Research Laboratories Review of Activities • 1980-1981

Telecom Australia

Review of Activities

Research Laboratories 770 Blackburn Road Clayton, Victoria 3168 Australia

Telecom Australia

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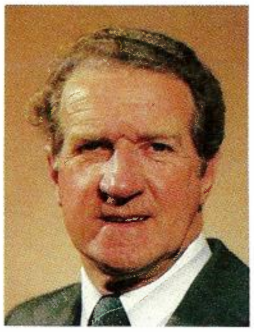
Foreword



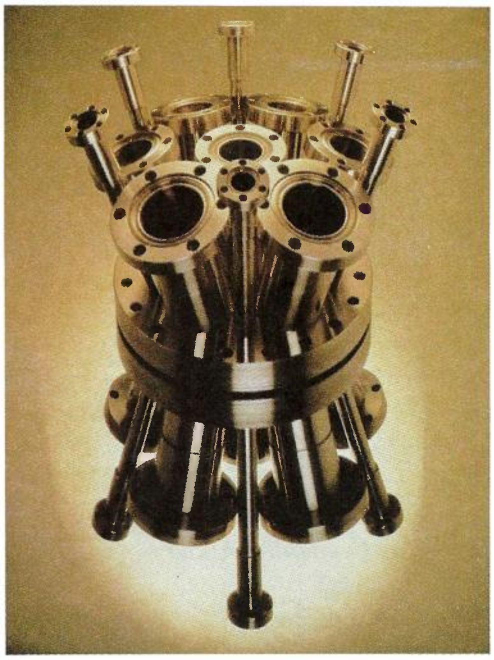
One of Telecom Australia's objectives is to provide its customers with economically priced, modern telecommunications services in keeping with world advances. Technology is an important key to the attainment of this objective. Telecom therefore seeks to develop its own internal competence in the fast-advancing field of telecommunications technology and to encourage the growth of similar competence in the local telecommunications industry through its R&D activities.

Effective R&D is an important factor in establishing and maintaining technological competence. The rate of technological development is increasing. In particular, there have been significant advances in recent times in microelectronics, satellite communications, fibre optics and digital transmission and switching. The intensifying interdependence between computer-based services and telecommunications services is likely to result in rapid, interactive development of both types of service through a merging of their fundamentally similar underlying technologies.

The expanding application of low priced, high reliability microcircuits in telecommunications and computer equipment, the proliferating adoption of digital transmission and switching techniques in telecommunications, and the high capacities of optical fibre transmission media will open new horizons for telecommunications in the next decade or so.

Although smaller in absolute terms than many of its overseas counterparts, Telecom Australia must maintain its competence on all technological fronts. As evidenced by this Review, Telecom's Research Laboratories will continue to play an important role in the technical assessment of Telecom's future service offerings and network developments.

W.J.B. Pollock – Chief General Manager



Ultra-high vacuum flange, manufactured by the Laboratories, for semi-conductor evaporation and analysis work on our Molecular Beam Epitaxy machine
The large tubes are for evaporators and analytical equipment, such as ion and electron guns; while the small tubes are for corresponding shutters. See article on page 55

Contents

The Role of the Research Laboratories

Under its Charter established by the Telecommunications Act, Telecom has the national responsibility to provide, maintain and operate telecommunications services in Australia which best meet the social, industrial and commercial needs of the people of Australia, and to make its services available throughout the country so far as reasonably practicable. The Charter also requires that services are to be kept up to date and operated efficiently and economically, with charges as low as practicable.

In meeting this responsibility, Telecom is mindful of the economic and practical benefits to be gained by the adoption of new and improved techniques, equipment and systems that result from advances in telecommunications science and technology. The correct choice of technology and emphasis on the efficient management of this technology in planning, developing and operating the telecommunications network ensures economy, efficiency and continuing flexibility in the on-going task of developing the network which provides the services to the community.

The Research Department, known as the Telecom Australia Research Laboratories, is the focal point for much of Telecom's research and development effort. The Laboratories began in 1923 as a Research Section in the Headquarters Administration of the then Postmaster-General's Department, having been established to provide specialist technical advice to the Chief Engineer on "the latest discoveries, inventions and developments in electrical communications and their promising and likely benefits to the Department's telephone and telegraph services".

Today, the Laboratories are a Department in the Headquarters Administration of Telecom. They are headed by the Director, Research, who is directly responsible to the Chief General Manager. The Laboratories' work programme is reviewed and determined annually through a corporate process which yields a rolling three year Programme of Research, Development and Innovation (RDI). The RDI process encompasses all technical activities performed within Telecom which, through the use of new or existing technology and techniques, can or will change the telecommunications services provided by Telecom to its customers, the technical performance standards of the systems used in the telecommunications network, or the operational efficiency by which Telecom provides these services over the network.

