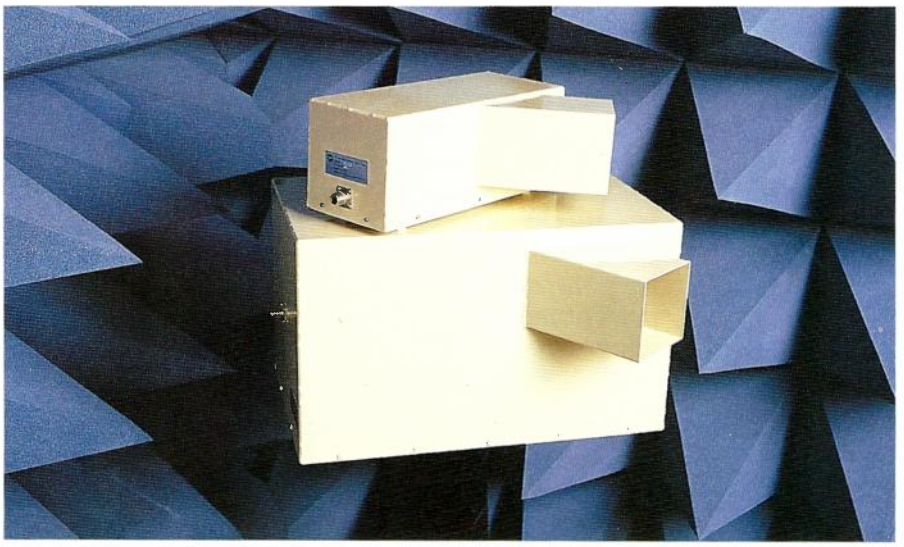
To overcome these problems, the Laboratories have developed two types of inexpensive Transverse Electromagnetic (TEM) cells. One measures 500 x 300 x 300 mm and is designed for testing RF radiation hazard meters in the depot. The other, measuring only 350 x 150 x 150 mm and thus more portable, is more easily used for testing in the field. Both are capable of testing the range of RF radiation hazard meters used by Telecom staff.



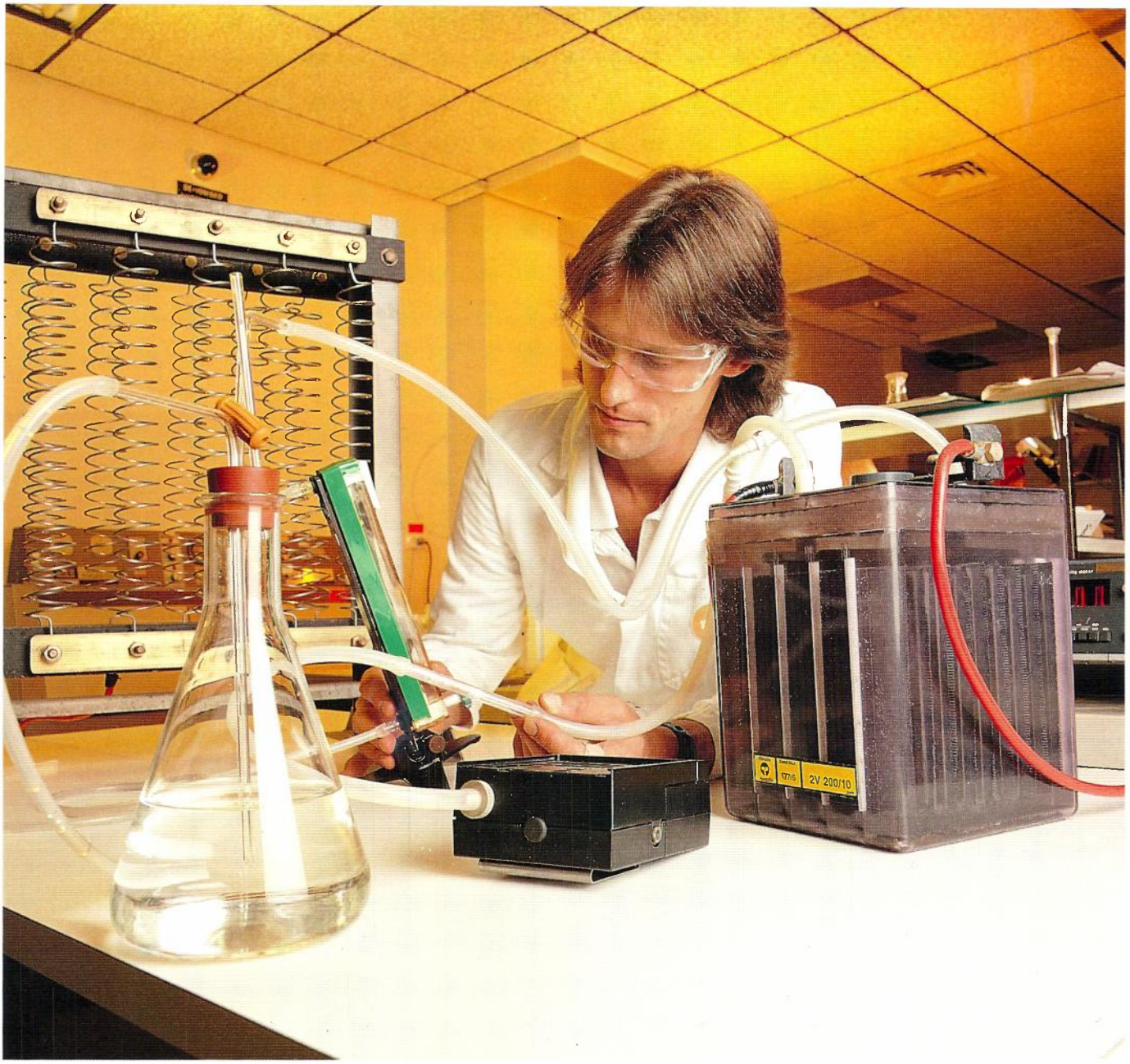
Above
Schematic of the TEM cell for testing RF radiation hazard meters

M.L. Crawford, of the US National Bureau of Standards, first described the design and use of TEM cells in the early 1970s. These cells were rectangular cross-section coaxial 50-ohm transmission lines, tapered at each end to adapt to conventional 50-ohm coaxial connectors. The central conductor (or septum) is a metallic sheet supported by dielectric material. When RF power flows through the cell, a TEM field is formed between the septum and the walls of the cell. For a well-designed and matched cell, the TEM field will simulate a plane wave in free space. All of Crawford's designs provide for tapered end-sections to match the rectangular coaxial section in the centre of the cell to the round coaxial connectors at each end. These tapered sections are both expensive to produce and bulky. In the Laboratories' designs, the tapered end-sections have been eliminated and the septums tapered to provide the transitions to the coaxial connectors. These designs result in small rectangular cells having only slightly poorer performance than that obtainable with a Crawford cell.

The two types of Laboratories-designed TEM cells and suitable commonly available ancillary test equipment and test procedures have been described in detail in Research Laboratories Report 7928. This project has made available inexpensive portable equipment, suitable for the testing of the range of RF radiation hazard meters in use by Telecom staff.



Right
The Laboratories-designed TEM cell for testing RF radiation hazard meters



Above
Stibine gas analysis in the laboratory

STIBINE GAS IN THE EXCHANGE ENVIRONMENT

The use of back-up battery power is essential for the provision of continuous service to the customer network in the event of mains power interruption. To supply this back-up power, exchanges have battery banks of lead-acid cells which are maintained on "float" until called into service when the mains power supply is interrupted. Following restoration of mains power, the batteries are recharged and generally only approached thereafter for routine maintenance procedures.

For its standard lead-acid storage cells, Telecom Australia specifies pure lead positive plates and lead negative plates containing low levels of antimony.

Theoretical knowledge of the electrochemical reactions that take place during the re-charging of these batteries indicates that, under certain conditions relating to antimony concentrations in the plates and charging rates, it would be possible to generate the toxic gas, antimony tri-hydride, which is more commonly known as "stibine". The Threshold Limit Value for exposure to stibine is 0.1 parts per million.

During the past year, the Laboratories undertook a series of sampling and chemical analysis procedures, to determine whether or not this threshold level could be surpassed on a routine basis in the Telecom exchange workplace. Under certain conditions, the presence of stibine was detected, confirming theoretical predictions, and the levels of stibine generated were quantified. Recommendations relating to the specification of batteries, installation and maintenance procedures have subsequently been made to ensure a safe working environment for Telecom staff.

CFCs, THE OZONE LAYER AND TELECOM

In the last ten years or so, there has been increasing scientific concern worldwide that a group of chemicals, known generally as chlorofluorocarbons (CFCs), is causing depletion of the world's ozone layer in the stratosphere. A related group of materials known as Halons are also implicated. Both CFCs and Halons are extremely stable and, once released into the atmosphere, remain virtually unchanged for decades. The most common CFCs in the atmosphere have an effective lifetime of 75 to 110 years. Over time, they drift up to the stratosphere where they play an important part in complex degradation reactions, resulting in the destruction of ozone molecules. The consequences of increased ultra-violet radiation following ozone depletion and its effects on humans and climate have been widely reported in the popular media in recent times.

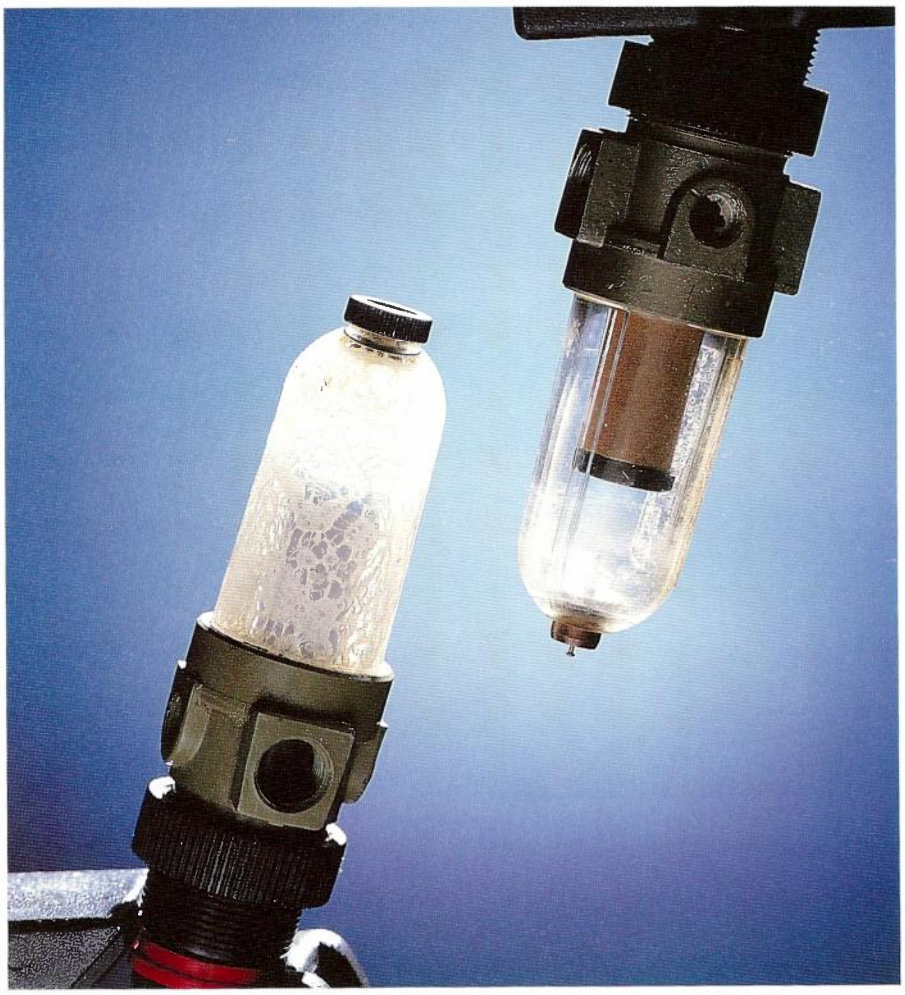
In 1988, in order to redress the problem of ozone depletion, Australia, along with many other countries, became a signatory to the United Nations Environment Programme, Montreal Protocol. The signatories agreed that, by 1990, they would freeze their consumption of CFCs (11, 12, 113, 114 & 115) at the 1986 level, followed by a 20% cutback before 1994 and a further 30% reduction before 1999. Consumption of Halons 1211, 1301 and 2402 will be frozen at 1986 levels by 1993.

Scientists at the Laboratories have been monitoring developments with CFCs and Halons for some time and, in collaboration with Telecom's National Occupational Hygienist, issued a draft Telecom policy in January 1989. The document takes cognisance of the Montreal Protocol and also the more rapid phasing out of CFCs proposed by various State Governments within Australia.

Telecom field staff use several products which contain CFCs, such as propellants in aerosol sprays, cleaning sprays and leak detecting systems. The Laboratories have been investigating alternative products which do not contain CFCs for field use. However, the effects of the substitute products must also be considered. For example, a polycarbonate filter bowl which was sent to the Laboratories for investigation was found to have crazing and stress cracks following contact with R22, the leak detector which Telecom recently introduced as a replacement for R11. In a small way, this highlights a typical secondary problem involved in the replacement or substitution of CFCs.

On a larger scale, the manufacturers of CFCs have millions of dollars invested in manufacturing plant and R&D programmes to develop safe alternatives to CFCs. The Laboratories are closely monitoring new developments, to ensure that Telecom can apply them as soon as is practicable and to provide Telecom staff with advice and answers to practical problems arising from the phasing out of CFCs and Halons.

Below
Cracked and crazed filter bowl resulting from exposure to a CFC substitute (left) compared with an undamaged filter bowl



ELECTROMAGNETIC COMPATIBILITY OF INFORMATION TECHNOLOGY EQUIPMENT

The International Electrotechnical Vocabulary (IEV) defines electromagnetic compatibility (EMC) as "the ability of a device, equipment or system to function satisfactorily in its electromagnetic environment without introducing intolerable electromagnetic disturbances into that environment or to other matter or equipment therein." The IEV definition incorporates the two key aspects of EMC. The words "to function satisfactorily" mean that the object is tolerant of others and is not susceptible to disturbances present in the environment. The words "without introducing intolerable disturbances" mean that the object gives no offence to others and emissions from it do not result in electromagnetic interference (EMI).

Above
Telecom's Touchfone 200

Both aspects of EMC are becoming increasingly important factors as Telecom Australia introduces an expanding range of information technology equipment (ITE). Even the humble "first phone" now falls within the scope of ITE. Telecom's recent introduction of the Touchfone 200 allows the manipulation of information, entered via the keypad by the telephone user, to provide storage, recall and abbreviated dialling of telephone numbers. The use of digital information processing and low-power integrated circuits in the ubiquitous first phone now means, more than ever, that both electromagnetic emissions and susceptibility must be taken into account if the low-cost realisation of such a product is to be successful.

However, an economic balance must be reached between the needs for EMC and the cost of the new product. If this balance is successfully achieved, the percentage of environments which are affected by, or interfere with, the new product will be acceptably small. Standard production devices will not be burdened with the cost of any special EMC measures that may have to be incorporated to deal with a small minority of hostile environments, and the overall cost to consumers will be minimised.

This approach was attempted in the development of the Touchfone 200. However, problems of susceptibility to EMI were encountered when Touchfones were installed in close proximity to medium frequency broadcast transmitter sites, neon signs, high voltage power lines, air surveillance radar systems, radio-frequency plastics welders and very high frequency mobile radio system base stations. The susceptibility manifested itself as audible interference in the form of intelligible audio demodulation, hum or buzzing, depending upon the type of interference source.

The Laboratories were asked to devise special modifications for the standard Touchfones to improve their im-

munity and thus enable them to operate satisfactorily in such hostile environments. A key requirement was that the modifications should impose minimal additional cost over that of the standard product, subject to the need that the problems must be solved.

The required improvements of the immunity of the Touchfone were obtained by making a number of seemingly minor modifications. However, in combination they had great significance electromagnetically.

Converting the analogue transmitter and receiver circuits from single-ended to balanced working provided a large immunity improvement, costing only a few extra components. The insertion of lossy radio-frequency suppression components at particularly sensitive points of the active circuits and in the telephone cord, and internal rearrangement of wiring in the handset, achieved additional immunity improvements. The required levels of immunity were thereby achieved at small additional cost.

As an outcome of this work, Telecom is now able to provide Touchfone 200 telephones, modified for improved EMC, to customers located in hostile environments, where the standard version of the Touchfone cannot be satisfactorily operated.

TRANSISTOR FAILURES IN RADIO PAGING TRANSMITTERS

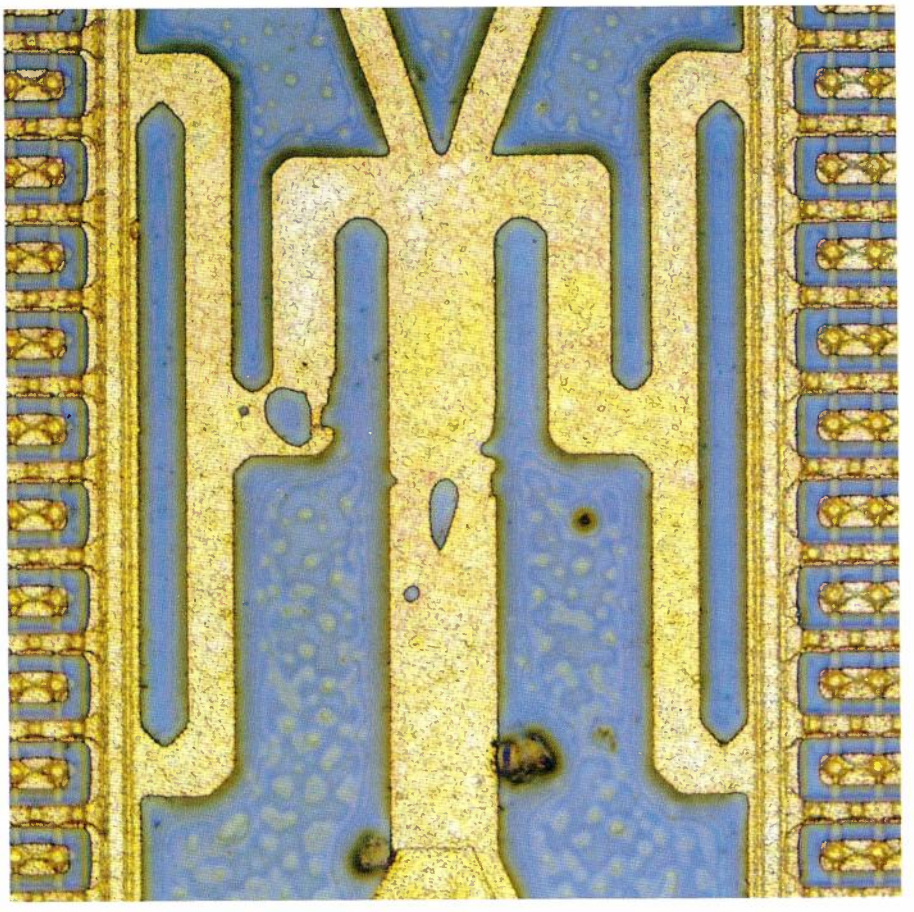
A recent investigation of early component failure involved high-power RF output transistors in radio-paging transmitters. These devices were reported to be overheating severely in service, such that, in some cases, the solder connecting the collector leads to the printed circuit boards had melted. Initially, it was thought that poor load matching may have been the reason, and this was seemingly supported by field observations that the electrical characteristics of the overheating devices, when removed from the equipment, appeared to be normal. However, some of the transistors were forwarded to the Laboratories, where they were subjected to a more comprehensive examination utilising a variety of failure analysis techniques. This revealed a number of defects, most of which resulted from inadequate quality control during fabrication. The faults included:

- ineffective die attach, preventing the efficient transfer of heat from the silicon to the heatsink and causing overheating,
- poor quality etching of both the metal and diffusion layers,
- broken bond wires and defective bonding, and
- contamination present on the surface of the silicon.

In addition, other defects arising from operation at excessive temperatures included metal migration between the base and emitter fingers. This was evidenced as short circuits, fusing of the metallisation and vapourisation of the silicon itself in several regions. The electrical characteristics of these devices appeared to be normal in the earlier field tests only because the damaged junctions were effectively isolated from the remainder of the device by the fused metal lines. However, the resulting increase in current density in the remaining active regions eventually produced even higher temperatures, leading to further catastrophic damage and eventual total device failure.

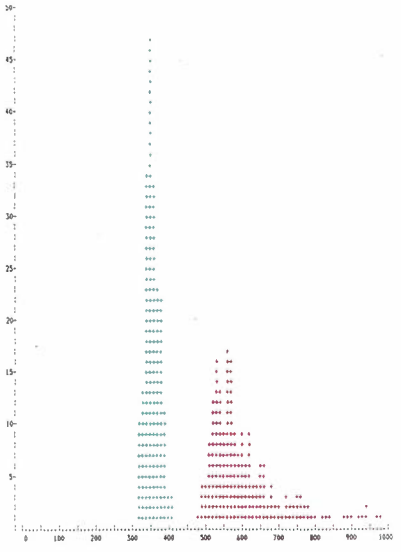
This case illustrated that it is often necessary to perform a detailed investigation of the individual components involved in order to identify the actual cause of a problem.

Below
Metallisation faults found in a failed RF output transistor



NEW GAS-FILLED OVER-VOLTAGE PROTECTORS

Electrical surge tests were recently performed by the Laboratories on the subscriber line interface card, LIC-8, used in the AXE 104 rural exchange system. These tests showed that the gas-filled protectors currently used in other exchange systems in the Telecom network may not provide adequate protection for the LIC-8 card. To overcome this problem, discussions were held with two manufacturers of gas-filled protectors. As a result, one manufacturer offered to develop an improved product with a maximum impulse firing voltage of not more than 550 volts.



Above
Distribution of firing voltages of new (left) and older generation gas-filled protectors

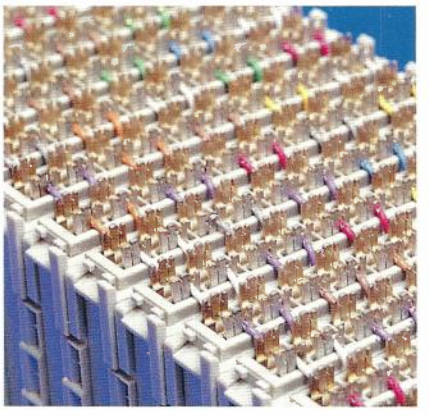
As an outcome of these discussions, both manufacturers now produce 230 volt (DC firing voltage) protectors with impulse firing voltages less than 550 volts. One is now able to produce protectors having an average impulse firing voltage of 360 volts. This dramatic improvement in the electrical characteristics of these devices will enable them to be used to protect equipment which had previously required more costly protection circuitry involving two or three separate protective components. The most immediate initial application is in PABXs.

MAIN DISTRIBUTION FRAME INTERCONNECTION TECHNIQUES

Electrical interconnection is an active area of study in the Laboratories, as it is vital to the reliability of Telecom's network and there is great diversity in the range of interconnection components which Telecom uses. A major task undertaken recently by the Laboratories was the assessment of various main distribution frame (MDF) designs offered to Telecom.

All MDF termination blocks nowadays use the insulation displacement method of termination, while some also use a combination of wire wrap and separable connectors for connection to exchange equipment. To evaluate the reliability of various termination designs, programmes of accelerated environmental tests, electrical measurements and mechanical tests were performed, in addition to materials analysis and assessment of the associated over-voltage protection systems.

Although the majority of the MDF termination systems performed well, some weaknesses became apparent. These included unacceptable over-voltage protection, unstable contact resistance and excessive mechanical flexibility leading to mechanical damage to the contacts during termination. As might be expected, no particular system contained all of the best features, and, as happens quite often, even the best of the systems tested was found to require some improvement to meet Telecom's exacting standards.