About 90% of the Laboratories' work programme comprises R&D projects and activities which are within the scope of the RDI programme. As such, this work obtains corporate endorsement and is co-ordinated with the work of other Departments, primarily the Engineering and Commercial Services Departments at Headquarters. The remaining 10% of the Laboratories' work programme comprises consultancy services in the specialised fields of precise technical and scientific measurement and analysis, technical information services and industrial property services. These latter functions are a natural extension of the primary investigatory functions of the Laboratories.

The Laboratories, by selecting relevant R&D projects in scientific and technological fields, seek to develop expertise which can be used to assist Telecom in its formulation and implementation of plans and policies for new or improved services, systems, equipment and practices. Through the application of this expertise, the Laboratories also assist Headquarters and State Administrations in the solution of technical problems that arise in the design, manufacture, installation, operation and maintenance of equipment in service in the telecommunications network.

These responsibilities of the Laboratories are met by maintaining a high level of expertise in the telecommunications and associated engineering disciplines, and in the related disciplines of physics, chemistry and metallurgy. This is done by conducting research and advanced development work on topics that are relevant to the Australian network, having regard to the work known to be in progress elsewhere in Australian research laboratories and in similar institutions overseas.

Many of the innovations, ideas and improvements proposed for the Australian network originate overseas. However, it is necessary for Telecom to have advance knowledge of these developments so that they may be evaluated soundly on social, economic and technical grounds, before they are accepted or adapted and modified for incorporation into the Australian telecommunications network. To help make these decisions and judgements with confidence, it is necessary for Telecom to have, at first hand, sound and competent technical advice. This is best derived from its own R&D, conducted in each relevant technological or scientific field.

Much of the technical advice received by Telecom in these new and developing fields of telecommunications is offered by the staff of the Research Laboratories. Most of the projects undertaken by the Laboratories, rather than being directed at production specifications, find their ultimate expression in the performance requirements incorporated in procurement specifications for the systems and equipment which are bought from the worldwide telecommunications industry. Other work is expressed in the assessment of materials, components and assembly practices used by suppliers in equipment tendered against Telecom procurement specifications. Occasionally, a project is carried to production when it is evident that the innovation, design and development work of the Laboratories will yield equipment directly suitable for field application.

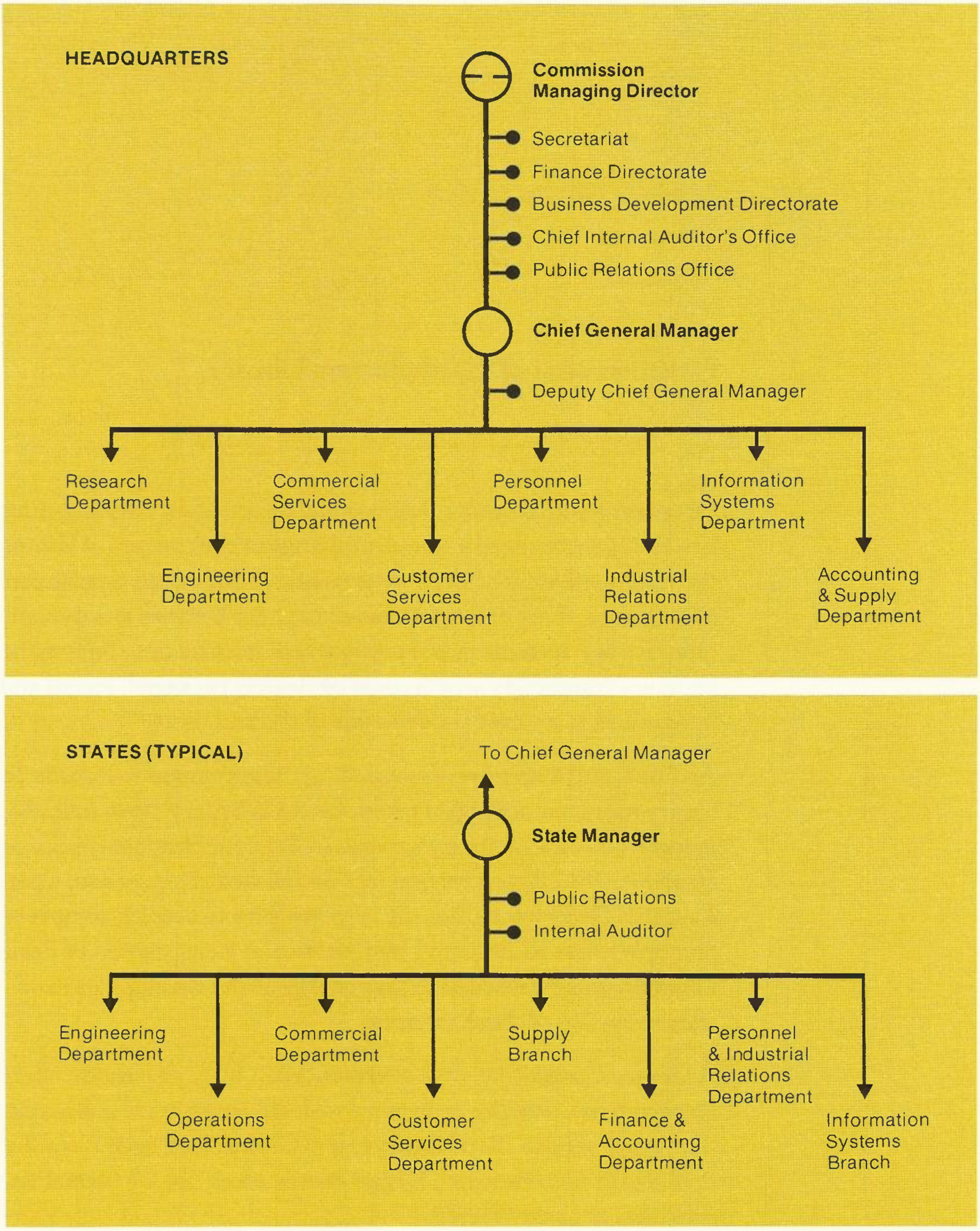
Apart from carrying out a research and development role, the Laboratories have specialist staff with knowledge and facilities in a number of disciplines, including the applied sciences, who conduct investigations into difficult technical problems that arise in the operation of telecommunications plant. Further, the Laboratories are responsible for Telecom's scientific reference standards for the measurement of time interval, frequency and electrical quantities. In the former case, they are an agent of the National Standards Commission.

Telecom, through its Research Laboratories, recognises the great variety and depth of research talent which exists in centres of higher learning and in industry in Australia. The Laboratories encourage these other research organisations to undertake specific projects of interest to Telecom and act as a focus for this activity for Telecom.

The role of the Research Laboratories remains basically the same as it was when they were first established. In essence, their basic function is to develop knowledge and skills in the advancing areas of telecommunications science and technology to assist Telecom to decide when, and to what extent, new technology is to be harnessed to provide new or improved customer services and systems.

In the selection of activities reported in the following pages, this edition of the Review of Activities of the Research Laboratories illustrates the ways in which the Laboratories have sought to fulfil their role during 1980-1981.

Organisational relationships of the Research Laboratories with other units of Telecom Australia



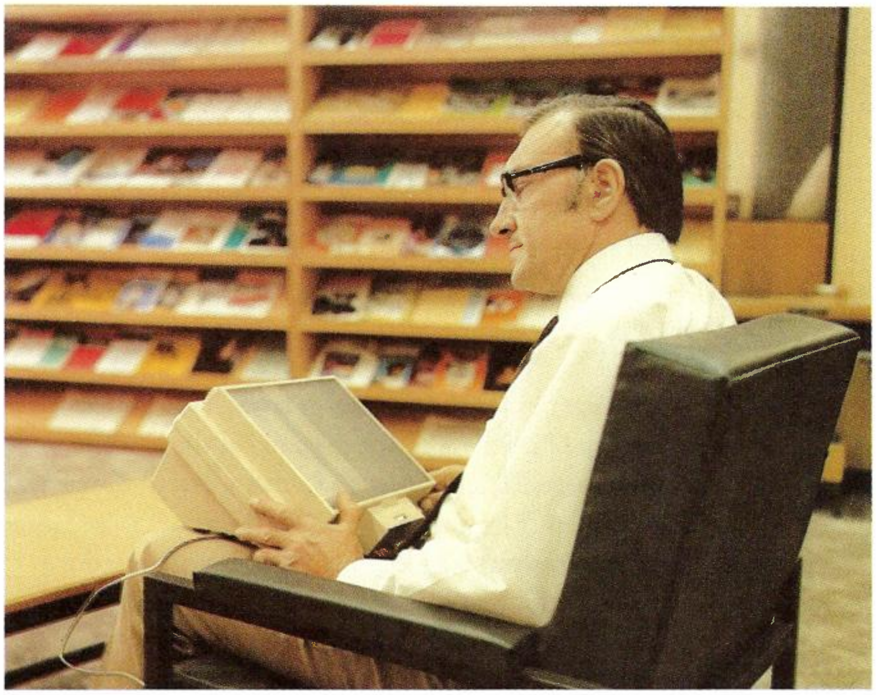
Items of Special Interest

Establishment of Headquarters Library

Developments in communications and information handling during the late 1970s encouraged a complete change in the concept of libraries. From the traditional view of libraries as passive, book-based repositories of information, there emerged a new image for libraries as a dynamic interface between users and producers of information. Information became a commodity which could be flexibly packaged, stored and handled in response to a variety of demands of the end users.