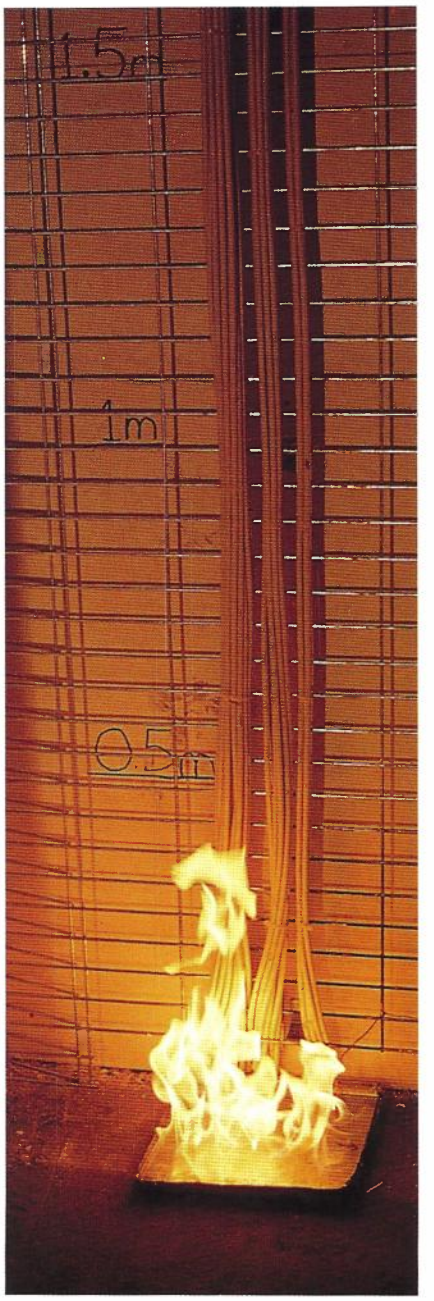


Above
Part of an MDF module, showing insulation displacement terminals

NEW SHEATH FOR AXE EXCHANGE CABLE

The secondary damage caused by the acidic and toxic smoke produced by combustion of polyvinyl chloride (PVC) cable sheath in telephone exchanges is recognised worldwide as a serious problem. For some time, scientists at the Laboratories have been investigating alternatives to PVC which would be halogen-free and fire-retardant, with low smoke generation and non-dripping properties when burning.

Below
In laboratory fire tests, the vertical cable configuration was used to represent the most vulnerable field condition



In these investigations, a number of small-scale fire tests were used to select six materials as the most promising substitutes for PVC from 23 materials offered by various manufacturers around the world, including Australia. The six materials were based on polyolefins and heavily filled with hydrated aluminium hydroxide. Following selection, the materials were used to manufacture cable samples for full-scale fire tests.

The development of a relevant full-scale fire test procedure was paramount to overcome some of the deficiencies inherent in small-scale laboratory tests. Inspection of several exchanges isolated the fire scenario which the tests needed to simulate. While many cables are horizontal throughout an exchange, it is the vertical configuration, and particularly the bunched cables feeding the shelves of an AXE exchange, that are the most commonplace and most vulnerable to fire.

The final full-scale fire tests were carried out at the National Building Technology Centre at North Ryde, NSW. A number of parameters such as time to ignition, rate of flame spread and smoke density were measured as each of the several cable samples was burning. As expected, the traditional material, polyvinyl chloride, exhibited one of the slowest flame spreads, but it also showed the fastest ignition time and evolved the highest amount of smoke. PVC was the only material tested which gave off corrosive gases.

This fire performance testing programme has confirmed that several grades of commercially available materials are suitable alternatives to PVC for cable sheath in AXE telephone exchanges. The results of these Laboratories' investigations have enabled Telecom's Network Engineering SRU to issue a specification for halogen-free, low-smoke, fire-retardant cable.

LONG-TERM PERFORMANCE OF OPTICAL FIBRE CABLE AND CABLE SPLICES

The installation of optical fibre cables has continued steadily over recent years in order to achieve Telecom's goal of having a nationwide optical fibre trunk network in place by the early 1990s. Single mode optical fibre and an Australian non-metallic cable design have been adopted by Telecom Australia as its standard for trunk cable networks, using the best available technology in terms of materials, manufacture and installation. To date, field experience with the optical fibre network has shown that it is superior to the copper network in terms of reliability and performance.

Nevertheless, with all new technology, there is an element of uncertainty relating to its very long term performance. A research programme is therefore underway in the Laboratories, whereby single mode fibres and cables are being subjected to highly accelerated tests in the laboratory, to investigate the effects of environmental factors which might cause performance deterioration over many decades in operational service. The programme covers factors such as thermal ageing, water immersion and exposure to high humidity and traces of hydrogen gas. In order to predict any change in transmission properties that might be occur in long operational service, high repeatability spectral loss measurements are made at frequent intervals and kinetic models are used to extrapolate the experimental results into service lifetimes of many decades.

So far, the overall outcome of this work has been positive, demonstrating that the Australian-made optical fibre cables used in Telecom's network are among the best currently available worldwide.

A complementary programme is also in progress in the Laboratories to investigate single mode optical fibre mechanical splices and their associated protectors, fixing hardware and organiser trays. The aims of this programme are to determine the best splice types for temporary repair purposes, and to ascertain whether or not mechanical splices are an acceptable alternative to fusion splices for permanent installation, for example, in the Customer Access Network (CAN). In such applications, good return loss performance is essential over long periods.

In the Laboratories' tests of mechanical splices, the splicing systems were assembled in accordance with their manufacturer's instructions and Telecom's standard field practices. They were then subjected to a wide range of controlled environmental tests in the laboratory, including dry-heat ageing, temperature cycling, high relative humidity, temperature and humidity cycling, immersion in liquids and mechanical vibration.

In some instances, the failure modes of the splices were consistent with the degradation mechanisms expected for their individual component materials. In other cases, the failure mechanisms are the subject of continuing studies. On the basis of the results obtained to date, the most cost-effective mechanical splices, suitable for use as temporary splices on the optical trunk network, have been identified. In addition, the Laboratories have been able to recommend technical specifications for relevant properties and test procedures for incorporation into Telecom's specifications.

Further assessments of the suitability of splicing systems for long-term application in the CAN are proceeding.

STANDARDS OF TIME AND FREQUENCY

A modern telecommunications network must incorporate accurate frequency and time standards to ensure its efficent operation and compatibility with other networks around the world.

Telecom Australia's predecessor, the Postmaster General's Department, first established frequency standards at the Laboratories in 1930, when frequency was derived from tuning fork oscillators. Since then, the standards installation has evolved to include state-of-the-art caesium beam frequency standards. The Laboratories are one of only two Australian organisations authorised under the National Measurement Act to operate secondary standards of measurement of frequency and time interval. The Laboratories are also the only telecommunications Verifying Authority under the Act, and hence have legal status for all measurements performed.

Distributions from the Laboratories' time and frequency standards include:

- Provision of synchronising signals from the National Reference Clock located at the Laboratories to control the Integrated Digital Network (IDN), the Digital Data Network (DDN) master clock and the Integrated Services Digital Network (ISDN) Exhibition exchange node.

  By synchronising its digital switching and transmission networks to this reference clock, Telecom minimises the digital slip rate performance between its Australian network and other networks, nationally and internationally. It also gains the ability to provide sophisticated network facilities and features associated with the ISDN, DDN and synchronous transmission multiplexing.
- Control of the frequency division multiplexed (FDM) analogue network via the distribution of two-tone reference frequencies.

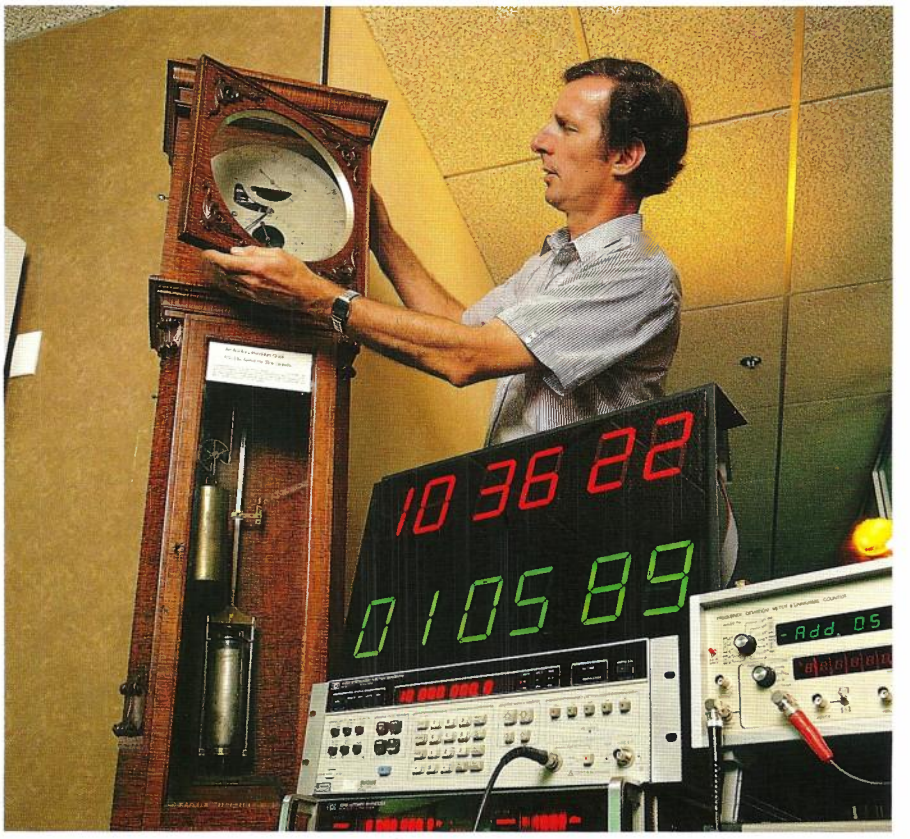
  This involves the distribution of a 1 kHz standard frequency over a voice channel of the FDM network, transmitted as the difference of two frequencies, 1.7 kHz and 2.7 kHz. The two-tone signal provides a frequency reference to enable accurate setting of carrier oscillators in the trunk system. It is also used as a reference signal for Laboratories-designed controlled oscillators, to provide precise phase and frequency. These are used as master oscillators in the trunk network and provide standard frequencies for use by master clocks for timing and frequency calibration.
- Provision of accurate and traceable time of day for Telecom's Speaking Clock network to the capital cities of all Australian States and to larger provincial cities, and the distribution of Civil Time Code signals in a binary coded decimal form over a voice channel.

  The Speaking Clock also provides the Australian Broadcasting Commission and a number of commercial radio stations with timing signals, which are broadcast as six pips to mark the hour. As the present Speaking Clock has reached the end of its economic life, a replacement has been developed by the Laboratories and the component systems are being manufactured by Australian firms. The oscillators, civil time receivers and time signal distribution units have been delivered and the announcing systems are undergoing final evaluation. Installation is expected in 1989/90.
- Distribution of accurate time of day to Telecom networks and services, such as AUSTPAC and Keylink, as well as to a range of government agencies and instrumentalities.
- Distribution of standard frequencies and special timing signals to industry, government agencies and universities in Melbourne and Adelaide via the Telecom network.

The Laboratories also provide technical advice to Telecom and its customers on network synchronisation and on specialised time and frequency equipment for timing systems.

The abovementioned time and frequency standards support a number of customer services as well as underpinning the integrity and international compatibility of Telecom's networks. They also provide Telecom with a precise basis for acceptance testing network equipment purchased from a wide range of suppliers. Accurate reference frequencies are also essential in Telecom's equipment servicing areas, to ensure that equipment continues to operate within specified limits for satisfactory network performance.

Below
Telecom's National Reference Clocks in the technologies of the 1920s (left) and the 1980s (right)



STANDARDS OF ELECTRICAL AND OPTICAL QUANTITIES

The Laboratories are responsible for providing and disseminating the reference standards of electrical and optical quantities required for Telecom's operations. These standards are directly traceable to the Australian National Standards of measurement maintained by the CSIRO. The Laboratories operate as a Verifying Authority, appointed by the National Standards Commission, and as a testing laboratory, registered with the National Association of Testing Authorities.

The Laboratories disseminate these reference standards throughout the Business Divisions and Shared Resource Units of Telecom by:

- calibrating all Telecom working reference standards on a regular recall basis,
- assessing the capability of measurement laboratories throughout Telecom by performing proficiency and audit tests, by the use of stable travelling standards and by subsequent analysis,
- developing specialised reference standards and measurement techniques,and
- providing specialist advice to other calibration and measurement areas in Telecom on all aspects of reference standards and associated operations.

Since their inception in 1923, the Laboratories have been responsible for the provision of reference standards for electrical quantities. This has now grown to cover the frequency range from dc to 40 GHz, with calibrations carried out on a wide range of reference standards, including dc voltage standards, vernier potentiometers, inductive dividers, standard resistors, standard capacitors, thermal converters, power transfer standards, volt ratio boxes, level transfer standards and attenuators.

In recent years, the introduction of optical fibres has produced a need for reference standards of optical quantities at infra-red wavelengths. A calibration facility has recently been established for optical units of power, attenuation and wavelength. These quantities are based on spatial measurements to avoid the uncertainties associated with optical connectors. Calibrations are performed on optical power meters, optical power sources and optical attenuators. This work has also involved instruction of the staff of Telecom's calibration centres and demonstration of newly developed optical calibration techniques, to ensure consistency and accuracy of measurement practices.

Improved optical and electrical capabilities are continually being developed.

A recent investigation of interest concerned the cleanliness of optical connectors. In any calibration process, it is imperative to have sound knowledge and control of the test conditions. With optical connectors, foreign materials, such as dust and metal particles on the ends of fibres and connectors, can seriously degrade their performance. Without inspection and adequate cleaning, connector losses can be in excess of 60 dB. This could have a direct bearing on the operation of the optical network, as calibration errors due to connectors could be transferred to field areas. To alleviate this problem, optical connectors are examined microscopically to determine their suitability for calibration situations.

Another recent project was the development of shielded and guarded 5-terminal high-value resistance standards in the range 10 meg-ohms to 100 tera-ohms. The design ensures adequate protection against leakage and external fields. While many areas in Telecom have high resistance measuring equipment, they lack suitably configured standards for calibration. Since such units cannot be obtained commercially, this project filled a special need.

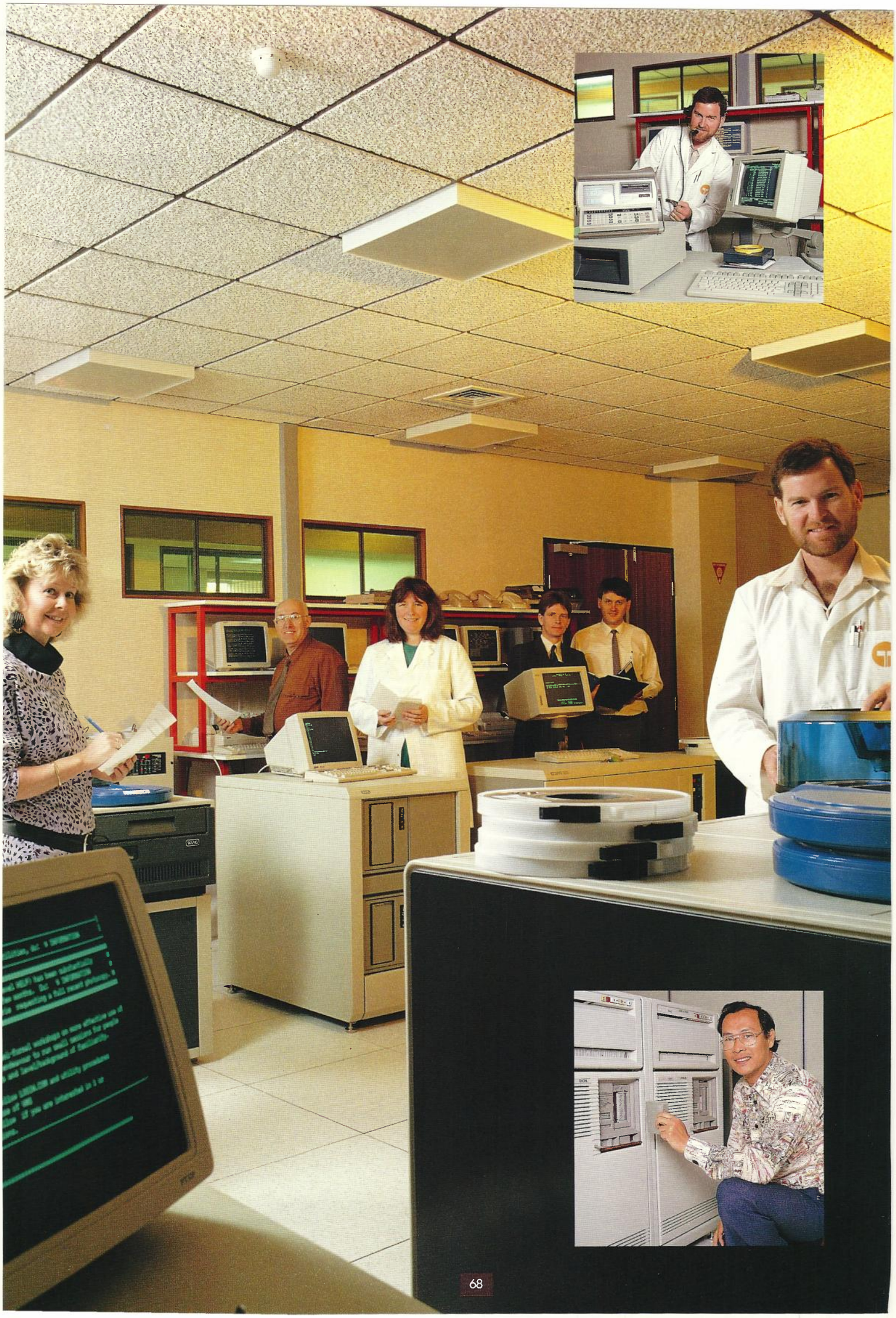
A Laboratory Policies and Procedures Manual was prepared during 1988, as required by the National Association of Testing Authorities. Outputs from this work will be disseminated to other Telecom measurement laboratories.

To improve the Laboratories' capability of electrical attenuation measurement, a computer-controlled measurement system was developed in the last year. Evaluation of the system has shown that it will be feasible to measure attenuation from 0 to 100 dB between dc and 18 GHz with a resolution of 0.001 dB.

The application of the Laboratories' reference standards validates measurements made throughout Telecom, in a manner traceable to national and international standards. The major benefits derived from this work are that Telecom's measurement capabilities are acceptable nationally and internationally, and that its measurements of the performance of new and installed equipment, especially in the areas which have a direct bearing on Telecom's network operations, are of traceable and high accuracy.

Future effort will aim at developing new reference standards and improved measurement facilities, with further automation of calibration processes. Improvements to the present capabilities will prepare Telecom for the more stringent measurement requirements of future high performance technology.

Above
Laboratories' engineer, Rod Pyke, sets up equipment for precise optical power measurement



TECHNOLOGY AND INFORMATION TRANSFER

The primary role of the Laboratories is to ensure that Telecom Australia has timely and relevant advice regarding new and existing technologies. The Laboratories' work programme is guided, established and reviewed by corporate processes to ensure its relevance to Telecom's needs for such advice. It comprises a number of R&D projects which generally seek to develop technical knowhow across the spectrum of evolving telecommunications science and technology. The Laboratories transfer the knowhow to clients units in the Customer Divisions and other Shared Resource Units of Telecom Australia, where it is applied in specific projects relating to the planning, implementation or operation of services and networks. These processes of technology and information transfer are ongoing and multifaceted. They occur through day-to-day working interactions between Laboratories' staff and those of the client units and through other formal and informal technology and information transfer mechanisms.

In general, significant and conclusive outputs arising from the Laboratories's R&D Programme are documented in technical reports and papers, published by Telecom Australia or presented for publication in the learned journals or conference proceedings of external organisations. These publications provide a formal means of information transfer from the Laboratories to specific Telecom clients, to interested Telecom management and staff, and to external R&D organisations, industry and academia. In addition, the Laboratories participate in the presentation of technical seminars and training courses which aim to transfer information to wider audiences in both Telecom Australia and the wider telecommunications community.

Other formal and informal processes provide avenues for technology and information transfer to and from the Laboratories. The Research Laboratories enlist the expertise and assistance of other R&D organisations, industry and academia through formal contracts for the performance of particular R&D projects, collaborative R&D arrangements and less formal peer group interactions.

Outputs from Laboratories' projects also yield inputs to national and international standardisation activities.

On occasion, industrial property licences are negotiated with external organisations for the commercialisation of inventions and other forms of industrial property arising out of the work of the Laboratories or other parts of Telecom Australia.

The following pages illustrate some of the more noteworthy examples of technology and information transfer from and to the Laboratories which have taken place over the past year.

THIRD AUSTRALIAN TELETRAFFIC RESEARCH SEMINAR

The first Australian Teletraffic Research Seminar was held at the Telecom Research Laboratories in November 1986. The objective of that seminar was to provide a focus for the traffic engineering research being carried out within Australia. This inaugural seminar was a great success and it was decided to hold similar seminars annually. The success of the first seminar was repeated at the second seminar, which was conducted by the Teletraffic Research Centre at the University of Adelaide in 1987. The third seminar was hosted by the Telecom Research Laboratories, and was held on 21/22 November 1988.

The theme chosen for the third seminar was "Future-proof Network Design and Management". A number of papers on this theme were presented and they provided excellent material for a stimulating forum discussion on the issues involved on the final day. The seminar was highly successful, both as regards the quality of papers presented and the level of audience participation. Approximately 100 persons attended, drawn from interested groups in Australian Universities, Colleges of Advanced Education, Telecom Australia and the Overseas Telecommunications Commission. A number of participants from the IXth CCITT Plenary Assembly meeting also managed to visit the seminar.

As a result of contacts made at the 12th International Teletraffic Congress in Turin, held earlier in 1988, the Laboratories' hosts were very fortunate to secure the services of a number of international speakers - who are recognised experts in the teletraffic engineering field - to address the opening session and to contribute to the discussion and panel sessions. These keynote speakers included Mr. P. Richards from Bell Northern Research, Canada, Dr. V. Ramaswami from Bellcore, USA, Dr. G. Gosztony of Hungary, and Mr. P. Lansard of CNET and Mr. J. Hauri of Alcatel-STC, both from France. In addition, some twenty teletraffic researchers from Australian organisations submitted papers, which were presented in six technical sessions over the two days of the seminar. It was clear from the large number of papers and delegates that teletraffic engineering research is attracting a high level of interest among engineers and mathematicians in Australian telecommunications organisations and academia.

ALCATEL-STC DELIVERS MACNET PROTOTYPE

In December 1986, Telecom Australia signed a contract with Alcatel-STC Pty Ltd for the development of a prototype optical fibre customer access network known as MACNET. MACNET uses a shared fibre architecture in which a passive multiport optical coupler is located close to a cluster of customers to provide independent access to all of them, with only one or two fibres between the coupler and the exchange. Each customer has a dedicated one or two fibre link to the coupler. Alcatel-STC subcontracted the optical coupler aspects of the prototype development to another Australian company, Australian Optical Fibre Research Pty Ltd, which then became responsible for the provision of low-loss fused biconical tapered couplers and optical filters. The contract was completed, and the experimental MACNET delivered to the Laboratories, within 20 months.

One of the key features of a shared fibre architecture is that the costs of expensive exchange components and the main distribution fibre are shared amongst the cluster of customers. The reduction in costs gained by this approach potentially brings forward the date at which optical fibre will be cost effective in customer network applications when compared with existing architectures using copper pairs.

One of the design objectives of MACNET was to provide each customer with all the low capacity services that they require, without the need to rearrange any external plant and without limiting access to foreseeable high capacity services in the future. This objective was met by the prototype MACNET, as each customer can be allocated (under software control from the exchange) one or more ISDN basic accesses.

The prototype MACNET has been widely demonstrated within Telecom Australia, and to other government and business organisations. MACNET was displayed at the Research Laboratories' seminars on "Telecom Services for the 1990's" in both Melbourne and Sydney in the latter quarter of 1988. In addition, overseas visitors to the Laboratories have shown considerable interest, and MACNET has featured strongly at the Australian Conferences on "Optical Fibre Technology" in 1987 and 1988.