An important step towards extending these changes to include Telecom library users has now been taken. On 15 February 1980, following an extensive review of library services in Telecom Headquarters, a new Headquarters Library Section was established. This section, a part of the Research Department, has the responsibility to provide comprehensive library services to Telecom Headquarters. A new position of Principal Librarian was established to take charge of the development and administration of these services.

A Library Committee, with representation from all Headquarters Departments, was also re-formed to determine overall policy relating to the library service. Two Library Users Groups (one each from the Engineering and Research Departments) allow users a formal voice in the provision of library services.



Portable microfiche reader in use

The Library Service currently operates through five locations. The majority of library staff and the major collection of library indexes and material are located in the city at 59 Little Collins Street, Melbourne, where centralised functions such as procurement, cataloguing and administrative actions are performed, in addition to the provision of a variety of regular information services to specialist staff and the operation of information retrieval and reference services. Outposts of this Library are located with major user groups at Communications House in the city, adjacent to the Engineering Training and Publications Units in South Melbourne, and at each of the two Research Laboratories' complexes at Clayton. The outposts are equipped with recent issues of journals and reference collections relevant to the interests of the user groups, and outposted staff provide information retrieval and reference services as well as general assistance on library matters. One special new facility which is providing benefits in terms of its ability to quickly tap an extensive reference data-base is the Library's access as a subscriber to an international computer-based information searching and abstracting system, accessed through communications terminals located in several of the Library locations.

Laboratories Play a Part in the The International Electrotechnical Commission Quality Assessment System for Electronic Components (IECQ)

An international quality assessment scheme for electronic components is being established under the auspices of the International Electrotechnical Commission (IEC) in order to facilitate international trade in electronic components. The aim of the IECQ System is to guarantee that in all participating countries, quality assessment procedures for nominated electronic components are defined and implemented to a uniformly high standard. Components which have been assessed under the System will carry a certificate of their conformity with the relevant specification.

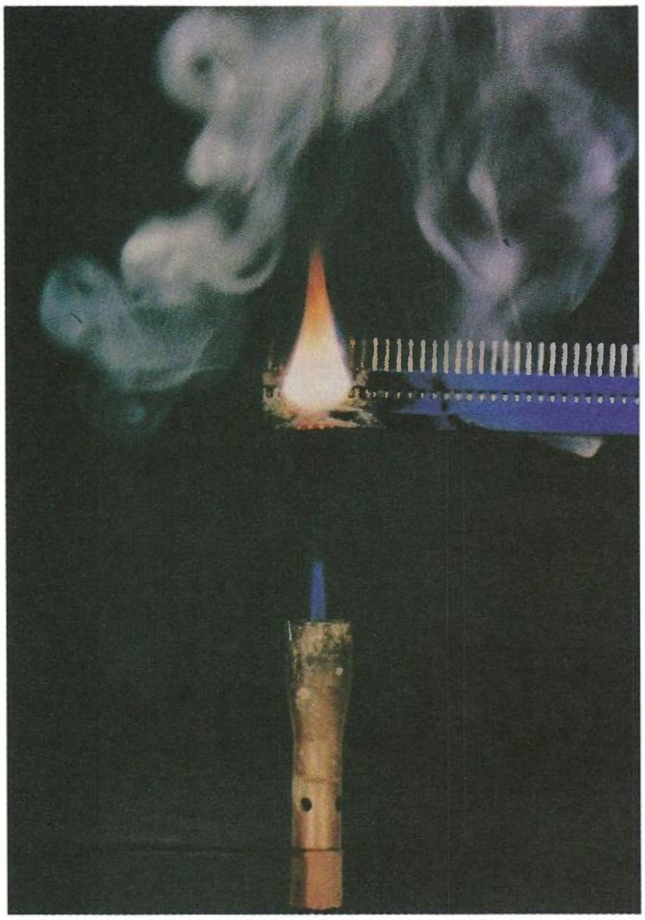
Similar regional quality assessment schemes are already in existence, for example, the BS9000 series system in the United Kingdom and the CECC System in Europe. The IECQ System has drawn on the experience gained in these schemes and its organisation and rules are largely based on the CECC System. Each participating country has an organisation to manage the System at the national level, a national standards organisation and a national Supervising Inspectorate. This Inspectorate monitors all the testing and inspection procedures of participating manufacturers and distributors of all components manufactured under the System, and performs audit testing of components in its own laboratory.

In Australia, these three functions are undertaken by the Australian Electrotechnical Committee and the Standards Association of Australia (SAA). As the SAA does not have its own testing facilities for electrical components, Telecom Australia's Research Laboratories have undertaken to perform most of the audit laboratory functions for passive components.

This involves a wide range of electrical and dimensional measurements and the performance of mechanical, environmental conditioning and accelerated aging tests. All these measurements must be traceable to national standards and the test conditions used must comply with the relevant specifications.

The traceability of electrical and temperature measurements is achieved through Sections of the Laboratories which are registered by NATA in

One aspect of IEC quality assessment testing the flammability of a component



these classifications. Other equipment required for vibration, bump, tensile, and solderability tests for example, has been calibrated by other Australian laboratories which hold the appropriate NATA registrations.

Before being accepted into the IECQ System, the applicant country's relevant national organisations and manufacturers are inspected by representatives from three member countries. Australia was inspected in January 1981 by delegates from Ireland, Belgium and USA. The inspection team visited the Research Laboratories and was fully satisfied with the standard of facilities, staff and procedures being used for audit testing of components.

Microwave Technology Seminar

The Research Laboratories have been actively engaged over recent years in an extensive programme of R&D in the field of microwave radio circuitry and associated techniques. Through this programme, a considerable knowledge and facilities base has been built up in a field where expertise in Australia is relatively limited.

With the opportunities for Australian industry participation offered by the impending establishment of the Australian National Satellite System, it was desired to make some of the microwave technology established in the Laboratories available to firms interested in the design and manufacture of microwave sub-assemblies or equipment. With this aim, a seminar was sponsored by the Research Laboratories to demonstrate the available areas of competence and facilities established for microwave technology in the Laboratories, so that interested firms could obtain an appreciation of what might be available from Telecom through consultancy arrangements.

The morning sessions of the two-day seminar were devoted to presentations by Laboratories' staff and the afternoons to visits to the Research Laboratories to inspect relevant facilities. The seminar opened with a keynote address about the Australian National Satellite System by Mr W.G. Gosewinckel of the National Satellite System Office of the Overseas Telecommunications Commission (Australia). Presentations followed on topics including microwave sub-system design, microwave circuit technology, and microwave and environmental test and measurement facilities. The seminar was successful in attracting about seventy people, having a range of interests and representing Australian industry, Government Departments and academic institutions.

The seminar was the first stage in an interactive process, which is expected to continue into 1981, whereby successful tenderers and subcontractors for parts of the National Satellite System will be enabled to consult with Telecom's experts to maximise the Australian component of the design of the System.

Precise Time and Frequency Conference

The Research Laboratories were represented at a Conference on Precise Time and Frequency held in Canberra during August 1980. The Conference was organised by the Canberra Division of the Institution of Radio and Electronics Engineers, Australia, and jointly sponsored by Telecom Australia, the Commonwealth Scientific and Industrial Research Organisation (CSIRO), the Department of Administrative Services and the Australian Development Assistance Bureau.

The two guest speakers were Dr. C.C. Costain from the National Research Council, Ottawa and Dr. R.G. Hall from the United States Naval Observatory, Washington. Both are internationally recognised experts in the time and frequency field. Other overseas participants were Dr. B.S. Mathur from the National Physical Laboratory, New Delhi; Brigadier S. Husain from the Ministry of Science and Technology, Pakistan; Mr. S. Inciong from the Philippines Atmospheric, Geophysical and Astronomical Authority, Manila; Mr. L. Amon, from the University of Otago, Dunedin, New Zealand; and Mr. B. Lohrey, from the Physics and Engineering Laboratories, Lower Hutt, New Zealand.

The Director, Research, who delivered the closing address, was accompanied by the Assistant Directors, Transmission and Standards and Laboratories Engineering, and eight other staff members from those two Branches of the Laboratories.

Of the 30 papers scheduled for discussion, four were contributed by Research Laboratories' staff, as follows:

- Maintenance of the Australian Telecommunications Commission's Time Scale – by R. Harris
- Radio and Terrestrial Time Signals in Australia – by R. Trainor
- Remote Control of Precision Oscillators – by R. Trainor
- The Increasing Requirement for Precise Timing in Digital Telecommunications – by R. Smith, L. Millott and R. Morgan.

The first two of these papers covered aspects of Australian time-keeping, an area where Telecom has had a long history of involvement, encompassing such items as speaking clock services and the standard frequency and time signal transmissions of radio station VNG. The third paper described a method by which precision oscillators are controlled by reference signals transmitted over the telephone network from the caesium beam standards in the Research Laboratories. The fourth paper highlighted the very stringent synchronisation requirements of future data transmission networks, where the stability of caesium clocks will be necessary.

A controlled oscillator was demonstrated at the conference. It remained phase coherent with its control signal from Melbourne within less than 100 nanoseconds over the five days of operation.