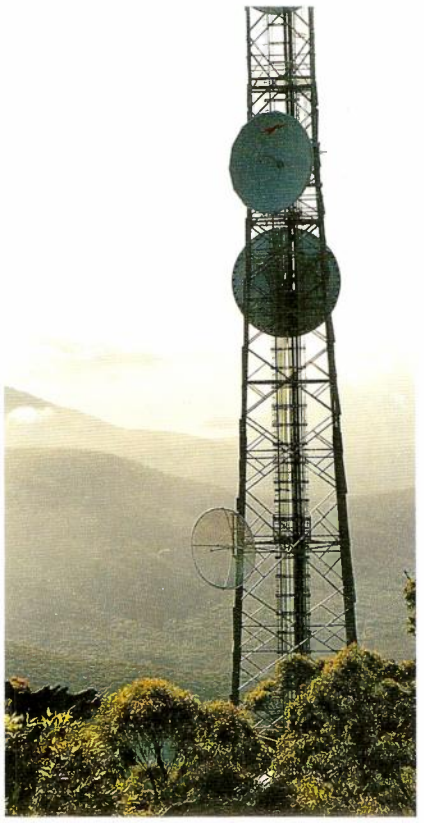
The development of MACNET has already greatly assisted Laboratories' studies of shared fibre architectures. It is also contributing to ongoing considerations within Telecom Australia on the future application of fibres in the customer access network, including the timing of further developments for business and residential applications. The future use of a MACNET architecture in the customer access network to provide high capacity services over a shared fibre system is discussed in greater detail elsewhere in this Review.

Left
Mr. Bruce Jones, Technical Director, Alcatel-STC, (centre) and Dr. Scott Rashleigh, Managing Director, Australian Optical Fibre Research, (at right) discuss MACNET with Mr. Harry Wragge, EGM, Telecom Research Laboratories, on the occasion of its handover

MARTIN COMMUNICATIONS PROTOTYPES DIGITAL RADIO TEST SETS

In August 1986, Telecom Australia awarded a research and development contract to the Melbourne-based company, Mintec Telecommunications Pty Ltd (now Martin Communications Pty Ltd), for the development of two prototype Digital Radio Test Sets. The Test Sets were to be developed in two versions, one version having more sophisticated functionality than the other. Martin Communications completed this task, delivering and successfully commissioning the prototype sets in the Laboratories in the latter months of 1988.

The primary function of these test instruments is to assess the performance of high capacity digital radio systems subjected to frequency-selective multipath fading. The measurement technique was originally conceived and validated in the Research Laboratories. It is based upon the simultaneous measurement of the radio channel linear amplitude distortion and the system bit error ratio.



Above
The Digital Radio Test Set in field use at Mt. Oberon, Victoria

The first test instrument, known as the "Equipment Evaluation Unit", was specified for the task of assessing, in the laboratory as well as in the field, the performance of digital radio equipment subjected to frequency selective multipath fading. To this end, the test instrument incorporates a hardware multipath fading simulator. Already, this test instrument has found numerous applications in the assessment of various digital radio equipment in the Laboratories.

The second test instrument, known as the "Path Evaluation Unit", was specified for the task of assessing the performance of in-service digital radio equipment. A unique feature of this application is the ability to separate the performance assessment of the digital radio equipment from the characterisation of the multipath fading encountered on the particular radio hop under test. Over the summer period of 1988/89, this test instrument was particularly useful in assessing the performance of some difficult digital radio hops. In particular, it was used in extensive tests of the Mt. Oberon to Flinders Island hop over Bass Strait in the Melbourne to Launceston link.

Currently, Martin Communications is in the process of further developing these test instruments into a commercial product which has a potential worldwide market.

JOINT DEVELOPMENT OF PROTOCOL TEST SETS BY SIEMENS AND TRL

During the past year, the Laboratories have continued to collaborate with Siemens (Australia) and Siemens (West Germany) to develop sophisticated protocol test sets. The collaboration brought together the hardware and software skills of the participants to meet an unsatisfied need for such facilities.

Communications protocols are the "rules" for the orderly generation and application of the signals which establish and monitor connections through the telecommunications network. In the evolving ISDN, these signals are quite complex and they are generated by the application of computer techniques, as is necessary to the multi-service potential of the ISDN concept. The simulation, monitoring and analysis of such signals requires the application of the storage and processing power of a computer, and hence, a protocol tester is a special purpose computer.

The previous edition of this Review reported the satisfactory completion of the development of an ISDN Protocol Test Set. Since then, Telecom has benefited from the application of the Test Set in its research, planning and introduction of the primary rate ISDN. Siemens has also successfully marketed the Test Sets to a number of equipment developers in Australia, as well as overseas.

The past year saw the successful joint development of another Test Set for application in the Common Channel Signalling No. 7 (CCS7) Network. The CCS7 Protocol Test Set incorporates software which enables it to be used for different implementations of the CCITT-standardised CCS7 system. This new signalling system is a key element in the separation of signalling into a special network to allow the realisation of the full potential of the multi-service ISDN. The software incorporated in the Test Set is quite complex, typically 500 kbytes. It has been designed to permit its speedy regeneration to accommodate future network changes, such as the introduction of a new version of CCS7 inter-exchange signalling, within a few days.

The two Siemens/TRL protocol test sets provide sophisticated and versatile means for monitoring, analysing and simulating network signalling at

various levels of complexity. In addition, they incorporate facilities for emulating some network equipment interfaces. They provide unique tools for the laboratory development and assessment of protocol implementations and related technical standards. They also meet a need for tools for the management and operation of the ISDN as it evolves over the next few decades with growing complexity and capability.

Through these developments, Telecom Australia has gained unique Australian-specific protocol testing facilities for use in its research and network operations. Siemens has also gained several unique and highly marketable additions to its product range. Thus, the joint development has been able to harness the skills of both organisations to match their complementary interests.

Above
Dr. Friedrich Thon of Siemens (left) and Harry Wragge (TRL) exchange agreements noting the satisfactory completion of the Protocol Test Set project

DIGITAL CELLULAR MOBILE RADIO SYSTEM STUDIES BY PHILIPS

Two major requirements for future mobile radio communications systems are that they should achieve high network capacity within the available radio frequency spectrum and that they should handle time varying communications traffic efficiently. In October 1988, Philips Communication Systems Limited, Australia, together with Philips PKI, West Germany, completed a research and development contract for investigations of a number of aspects of future generation cellular mobile radio systems which impact on these requirements. The investigations placed emphasis on systems utilising very small cells (ie. microcells), as a significant increase in system capacity can be achieved only by such means.

Aspects considered under the contract were:

- strategies for efficient cell-to-cell handover,
- algorithms for dynamic channel assignment, and
- propagation characterisation for micro-cellular planning.

Handover strategies based on field strength measurement were those considered . Important outcomes of studies of this topic demonstrated the influence of the handover strategy parameters on some important system performance criteria, such as the number of handover events along a given route and the average number of handover events per call.

Dynamic channel assignment, which has previously been seen as a means to cope with time-varying traffic, was considered for application to micro-cellular systems. The studies performed under the contract gave particular emphasis to the amalgamation of intra-cell handover with efficient algorithms for dynamic channel assignment. The benefits identified were improvement of the co-channel re-use and the capability to adapt to instantaneous interference conditions.

The implementation of micro-cellular systems requires that the heights of the base station antennas are below the heights of the surrounding buildings. However, propagation in this environment is not well understood. The measurement programme and subsequent analysis undertaken as part of the contract have enabled a general description of the propagation environment to be formulated. The description will provide valuable assistance to the planning of Telecom's future microcellular systems.

SMALL SATELLITE EARTH STATION DEVELOPED BY MITEC LTD

In the mid-1980s, the Laboratories commenced investigations of new satellite communications services which might be provided by means of small portable terminals. To assist these studies, a research and development contract was placed with Mitec Limited, then a subsidiary of the University of Queensland and a national centre of excellence in microwave technology. Mitec Ltd is now a fully commercial company. Under the contract, Mitec was required to investigate and develop a small prototype terminal which would be easily portable and operate at the present AUSSAT Ku-band frequencies of 12/14 GHz.

This "suitcase" terminal was needed by the Laboratories to provide a test-bed for the evaluation of the technical feasibility of providing services by means of a terminal having only a small antenna, only about 0.3 metres in diameter. The services of interest were those providing low bit-rate messaging and data transfer.

Above
The "suitcase" satellite terminal developed by Mitec

The prototype terminal development was satisfactorily completed by Mitec late in 1988 and subsequently delivered to the Research Laboratories. It is currently being used for its intended purposes.

The successful completion of this project required innovative and novel design so that the required performance of the terminal could be achieved with the given antenna size and other constraints. With the expertise gained, Mitec, Telecom and Australian industry are now well placed to develop commercial terminals embodying the Mitec technology, should a services application emerge for this type of small portable terminal.

SPONSORED EXTERNAL RESEARCH AND DEVELOPMENT

Telecom Australia is aware of the external R&D capabilities in telecommunications science and technology which exist in local industry, in academia and in specialised Australian research institutions such as the Commonwealth Scientific and Industrial Research Organisation (CSIRO). Recognising the mutual benefits of co-operative effort, it actively supports pertinent projects in these organisations through formal contracts and agreements and through its participation in the activities of bodies such as the Australian Telecomunications and Electronics Research Board (ATERB).

The Telecom Research Laboratories act as one channel for the provision of such support by Telecom, in particular, for research studies on telecommunications topics having potential application in the longer term development of the telecommunications network. The Laboratories also contract out development projects in specialised fields to meet an instrumentation or similar technical need which cannot be met from the usual sources of supply.

In addition, as outlined in the previous item, the Laboratories administer Telecom's Product Development Fund. Through the Fund, Telecom provides financial and occasional technical assistance to selected industrial entrepreneurs proposing to develop new and promising telecommunications-oriented products.

During 1988/89, the Research Laboratories have managed a portfolio of 16 R&D contracts with industry (total value $3.7 million) and 35 R&D contracts with other R&D institutions and academia (total value $5.1 million). The durations of the contracts vary from less than one to several years.

Total expenditures on extramural R&D by the Research Laboratories in 1988/89 will be approximately $2.0 million. Of this total, $0.25 million will be disbursed to academia via ATERB for R&D on telecommunications topics. The remainder comprises direct payments made to R&D contractors and occasional specialist consultants.

R&D contracts administered by the Laboratories during the past year concerned the study topics or developmental projects listed below:

Contracts with Industry

Research investigations of:

- Services Interworking, Communications Protocols and Interfaces Utilising an Experimental ISDN Exchange
- Cellular Digital Radio Transmission Systems for Mobile Services
- Interconnect Technology in Metal Oxide Semiconductor (MOS) Devices

Development of:

- An Optical Regenerator Test Instrument
- An Announcing Machine for the Speaking Clock Service
- An X.400 Messaging Terminal
- An Antenna Rotator
- Mobile/Portable Earth Terminal for Satellite Communication
- A Sample Preparation Facility for Electron Microscopy
- Digital Microwave Test Sets
- A Continuous Solar Simulator and Cell Testing System
- Electrical Transient Recorders
- MacNET - An Optical Fibre System for the Customer Access Network
- Software Enhancements for a Protocol Engineering Tool

Contracts with Academia and CSIRO

Research investigations of:

- Geographic Information Systems for Telecommunications Applications
- Human Factors Aspects of X.400 Messaging Systems
- Communications Security and Digital Encryption Techniques
- Implementation of Discrete Cosine Transform Coding Systems
- An Interactive Real-time Network Management System
- A Barium Vapour Laser (2.5 micron)
- Ion Implantation in II - IV Compound Semiconductors
- Receiver Structures for Optical Fibre Transmission Systems
- Equalisers for Digital Subscribers Loops
- Metal-Insulator Semiconductor Structures
- Fluoride Glass Systems for Mid-Infrared Optical Fibres
- Packaging Techniques for VLSI Circuits

- On-line Computer-based Directory Database Structures
- Distributed Information Systems
- Advanced Design and Testing Techniques for VLSI Circuits
- Millimetre Wave Digital Radio Systems
- Optical Phase Modulators
- Circuit Design Techniques for Optical Communications Systems
- Optical Switch Technology
- Digital Switchblock Device Technology
- Wideband Switching in the Optical Domain
- A Software Tool for Common Channel Signalling Network Planning
- A Real-time Fibre Tension Measuring Instrument
- Telecommunications Traffic Engineering
- A Mid-Infrared Objective Lens
- Fault-tolerant Microcomputer Systems
- Calibration Facilities for Photovoltaic Cells

In addition, the Laboratories occasionally participate in joint projects with other national and international bodies such as the Overseas Telecommunications Commission (Australia), Aussat Pty. Ltd., the CSIRO, international standardisation bodies such as the CCITT and CCIR, and overseas telecommunications administrations.

TELECOM AUSTRALIA'S PRODUCT DEVELOPMENT FUND

Telecom Australia has undertaken a number of initiatives, particularly since 1984, to encourage Australian design and development of telecommunications-oriented products. To further increase its commitment to local industry, Telecom proposed the establishment of the Product Development Fund (PDF) in a submission to the Inglis Review Committee on Government Technology Purchasing Arrangements. The Fund was launched on 27 January 1987 with an annual budget of $5 million. It is specifically aimed at small and middle sized Australian companies.

The Fund provides financial assistance to selected local entrepreneurs and inventors who wish to promote ideas, concepts or developments for possible adoption within the Australian telecommunications network. In addition to such financial assistance for new product development, Telecom will, on occasion, lend some projects the benefits of Telecom's engineering knowledge and facilities as development aids. In return for these funds and assistance, Telecom seeks industrial property rights in a particular product commensurate with its inputs to the project.

The PDF is controlled by a Committee of Senior Management under the Chairmanship of the Executive Aide to Telecom's Chief General Manager. The full-time Manager of the Fund is located in the Research Laboratories, but co-opts resources from throughout Telecom to assist in the assessment of applications for funding. In particular, the Technical Liaison Office (Network Engineering SRU) and the Intellectual Property Section (Telecom Research Laboratories) play significant roles in the operation of the Fund. All Laboratories' Branches have, on occasion, been involved in technical aspects of the assessment procedure, and several are now involved in continuing liaison with successful applicants during the product development phase.

Products supported by the Fund now include specialised power supplies, a voice-activated controller for telecommunications equipment, antistatic mats and sophisticated software tools for the implementation of communications protocols. In total, over 20 new product initiatives are currently being supported at a total cost of over $3 million.

OVERSEAS VISITS BY LABORATORIES' STAFF

It is an important responsibility of any viable research organisation to keep abreast with developments and changes in particular fields of interest. To this end, the Laboratories arrange an annual programme of overseas visits, enabling Laboratories' staff to interchange experience, technical knowledge, opinions and ideas with research personnel of other organisations. The visits are normally to other telecommunications administrations, universities and industry. In addition, Laboratories' staff undertake overseas visits to participate in the standards development and other activities of international forums and conferences of world telecommunications bodies and related organisations.

The following staff members have travelled overseas during the past year:

R.G. Addie
J. Billington
A.J. Bundrock
J.C. Campbell
L.H. Campbell
R.P. Coutts
P.C. Craig
R. Exner
D.E. Everitt
M.J. Flaherty
P.H. Gerrand
R.J. Harris
S. Hinckley
J. Hubregtse
Y.H. Ja
G.F. Jenkinson
I.P. Macfarlane
D.R. Manfield
P. McNamara
J.L. Park
M. Rossiter
C.D. Rowles
C.J. Scott
B.M. Smith
J.L. Snare
T.D. Stephens
I.K. Stevenson
S.L. Sutherland
D.E. Thom
P.J. Tyers
A. Urie
B.F. Usher
R.J. Vizard
R.E. Warfield
G.R. Wheeler
M. Zukerman

VISITORS TO THE LABORATORIES

The work of the Laboratories often calls for close liaison with Australian universities and other tertiary educational institutions and with the research establishments of Government Departments, statutory authorities and private industry. Reciprocal visits are made by the staff of the Laboratories to these and other establishments for mutual participation in discussions, symposia and lectures. In some instances, visitors with expertise in particular fields contribute directly to the work of the Laboratories as consultants.

The Laboratories' activities are also demonstrated to specialist and non-specialist groups from business, industry, professional societies, Government Departments and academia. This is achieved through arranged discussions, inspection tours and demonstrations and, at longer intervals, by formal "Open Days", when the work of the Laboratories is exhibited to invited guests from many walks of life.

During the year, experts from overseas telecommunications authorities, academia, Government Departments and manufacturing companies have also visited the Laboratories.

Some of the groups and individuals who visited the Laboratories during the year are listed below:

- A party from the Department of Social Security, comprising:
  - Mr R. Emerton, First Assistant Secretary, Facilities
  - Mr T. Trichler, Director, Communications
  - Mr J. Munslow, Director, Technical Co-ordination
  - Mr J. Canning, Assistant Secretary, ADP Systems Planning
  - Mr D. Rowlands, Director, Planning
  - Mr C. Rutten
  - Mr J. Canniry, and
  - Mr L. Norris, Communications Consultant.

  The party was introduced by Mr C. Muir, Telecom's Account Manager for the Department of Social Security, Corporate Customer Division.
- A party from the Broken Hill Proprietary Company Ltd., comprising:
  - Mr J. Watson, Director, BHP Melbourne Research Laboratories,
  - Mr I. Mair, Executive Officer, Corporate Planning
  - Mr T. Gittens, Manager, Materials R&D, BHP Co. Ltd.
- A party of visitors from Indonesia, comprising:
  - Mr Iman Santoso, Head of the Telecommunications Planning Division, Perumtel
  - Mr Satrio Wibowo, Head of the Telecommunications Network Division, Perumtel
  - Mr Bambang Soekmantoro, Head of the Centre for Communications Research and Development, Perumtel
  - Mr Peonggoeh, Head of the Telecommunications Testing Division, Perumtel
  - Mr D.K. Kariana, Plant Manager, Kabelindo
  - Mr J. Saleh, Marketing Manager, Kabelindo.

  The visitors were introduced by Mr T. Pennay of Olex Cables (Australia) Pty. Ltd.
- A party from the ANZ Banking Group Ltd., comprising:
  - Mr P. Mullholland, Manager, Tandem Development
  - Mr L. Fittinahoff, Manager, Communications Planning
  - Mr C. Stevenson, Communications Engineer
  - Mr P. Mason, Communications Engineer.

  The visitors were accompanied by Mr G. Riddock, Service Manager, and Ms M. van Kruger, Service Representative, of Telecom Australia.
- Mr V. Shrivastav of International Engineers and Project Consultants Ltd., and Representative in India of Telecom Australia International Ltd (TAI), accompanied by Mr P. Clifton of TAI.
- Mr J.R. Seo and Mr S. Jang of the Electronics and Telecommunications Research Institute, Korea.
- Mr M. Woolley, First Assistant Secretary, Department of Finance,and Mr G. Latimer and Ms M. Challis, also of the Department of Finance and members of the Inter-departmental Information Exchange Steering Committee.
- A party from the State Science and Technology Commission (SSTC) of the Peoples' Republic of China, comprising:
  - Mr W. Wufeng, Secretary-General, SSTC
  - Mr L. Guangning, Division Chief, SPARK Program Office
  - Mr X. Wencheng, Vice Mayor, Shaoxing City
  - Mr Z. Shiyony, Director, Technology Development Department, Sichuan Provincial Commission
  - Mr D. Tianwen, Laboratory Director, Communication, Telemetry and Telecontrol Research Institute
  - Mr C. Futeo, Interpreter.

  The visitors were accompanied by Mr D. Rumble of the Department of Industry, Technology and Commerce.
- Mr B. Woods, General Manager, Group Information Systems, and Mr A. Young, Chief Manager, Group Information Systems, of the National Bank Australia Ltd, accompanied by Mr K. Dearsley, Account Manager, Major Accounts Unit, of Telecom's Corporate Customer Division.
- A party from the Department of Employment, Education and Training, comprising:
  - Mr P. Dunlop, Assistant Secretary, ADP
  - Mr D. Holmes, Director, Management Division
  - Mr A. Talulelei, Director, Auststudy Project
  - Mr L. Brough, Director, Communications.
- Messrs Jumras and Opas, telecommunications engineers from Thailand, accompanied by Mr I. Richardson of Telecom's Engineer Development Section.
- A party from the Thai Mission on Telecommunications Technology, comprising:
  - Mr K. Snidyongso, Deputy Permanent Secretary, Ministry of Science & Technology
  - Professor P. Thajchayapong, Director, National Electronics and Computer Technology Centre
  - Mr S. Muennarintr, Senior Scientist, Public Sector/Private Sector Liaison

- Mr K. Surapunthu, Director, Telegraph Division, Telecommunications Department of Thailand
- Mr A. Indralagshana, Senior Engineer, Corporate Planning, Telephone Organisation of Thailand
- Mrs V. Chaipackdee, Chief of Communications Planning, National Economic and Social Development Board.

- The Surveyor General of Victoria and Director of Landata, Mr R. Eddington, accompanied by Mr B. Acland, Manager, Public Enquiry Service of Landata, Mr G. Taloni, Manager, Business Activities of Landata, and Mr P. Loughrey, Manager, Cadastral Mapping Activities of Landata.

- Dr C.M. Adams, Director, Institute of Industrial Technologies, CSIRO, accompanied by CSIRO colleagues Drs T.H. Sparling, M.J. Murray and N.S. Ham.

- Professor A. Sale of the Department of Information Science and Electrical Engineering, University of Tasmania.

- A party of BHP Company executives, comprising:
  - Mr J. Hudson, Manager, Information Systems
  - Mr P. McLure, Manager, Information and Communications Services
  - Mr G. Ferguson, Principal Systems Engineer, Information Planning and Technology
  - Mr S. White, Senior Systems Engineer
  - Mr J. Price, Superintendent, Information Systems Operations.

  The visitors were accompanied by Ms C. Chapkoun, Senior Sales Implementor, Major Accounts Unit, of Telecom's Corporate Customer Division.

- Members of the Information Technology and the Communications Technology Committees of the Department of Industry, Technology and Commerce, both of which are associated with the Federal Government's scheme known as 'Grants for Industry Research and Development'.

  The visiting members from the Information Technology Committee comprised:
  - Dr F. Barr-David, Chairman, and Chief of Technical Operations, Impact Systems Ltd
  - Professor V. Gledhill, Director of the Centre for Evening and External Studies, Macquarie University
  - Mr G. Jackson, Director, Asia Pacific Region, Pyramid Technology Corporation
  - Professor R. Jarvis, Department of Electrical and Computer Systems Engineering, Monash University
  - Mr T. Henshaw General Manager, Applied Research and Development, Computer Power Group,and
  - Ms S. Coleman, Publisher, Pacific Computer Weekly.

  The visitors from the Communications Technology Committee, also chaired by Dr F. Barr-David, included:
  - Messrs B. Jones, Technical Director, Alcatel - STC
  - Dr R. Frater, Director, CSIRO Institute of Information and Communications Technology
  - Mr C. Howells, Managing Director, Netcomm (Aust) Pty Ltd, and
  - Mr L. Tyrrell, National General Manager, Network & Consumer Services, of Telecom's Metropolitan Division.

- Dr B.T. Dingle, Chairman of Gain Electronics Co., New Jersey, USA.

- Mr R. Stafford, Manager, Client and Membership Services, Electronics Research Association, UK.

- Dr L. Posadas, University of the Philipines.

- Professor D. Neilson, University of New South Wales.

- Drs G. Nyberg and T. Gengenbock, LaTrobe University.

- Professor R.S.C. Smart, South Australian Institute of Technology.

- Dr Neila, Royal Melbourne Institute of Technology.

- Mr R.S. Owens, Australian Communications and Telemetry Pty. Ltd.

- Messrs P. Hawker, B. Hill and J. Raymond of the Department of Veterans Affairs, accompanied by Messrs G. Nicola, Telecom National Business Manager, and R. Lacey, Telecom Account Manager.
- Mr J.C. Littlemore, Commissioner, Australian Telecommunications Commission.
- Messrs J.C. Doig, J. Mifsud and I.J. Smart of the National Australia Bank, accompanied by Mr G. Davidson, Telecom Communications Consultant.
- Messrs J. Webster and G. Luther from the Department of Transport and Communications and also members of the Cable TV Review Team.
- Mr D.L. Hammond, Deputy Director, Corporate Development, Hewlett- Packard Laboratories, USA.
- Mr J. Jay, Corning Glass Works, USA.
- A group of 35 members of the Physics Society, Monash University, led by Ms H. Smith.
- Messrs G. Brookes, J. Williams, T. Arnel and T. O'Donoghue of the Attorney General's Department, State of Victoria, accompanied by Mr D. King, Telecom Account Manager, and Mr L. Hodgson, Telecom National Business Manager, Victorian Government Account.
- Thirty-eight members of the Australian Telecommunications Users Group (ATUG), Victorian Division.
- Professor B. Denton, Professor of Chemistry, University of Arizona.
- Mr W. Hass, Federal Minister of Economics, Federal Republic of Germany, introduced by Mr A. Gosman of the Department of Industry, Technology and Commerce.
- Senior Members of the Coles/Myer Ltd Group
- Senator A. Lewis, Opposition Spokesman for Communications in the Federal Parliament.
- Messrs R. Cheung, B. Graham and A. Al-Tarafi of Hewlett Packard Ltd.
- Mr K.R. Narayan, Minister for Science and Technology, India.
- His Royal Highness, Prince Abdul-Aziz Bin Ahmed, of Saudi Arabia, accompanied by His Highness, Prince Abdullah Mussad Al-Sudeiry, Sheikh Al Khamis and Messrs Al Omayar, Al Hajri and Al Fassim.

- A party from NSW Government Departments, comprising:
  - Mr G. Payne, Director, Management, and Mr T. Rogers, Assistant Director, Business and Consumer Affairs Department,
  - Mr R. Moxeham, Deputy Chief Engineer, Mr J. Waring, Manager, Commercial Operations, and Mr P. Belcastro of the Public Works Department,
  - Mr B. Henry, Director, Management Information Systems, and Mr N. Ratjiens of the Department of Education, and
  - Mr R. Ranger, of Elcom.

  The visitors were acompanied by Messrs L. Bozza, F. McNamara, B. Penhall and P. Gerrand of Telecom's Corporate Customer Division.
- Mr G. Watkins, Manager, International Product and Applications Engineering, Telecommunications Products, Corning Glass Works, USA.
- Mr R. Perry, Managing Director, ZBB (Australia) Ltd., and Dr P. Singh, Murdoch University.
- Mr R. Beesley, Technical Manager, Cabot Plastics Ltd, UK.
- Professor U. Mlecek, Director, Research Laboratories, Deutsche Bundespost, Federal Republic of Germany.
- A party from the State Electricity Commission of Victoria, comprising:
  - Mr I. Bates, General Manager, Transmission
  - Mr. L. Herbert, Manager, Office Systems
  - Mr J. O'Farrell, Business Communications Manager
  - Mr W. Warne, Senior Analyst, Network Systems
  - Mr R. Di Lorenzo, Communications Support Programmer
  - Mr A. Spicer, Technical Services Engineer
  - Mr I. Smith, Communications Engineer
  - Mr J. Ambrose, Communications Design Engineer
  - Mr J. Haydon, Communications Development Engineer
  - Mr M. Slee, Communications Services Engineer
  - Mr C. Parkinson, Special Services Officer.
- Mr M. Siregar, Engineer, Marketing Division (New Services), Perumtel, Indonesia.
- Mr G. King, Technical Manager, Dussek Campbell Pty. Ltd.
- Mr R. Lindsay, National Manager, Plastics and Rubbers, Robert Bryce and Co. Ltd.
- Mr T. Yoshida, Manager, Optoelectronic Components Department, Planning and Development Centre, Nippon Mining Co. Ltd, Japan.
- Professor R. Barfort, Faculty of Applied Science, University of New South Wales.
- A party from the Australian Education Council, comprising:
  - The Hon L.M.F. Arnold, MP, (Chairman) Minister of Employment and Further Education, South Australia
  - Emeritus Prof. R. StC. Johnson, Commonwealth Department of Employment, Education & Training
  - Mr A. Abrahart, Commonwealth Department of Employment, Education & Training
  - Dr M. Angus, Ministry of Education, Western Australia
  - Mr M. Cove, Education Department, Tasmania
  - Mr P. Ellyard, Ministry of Education, South Australia
  - Mr B. Holmes, Ministry of Education, South Australia
  - Mr P. Sandery, Ministry of Education, South Australia
  - Mr C. Makepeace, Department of Education, Northern Territory
  - Mr M. Mathias, Ministry of Education, Victoria
  - Dr R. Watts, NSW College of TAFE
  - Mr J. Tainton, Department of Education, Queensland.
- Mr G. Cook, Manager, Advanced Technology Corporate Strategy Division, and Mr D. Tapp of the Telecom Corporation of New Zealand Limited.
- Mr E. Dobson, Director, Communications, and Mr G. Harber, Manager, Parliamentary Information Systems, from the Communications Management Group, Parliament House, Canberra, accompanied by Mr G. Coleman, Telecom Account Manager.
- A party from the Meteorological Bureau comprising:
  - Dr D. Gauntlett, Deputy Director, Services
  - Mr M. Moore, Deputy Director, Research and Systems
  - Mr S. Munro, Assistant Director, Communications & Computing
  - Dr M. Manton, Chief, Meteorological Research Centre
  - Mr P. Noar, Assistant Director, Services
  - Mr B. Wright, Regional Director, Victoria
  - Mr D. Linforth, Supervising Meteorologist, Public and Marine Services
  - Dr G. Love, Supervising Meteorologist, National Meteorological Centre
  - Mr M. Hassett, Communications Manager
  - Mr P. Barcley
  - Mr J. Henderson.
- A party from Thailand, comprising:
  - Mr K. Snidvongs, Deputy Permanent Secretary, Ministry of Science, Technology and Energy, Thailand
  - Mr R. Sugthana, Secretary to the Minster
  - Mr G. Jira, Vice President Marketing, Unimesa Company
  - Mr S. Roongphornchai, President, L & R Enterprises Ltd.

  The visitors were introduced by Dr G. Pure and Mr I. Saul of the Department of Industry, Technology & Commerce.
- A party from the Coles Myer Ltd. Group, comprising:
  - Mr G. Fletcher, Director, Retail Services
  - Mr G. Campbell, Group General Manager, Management Information Systems
  - Mr D. Botherway, General Manager, Information Systems Security
  - Mr M. Entwisle, General Manager, Technical Services
  - Mr N. Nikfarjam, General Manager, Systems Planning & Development Centre
  - Mr D. Robertson, General Manager, Data Centres
  - Mr B. Will, General Manager, Management Services
  - Mr R. Weaver, Manager, Communications Services.

- A party from the House of Representatives Standing Committee on Transport, Communications and Infrastructure, comprising:
  - Mr J. Saunderson, Chairman
  - Mr T. Flecher, Rural Communication Needs
  - Mr C. Hollis, Transport
  - Mr D. Jull, Applications for Education
  - Mr J. Langmore, National Infrastructure
  - Mr M. Aldons, Secretary
  - Mr C. Patterson, Administrative Arrangements
  - Mr R. Gorman.
- A party of international experts on defence communications, comprising:
  - Mr I.J.L. Smietan, Space and Naval Warfare Systems Command, USA
  - Mr R. Kenyon, HQ Air Force Systems Command, USA
  - Mr A. Johnson, Air Force Wright Aeronautical Laboratories, USA
  - Dr J.L. Pearce, Director, Electronics Division Defence Research Establishment, Canada
  - Col P.C. Coderre, National Defence Headquarters, Canada
  - Dr B. Burgess, Royal Signals and Radar Establishment, UK
  - Dr T. Thorpe, Royal Signals and Radar Establishment, UK.

  The visitors were introduced by Mr F.B. Andrews, Research Leader, Communications, Defence Science & Technology Organisation (DSTO), Australia.
- Messrs D. Ingham, R. Sinclair, F. Kenyon, T. Davies, B. Robertson and K. Johnstone of the Westfield Corporation Ltd.
- Messrs H. Piper and D. Hawes of David Jones Australia Limited, accompanied by Ms R. Graham, Telecom Account Manager.
- Communications executives from CRA Limited,comprising:
  - Dr R. Booth, Vice President, Communications
  - Mr P. Feehan, Manager, Communications
  - Ms S. Nicholson, Information Officer.

  The visitors were accompanied by Mr T. Walsh and Ms M. Babanine, Telecom Account Managers.
- A party from the Philips Group of Companies, comprising:

from Philips Telecommunications Systems Ltd., Nurnberg:

  - Dr K. Jobmann, Product Policy
  - Dr M. Buettmer, Cable Transmission Systems
  - Mr P. Grotemeyer, Strategic Marketing and Network Planning
  - Mr G. Belsemeyer, Product Manager, Cross Connect Systems
  - Mr W. Buchholz, Development Manager, Optical Transmission Systems

  and from Philips Telecommunications Systems Ltd., Australia:
  - Mr B. Adams, Executive Manager, Technology
  - Mr J. Esnault, Marketing Manager, Transmission Systems.
- A delegation from the Ministry of Posts and Telecommunications, The Peoples Republic of China, comprising:
  - Mr W. Jichuan, Vice-Minister, Ministry of Posts and Telecommunications
  - Mr Z. Xintong, Director, Department of External Affairs, of the Ministry
  - Mr L. Sicong, Deputy Director, Department of External Affairs
  - Mr S. Benji, Deputy Division Chief, Department of External Affairs
  - Mme Wang Yu Rong, Senior Engineer.
- A party from the Department of Foreign Affairs & Trade, comprising:
  - Mr L. Cook, Project Manager, ADC Net Project
  - Mr G. Nicholls, Director, Engineering Planning
  - Mr R. Greeney, Project Officer, Net Project.

  The visitors were accompanied by Messrs R. Lacey and A. Goonan, Telecom Account Managers.
- Mr C. Wheddon, Division Manager, Speech and Language Processing, British Telecom Research Laboratories.
- Representatives of local and overseas cable manufacturers, including:
  - Dr M. Clark, Strategic Development Manager, MM Cables Pty. Ltd., Australia
  - Mr K. Spedding, Manager, Cables & Process Engineering, BICC, UK
  - Mr K. MacDonald, Technical Manager, BICC, UK
  - Mr A. Ragni, Design & Development Manager, Ceat Cavi Industrie srl, Italy.
- A party from the Ministry of Communications and the telecommunications industry of South Korea, comprising:
  - Mr Y. Shin, Vice-Minister, Ministry of Communications
  - Mr Y. Suh, Director, Policy Planning Division, Ministry of Communications
  - Mr S. Kim, Vice-President & Executive Managing Director, Long Line Business Group, Korea Telecommunications Authority
  - Mr E. Lee, President, Data Communications Corporation of Korea
  - Mr H. Bahk, Director, Electronics & Telecommunications Research Institute, Korea
  - Mr S. Yangl, President, Korea Telecommunications (International)
  - Mr H. Yoo, Manager, Korea Telecommunications (International)
  - Mr C. Kim, Director, Korea Trade Office.
- A party from the Sichuan Province of The Peoples Republic of China, comprising:
  - Mr Z. Yingwen, Director of the Sichuan Province Foreign Economic Relations and Trade Commission
  - Mr H. Xiancong, Deputy Director of the Sichuan Province Economic Planning Commission
  - Mr G. Xiaolong, Deputy Director of the Sichuan Province Economic Planning Commission
  - Mr C. Xuerun, General Manager of the Chengdu Merchants International Travel Company.

- A party of senior executives from Australian Government Agencies, comprising:
  - Mr A. Hillier, Deputy Secretary, Department of Administrative Services
  - Mr P. Barrett, Deputy Secretary, Department of Finance
  - Mr M. Woolley, First Assistant Secretary, Regional & Accounting Division, Department of Finance
  - Mr D. O'Connor, Deputy Comptroller-General, Australian Customs Service
  - Mr G. Bannister, First Assistant Secretary, Systems, Australian Customs Service
  - Mr A. Arena, Acting First Assistant, Secretary, Telecommunication Policy Division, Department of Transport & Communications
  - Mr J. Humphreys, National Manager, Systems, Department of Social Security.

  The visitors were accompanied by Mr L. Bozza, General Manager, and Mr P. Gilbert, National Business Manager, of Telecom Australia's Corporate Customer Division.
- Mr S. Yoshitake, Senior Manager, Engineering Strategic Planning, and Mr M. Taguchi, Manager, Engineering Strategic Planning, of the Headquarters Group of NTT, Japan.
- A party from the Military Research and Development Centre of Thailand, comprising:
  - Colonel S. Krabuanrat, Deputy Director, Technology
  - Colonel W. Chairerk, Chief of Communications and Electronics R&D
  - Colonel W. P. Polowat, Chief of Materials R&D
  - Wing Commander B. Chodchoey, Staff Officer, Combat R&D
  - Wing Commander P. Sangaunmu, Staff Officer, Communications and Electronics R&D.

  The visitors were accompanied by Mr C. White, Director of International Programmes, of the Australian DSTO.
- Mr R. Duncan from the Rural & Industries Bank of Western Australia.
- A party from Siemens AG, West Germany, and its Australian subsidiary, comprising:
  - Dr F. Thon, Senior Technical Director, Instrumentation Manufacture, Siemens AG
  - Mr M. Winau
  - Mr T. Korbel
  - Mr O. Van Zyl
  - Mr J. Green.
- A party from the Telecommunications Policy and Communications Technology Divisions of the Department of Transport and Communications, comprising:
  - Ms J. Davidson
  - Mr I. Johnston
  - Mr B. Scott
  - Ms A. Stephenson
  - Ms E. Calero
  - Mr D. Cornford
  - Mr D. McNeill
  - Mr G. Hutchinson
  - Mr M. Walker.
- A party from the CSIRO, comprising:
  - Mr G. Batchelor, General Manager, Management Information Systems
  - Mr D. Sunderland, Assistant General Manager, MIS Operations
  - Ms M. Fleming, Information Technology Consultant
  - Ms A. Gracie, Voice Network Manager
  - Mr B. Bautovich, Engineer, Division of Plant Industry.

THE LABORATORIES - SUMMARY INFORMATION

MISSION

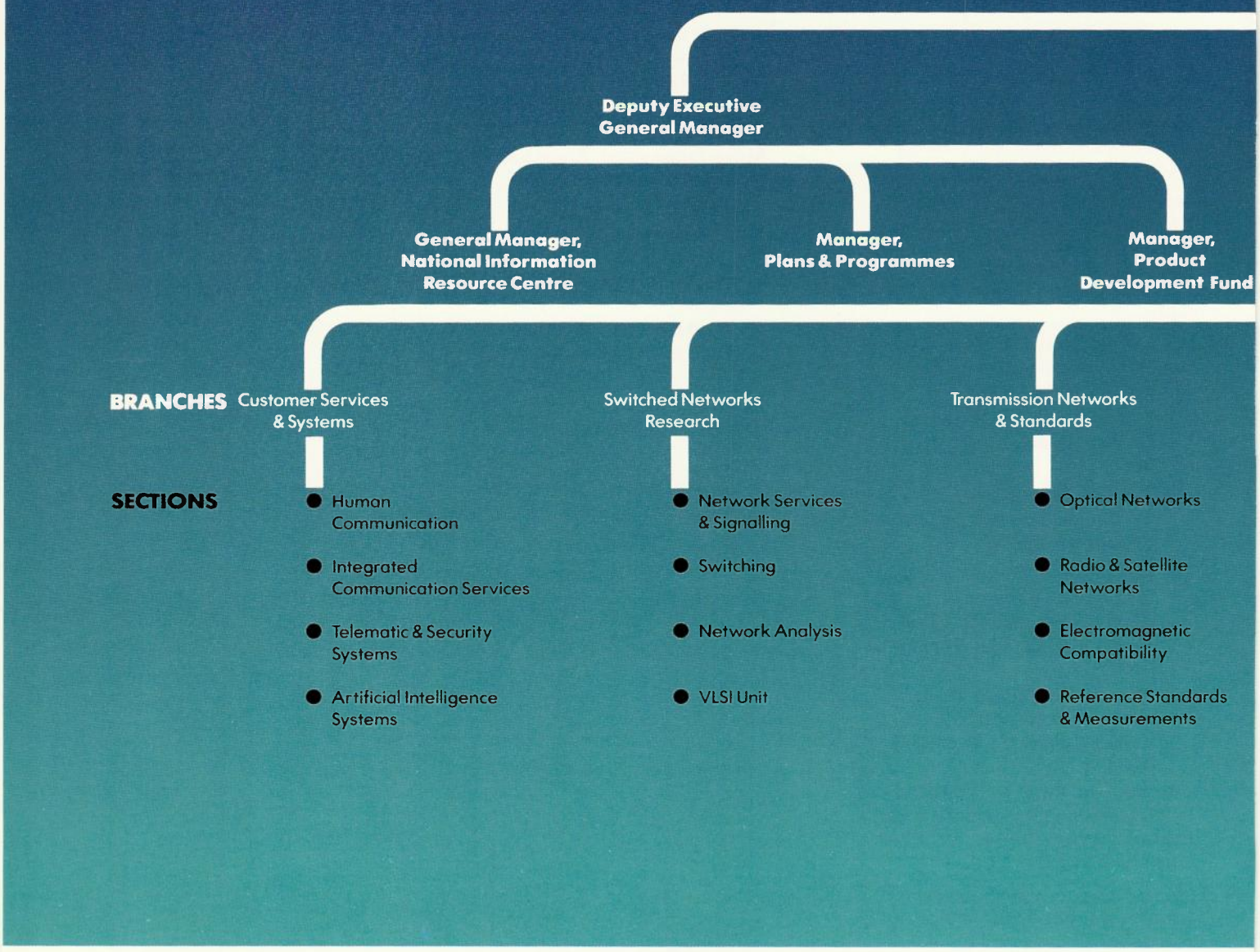
Research Excellence for Telecom's Success

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

OVERALL OBJECTIVES

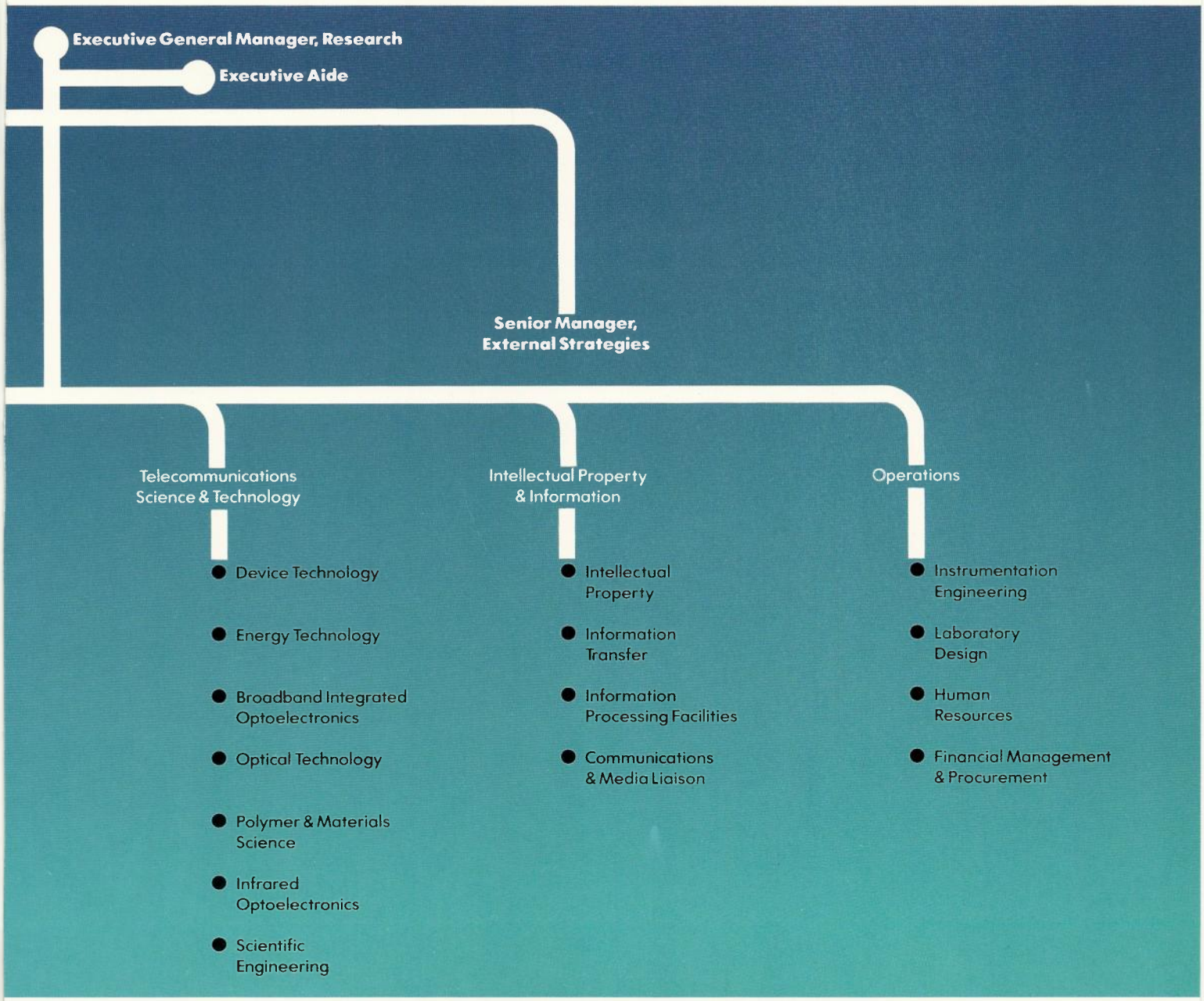
- Maintain a position at the forefront of knowledge in communications science and technology, in order to provide expert participation in the formulation and implementation of policies for the introduction of advances in science and engineering of relevance to Telecom Australia
- Conduct specific development and design projects and scientific and engineering investigations related to telecommunications problems

THE TELECOM RESEARCH LABORATORIES' ORGANISATION

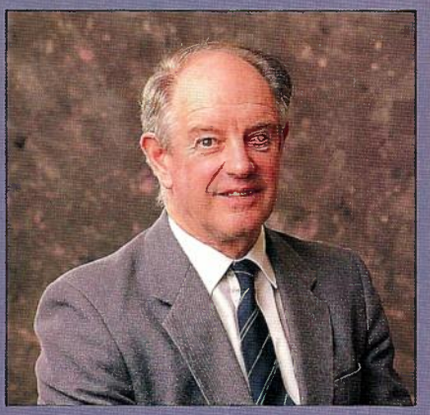


ORGANISATION

The Telecom Research Laboratories constitute a Shared Resource Unit of Telecom Australia. The Executive General Manager, Research, heads the Laboratories' organisation. He is responsible to the Managing Director of Telecom Australia. The Laboratories comprise an Executive Group, the National Information Resource Centre and 27 Sections arranged in six Branches. The scientific and engineering Sections each possess expertise in particular areas of telecommunications engineering or science, as can be seen from the statements of Branch objectives and Section functions in the following pages.