Resolutions agreed by the Conference included:

- that the Australian Broadcasting Commission (ABC) should provide some network connections without using their "Fedlock" system to facilitate time comparisons by the TV synchronising pulse method;
- that facilities for precise time transfer should be provided on the proposed Australian National Satellite System;
- that a programme of travelling clock visits to ASEAN countries should be instituted;
- that a precision time transfer link via satellite should be used to connect Australian time-keepers to the Bureau International de l'Heure;
- that Australia should actively participate in relevant CCIR activities and other symposia in the region; and
- that an International Time and Frequency Conference be held in Australia in 1983.

The Research Laboratories took advantage of the visit by Dr. Hall to consult him in a private capacity on the day prior to the Conference. Discussion centred around the USNO experience with large caesium clock ensembles and methods of relating their time-keeping with others via Omega, Loran and other transmissions.

Lectures at a NATO Advanced Study Institute

Dr F.J.W. Symons, Assistant Director, Switching and Signalling, was invited to deliver some lectures at a NATO Advanced Study Institute (ASI) on the theme "New Concepts in Multi-user Communication", which was held at the University of East Anglia, Norwich, England, from August 4-16, 1980. The ASI was sponsored by the NATO Scientific Affairs Division and was primarily a high level teaching activity where carefully defined subjects of international interest were presented in considerable depth. The systematic and coherently structured programme included lectures, tutorials and panel sessions presenting the actual status of the subjects covered. Most of the lecturers spent three hours explaining their subjects in depth, and there were further opportunities for discussion of particular topics. About 120 people attended the ASI, including 24 lecturers who were mostly from NATO countries.

Dr Symons delivered two lectures on the representation, analysis and verification of communication protocols using Numerical Petri Nets. The lectures were based on his research work carried out between 1975 and 1978 at the University of Essex, England, under a Telecom Australia Postgraduate Study Award. Details of the material covered by the lectures were published in Research Laboratories Report No. 7380 "Representation, Analysis and Verification of Communication Protocols", and a description of an application of these techniques can be found elsewhere in this Review.

Distinguished Visitors to the Laboratories

Like most research organisations, Telecom's Research Laboratories are visited by a variety of people for a variety of purposes in any one year. Whilst all visits are considered important, some particular visits are more notable than others, either because the visitors are people of high distinction or because the purpose of the visit is one of significant importance.

The following paragraphs record details of two notable visits which occurred during the year:

Visit by Officers of the Department of Communications

On 15 December 1980, senior officers of the Department of Communications visited the Laboratories.

The visiting party comprised:

Mr R.B. Lansdown	Secretary
Mr A.F. Guster	First Assistant Secretary, Satellite Policy and Coordination Division.
Mr R. Ramsay	First Assistant Secretary, Radio Frequency Management Division.
Mr E.J. Wilkinson	First Assistant Secretary, Special Adviser.
Mr P. Westerway	First Assistant Secretary, Broadcasting, Planning and Operations Division.
Mr D. Williamson	Acting Assistant Secretary, Operations, Radio Frequency Management Division.
Mr D. Eyles	Assistant Secretary, Broadcasting Development Division.
Mr V. Jones	Engineer Class 5, Broadcasting, Planning and Operations Division.

The visitors were welcomed by Mr H.S. Wragge, Assistant Director, Customer Systems and Facilities Branch on behalf of the Director. After introducing the visiting party to the other five Assistant Directors in charge of Branches of the Laboratories, Mr Wragge briefly outlined the main functions and role of the Laboratories. Each of the Assistant Directors then outlined his Branch's activities and viewpoints related to likely future developments of services and systems in the network, as digital and stored program control techniques supplant analogue services and systems. This was followed by general discussion.

The Director, Mr E. Sandbach, joined the visitors, who then inspected and discussed, in the laboratory, the experimental work relating to the proposed Homestead and Community Broadcasting Satellite Service (HACBSS) network.

In the afternoon, the visitors were acquainted with current research activities in optical fibre characterisation and system evaluation, conferencing studies and a field research project based on a multi-facility subscriber's telephone instrument developed in the Laboratories to assess customer reaction to new facilities which might be made available with the proliferation of SPC telephone exchanges.

The party then toured the Applied Science laboratories and inspected, in particular, the Environmental Physics and Reliability Physics laboratories. Also inspected were the microelectronics facilities- including those used for both thick and thin film hybrid circuit prototype development.

The day concluded with a general discussion on the Laboratories R&D activities in relation to technology trends and policy consequences.

Visit by Dr Makoto Terajima, NTTPC, Japan
Dr M. Terajima, Director of the Electronic Equipment Development Division of the Electrical Communication Laboratories, Nippon Telegraph and Telephone Public Corporation, Japan, visited the Research Laboratories on 20 October 1980.