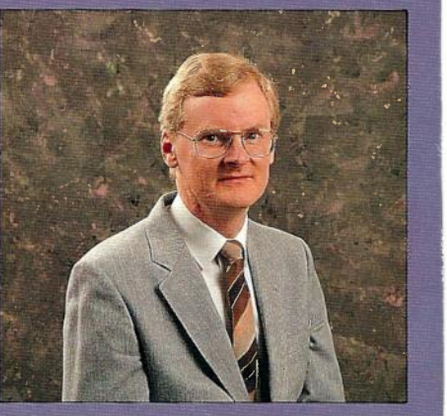


THE LABORATORIES' MANAGEMENT COUNCIL

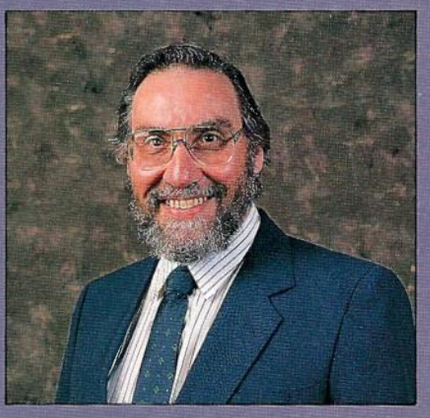


Harry S. Wragge, AM
Executive General Manager

Roger Smith
Deputy Executive General Manager

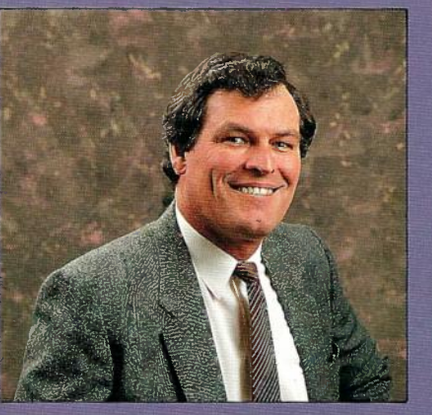


Geoffrey M. Willis
Senior Manager, External Strategies



Terry H. Brown
Executive Aide

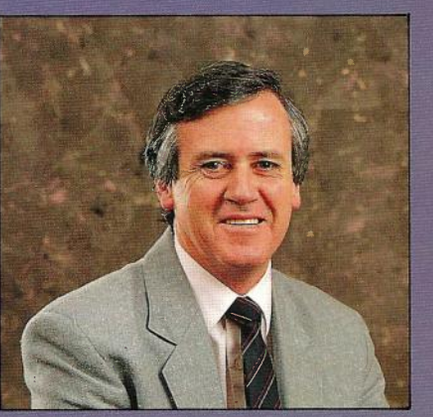
Helen V. Rodd
General Manager,
National Information Resource Centre



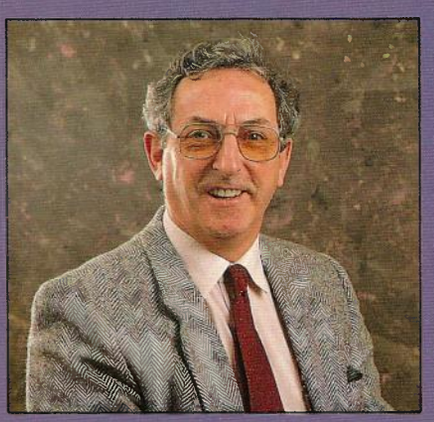
Noel F. Teede
General Manager,
Customer Services & Systems

James L. Park
General Manager,
Switched Networks Research

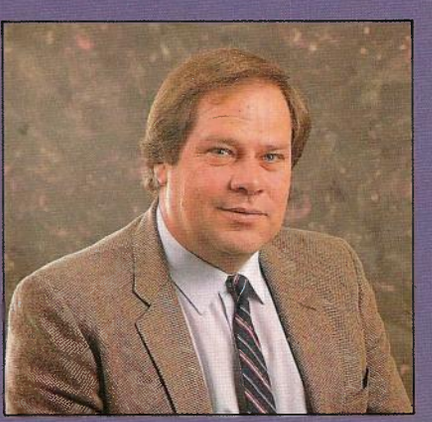
Alan J. Gibbs
General Manager,
Transmission Networks & Standards



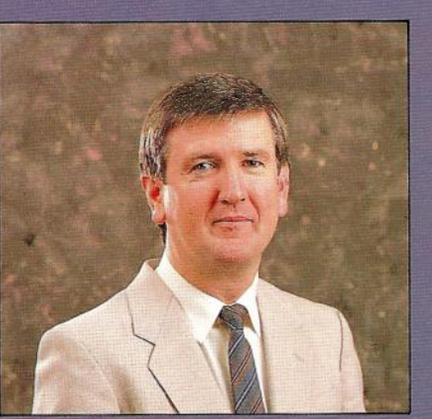
P.V.H. (Harvey) Sabine
General Manager,
Telecommunications Science & Technology



Frank W. Arter
General Manager,
Intellectual Property & Information



Brian M. Douglas
General Manager,
Operations



Brian F. Donovan
Manager,
Communications & Media Liaison

FUNCTIONAL ORGANISATION AND STAFF

LABORATORIES' EXECUTIVE GROUP

Executive General Manager:
H.S. Wragge, AM, BEE(Hons), MEngSc(Hons), FTS, FIEAust, FIREE

Deputy Executive General Manager:
R. Smith, BE(Hons), ME, MIEE, SMIREE

Senior Manager, External Stategies:
G.M. Willis, FRMIT, MIEAust, SMIREE

Manager, Plans & Programmes:
A.J. Stevens, BE, MIEEE

Manager, Product Development Fund:
R.A. Court, BE(Hons), BSc, MEngSc, SMIEEE, SMIREE

Senior Analyst, Product Development Fund:
J.P. Nakulski, BE(Hons)

Executive Aide:
T.H. Brown

Support Staff:
J. Cowley

J.E. Dickson

NATIONAL INFORMATION RESOURCE CENTRE

Functions

- Provide comprehensive information and library services to all Divisions, SRUs and Directorates of Telecom Australia, including translation of foreign languages
- Integrate information resources within Telecom Australia, with due regard to the development of common standards and systems.

General Manager:
H.V. Rodd, BA, Dip Lib

Administrative Officer:
L.E. Browney, BA, Grad Dip App Soc Psych

Professional Staff:
C.E. Bartlett, BSocSc
Y.B. Chen, BA, Grad Dip Lib, Grad Dip Rec
E. Corr, Dip Lib
J.M. Lindner, BSocSc, Dip Lib, AALIA
A.R. McCarroll, BSocSc
D.J. Richards, BA, Dip Lib
M.F. Russell, BScEd, Grad Dip Lib, AALIA
C. Sakis, BSc, Grad Dip Lib, AALIA
J. Saunders, BA, Grad Dip Lib Sc, Dip Ed
J.A. Smith, BA, Dip Lib, Dip Ed, AALIA
E.M. Spicer, BA, Dip Lib
J.M. Stewart, BA, AALIA
G.P. Thompson, BA(Hons), Grad Dip Info Serv
J.E. Thompson, MA, Grad Dip Lib, AALIA
C. Tschernitz, BA, Grad Dip Lib, AALIA
E.M. Tunaley, BA(Lib)
G.P. Woods, BA(Lib), Dip Lib
A.L. Ying, BA, Grad Dip Info Serv, AALIA

Translation Staff:
D.F. Connor, BA, NAATI

Support Staff:
G.V. Banik
L.O. Connor
L.A. DeCampo
V.E. Deem
C. Frauenfelder
S.M. Lynch
M.H. Rankin

Melbourne Information Resource Centre

Professional Staff:
A. Hatfield, BA, Dip Lib
K. Sridhar, MA, Dip Lib, AALIA

Support Staff
D. Higgins

Sydney Information Resource Centre

Professional Staff:
S. McDougall, BA(Lib), AALIA
S.R. Ruge, BA, Grad Dip Lib Sc

Support Staff:
A.M. Boniecki
P.J. Flanagan
C.B. Henderson
L. Mazzotti
S.M. Prout

Brisbane Information Resource Centre

Professional Staff:
J.P. Don, BA, Grad Dip Lib Sc
J. Meyer, BA

Support Staff:
I.E. Bull
L.J. Voss

Adelaide Information Resource Centre

Professional Staff:
P. Fitzgerald, BA(Lib)

Support Staff:
C.S. Hudson
S.M. Manning

Perth Information Resource Centre

Professional Staff:
K. Delaney, BAppSc(Lib)

Support Staff:
J. Brindley
M. Cooper
J. Paddon

CUSTOMER SERVICES AND SYSTEMS BRANCH

Objectives

- In the field of customer services and systems, conduct research, exploratory development and field experiments, contribute to specifications, assist in the assessment of tenders, and provide other advice and recommendations as appropriate relating to:
  - user needs for telecommunication services, considering both human and technical aspects
  - the evolving Telecom Australia network and the application of network-based facilities to support customer requirements, including service combination and interworking
  - technical and human aspects relating to efficient network and service access procedures, and end-to-end performance criteria
  - structured techniques for modelling telecommunications services.

Branch Executive Group

General Manager:

N.F. Teede, BE(Hons), PhD, Dip Mgt

Branch Administrative Officer:

H. Merrick

Support Staff:

M.A. Cieslak

C. O'Meara

J. Venn

Human Communication Section

Functions

- Provide information, advice and consultancy as defined in the Branch objectives
- Undertake theoretical and experimental research into the processes of human communication over telecommunication networks, including user perceived end-to-end performance
- Conduct theoretical and experimental research into the human and related technical aspects of the procedures required to access services and facilities
- Develop models for describing user attributes and perceived needs, and for classifying telecommunication services
- Conduct studies into the needs of communities and organisations for telecommunication services.

Section Head:

G.D.S.W. Clark, BEE(Hons), MSc, MIEAust

Professional Staff:

W.F. Allen, BA(Hons)

E.S. Bednall, BSc(Hons), PhD

M.A. Cavill, BA(Hons), Dip TRP, MRAPI

J. Chessari, BSc(Hons)

J.K. Craick, BE(Hons), BSc

L.G. Cromwell, BA(Hons), Dip Viet, PhD

M. Davis, BA(Hons), Cert App Sc

P. Edney, BA(Hons), MA

S. Greener, BSurv(Hons), Grad Dip Comp Sc

J.B. Guy, BSc, PhD

L.L. Kennedy, BA(Hons), TSTC

G. Lindgaard, BSc(Hons), MSc, RN, MAPS, MAPA

W.P. Mee, BA(Hons)

L. Perry, BA(Hons), MAPS

A.E. Spurritt, BA(Hons)

Technical Staff:

P.S. Bouchier

A.H. Borg

D.J. Lane

Integrated Communication Services Section

Functions

- Provide information, advice and consultancy as defined in the Branch objectives
- Conduct theoretical and experimental research into the provision of all types of video services; contribute to international standardisation in this area
- Investigate the delivery of voice and data based value added services to corporate and business customers through simplification and customisation of the user interface and through the development of specialised network facilities
- Provide assistance with the definition of customer premises equipment for, and the provision of advanced services on, narrowband and broadband Integrated Services Digital Networks
- Provide advice on the effect on Telecom's services of utilisation of personal computers by Telecom and by Telecom's customers.

Section Head:

J.C.N. Ellershaw, BE(Hons), BSc, PhD, MIEEE

Professional Staff:

M.J. Biggar, BEE(Hons), MEngSc, PhD, DIC, IREE

P.F. Duke, BTech, Dip Maths

N.H. Duong, BE(Hons), MEngSc

M.J. Flaherty, BE(Hons), PhD

J.E. Gottschalk, BSc(Hons), PhD

A.J. Hopson, BE(Hons)

B.J. McGlade, BEE(Hons)

P.I. Mikelaitis, BE, MEngSc, MIEEE

T. Oetterli, BE(Hons)

D.Q. Phiet, BE(Hons), PhD

R.A. Seidl, BE(Hons), PhD

J.S. Spicer, BE(Hons)

W. Tan, MSc, PhD, DIC

Technical Staff:

J.B. Carroll

D.A. Drummond

G.R. Leadbeater

T.R. Long

Telematic and Security Systems Section

Functions

- Provide information, advice and consultancy as defined in the Branch objectives
- Conduct theoretical and experimental research into:
  - message-based services
  - interactive database services, including electronic directory services
  - interworking between these service types
- Develop structured models of telematic and message-based service types.
- Conduct theoretical and experimental research into techniques for providing:
  - secure transport of speech signals and user data over telecommunication networks
  - secure controlled access to network based facilities, data-bases, etc.
  - secure value added services
- Conduct theoretical and experimental research into the techniques of securing the telecommunications network infrastructure used to deliver customer services
- Contribute to and evaluate international standards relating to telematic services and secure telecommunications systems.

Section Head:

J.L. Snare, BE(Hons), MEngSc

Professional Staff:

M.O. Andrews, BE(Hons), BSc

L.D. Barnes, BSc(Hons)

T. Batten, BE(Hons), MIEEE

P.V. Bysouth, BE(Hons)

C.H. Chan, BE, MEngSc

P.C. Craig, BE(Hons), PhD, MIEAust

N. Demytko, BSc, BE(Hons), MAdmin

R. Exner, BSc, BE(Hons), MAppSc, MIEEE

S.J. Faulks, BSc(Hons), PhD

A.W. Johnson, BE

S. Legg, BSc(Hons)

I.R. Lewis, BE(Hons), IEEE

S. Pungsornruk, BE, MSCS

B.P. Smetaniuk, BSc(Hons), Dip Comp Sc, PhD

M.R. Warner, BE(Hons), MIEEE

E.A. Zuk, BE, ME, MIEEE

Technical Staff:

B.W. Booth

I.C. Meggs

I.J. Moran

R.I. Webster

Artificial Intelligence Systems Section

Functions

- Provide information, advice and consultancy as defined in the Branch objectives
- Develop new service platforms, particularly based on artificial intelligence techniques
- Develop new information-based services, particularly based on easier information access
- Develop client information systems, particularly those involving expert systems and advanced techniques
- Consult with clients concerning their computer system requirements, and develop specialised solutions.

Section Head:

A.J. Jennings, BE(Hons), PhD, SMIEEE, SMIREE

Professional Staff:

J. Cybulski, MAppSc

L.A.R. Denger, ENSEMN, MIEEE, MSocFrElec

A. Kowalczyk, MAppSc, PhD

C.A. Leckie, BSc, BE(Hons)

P.L. Nicholson, BE, MIEEE

C.D. Rowles, BSc, BCommE, MIEEE

Technical Staff:

R.B. Coxhill

P.F. Elliott

SWITCHED NETWORKS RESEARCH BRANCH

Objectives

- In the fields of switching and signalling, conduct studies, exploratory development and field experiments, contribute to specifications and provide advice and recommendations as appropriate relating to:
  - technical aspects of switching and signalling within the Telecom network
  - new switching and signalling systems which use extensions of present techniques, or new techniques with particular reference to their integration into the existing network
  - compatibility of switching and signalling systems
  - cost sensitivity studies
  - traffic engineering.

Branch Executive Group

General Manager:

J.L. Park, BE(Hons), MEngSc, SMIEEE

Branch Administrative Officer:

S.J. Chalk

Support Staff:

J. Guthrie

M. Oliver

A. Paisley

P. Sweeney

S. Tarpkos

Network Services and Signalling Section

Functions

- Conduct research into switching and signalling networks, systems and techniques in order to provide specialist advice, information and recommendations to other areas of Telecom
- Assess the potential of future switching and signalling networks, systems and techniques in relation to Telecom's needs
- Develop models to validate theoretical studies of switching and signalling networks, systems and techniques
- Contribute to the development of national and international standards.

Section Head:

R.J. Vizard, Dip Elec Eng, BEE

Professional Staff:

N.P. Aylott, BE(Hons), BSc(Hons), MIEAust

J. Billington, BE(Hons), MEngSc, MIEEE

L.H. Campbell, BSc(Hons), PhD

H.K. Cheong, BE(Hons), PhD

B.T. Dingle, Dip Elec Eng, BE(Hons)

H.J. Everitt, BSc(Hons), MSc

D.M. Harsant, BE(Hons)

M.A. Hunter, BE(Hons)

S.M. Jong, BE

B.W. Keck, BSc(Hons), BE(Hons), PhD

D. Kirkham, BE(Hons)

S.A. Leask, BE(Hons), MIEEE

R. McNaughton, BSc, Dip Comp Eng, MACS, MIEEE

K. Parker, BSc(Hons), PhD

P.J. Richardson, BE(Hons)

G.P. Rochlin, BSc, MACS, MIEAust

M. Subocz, BE(Hons), MEngSc, MIEAust

E.M. Swenson, MSc, Grad Dip DP, MAIP, MIEEE, MIEAust

M. Valk, BE

A. Valmari, BE(Hons), MEngSc

G.R. Wheeler, BSc(Hons), MSc, Grad Dip Comp Sc

F.R. Wylie, BE

Technical Staff:

R.L. Backway

K.J. Clark

H.G. Fegent

Switching Section

Functions

- Provide specialist advice, consultation, information and recommendations in relation to future switching techniques and their impact on Telecom services and networks
- Conduct research into new switching techniques that can support future integrated narrowband and broadband services
- Investigate packet switching strategies for future network evolution, particularly maintaining expertise in the protocols and network structures required for the application of advanced services such as Electronic Funds Transfer
- Study interworking between different switched networks and develop interworking techniques where appropriate to meet future network needs
- Develop switched data networks performance analysis and monitoring techniques and apply them to switched data networks
- Contribute to the development of standards for packet switched data networks and the Broadband ISDN and participate in their application.

Section Head:

P.A. Kirton, BE(Hons), PhD, MIEEE

Professional Staff:

G.N. Aumann, BE(Hons), MEngSc

J.L. Burgin, BE(Hons), MIEEE

G.A. Foers, BE(Hons), MIEEE

G. Foster, BE(Hons)

P.R. Hicks, BE, BSc, MEngSc

H. Katz, BSc, MSc

D.W. McMillan, BE(Hons), BSc

S. Michnowicz, BE(Hons), BSc

C.J. O'Neill, BE(Hons), PhD

R.A. Palmer, BE(Hons), PhD, MIEEE

C.J. Scott, BAppSc, MAIP, MIEEE, MIEAust

S.L. Sutherland, BE(Hons), MIEEE

D. Tate, BE

E. Tirtaatmadja, BE(Hons), MEngSc, MIEEE

Technical Staff:

P.S. Ellis

J.R.J. Valadon

D.J. Hardwick

Network Analysis Section

Functions

- Study the performance of Telecom's circuit and packet switching networks under normal and overload conditions and recommend traffic routing and control strategies needed to maximise traffic throughput at all times
- Develop mathematical models and techniques needed for planning and dimensioning minimum-cost circuit and packet switching networks meeting specified performance standards
- Investigate the traffic characteristics and traffic capacity of new switching and signalling systems adopted or being considered for adoption by Telecom
- Recommend traffic performance standards and network structures for new switching and signalling systems being considered for adoption by Telecom
- Operate as a national reference authority providing advice for traffic engineering theory and education
- Maintain a constant review of world developments in traffic theory and its application to telecommunications networks.

Section Head:

R.E. Warfield, BE(Hons), PhD

Professional Staff:

R.G. Addie, BSc(Hons), PhD

D.M. Conway, BSc(Hons)

A. Maheswaran, BE(Hons), PhD

A.F. Mich, BSc(Hons), MSc

M.H. Rossiter, BSc(Hons), PhD

R. Taylor, BSc(Hons), MSc, PhD

M. Zukerman, BSc, MSc, PhD

VLSI Unit

Functions

- Maintain expertise and knowledge of the latest VLSI design techniques and capabilities
- Develop skills and facilities to enable telecommunications hardware systems to be designed by application of advanced software design tools and implemented using VLSI tecniques.

Manager:

I. Dresser, BE

Professional Staff:

N. Leister, BE, MIREE

B.R. Nigli, BSc, AACS

Technical Staff:

S.P. Curlis

TRANSMISSION NETWORKS AND STANDARDS BRANCH

Objectives

- In the field of transmission networks and standards, conduct research, exploratory developments, system applications and field experiments, contribute to specifications, assist in the assessment of tenders and provide advice and recommendations as appropriate relating to:
  - the technical aspects of new transmission networks and systems within the Telecom Australia networks including their integration into the existing network
  - the electromagnetic compatibilty (EMC) of electronic/communication systems and equipment and prototypes, including the reduction or removal of hazards due to electromagnetic (non-ionizing) radiation from such equipment
  - the provision of a sound scientific basis for all measurements made by and within Telecom Australia by arranging traceability of accuracy of measurement of fundamental engineering and physical quantities to the Australian National Standards.

Branch Executive Group

General Manager:

A.J. Gibbs, BE(Hons), ME, PhD, SMIEEE, SMIREE

Branch Administrative Officer:

A. Mehmet

Information Systems Co-ordinator:

J.L. Kelly

Support Staff:

D.R. Foster

J. Higgins

K.M. Kingstone

M. McKinstry

S. Simpson

Optical Networks Section

Functions

- Provide information, advice, consultancy and recommendations as defined in the Branch objectives
- Conduct research and exploratory development into the transmission characteristics of optical media and conduct research into transmission systems and networks which utilise optical media
- Evaluate the potential applications and utilisation of systems using such media for the transmission of telecommunications services in the local, junction and trunk networks
- Investigate the interworking of such systems with other parts of the transmission and switching network
- Maintain an awareness of, and evaluate and advise on, emerging techniques relating to optical transmission systems for the distribution of services within the customer's premises using local area network techniques and associated contention resolution methods, taking into account:
  - the interworking of such systems with other parts of the transmission and switching network and the requirements of existing and emerging telecommunications services, and
  - network maintenance, reliability and security to provide customer service integrity
- Conduct experiments and participate in field trials designed to demonstrate the feasibility of new optical fibre systems and networks.

Section Head:

B.M. Smith, BE(Hons), PhD, SMIEEE

Professional Staff:

J.L. Adams, BSc(Hons), PhD, IEEE, GradAIP, MIEAust

R.W.A. Ayre, BE(Hons), BSc(Hons), MEngSc, MIEEE

D.J. Bakewell, BEE(Hons), MIEEE, MIEAust

B.R. Clarke, BE(Hons), PhD

C. Desem, BSc(Hons), MSc, PhD, MIEEE

M.D. Hayes, BE(Hons), BSc

K.J. Hinton, BE(Hons), BSc(Hons), MSc, PhD, Dip IR

I.M. McGregor, BE(Hons), MEngSc,PhD

S.J. Newnham, BE(Hons)

G. Nicholson, BE(Hons), MEngSc, MIEEE

P.G. Potter, BE(Hons), PhD

T.D. Stephens, BE(Hons), MEngSc

Technical Staff:

L.W. Bourchier

G. Dhosi

E.A. Dodge

J.H. Gillies

I.D. Moyes

R. Owers

G. Prete

D.J. Temple

R.C. Witham

N.W. Wolstencroft

Radio and Satellite Networks Section

Functions

- Provide information, advice, consultancy and recommendations as defined in the Branch objectives
- Conduct research into transmission systems which utilise radio media, including both terrestrial and satellite systems and networks
- Evaluate the potential application of wireless access systems and networks for existing and emerging telecommunications services
- Conduct theoretical studies, hardware development and field investigations to demonstrate the feasibility of new wireless access systems
- Investigate the interworking of such systems with other parts of the telecommunications network
- Investigate and develop systems and testing methods/apparatus.

Section Head:

A.J. Bundrock, BE(Hons)

Professional Staff:

G. Bharatula, BSc, MSc, MTech, MIEAust

J.C. Campbell, BE(Hons), MEngSc, MIEEE

Z. Debanic, Dip Elec Eng, MIEEE

R.K. Flavin, BSc, MSc, SMIREE

D.H.M. Giddy, BSc, BE(Hons), GradIEAust, MIEEE

R.A. Harvey, BSc, Dip Radio Eng, MIREE

G.F. Jenkinson, BSc

I.C. Lawson, BEE

L.J. Millott, BE(Hons), MEngSc, SMIEEE

A.R. Urie, BE(Hons), MIEEE

M. Wilkinson, BE, MEngSc, PhD, MIEEE

Technical Staff:

F.S. Beyer

D.K. Cerchi

M.J. Durrant

J. Gravina

D.A. Jewell

G.W. Kay

A.D. Martinus

P.S. Richardson

J.J. Sekfy

B.W. Thomas, BA

D.J. Thompson

Electromagnetic Compatibility Section

Functions

- Provide information, advice, consultancy and recommendations as defined in the Branch objectives
- Conduct research and exploratory development of techniques for achieving electromagnetic compatibility (EMC) of electronics/communications systems and equipment
- Conduct research and exploratory development of techniques for the assessment and prevention of the biological hazards of electromagnetic (non-ionising) radiation from electonic or communications systems and equipment
- Conduct research and exploratory development of new, advanced and novel antennas for telecommunications applications
- Investigate and develop specifications, standards and methods of measurement of incidental electromagnetic (EM) emission and susceptibility levels for electronic or communications equipment and systems
- Investigate, evaluate and develop measurement and calibration facilities of both the indoor and outdoor types (including chambers and test ranges) for antenna, EMC and EM hazard assessments, measurements, tests and calibration applications
- Maintain and promote an awareness of EMC, EM hazards and antenna applications and implications for systems, equipment and network performance, and provide consultancy and technical advice to Telecom on a national basis.

Section Head:

K.H. Joyner, BSc(Hons), PhD, Dip Ed, MARPS, SMIREE, MBEMS

Professional Staff:

W.S. Davies, BE, MEngSc(Hons), PhD

A.H.J. Fleming, BSc, MAppSc, MIREE, MAMS

S. Iskra, BE(Hons), MIEEE

I.P. Macfarlane, Dip Elec Eng, BEE, SMIEEE

E. Vinnal, BE(Hons),MIEEE

Technical Staff:

G.J. Bail

A.J. Cole

P.R. Copeland

D.M. Farr

R.J. Francis

B.C. Gilbert

S.J. Hurren

C.F. Wilson

M.P. Wood

Reference Standards and Measurements Section

Functions

- Plan and oversight the implementation, operation and further development of a system of engineering references and calibration facilities for Telecom Australia
- Operate, maintain and calibrate Telecom Australia's central engineering references in terms of the Australian National Standards of Measurement
- Develop improved engineering references, calibration and measuring techniques and procedures to meet Telecom Australia's developing technology and operational needs
- Develop special techniques, systems and equipment for the application of measurement technology to the solution of engineering plant problems
- Operate as a Verifying Authority and Signatory in accordance with the requirements of the National Standards Commission and the National Association of Testing Authorities
- Liaise with other sections of Telecom Australia to ensure that all standards of reference have an appropriate authenticity of calibration as required by the Weights and Measures Act
- Liaise with other national and international measurement laboratories and authorities, particularly the International Telecommunications Union, Union Radio Scientific Internationale, the Standards Association of Australia and the National Association of Testing Authorities.

Section Head:

R.W. Harris, BSc(Hons), BE(Hons), BComm

Professional Staff:

J.P. Colvin, Dip Elec Eng, BE

D.A. Latin, BE, MEngSc

E. Pinczower, Dip Elec Eng, MIEAust

R.W. Pyke, Dip Elec Eng, BE(Hons), MIEAust

B.R. Ratcliff, Dip Comm Eng, ARMIT

Technical Staff:

J.H. Baldock

K.J. Bassett

J.B. Erwin

C.R. Flood

B. Juska

P. Lindley

G.F. Lucas

T.W. Pearson

R.H. Yates

TELECOMMUNICATIONS SCIENCE & TECHNOLOGY BRANCH

Objectives

- Conduct scientific research, exploratory development, laboratory and field experiments, provide expert scientific advice and recommendations contributing to the establishment of design, performance and assessment criteria and specifications relating to:
  - the characteristics and properties of new materials, devices and equipment technologies for application in the telecommunications network
  - the impact and compatibility of new technology and new applications of existing technology with those already in the Telecom Australia network
  - the forecasting and evaluation of developing trends in telecommunications technology particularly suitable for application in Australia
  - the mechanisms of degradation and service failures and the development of mitigation techniques
  - impact of the environment on personnel and plant and the development and implementation of appropriate protective measures
  - the assessment of the operational reliability of materials, components and devices
  - the evaluation and development of advanced materials, the application of emerging scientific technologies, and research into improved scientific or analytical procedures
  - the processing and application of new materials and methods for the realisation of specialist electromechanical and mechanical hardware.
- Maintain liaison and exchange information with appropriate research establishments and learned institutions and participate in material and international standardisation activities.

Branch Executive Group

General Manager:

P.V.H. Sabine, BSc, BE(Hons), PhD

Branch Administrative Officer:

C.J. Chippindall

Computing and Programme Co-ordinator:

A.M. Fowler, MIEAust

Support Staff:

S.M. Collins

A. Hodges

T.D. Lindsay

G. Menelaou

H. Oates

C. Williams

Energy Technology Section

Functions

- Provide information, advice and consultancy as defined in the Branch objectives
- Undertake fundamental investigations into energy, its sources, conversion, storage, utilisation and conservation, including electrical and thermal forms for both stationary and mobile applications
- Evaluate and make recommendations on the potential impact of changing energy technology on Telecom Australia's operations
- Undertake the design, exploratory development and experimental assessment of new devices and techniques for power generation and cooling, and make recommendations on their application in Telecom Australia's operations, particularly in remote areas.

Section Head:

D.J. Kuhn, BE(Hons), MEngSc

Professional Staff:

J.J. Der, BSc, ARACI

D.C. Gates, BE(Hons), MBBS

E.E. Gibbs, BSc(Hons), PhD

S. Hinckley, BSc(Hons), PhD, MIEE, GradAIP

I. Muirhead, BSc(Hons), MEnvStud

T. Robbins, BSc(Hons), MSc, MIREE

S. Sulcs, BA, BSc, Dip Ed

Technical Staff:

L.O. Barling

E.D.S. Fall

R.W. Garner

B.K. Hawkins

N.J. Whitaker

Broadband Integrated Optoelectronics Section

Functions

- Provide information, advice and consultancy as defined in the Branch objectives
- Undertake fundamental investigations into solid state electronics, including the exploratory development and fabrication of devices and circuit elements which have functions based on the exploitation of special material properties
- Develop and provide specialised facilities in the field of solid state electronic materials and devices arising from the above.

Section Head:

G.L. Price, BSc(Hons), PhD, FAIP, MAPS, MIEEE

Professional Staff:

J. Dell, BEE(Hons)

J. Hubregtse, Dip Comm Eng, MIREE

M.J. Joyce, BSc

P.C. Kemeny, BSc(Hons), PhD, GradAPS

R. Pattie, BEE

J. Szymanski, MSc, PhD

B.F. Usher, BSc(Hons), PhD, Dip Ed, MAIP

G. Yoffe, BSc(Hons), MSc, PhD

Technical Staff:

F. Gigliotti

K.J. Moseley

L.G. Powell

R.C. Tarran

Optical Technology Section

Functions

- Provide information, advice and consultancy as defined in the Branch objectives
- Undertake fundamental investigations into the generation, amplification, modulation, detection and waveguiding of coherent electromagnetic radiation having submillimetre or shorter wavelengths, and into techniques or phenomena which can effect the propagation characteristics of such radiation
- Investigate and advise on active and passive circuit configurations of opto-electronic devices and their application in telecommunications systems.

Section Head:

G.O. Stone, BE(Hons), MEngSc, PhD, MIEEE, MIREE

Professional Staff:

A.M. Duncan, BSc, BE(Hons)

S. Goh, BSc, MSc, PhD

Y. Ito, BE(Hons), ME

Y.H. Ja, BE, PhD, MAOS

P.M. McNamara, BSc(Hons), MSc, PhD

G.E. Rosman, BEE, ME

T. Warminski, MSc, PhD, DSc

Technical Staff:

W.C. Andrews

C.G. Byrne

D.A. Calwell

B.P. Cranston

Device Technology Section

Functions

- Conduct research into:
  - the reliability of electronic components and devices
  - the properties of metals and alloys
  - the physical properties of materials and components and their performance under environmental and high potential stresses
  - materials surface - related phenomena
- Conduct scientific studies into high potential phenomena and their effects on Telecom Australia's plant and equipment; investigate protective devices and develop measures for the protection of staff, subscribers and plant
- Conduct scientific studies into the properties and life expectancy of components, devices and assemblies and investigate causes of failure and degradation
- Conduct scientific studies into the influence of surface characteristics on the behaviour of materials and devices
- Conduct scientific studies into the behaviour of metal products and investigate electrical contact or interconnection systems
- Devise and develop specialised test measurement or analytical techniques as needed
- Investigate testing methods applicable to the characterisation and failure analysis of materials and components
- Provide information, advice and consultancy as defined in the Branch objectives.

Section Head:

G.G. Mitchell, BSc(Hons), MSc

Professional Staff:

E.J. Bondarenko, Dip App Phys, BAppSc, MAIP, MIEAust, SMIREE, FRAS

S.J. Charles, BAppSc

P.W. Day, BE

J.R. Godfrey, Dip Met

C.G. Kelly, BAppSc, AAIP, MAXAA, MAVS

T.J. Keogh, Dip Sec Met

M.H. Kibel, BSc(Hons), PhD, MAVS, ARACI, CChem

S.W. Li, BSc(Hons), Dip Tech Sc, MSc

A.J. Murfett, BSc(Hons)

T.P. Rogers, BAppSc, MAppSc

C. Sandford, BSc

D.C. Willis, BEE(Hons)

Technical Staff:

G. Allison

J.C. Ellery

C. Frost, BAppSc

R.G. Hand, BEE

M. Jorgensen, Dip Sec Met

D.S. McCallum

S.F. Molnar

D.A. Nolte

S.L. Parkinson

K.L. Scott

Polymer & Materials Science Section

Functions

- Conduct exploratory research in the field of polymer science and technology and develop polymer materials systems and processes specifically suited to Telecom Australia's network and the Australian environment
- Conduct scientific studies into environmental factors and their effects on materials, components and equipment; measure the incidence and distribution of climatic factors
- Conduct exploratory research into the chemical properties, composition of materials and their effects on plant and personnel
- Devise or develop specialised test methods and analytical techniques as needed
- Operate as a verifying authority and signatory in accordance with the requirements of NATA in the field of temperature and humidity measurements
- Provide information, advice and consultancy as defined in the Branch objectives.

Section Head:

B.A. Chisholm, Dip App Chem, MSc, Grad RACI, Grad PRI

Professional Staff:

D.J. Adams, Dip App Chem, GradRACI

R.N.M. Barrett, BSc(Hons), CChem, FRSC

R.J. Boast, Dip App Chem, Grad Dip Pol Sc, ARACI, CChem

T.J. Elms, Dip App Sc, Grad Dip Anal Chem, ARACI, CChem

S. Georgiou, BAppSc, Grad Dip Anal Chem

G.W.G. Goode, BSc

A.W. Kruijshoop, NatIr(Delft)

B.J. Keon, BSc, Grad Dip Pol Sc, Grad RACI

P.R. Latoszynski, Dip App Sc, Grad Dip Anal Chem, ARACI, CChem

D.E. Thom, BSc, Dip Ed, Dip Proc Comp Systems

Technical Staff:

S.D. Barnett

L.A. Bautista

D. Coulson

D.A. Holding

M.C. Hooper

A.S. Impey

B.L. James

R.R. Pierson, Dip Res Cons Stud, ARACI, CChem, MAIST

I.M. Tippett

M.M. Turner

Infrared Optoelectronics Section

Functions

- Conduct exploratory research on optoelectronic devices suitable for mid-infrared optical fibre communications
- Conduct studies and experimental work on Metal-Organic Chemical Vapour Deposition techniques for the growth of materials applicable to infrared devices
- Develop fabrication procedures suitable for processing materials into optoelectronic devices for telecommunications applications
- Develop test and characterisation procedures for mid-infrared optoelectronic devices
- Provide information, advice and consultancy as defined in the Branch objectives.

Section Head:

J. Thompson, BA(Hons)

Professional Staff:

N. Bharatula, MSc(Chem), MTech, GAIP

G.I. Christiansz, BSc(Hons), PhD, Dip Ed

P.J. Gwynn, Dip App Chem

M. Kwietniak, BSc, MEngSc, PhD, MIEEE, MAPS, MAVS

P.W. Leech, FRMIT, MAppSc, PhD

G. Pain, BSc(Hons), PhD, ARACI, CChem

N. Petkovic, BSc, MSc, MIEA, SMIREE

Technical Staff:

R.J. Anderson

G. Brinson

M. Crarey

A.S. Doherty

G.K. Smith

Scientific Engineering Section

Functions

- Conduct research into the application of new materials, components fabrication and assembly techniques applicable to the design and construction of mechanical, electrical and electronic equipment and tools required within the Research Laboratories and elsewhere in Telecom Australia
- Provide for Telecom Australia a specialist design facility, including mechanical and electromechanical engineering design of the hardware aspects of telecommunications models; arrange for production of these designs within Telecom Australia or industry or, when necessary, within the Section; establish specification criteria for performance and quality, and the necessary measuring equipment, and employ these to ensure adequate performance of the items produced
- Oversight on-the-job training in mechanical engineering fields for the Research Laboratories
- Prepare and modify drawings incorporating associated design drafting, investigations and computations
- Ensure that the standard of engineering documentation prepared in the Laboratories conforms to Telecom Australia's policies and standards
- Provide consultative services on the standard or specification of contractor supplied engineering documentation.

Section Head:

J.R. Lowing, Dip Sec Met

Professional Staff:

A.R. Gilchrist, Dip Mech Eng, BE(Hons), GradIEAust

W.F. Hancock, Dip Elec Eng, MIEAust

P.F.J. Meggs, Dip Mech Eng, ARMIT, Grad Dip Ind Mgt, MIEAust, SMSME

Technical Staff:

K.L. Everett
T.J. Hand
F.I. Hanratty
J.W. Kalisz
J.D. Kisby
S.J. Lloyd
L. McCallum
D.J. McMillan
P.N. McMullen
R.N. Nicoll
W.L. Reiners
B.W. Walker

Chief Draftsman:

M.K. Brown

Drafting Staff:

A. Carratelli
M.P. Haslinghouse
R.N. Jackel
B.C. James
B.J. Kerr
A.J. Lynch
A.J. Norrish
D.G. Peck
M.F. Rogers

INTELLECTUAL PROPERTY AND INFORMATION BRANCH

Objectives

- Conduct studies, participate in policy formulation, contribute to specifications for and assessments of tenders, develop and operate systems, facilities and processes, and provide advice and recommendations as appropriate relating to:
  - the identification, securing and exploitation of intellectual property rights relevant to the interests of Telecom Australia, including intellectual property aspects of Telecom Australia's relationships with other parties
  - the management and operation of the Research Laboratories' programme of R&D contracts and related processes for R&D collaboration with external organisations
  - technology and information transfer from the Research Laboratories to other units of Telecom Australia, industry, academia and other external organisations
  - co-ordination of the participation of staff of the Laboratories in the activities of external organisations
  - recruitment and development of professional and technical grade staff of the Research Laboratories
  - the investigation, development and operation of centralised, integrated, networked computer-based facilities - in support of the Research Laboratories' management, administration and investigatory functions.

Branch Executive Group

General Manager:

F.W. Arter, BEE, MEngSc

Branch Administrative Officer:

T.M. Walsh

Intellectual Property Section

Functions

- Interpret and execute Telecom Australia's policy on intellectual property and provide specialist advice and assistance to management and staff of Telecom Australia on the intellectual property aspects of their activities within Telecom Australia and with external organisations
- Identify, secure and, where relevant, exploit Telecom Australia's interests in intellectual property arising out of its internal activities or those with external organisations
- Co-ordinate, establish and manage the Research Laboratories' programme of R&D contracts, collaborative research agreements and related activities
- Develop and participate in the execution of strategies for the transfer of technology developed within Telecom Australia, and in particular, the Research Laboratories, to industry.

Manager:

O.J. Malone, BEE

Professional Staff:

P. Gretton, Dip Elec Eng

R.E. Ollerenshaw, BEE

A.W. Wheeldon, BSc(Hons)

Support Staff:

C.F. Wilson

Communications & Media Liaison Section

Functions

- Develop and implement communications strategies and initiatives to effectively represent and promote the role, relationships and activities of the Laboratories to a variety of target audiences within and outside Telecom Australia
- Provide a focal point for public media interfaces with the Laboratories, collaborating with Telecom's Corporate Communications Directorate to publicise the role and activities of the Laboratories and enhance the image of Telecom Australia
- Co-ordinate, prepare and/or edit items representing or publicising the role and activities of the Laboratories to a variety of target audiences via print, audio and visual media, including displays and demonstrations
- Provide information on the results of Laboratories' activities to key client groups within Telecom Australia, in support of the Laboratories' Business Plan.

Manager:

B.F. Donovan

Science Writer:

S. Nason, BAppSc

Support Staff:

C. Anderton

Information Transfer Section

Functions

- Develop and implement methods and programmes for the effective transfer of technical information generated within the Research Laboratories to other units of Telecom Australia, and where appropriate, to external industrial organisations, R&D institutions and academia
- Co-ordinate and oversight technical publications emanating from the Research Laboratories, including the development and operation of efficient publication processes and procedures
- Perform editorial functions and oversight approval, classification and issue procedures for technical publications of the Laboratories
- Provide a focus for technical liaison with, and representation of Laboratories' activities to, external organisations and persons, including the development and operation of information retrieval services, talks, visits, displays, etc.
- Assist in the recruitment of professional and technical grade staff for the Research Laboratories, and develop, co-ordinate and execute programmes for their technical development.

Manager:

L.N. Dalrymple, Dip Elec Eng, GradIEAust

Technical Staff:

C.A. Block

A.M. Johnson

R.J. McKenzie

K.M. Matthews

A.K. Mitchell

M.F. Phipps

Support Staff:

G.E. Cock

M.F. Urbancic

Trainee Technical Staff:

P.J. Buissink

D.P. Dickens

B.J. Edwards

P.J. McIntosh

P.M. Rosenberg

Functions

- Conduct relevant investigations and, in consultation with TRL Branches, develop secure, integrated, networked computer facilities for the Laboratories - to provide, with timely anticipation, cost-effective facilities for all centralised information processing needs of the Laboratories, including office automation and management information systems, text/graphics communications and the complete range of scientific computing applications necessary to support the Laboratories' R&D programme
- Prepare software and hardware specifications for, and co-ordinate the acquisition and commissioning of, such facilities, liaising with other units of Telecom Australia and industry as required
- Evaluate, specify, procure and/or develop hardware and software for the abovementioned purposes
- Manage and administer the facilities efficiently, with appropriate security and availability as befits particular applications of the facilities
- Co-ordinate the acquisition and commissioning of hardware and software procured from external suppliers, liaising with other Telecom units and industry as required
- Provide and/or arrange cost-effective hardware and software maintenance, ensuring maximised availibility of the facilities to users
- Provide user support and consultancy services to all users of the facilities throughout the Laboratories
- Develop, co-ordinate, conduct and/or arrange training programmes for users of the facilities
- Provide expert technical advice on computing equipment and networks, including ancillary terminal equipment and applications software, to other Laboratories' Branches.

Manager:

P.J. Tyers, BE(Hons), BSc, MIEEE

Professional Staff:

J.A. Gilmour, BAppSc, MIEEE

J.G. Hollow, BE(Hons), PhD, MIEEE

P.Y.F. Hui, BSc

R. Liu, BSc(Hons), Dip Comp Sc, MACS

E.C.S. Ng, BSc, Dip Ed, M Ed Stud, Grad Dip Comp

Technical Staff:

M. Armstrong

S. Dovile

R.B. Gotch

L.P. Lorrain

P.C. Murrell

W.W. Staley

Support Staff:

D.J. Noble

B.L.P. Stone

OPERATIONS BRANCH

Objectives

- To provide support to professional and technical staff of the Research Laboratories in the areas of:
  - laboratory design and instrumentation facilities
  - human resources management
  - financial resources management and purchasing
  - general administration.

Branch Executive Group

General Manager:

B.M. Douglas

Branch Administrative Officer:

M.T. Lambert

Support Staff:

E.C. Bailey

J.H. Darbyshire

S.J. Hoare

R.P.E. Johnstone

E. McLeod

T. Miller

D.A. Pritchard

E. Williamson

Instrumentation Engineering Section

Functions

- Study instrumentation trends relevant to present and future Telecom Australia applications; design and develop novel instrumentation systems for specific needs which cannot be obtained from commercial sources
- Develop and maintain facilities, including calibration standards, required for the calibration and maintenance of advanced laboratory test equipment and apply these facilities to ensure the high standard of performance required of Laboratories' instrumentation
- Conduct the procurement programme for all new equipment for the Laboratories, including preparation of technical specifications, tender evaluations and technical reports; perform acceptance testing of new equipment.

Manager:

A.M. Collins, BSc

Professional Staff:

P. Standaert, BE(Hons)

Technical Staff:

H.W. Anders

G.F. Brownfield

B.J. Churchill

P.J. Dalliston

S.B. Davenport

D.C. Diamond

D.M. Gellert

D. Goulding

S.J. Heath

M.J. Leary

R.B. Rizzo

K.L. Rogers

D. Wilson

Support Staff:

R. Fernandes

L.B. Phung, BA

M. Scott

F. Skidmore

Laboratory Design Section

Functions

- Plan and specify, in conjunction with other Telecom Australia staff, accommodation requirements of the Laboratories in future and existing buildings; liaise with construction authorities and contractors as appropriate; plan and co-ordinate the occupation of new accommodation
- Maintain special laboratory buildings, fittings, services and facilities; liaise with Buildings SRU to arrange all buildings and building services, repairs and maintenance required within the Laboratories
- Co-ordinate all safety, security, and fire protection matters within the Laboratories.

Manager:
T.W. Crichton

Technical Staff:

W. Alkemade	B.J. Maloney
S.R. Collins	J. Scicluna
R.I. David	J.R. Stephens
R. Fodero	

Support Staff:
R.A. Nelson

Cleaning Staff:

C. Cornell	M. Macaronis
F. Freeman	C. Marshall
M. Gavrila	A. Mihalek
E. Guidice	H. Perdikis
D. Laurie	N. Perdikis
A. Lesnjak	L. Simic
A. Lindsay	S. Young

Human Resources Section

Functions

- Provide a value added service to assist the achievement of the Laboratories' Business Plan by developing and implementing strategies in the field of human resource management, in particular:
  - staff development
  - personnel services
  - recruitment and selection
  - performance appraisal
  - manpower and organisation planning
  - industrial relations
  - legislation/administrative law
  - occupational health and safety.

Manager:
P. Farnes, BA

Manpower and Organisation Officer:
T.W. Dillon

Personnel Services Officer:
L. Roberts

Support Staff:

H.C. Carbery	K. Schwarzenberg
V. Flanagan	S. Van Den Heuvel
M. Green	C. Walker
F.L. McDonald	

Budgets and Finance Section

Functions

- Provide a co-ordinated framework of resources, systems and advice for the management of all Laboratories' financial, budget control and purchasing activities.