He held discussions with the Research Laboratories' management on the general role of the Laboratories and the determination of their programme of activities. He then visited the following Sections of the Laboratories where more detailed discussions took place as indicated:

Microelectronics Section – discussion of studies related to the design, realisation and fabrication of miniature, thick and thin film hybrid circuitry and microstrip components.

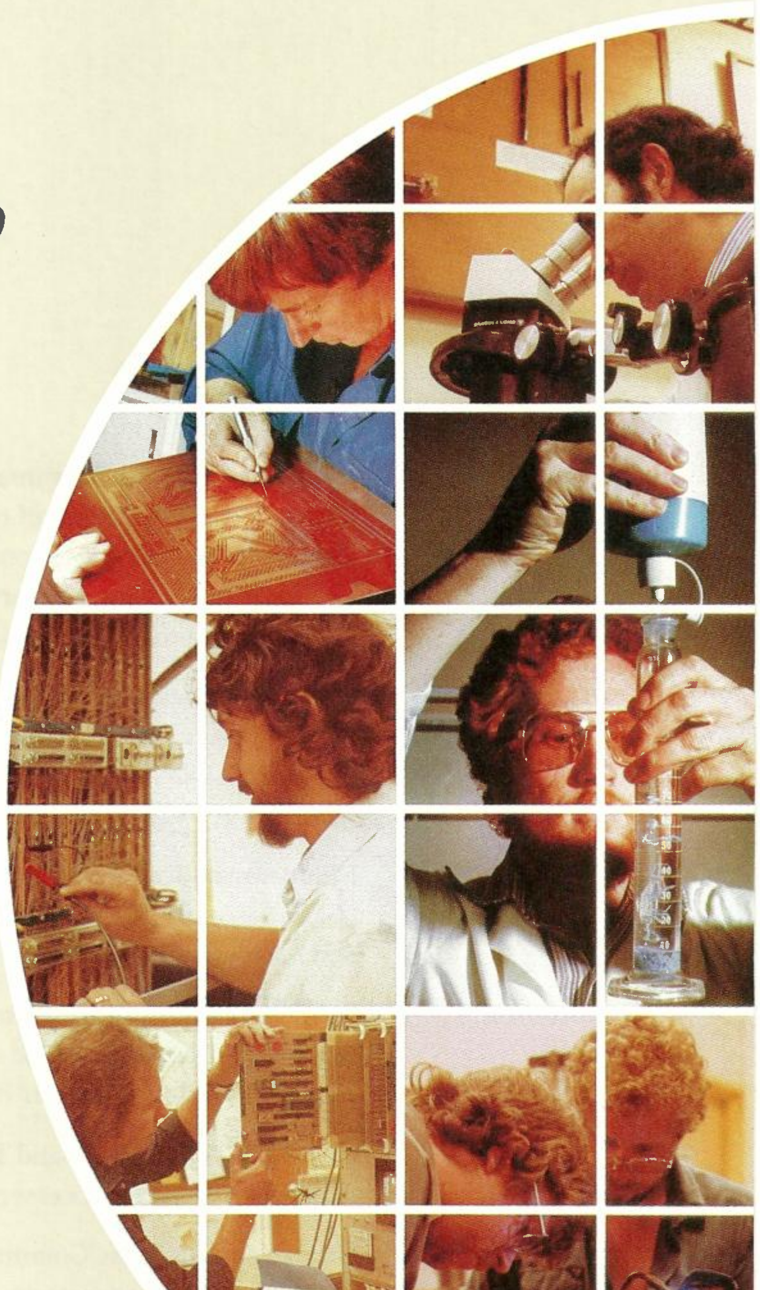
Solid State Electronics Section – examination of work currently being done in the holographic field and discussion of the proposed use of the recently installed Molecular Beam Epitaxy equipment.

Computer Applications and Techniques Section – discussion of the philosophy of microprocessor development systems.

Human and Business Communication Sections – inspection and demonstration of an experimental multi-facility subscriber's telephone instrument and of a simulation of a Videotex service.