Manager:
M.A. Chirgwin

Management Information Officer:
M.J. Holmes

Budgets Officer:
K.J. Sexton

Budgets Accountant:
P.S.S. Felix, BBus

Senior Supply Officer:
J.R. Utan

Support Staff:

B. Chivers	S. Scambler
D.J. Clutterbuck	J. Stonehouse

Stores Staff:

M.J. Anderson	R.J. Mullins
M. Gie	M. Rickards

STAFF AFFILIATIONS WITH EXTERNAL BODIES

Staff of the Laboratories are active members of advisory committees of educational establishments, governing bodies of professional and learned societies, study groups and technical committees of standards organisations and advisory committees convened by other national and international organisations. These include:

NATIONAL EDUCATIONAL BODIES

Technical and Further Education Board, Victoria

- Science Laboratory Standing Committee — T.J. Elms

Melbourne University

- Committee of Convocation — H.S. Wragge
- Faculty of Engineering — H.S. Wragge

Monash University

- Research Associate - Department of Materials Engineering — M.S. Kwietniak

Chisholm Institute of Technology

- Advisory Board, Centre for Business Technology — H.S. Wragge
- Chairman, Digital Electronics Course Advisory Committee, Faculty of Applied Science — H.S. Wragge
- Course Advisory Committee, Department of Chemistry and Biology — R.J. Boast
- Course Advisory Committee, Division of Information Technology — A.J. Jennings
- Course Advisory Committee, Electrical Engineering Department — A.J. Jennings

Royal Melbourne Institute of Technology

- Course Advisory Committee, Department of Metallurgical Engineering — P.V.H. Sabine

Swinburne Institute of Technology

- Council Member — H.S. Wragge

Victracc

- Director — H.S. Wragge

Communication Research Institute of Australia

- Board of Governors — H.S. Wragge

NATIONAL PROFESSIONAL BODIES

Australian Institute of Energy — D.J. Kuhn

Australian Telecommunications and Electronics Research Board — R. Smith

Australian X-Ray Analytical Association

- Victorian Branch
  - Committee Member — B.F. Usher

Commonwealth Special Research Centre for Electronic Structure of Materials — G.L. Price

Institute of Electrical and Electronic Engineers

- Australian Council
  - Committee Member — L.J. Millott
- Victorian Section Committee
  - Chairman — L.J. Millott
  - Secretary/Treasurer — R.A. Palmer
  - Committee Members — R.A. Court, A.J. Gibbs, A.J. Jennings
- Communications Chapter
  - Committee Members — T.J. Batten, E. Vinnal

Institution of Engineers, Australia

- Chairman, Accreditation Board — H.S Wragge

Telecommunication Society of Australia

- Council of Control — G.F. Jenkinson
- Board of Editors: "Australian Telecommunication Research" — G.D.S.W. Clark, A.J. Gibbs, M.A. Hunter, G.F. Jenkinson, D.J. Kuhn, I.P. Macfarlane, H.V. Rodd, J. Thompson

The Royal Australian Chemical Institute

- Polymer Division Committee — B.A. Chisholm

NATIONAL STANDARDISATION BODIES

Standards Association of Australia (SAA)

- Australian Electrotechnical Committee — P.V.H. Sabine
  - IEC Quality Assessment Scheme for Electronic Components — P.V.H. Sabine
- Co-ordinating Committee on Fire Tests — D.J. Adams
- Information Technology Standards Board — J.L. Park
- Plastics Standards Board — B.A. Chisholm
- Telecommunications and Electronics Standards Board and Executive — G.M. Willis

SAA Technical Committees

- Battery Standards
  - Primary Cells and Batteries — J.J. Der
  - Secondary Batteries — J.J. Der
- Chemical Industry Standards
  - Adhesives — R.J. Boast
  - Examination of Workplace Atmospheres — R.C.M. Barrett
  - Heavy Duty Paints — D.J. Adams

- Computers and Information Processing Standards
  - Computer Graphics — P.I. Mikelaitis
  - Data Communications — C.J. O'Neill, P.R. Hicks
  - EFT Authentication and Security — J.L. Snare
  - EFT Communications — C.J. O'Neill, J.L. Park, J.L. Snare
  - Open Systems Interconnection — P.C. Craig, R. Exner, J.L. Park, E.A. Zuk
  - Programming Languages — G.P. Rochlin
  - Text and Office Systems — R. Exner, B.P. Smetaniuk
- Electrical Industry Standards
  - Control of Undesirable Static Charges — G.W.G. Goode
  - Electrical Accessories — P.W. Day
  - Electrolytes — R.C.M. Barrett
  - Indicating and Recording Instruments — E. Pinczower
  - Lightning Protection — E.J. Bondarenko
  - Plastics — B.A. Chisholm
- Mechanical Engineering Industry Standards
  - Hand Tools — P.F.J. Meggs
- Metal Finishing Standards
  - Armouring Cable — T.J. Keogh
  - Electroplating & Methods of Test — T.J. Keogh
  - Metal Finishing — J.R. Godfrey
  - Methods of Test — T.J. Keogh
  - Tin and Tin Alloys — J.R. Godfrey
  - Zinc and Cadmium Coatings — T.J. Keogh
- Metal Industry Standards
  - Precious Metals — J.R. Godfrey
  - Steel Wire Rope and Strand — T.J. Keogh
- Plastics Industry Standards
  - Flammability of Plastics — D.J. Adams
  - Fuel Tanks and Containers — D.J. Adams
  - ISOTC 61 Plastics Advisory Committee — B.A. Chisholm, D.J. Adams
  - Mechanical Testing of Plastics — B.A. Chisholm
  - Outdoor Weathering of Plastics — G.W.G. Goode
  - Testing of Plastics — B.A. Chisholm
- Safety Standards
  - Industrial Safety Gloves — T.J. Elms
  - Industrial Safety Helmets — R.J. Boast
  - Safety of Electronic Equipment — I.K. Stevenson
  - Safety of Information Technology Equipment — I.K. Stevenson
- Telecommunications and Electronics Industry Standards
  - Automatic Electronic Identification Equipment — K.H. Joyner
  - Electromagnetic Interference — S. Iskra, I.P. Macfarlane
  - Environmental Testing — M.C. Hooper
  - Hazards of Non-Ionizing Radiation — K.H. Joyner
  - Measurement Methods for RF Radiation — K.H. Joyner, I.P. Macfarlane
  - Passive Electronic Components — S.J. Charles
  - Polyethylene Insulation for Telecommunications — D.J. Adams
  - Semiconductor Devices — G.G. Mitchell
  - Siting of Radiocommunications Equipment — R.K. Flavin, K.H. Joyner
  - Solar Photovoltaic Cells & Modules — D.J. Kuhn

NATIONAL ASSOCIATION OF TESTING AUTHORITIES (NATA)

- Assessor for Environmental Testing — M.C. Hooper
- Assessor for Laboratories Engaged in Electrical Testing — E. Pinczower, J.B. Erwin
- Assessor for Laboratories Engaged in Testing Plastics — B.A. Chisholm
- Electrical Testing Registration Advisory Committee — G.M. Willis
- Organic Materials Technical Group — B.A. Chisholm

OTHER EXTERNAL ORGANISATIONS

Australian Government Paint Committee — D.J. Adams

Commonwealth Special Research Centre for Electronic Structures of Materials — G. Price

CSIRO

- Standards Advisory Committee — G.M. Willis

Daratech P/L (Victorian Department of Agriculture and Rural Affairs)

- Director — O.J. Malone

Department of Industry, Technology & Commerce

- Advanced Electronic Materials Committee — B.F. Usher

Department of Resources and Energy

- Committee for the Japan-Australia Collaborative Program on Remote Area Power Supplies — P.V.H. Sabine

National Energy Research, Development and Demonstration Council

- Technical Standing Committee on Solar, Wind and Nuclear Energy — D.J. Kuhn, N.F. Teede

National Occupational Health and Safety Commission

- Working Party on Non-ionising Radiation, Standing Committee on Standards Development — K.H. Joyner

Victorian Solar Energy Council

- Project Steering Committee — D.J. Kuhn

INTERNATIONAL BODIES

The Laboratories participate in the activities of a number of international bodies and committees. These include:

- The International Telegraph and Telephone Consultative Committee (CCITT)
- The International Radio Consultative Committee (CCIR)
- The Australian and New Zealand Association for the Advancement of Science (ANZAAS)
- The Bureau International de l'Heure (BIH)
- The International Electro-technical Commission (IEC)
- The International Standards Organisation (ISO)
- The International Federation of Documentation, Committee for Asia and Oceania (FID/CAO)

In particular, staff of the Research Laboratories held offices in the following international bodies during the year:

- IEC Joint Co-ordination Group on Optical Fibres, Working Group O — R.W.A. Ayre
- International Special Committee on Radio Interference (CISPR) Working Groups — S. Iskra, I.P. Macfarlane
- Teletraffic Engineering Training Project (TETRAPRO), ITU/ITC — J. Rubas
- Vice-Chairman, CCITT Study Group VII/48 — J.L. Park
- World Energy Council — N.F. Teede

REPORTS, PAPERS AND LECTURES

Research Laboratories Reports and Branch Papers are the vehicles by which the results of research studies and investigations, development projects and other specialised tasks undertaken in the Laboratories are officially documented. Staff of the Laboratories also contribute papers to Australian and overseas scientific and technical journals, and present papers to learned societies both in Australia and overseas. The following lists show the reports, papers, lectures and talks published or presented by Laboratories' staff during the last 12 months.

RESEARCH LABORATORIES REPORTS

REPORT	AUTHOR(S)	TITLE
7890*	R.W. Pyke	Optical Fibre Reference Standards - Overseas Visit Report, November 1986
7894*	P. Standaert, S. Curlis & A.J. Stevens	An Automatic Battery Testing Facility - A Scanner
7899*	N.A. Leister, P. Standaert & A.J. Stevens	An Automatic Battery Testing Facility - Sub-controller Hardware
7902*	P.F.J. Meggs	Telecom Australia's Involvement in SAA Committee ME/10 - Hand Tools
7903*	P.W. Leech	Overseas Visit - September/October 1987
7906*	G. Bharatula	Viability of Packet Radio for Future Public Land Mobile Communications
7910	P.R. Latoszynski	Stabiliser Compatibility with Polypropylene
7911	R.A. Palmer	Output Queue Functionality and Architectures for Asynchronous Transfer Mode Switching
7912*	J.L. Park	CCITT Study Group VII: Data Communication Networks, Report on Activities for the 1985-1988 Study Period
7913*	E. Tirtaatmadja, G. Nicholson, C.J. Scott & G.J. Semple	Optical Customer Access Network Options
7914	R.J. Fone	A Numerical Petri Net Description of ISDN Layer 3 Procedures
7915	R.J. Fone	An Analysis of a Numerical Petri Net Description of ISDN Layer 3 Procedures
7916*	B.J. McGlade	X.PC - A Portability Guide

REPORT	AUTHOR(S)	TITLE
7917	G.F. Jenkinson	CCIR Interim Study Group 4 Meeting and Joint Interim Working Party/ORB(2): November - December 1987
7918*	G.J. Cowle & J.L. Adams	Linewidth Reduction Techniques for Semiconductor Laser Diodes
7919	G.J. Cowle	Laser Linewidth Determination by the Self-Heterodyne Technique
7920	B.R. Clarke & L.W. Bourchier	The Wavelength Response of Optical Filters Employing a Grating and Single Mode Input Fibres
7921	J.P. Lacey & B.J. McGlade	Specification for an Electronic Minutes Circulation System
7924	S.J. Charles	Laser Diode Reliability
7925	S.R. McAllister	Using ORACLE SQL* Forms
7926 *	C.J. O'Neil	Congestion Control in the Broadband ISDN
7927	D.J. Temple & G. Nicholson	Polarisation Measurement System for Optical Fibre Cables
7928	P.R. Copeland	A Transverse Electroagnetic Cell for Testing Radio Frequency Radiation Hazard Meters
7929*	Staff of the Telecom Research Laboratories	Papers presented at the 13th Australian Conference on Optical Fibre Technology (ACOFT'88), Hobart, December 1988
7931*	D.W. McMillian & W.S. Marcus	Port Controller Functionality and Architectures for ATM Switching
7932*	G.W.G. Goode	Joint Use of Lift or Building Hoist Travelling Cables
7933*	B.J. Keon	Side Polished Optical Fibre Couplers : An Introduction
7934*	C.J. Scott	Video Services in Broadband ISDN : An Overseas Visit Report
7935*	R.B. Gotch	A Localtalk Installation Manual for TRL
7936*	S.L. Sutherland	Broadband ISDN Standardisation Status

Notes:

*The Reports marked * are classified as "For Telecom Australia Use Only". In addition, several confidential Reports with restricted distribution were produced.*

BRANCH PAPERS

PAPER NUMBER	AUTHOR(S)	TITLE
AS0109*	E.E. Gibbs & T.P. Rogers	Process Characterisation and Testing of AWA NMOS Multi-Project Chip Devices
AS0114*	E.J. Bondarenko	Electrical Tests on Optical Fibre Cable Locator Transponders
AS88/003*	T.J. Keogh & M. Jorgensen	The Termination of Single Pair Screened Ployethylene Insulated Cable with Seimens MDFs
AS88/004*	T.J. Keogh & M. Jorgensen	The Evaluation of Type D Subminiature Connectors with IDC Termination
AS88/006*	T.P. Rogers	Mobile Radio-Paging Transmitter RF Power Transistor Failures
AS88/007*	T.P. Rogers	Touchfone 200 Repertory Dialler Integrated Circuit Evaluation (OKI 60521-17)
AS88/008*	T.J. Keogh & M. Jorgensen	Failure of Direct Lead Plough Tines
AS88/009*	T.P. Rogers	Touchfone 200S Dialler IC Evaluation (OKI MSM 61806-01)
CSS0142	G. Lindgaard	What's on the Menu - or Better, What Should be on the Menu? A Literature Review and Guidelines for Menu Design
CSS0146	T. Batten	Linear Hamming Code
CSS0147	P.V. Bysouth	Random Number Generation using the Linear Congruential Algorithm
CSS0149*	P.V. Bysouth & J.L. Snare	A Proposed Authentication Security Service for AUSTPAC
CSS0151*	A.W. Johnson	Smart Cards for Secure Communications Systems Research
CSS0152	G. Lindgaard	Testing for Legibility of Characters on a Screen
CSS0153	T. Batten & J.L. Snare	Network Security Issues of Concern to Government Departments
CSS0159*	J.L. Snare	Electronic Funds Transfer Security - Trend Review
CSS0160*	G. Lindgaard	DCRIS and Some of its Problems
CSS0161*	E.A. Zuk	Trends in Open Systems Security
CSS0162*	J. Baxter	A Stream Cipher Demonstration Program
CSS0163*	P.F. Duke	Telecommunications Applications of Voice I/O

PAPER	AUTHOR(S)	TITLE
CSS0172*	J. Chessari	The Status of EMFAS On-line Text Retrieval Systems: A Usability Assessment
SD/0005*	F.J.W. Symons	Some Recommendations for the Telecom Research Laboratories based on Analysis of Funding, Resources, etc
SNR0118*	G.P. Rochlin	An Information Model for Intelligent Network Services
SNR0142*	M. Littlewood	The Distribution of Multiservice Network Control Functions
SNR0146	H.J. Everitt	Modelling Stenning's Protocol Using PROTEAN
SNR0147	H.J. Everitt	Temporal Logic as a Query Language for PROTEAN's Reachability Graphs
SNR0148*	E. Tirtaatmadja & C.J. Scott	The B-ISDN Customer Access Network - A Discussion
SNR0149	M. Zukerman	Circuit Allocation and Overload Control in a Hybrid Switching System
SNR0150	R. McNaughton & S.A. Leask	A Report on The First Australian Forth Symposium
SNR0151*	J. Rubas	Review of Teletraffic Engineering Education
SNR0160*	H.J. Everitt	The Service Management System in the Intelligent Network
SNR0162	M. Zukerman	Applications of Matrix-Geometric Solutions for Queuing Performance of a Hybrid Switching System
SNR0163	M. Zukerman	Bandwidth Allocation for Bursty Isochronous Traffic in a Hybrid Switching System
SNR0166*	P.J. Richardson	Logical Connections Using SCCP
SNR0167*	B.W. Keck	Mobile Application Part, First User of Transaction Capabilities Application Part
SNR0168*	E. Tirtaatmadja	Broadband ISDN Switching in the Customer Access Network
SNR0169*	H. Katz	Technical Developments Required to Use the TRAN$END/AUSTPAC Network and the ISDN to Provide an Alarm Telemetry Service
SNR0170*	P.R. Hicks & J.L. Park	CCITT Activities Relating to Network Management
SNR0171*	L.H. Campbell	The Current Intelligent Network Scene: Report of Overseas Visit, October/November 1988
SNR0172*	H.J. Everitt	Customer Data in the Intelligent Network
SNR0174*	R. Taylor	NetCAD Report 1 - The Computation of Network O-D Availability
SNR0175*	D.M. Conway	NetCAD Report 2 - A Graphical Editor for Telecommunication Networks
SNR0176*	D.E. Everitt	A Comparison of Channel Assignment Strategies for Mobile Communications Systems
TNS0164*	R. Masciulli	Modal Noise Aspects of the Transmission of 850 nm Optical Signals on 9/125 micron Fibre
TNS0169*	R.C. Witham & I.M. McGregor	Field Visit to Croydon District
TNS0170*	D. Ben-Meir	Area Capacity of Second Generation Cordless Telephones
TNS0172*	A. Urie	Cordless Extension of Cellular Mobile Telephone Systems
TNS0173*	G. Bharatula	Future Developments in Radio Paging
TNS0174*	I.P. Macfarlane	Evaluation of Two 12V DC/240V AC Inverter Units
TNS0175*	S.J. Hurren & D.M. Farr	An Initial Evaluation of Earth Station Antennas for the ITERRA Network Service
TNS0176*	D.M. Farr, R.J. Francis & S.J. Hurren	Evaluation of RFS Grid Kit Antenna Type GKA 38/1415
TNS0177*	G.J. Semple	A Review of Optical Fibre Network Architectures for Application in the Customer Access Network
TNS0178*	G. Nicholson	A Discussion of Optical Fibre Customer Access Network Scenarios
TNS0181*	A. Bettiol & S. Iskra	Potential Direct Internal Interference to Information Technology Equipment (ITE) from Multiple Co-located Basic Access ISDN Systems
TNS0182*	P.G. Potter	Assessment of Canstar Super 100 Network
TNS0188*	R. Jones & P.G. Potter	Transmission Testing of HP Starlan 10 Local Area Network

PAPER	AUTHOR(S)	TITLE
TNS0190*	S. Iskra	Assessment of the Electromagnetic Interference Characteristics of the HP Starlan 10 Local Area Network
TNS0191*	R.W.A. Ayre	Laser Safety in Optical Fibre Systems: Implications of the New Draft Australian Standard on Laser Safety
TNS0192*	G.J. Semple	Optical Fibre Architectures and Systems for the Customer Access Network
TNS0195	G.J. Semple	WDM over a Macnet Architecture with a Wavelength-Dependent Multi-port Coupler
TST0119*	P.W. Day	Siemens T23 A230
TST0121*	S.J. Faulks & S. Georgiou	Contamination on Half-Inch Magnetic Tape
TST0122*	S.F. Harper	EEPROM Reliability
TST0124	T.P. Robbins	Accurate Dynamic Model for Power MOSFETs
TST0127*	C.J. Ellery & S.J. Faulks	Use of Abrasive Bristle Cleaning Strips on Crossbar Exchange Relay Contacts
TST0128*	R.J. Boast & S.D. Barnett	Investigation of Problems with Siemens Heat Shrink Sleeving used for the Telecom Openable Joint
TST0129*	D.J. Adams & G.W.G. Goode	Plastics Terminal Boxes for "Solarex" Photovoltaic Modules
TST0130*	J.J. Der	Performance Evaluation of 6V 90Ah Battery Manufactured by Battery Energy South Pacific Pty Ltd
TST0131*	J.R. Godfrey	Evaluation of Main Distribution Frame Termination Modules
TST0132*	A.J. Murfett	Long Term Dry & Damp Heat Tests on Solar Modules - Report No. 2
TST0133*	D.C. Willis	High Voltage Evaluation of SLP10-K-2 Subscriber Line Protector
TST0134*	P.W. Day	Electrical Protection Investigation, Darwin, March 1989
TST0135*	P.W. Day	Field Exposure of Gas Filled Protectors
TST0136*	S. Li	Use of Liquid Crystals for Determining the Site of Electrostatic Discharge to Integrated Circuits
TST88/010*	T.P. Rogers	Evaluation of Fujitsu 8K SRAM for TDCC Equipment
TST88/011*	P.W. Day	High Voltage Evaluation of the Alcatel-STC Energy Management Terminal
TST88/012*	T.P. Rogers & S. Molnar	Motorola 8K SRAM for Use in Telephone Equipment
TST88/031*	E.D.S. Fall	Laboratory Tests of Five Amorphous Solar Module Types
TST89/001*	T.J. Keogh	Failure of Load Wheels on Jungheinrich Man-Up Kombi
TST89/002*	J.R. Godfrey	Amtron DIN41612 Connectors - Evaluation of January 1989 Product
TST89/003*	S.W. Li	Failure in National Power Driver LM7545N P8432DS
TST89/CR0	C.G. Kelly & S. Georgiou	Contamination on Half-Inch Magnetic Tapes
TT88/010*	L.A. Denger	A Survey of Expert Systems for Telecommunications Operation and Maintenance
TT88/014*	P.F. Elliott	A Mid-Infrared Optical Fibre Attenuation Measurement Method using a Fourier Transform Spectrometer
TT88/015*	A. Kowalczyk, et al	Thermal Radiation Noise in Mid-Infrared Optical Communication
TT88/016*	P. Kabaila & A. Kowalczyk	On the Appearance of Finite Patterns in Shift Register Sequences
TT88/017*	A. Kowalczyk	Rough Simplifications of Decision Tables
TT88/018	T.P. Robbins	Modelling and Simulation of a Power MOSFET and a Switchmode Topology using PSPICE
TT88/019*	I.J. Muirhead	Improving the Reliability of Solar Power System Design
TT88/020	C.D. Rowles	Co-Operative Response from Intelligence Assistants in TASK Oriented Domains
TT88/021*	A.J. Jennings	Artificial Intelligence
TT88/022*	A.J. Jennings & C.D. Rowles	Capability-Based Natural Language Understanding
TT88/024*	S. Hinckley & J.J. Der	Positive Post Corrosion and Copper Poisoning in Large Capacity Lead-Acid Stationary Batteries
TT88/025*	C.D. Rowles & C.A. Leckie	A Design Automation System Using Explicit Models of Design
TT88/026*	E.E. Gibbs & A.J. Murfett	Accurate I-V Measurements of Amorphous Silicon Photovoltaic Modules

PAPER NUMBER	AUTHOR(S)	TITLE
TT88/027*	F.M. Hamilton & J.J. Der	Performance Evaluation of 1986 Prototype Pasted-Plate Lead-Acid Batteries for Stationary Applications
TT88/029*	A. Kowalczyk	Towards Approximate Models of Telecommunication Network History for Machine Learning
TT88/030*	B.K. Hawkins	Installation Report - Solar Module Cold Site at Mt Buller, Victoria - May/June 1988

Notes:

*The Branch Papers marked * are classified as "For Telecom Australia Use Only". In addition, several confidential Papers with restricted distribution were produced.*

PAPERS PUBLISHED OR PRESENTED BY TRL STAFF

AUTHOR(S)	TITLE, ETC.
G.K. Reeves et al	'Titanium Silicides Formed by Rapid Thermal Vacuum Processing', Journal of Applied Physics, Vol.63, No.6, March 1988
M.H. Kibel	'Characterisation of II-VI Semiconductor Materials Using Surface Analytical Techniques', 7th National Conference, Australian X-ray Analytical Association, Perth, August 1988
E.J. Bondarenko	'Lightning Strike Damage to Optical Fibre Cables', ACOFT'88 Conference on Optical Fibre Technology, Hobart, December 1988
P.W. Leech	'The Effect of Nitrogen Implantation on the Tribological Properties of Gold-based Alloys and Electroplated Palladium', IEEE Transactions on Components, Hybrids & Manufacturing Technology, Vol.11, No.1, March 1988
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Y.H. Ja	'Optical Beam Deflection Using Dynamic Volume Reflection Gratings', Optical and Quantum Electronics, Vol.21, March 1989
T. Warminski	'Homogeneity and Purity of II-VI Compounds', Materials Australia, September 1988
G.E. Rosman et al	'Stimulated Four-Photon Mixing in Bent Few-Mode Optical Fibres', Optical and Quantum Electronics, Vol. 20, 1988
T. Warminski	'Remarks on the Electron Probe Micro-Analysis of Mercury Cadmium Telluride', 3rd Australian Conference on II-VI Semiconductors, Adelaide, April 1989
Y.H. Ja	'An Improved Scheme Using the Shooting Method to Solve Degenerate Four-wave Mixing Equations', Australian Journal of Physics, Vol 42, 1989

AUTHOR(S)	TITLE, ETC.
R.R. Pierson	'Chemical Vapour Deposition of Materials for Australia's Optic Fibre Telecommunications Network', Chemistry in Australia, Vol.55, No.8, August 1988
P.R. Latoszynski & R.J. Boast	'Polymers in Telecommunications - Their Performance in Hostile Environments', 17th Australian Polymer Symposium, Brisbane, January 1989
J. Szymanski	'Angular Distribution of Positrons Emitted from Metal Surfaces', Physical Review B, Vol.38, No.16, 1989
P.V.H. Sabine	'New Challenges in Optoelectronics Materials Technology', CHEMECA, Australian Bicentennial Conference, Sydney, August 1988
P.V.H. Sabine	'Trends in Optoelectronics', Seminar on Telecommunications Through the '90s, Melbourne, October 1988
P.L. Nicholson	'Telecom's Experience with Expert Systems', Australian Computer Society, (Queensland Branch), Seminar on Expert Systems, June 1988
A.J. Jennings	'Artificial Intelligence', Seminar on Telecom's Services for the 1990s, Melbourne, September 1988
D.J. Kuhn & S.C. Goh	'Warm Superconductors - A New Energy Technology Frontier', SAE Australasia Journal, May/June 1988
J.J. Der	'Battery Testing Parameters and Their Relative Importance', Battery Users Group Meeting, CSIRO, Fisherman's Bend, February 1988
I.J. Muirhead & D.J. Kuhn	'Photovoltaic Power System Design Using Available Meteorological Data', PVSEC-4, Conference on Photovoltaics, Sydney, February 89
S.C. Goh I.T. Hawkes	'Structure of Amorphous Silicon Film Produced by 50 HZ AC Glow-Discharge', PVSEC-4 Conference on Photovoltaics, Sydney, February 1989
A.J. Murfett	'Stability of Power Amorphous Modules', PVSEC-4, Conference on Photovoltaics, Sydney, February 1989
S. Hinckley G.I. Christiansz	'Electrodeposition of Semiconductor Alloys for Photovoltaic Applications', PVSEC-4, Conference on Photovoltaics, Sydney, February 1989
D.J. Kuhn	'Energy into the '90s', Seminar on Telecommunications Through the '90s, Melbourne, October 1988

AUTHOR(S)	TITLE, ETC.
G.E. Rosman & T. Warminski	'The Effect of Fibre Drawing on Fluoride Glass Composition', 7th National Conference, Australian X-ray Analytical Association, Perth, August 1988
T. Warminski	'Analytical WDX/EDX - Studies of Heavy Metal Fluoride Glasses Used for Drawing Optical Fibres', Australian X-ray Analytical Association, New Horizons in Analytical Science, Perth, August 1988
T. Warminski & A.M. Duncan	'New Glass Preform Composition Assessment in the Process of Designing and Fabricating Mid-Infrared Optical Fibres', ACOFT'88 Conference on Optical Fibre Technology, Hobart, December 1988
G.O. Stone, G.E. Rosman, B.P. Cranston & Y. Ito	'Demonstration of Fluoride Glass Fibre Transmission Near 2500 Nanometres', ACOFT'88 Conference on Optical Fibre Technology, Hobart, December 1988
Y.H. Ja et al	'Optical Wavelength Demultiplexing using Reflection Gratings and Recorded in Photorefractive Crystals', ACOFT'88 Conference on Optical Fibre Technology, Hobart, December 1988
P. McNamara et al	'Surface Defects on Fluoride Glasses Induced during Fibre Drawing', 5th International Symposium on Halide Glasses, Shizuoka, Japan, June 1988
M.J. Joyce, B.F. Usher et al	'Concentration-Dependent Band Offset in InGaAs-GaAs Strained Quantum Well', Physics Review B, Vol.38, December 1988
J. Szymanski et al	'Exact Solution for the Hartree Fock Approximation to the Electron Gas', Recent Progress in Many-Body Theories, Plenum Press, New York & London, 1988
J. Szymanski et al	'Dynamic Correlations in the Electron Gas: The Mean Field Picture and Beyond', Recent Progress in Many-Body Theories, Plenum Press, New York & London, 1988
P.J. Orders, B.F. Usher & M.J. Joyce et al	'Observation of Compressive and Tensile Strains in InGaAs/GaAs by Photoluminescence Spectroscopy', Applied Physics Letters, July 1988
P.C. Kemeny	'III-V Semiconductor Thin Film Optics: Optical Modulator and Filter Arrays', Journal of Applied Physics, Vol.64, No.11, December 1988
J. Szymanski	'Systematic Trends in Adsorption Properties of HgTe and CdTe Surfaces', 19th International Conference on the Physics of Semiconductors, Poland, August 1988
G.L. Price	'Reflection on High Energy Electron Diffraction', 7th National Conference, Australian X-ray Analytical Association, Perth, August 1988
G.L. Price	'Growth of Highly Strained InGaAs on GaAs', 7th National Conference, Australian X-ray Analytical Association, Perth, August 1988
B.F. Usher	'Kinematical Simulation of Double-Crystal X-ray Diffraction Spectra of Strained Layer Superlattices', 7th National Conference, Australian X-ray Analytical Association, Perth, August 1988
J. Hubregtse & P.C. Kemeny	'The Fabrication of Surface Lasers and Modulators', ACOFT'88 Conference on Optical Fibre Technology, Hobart, December 1988
P.C. Kemeny & J. Hubregtse	'A New Class of III-V Optoelectronic Devices - Surface Lasers, Modulators and Filters', ACOFT'88 Conference on Optical Fibre Technology, Hobart, December 1988
G.L. Price	'Growth of Highly Strained InGaAs on GaAs', Applied Physics Letters, Vol.53, No.14, October 1988

LECTURES PRESENTED BY TRL STAFF

AUTHOR(S)	TITLE, ETC.
H.S. Wragge	'Future Direction in Telecommunications', Bulter Cox Foundation Melbourne, May 1989
A. Kowalczyk	'Towards Approximate Models of Performance for Machine Learning', Mathematics Department, Monash University, October 1988
A.J. Jennings	'Telecom's Experience with Expert Systems', Australian Computer Society, Special Interest Group on Expert Systems, Melbourne, November 1988
A.J. Jennings	'Finding HAL a Job : AI in the Office', Lecture, Deakin University Department of Mathematics and Computing, May 1988
C.D. Rowles	'AI Research at Telecom Research Laboratories', Research Day for Computer Science, Monash University, February 1989
C.D. Rowles	'Language Understanding in the Medici Project: Integrating Semantics, Pragmatics and Planning', Seminar, Natural Language and Knowledge Representation, Melbourne University, March 1989
A. Kowalczyk	'Generalisation of Shannon's Entropy with Applications to Machine Learning', Mathematics Department, Monash University, July 1988
C.D. Rowles	'Capability Based Natural Language Understanding', ICOT 2nd & 5th Research Laboratory, Minato-ku, & NTT Basic Research Laboratory, Musashino, Japan, August 1988
G. Lindgaard	'Providing Assistance for the User by Iterative Design Procedures: The Pragmatics of Help Systems', Department of Computing and Information Technology, Griffith University, October 1988
G. Lindgaard	'Designing Systems for Usability: The Challenge of X.400', Department of Computer Science, Queensland University, October 1988
N. Demytko	'Secure Communications', Department of Pure Mathematics, Adelaide University, September 1988
J.L. Snare	'Secure Communications', Australian Education Council, Melbourne, October 1988
R. Exner	'Electronic Directories for Tomorrow's Telecommunications', IEEE/Telecommunication Society of Australia, Victorian Chapter, Melbourne, April 1988
M. Zukerman	'QPSX', Telecommunication Society of Australia, Melbourne, September 1988
M. Zukerman	'QPSX MAN - The IEEE 802.6 Evolving Standard: Performance Evaluation and Overload Control', IBM Scientific Research Center, Zurich, June 1988
M. Zukerman	'QPSX MAN - The IEEE 802.6 Evolving Standard: Performance Evaluation & Overload Control', University of California, June 1988
M. Zukerman	'QPSX MAN - The IEEE 802.6 Evolving Standard: Performance Evaluation & Overload Control', AMP Theatrette, Melbourne, September 1988
M. Zukerman	'Queueing Analysis for the DQDB Protocol', University of Stuttgart & University of California, June 1989
L.H. Campbell	'The Intelligent Network Concept for New Telecommunications Services', Computer Science Department, LaTrobe University, October 1988
L.H. Campbell	'The Intelligent Network: An Architecture for New Telecommunications Services', Computer Science Department, Monash University, June 1988
L.H. Campbell	'Intelligent Networks', Telecommunication Society of Australia, Melbourne, August 1988
L.H. Campbell	'The Evolution to Broadband Customer Access', Bell Communication Research, New Jersey, September 1988
J.L. Burgin	'Broadband ISDN Call Control', Department of Electrical and Computer Systems Engineering, Monash University, June 1988
K.H. Joyner	'Possible Mechanisms of Cancer Promotion', Workshop on "The Carcinogenic Potential of Extremely Low Frequency Magnetic Fields", Australian Radiation Laboratories, May 1988
K.H. Joyner	'Microwave Cataract & Litigation - A Case Study', Australian Radiation Protection Society Conference, Perth, June 1989
K.H. Joyner	'Revision of the Australian Radiofrequency Exposure Standard', Australian Radiation Protection Society Conference, Perth, June 1989

AUTHOR(S)	TITLE, ETC.
J.G. Hollow	'Radio Tomorrow and Electronics Today', 1988 Physics Teachers' Conference, Monash University, September 1988
R.P. Coutts & J. Boland	'Mobile and Universal Portable Communications', IEAust Meeting, Parkville, June, 1988
P.V.H. Sabine	'Telecom Australia - First in Telecommunications', 5th Marcel Grossman Meeting, Perth, August 1988
P.V.H. Sabine	'Future Developments in Optical Fibre Technology', Telecommunication Society of Australia, Brisbane, June 1988
P.V.H. Sabine	'Optoelectronics - A Key Future Technology', Telecommunication Society of Australia, Melbourne, June 1988
G.L. Price & B.F. Usher	'Does a Strained Quantum Well Relax?', 13th Condensed Matter Physics Meeting, Wagga Wagga, February 1989
B.F. Usher & J. Dell	'Observation by X-ray Diffraction at the Collapse of Strained InGaAs Single Quantum Wells Grown by MBE on Patterned GaAs Substrates', 13th Condensed Matter Physics Meeting, Wagga Wagga, February 1989
J. Szymanski	'Electron Correlations in Multilayer Electron Structures', 13th Condensed Matter Physics Meeting, Wagga Wagga, February 1989
G.W. Yoffe	'Surface-Emitting Light Sources for Optical Communications', 13th Condensed Matter Physics Meeting, Wagga Wagga, February 1989
J. Szymanski	'Energy Loss Mechanisms for Hot Electrons in GaAs Superlattices', 13th Condensed Matter Physics Meeting, Wagga Wagga, February 1989
J. Szymanski	'Memory-Function Approach to Dynamic Correlations in Strongly-Interacting Electron Systems', 13th Condensed Matter Physics Meeting, Wagga Wagga, February 1989
M.J. Joyce, B.F. Usher & M. Gal	'Photoluminescence and Photoreflectance Observations in InGaAs/GaAs Strained Quantum Wells', 13th Condensed Matter Physics Meeting, Wagga Wagga, February 1989
P.C. Kemeny	'Semiconductor Superlattices: A Brief Review of Their Physics and Applications', 13th Australian Condensed Matter Physics Meeting, Wagga Wagga, February 1988
B.F. Usher	'Strained Layer Superlattices for Optical Communications Device Applications', Royal Signals and Radar Establishment, Malvern, UK, April 1988
S.C. Goh	'Warm Superconductors', IEAust/IREE Joint Lecture, Melbourne, August 1988
S.C. Goh	'Small Signal Applications of Superconductors', IEAust/IREE Joint Lecture, Melbourne, August 1988
S.C. Goh	'Brian Josephson's Dream and Small Signal Applications of Superconductors', IEAust/IREE Joint Lecture, Melbourne, August 1988
P. Latoszynski	'Polymers in Telecommunications', Plastics Institute of Australia Seminar on Plastics for Electronics and Telecommunications, Monash University, May 1989
A.J. Murfett	'Solar Powered Telecommunications Systems', IREE Lecture, Melbourne, March 1988
G.L. Price	'III-V Optoelectronics at Telecom Research Laboratories', Electrical Engineering Department, University of Western Australia, August 1988

TECHNICAL CONTRIBUTIONS BY TRL STAFF TO STANDARDS ORGANISATIONS

AUTHOR(S)	TITLE, ETC
R.A. Seidl	'New Question on Video Coding for Broadband Services', CCITT Study Group XVIII, January 1988
M.C. Wilbur-Ham	'Status Report on SAA IS/1/21 Working Group 1', Standards Association Australia Meeting, Canberra, May 1988
M.C. Wilbur-Ham	'Status Report on SAA IS/1/21 Working Group 1', Standards Association Australia Meeting, Sydney, August 1988
T. Batten	'Comments on the AT&T Proposal for Error Protection of IEEE 806.6 Segments', IEEE 802.6 Working Group, September 1988
S.L. Sutherland	'Service Protection in the Broadband ISDN', CCITT Study Group XVIII, Contribution No. D1713/XVIII, May 1988
S.L. Sutherland	'Signalling at the User-Network Interface of B-ISDN - A Discussion of Enhancements', CCITT Study Group XVIII, Contribution No. D.28, January 1989
S.L. Sutherland & J.L. Burgin	'Options for Broadband ISDN Resource Management using Virtual Path Capacity Assignment', CCITT Study Group XVIII, Contribution No. D.27, January 1989
S.L. Sutherland, R.A. Palmer, C.J. O'Neill & G.A. Foers	'Quality of Service in Broadband ISDN - The Use of Priority', CCITT Study Group XVIII - Contribution No. D.25, January 1989
S.L. Sutherland & C.J. O'Neill	'Congestion Control in the Broadband ISDN - A Discussion of Techniques', CCITT Study Group XVIII - Contribution No. D.26, January 1989
S.L. Sutherland, J.L. Burgin & R.G. Addie	'Virtual Direct Routing Techniques', CCITT Study Group XVIII Meeting, Geneva, June 1988
S.L. Sutherland	'ATM Cell Header Functions and the "Likely Solution" Cell Format', CCITT Study Group XVIII, Working Party 8, Question 2, Geneva, June 1989
S.L. Sutherland & C.J. O'Neill	'ATM Priority in the B-ISDN', CCITT Study Group XVIII, Working Parties 6 and 8, Questions 2 and 5, Geneva, June 1989
S.L. Sutherland, R.A. Palmer et al	'ATM Cell Header Functional Requirements', CCITT Study Group XVIII Meeting, January 1989
I.P. Macfarlane	'Measurement of Interference at the Communication Ports of ISDN Equipment', CISPR Sub-Committee G, Working Group 2, September 1988
I.P. Macfarlane	'Longitudinal Conversion Loss of In Situ Star Quad Telephone Cables', CISPR Sub-Committee G, Working Group 2, November 1988
I.P. Macfarlane	'A Probe for the Measurement of Longitudinal Conversion Loss and Transverse Conversion Loss in the Frequency Range 0.04-30 MHz', CISPR Sub-Committee G, Working Group 2, November 1988
W.S. Davies	'Interconnecting Media Unbalance Specification for Basic UNI', CCITT Study Group XVIII, Working Party 3, Geneva, June 1989
I.P. Macfarlane	'Predictability of Vertically Polarised Radiation in Vertical Directions based upon Earthbound Measurements in the Frequency Range 1606.5 - 2000 kHz', CISPR/B/WG1/A/WG3(Macfarlane)1, April 1989
I.P. Macfarlane	'Limits for Protection of Safety of Life Services in the Frequency Range 1606.5 - 2000 kHz in Region 3', CISPR/B/WG1(Macfarlane)2, April 1989
I.P. Macfarlane	'Specification of Measurement Distance for In Situ Measurements of ISM Apparatus for Protection of Specific Safety Services', CISPR/B/WG1(Macfarlane) 3, May 1989
I.P. Macfarlane	'Further Consideration of Limits for Protection of Safety of Life Services in the Frequency Range 1606.5 - 2000 kHz in Region 3', CISPR/B/WG1(Macfarlane) 4, May 1989
I.P. Macfarlane	'Interference Field Strength Limits Below 30 MHz for the Basic Access ISDN - Response to CISPR/G/WG2 (Copenhagen/Ideguchi)4 CISPR/G/WG2, (Copenhagen/Macfarlane) 8, May 1989
I.P. Macfarlane	'The Effects of Cable Resonance on Common Mode Voltage Limits for the Signal Ports of ISDN ITE', CISPR/G/WG2 (Ad hoc ISDN Limits/Macfarlane) 5, May 1989

AUTHOR(S)	TITLE, ETC
I.P. Macfarlane	'A Rationale and Proposal for LF/MF Field Strength Limits of Signal Cable Radiation of the Basic Access ISDN' CISPR/G/WG2(Ad Hoc ISDN Limits/Macfarlane) 4, February 1989
R.K. Flavin	'Propagation Factors - Satellite Earth Stations', SAA Draft Standard TE/14/4/88-197: Siting of Radiocommunications Facilities, August 1988

INTELLECTUAL PROPERTY

It is a policy of Telecom Australia to protect its interests in any worthwhile intellectual property, notably patentable inventions but also registerable designs, which might be generated by its staff in the course of their work. Some of the inventions patented by Telecom Australia have been made by Laboratories' staff, but Telecom's intellectual property portfolio comprises inventions and designs conceived by staff throughout Telecom. The staff of the Laboratories contribute to assessments of the technical novelty and likely usefulness of new ideas as they arise as possible subjects for patent or similar action. The list below summarises the portfolio of intellectual property held by Telecom Australia. The portfolio includes applications for letters patent and registered designs.

PATENTS AND PATENT APPLICATIONS

Invention Title (inventor/s)	Application Number	Patent No. (if granted)	Country
Self Adaptive Filter and Control Circuit (Mackechnie, L.K.)	98800	3732410	USA
Control of Operation of a System (McLeod, N.W.)	166819 46-56442	3745418 888597	USA Japan
Smoke Detector (Gibson, L. & Packham, D.R.)	367260	3874795	USA
Detecting Signal Components in Multi-Frequency Signals (Proudfoot, A.D.)	387855 178402	3882283 984068	USA Canada
Noise Assessment of PCM Regenerators (Gibbs, A.J.)	52160/79 1134915 93228	525766 1134915 4300233	Australia Canada USA
Cable Hauling (Alcorn, J.)	17465/83	559320	Australia

Invention Title (inventor/s)	Application Number	Patent No. (if granted)	Country
Instant Speaker Algorithm for a Digital Conference Bridge (Phiet, D.Q.)	39841/85	566718	Australia
	85306496		Europe
	8600304	1232663	UK
	490497		Canada
	60-201967		Japan
	775549	4644530	USA
Characterisation of Digital Radio Signals (Martin, A.L.)	43227/85		Australia
	AU85/00107		PCT
	829150		USA
	61-502858		Japan
	8600304		UK
	175/85		Denmark
	860176		Finland
	860100		Norway
	85902515		Europe
	1211/85		Ireland
	543131	543131	Spain
	551145	551145	Spain
	481293	1236580	Canada
Cable Laying Apparatus (Vidler, R.A.)	47460/85		Australia
	491271	1239541	Canada
	213532		NZ
	8523098	2166602	UK
	905998	4744696	USA
Conforming the Frequency Spectrum to a Desired Form (Sneddon, B.W. & Beadle, S.G.)	49251/85	572703	Australia
Optical Distribution System (McGregor, I.M.)	63790/86		Australia
Method of Initial Synchronisation for Full Duplex Digital Transmission (Jennings, A.J. & Clarke, B.R.)	66929/86		Australia
Switch Number Identifier (Coles, J., Nicholls, R. & Keith, J.)	73005/87		Australia
Digital Error Logger (Livsey, J. et al)	21882/88		Australia
Electro-optic Modulator (Kemeny, P.C.)	AU88/00489		PCT (Australia USA Europe Japan Korea)
	89100122.0		China
Current Injection Laser (Kemeny, P.C.)	AU88/00490		PCT (Australia USA Europe Japan Korea)
	89100123.9		China
Current Injection Modulator (Kemeny, P.C.)	AU88/00491		PCT (Australia USA Europe Japan Korea)
	89100121.2		China
Optical Switch (Ja, Y.H.)	28751/89		Australia
Trench Digging Apparatus (Vidler, R.)	30779/89		Australia
Tooth Removing Device for Trench Digging Apparatus (Vidler, R.)	AU89/00075		PCT (Australia Europe USA)
Magneto-optic Device (Ito, J. & Dai, X.)	31645/89		Australia
VDR for Broadband ISDN (Burgin, J. et al)	34925/89		Australia
AX-EL Class Marking Apparatus (Manson, A.)	PI8250/88		Australia
	PI8363/88		Australia
Electro-chemical Deposition of Semiconductors (Hinckley, S. et al)	36125/89		Australia
GENESIS PABX Interface (Franchina, J.)	PI8990/88		Australia

Invention Title (inventor/s)	Application Number	Patent No. (if granted)	Country
Method & Apparatus for Forming Ohmic Contacts (Hubregtse, J.)	PI9261/88		Australia
Main Distribution Frame Structure (Longland, D.G.)	PJ0781/88		Australia
Share-Medium Communication Network (Zukerman, M.)	PJ1841/88		Australia
Telecommunications Systems and Routing Method (Bailey, P et al)	PJ4216/89		Australia

REGISTERED DESIGN APPLICATIONS & REGISTERED DESIGNS

Design Title (author/s)	Application Design No.	Number (if reg.)	Country
Telephonic Apparatus (Design & Development Group)	8087/84	96141	Australia
Telephone (Burland, B.T. & Joseph, N.E.)	1328/85	97562	Australia
Telephone Plug (Pickering, A.R.)	1327/85	96041	Australia
Base Plate for a Telephone (Atkins, D.)	1765/85	95362	Australia
Telephone Handset (Atkins, D.)	1766/85	95363	Australia
Telephone (Atkins, D.)	1767/85	95364	Australia
Telephone (Atkins, D.)	1768/85	95365	Australia
Telephone (Atkins, D.)	7595/86	102846	Australia
	934148	298128	USA
	46854/86		Japan
	20868	20868	NZ
	1038314	1038314	UK
	86301020	1107	China
	1544/86	26842	Germany
	61624-00	15565.00	Netherlands
	157740	157740	India
Support Structure for Electrical Connectors(Longland, D.G. et al)	654/88	102313	Australia
	22138	22138	NZ
Wall-Box(Hall, P. & Wilson, G.)	1289/88		Australia
Telephone (Atkins, D.)	1299/88		Australia
	258980		USA
	41127/88		Japan
	22227	22227	NZ
	1054438		UK
	88301611		China
	88 02 667		Germany
	63737-00	17961.00	Netherlands
	106296		India
A Circuit Board (Macfarlane, I.P.)	2236/88		Australia
Telephone (Atkins, D.)	814/89		Australia

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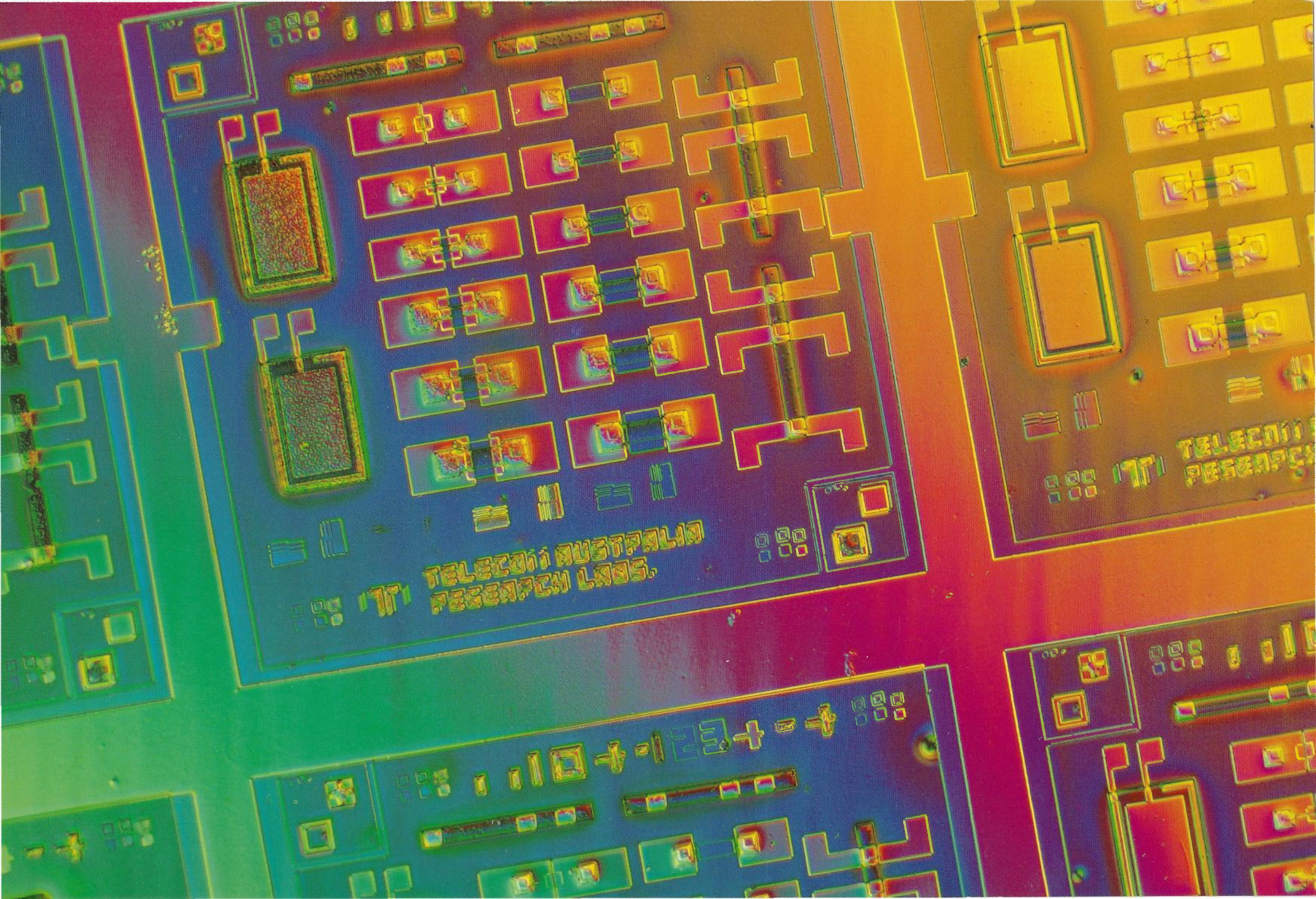
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