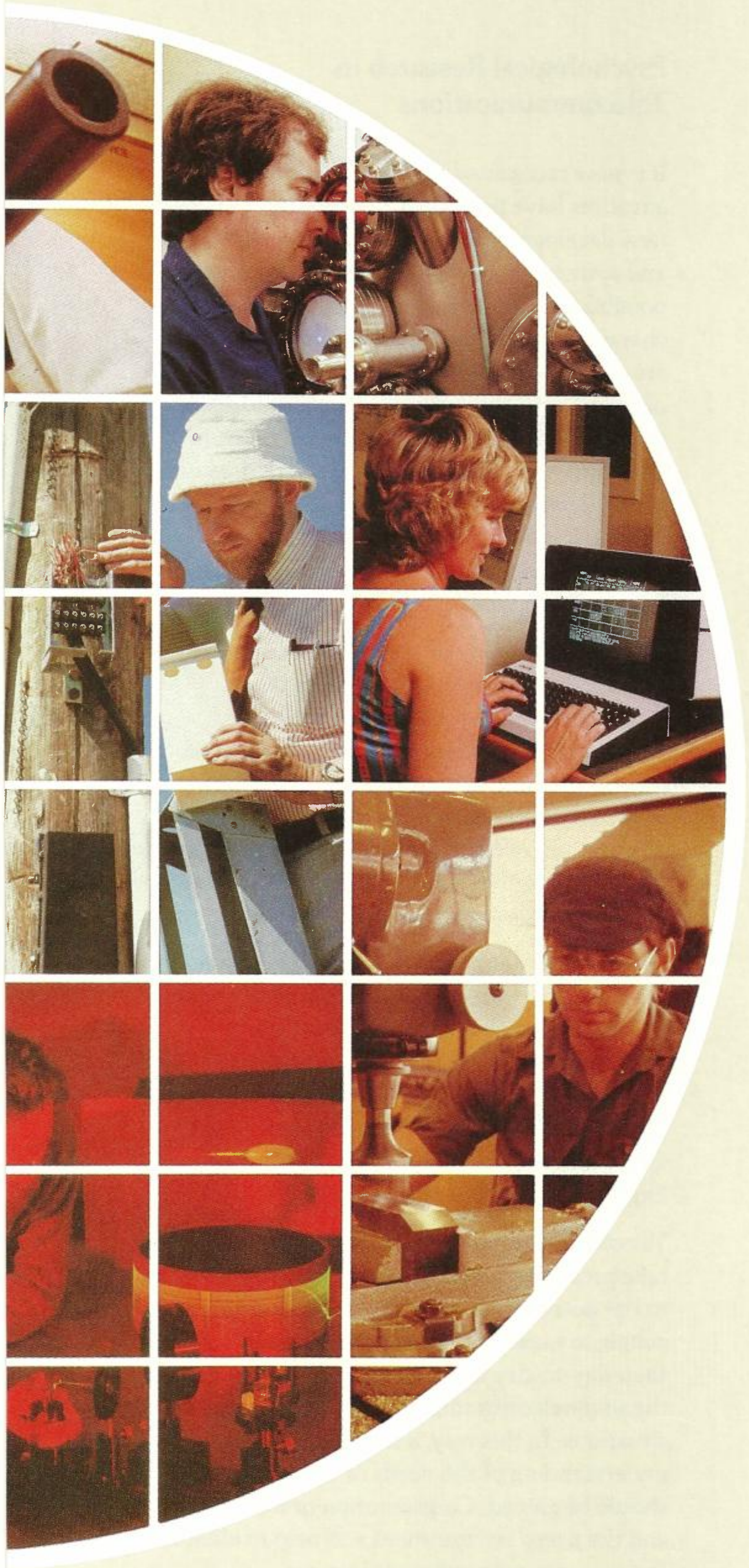
Sections of the Switching and Signalling Branch – discussion of applications of the CCITT Specification and Description Language (SDL) to data switching systems; demonstration of a computer graphics aid developed for the behavioural specification of new communications facilities for the telecommunications network; and demonstration of a data capture analyser interface for a stored program controlled telephone exchange.

A Selective Review of Current Activities



In accord with their functions, the Laboratories are engaged in a large number of investigatory and developmental projects and specialty activities in the engineering and scientific fields. This work is chosen for its relevance to Telecom Australia's customer services and network systems and comprises a wide variety of specific topics pertinent to the present technical standards and future technical advance of these services and networks.

It is not possible to report, even briefly, on all Laboratories' projects in this Review. As a consequence, the activities reviewed in the following pages have



been selected to give an overall picture of the type and breadth of work undertaken, and of the degree to which the Laboratories are keeping abreast of world developments in communications science. A more comprehensive list of current projects is issued in the "Research Quarterly" and this is available to selected bodies with special and more specific interest in the work of the Laboratories.

The normal method of publishing the detailed results of a research project is through a Research Laboratories Report, prepared when an investigation has reached a conclusion or a conclusive stage. It is the vehicle by which the results of the work are conveyed to the "client" and other interested sections of Telecom Australia, and in many cases, to other telecommunications agencies and industry as well as to other research bodies, both local and overseas.

The staff of the Laboratories also contribute to Australian and overseas technical journals and present papers to learned societies. An indication of the scope of this activity can be gained from the lists given in the last section of this Review of Activities.

Activities in the Customer Field

Telecommunication networks are being required to carry an increasing plethora of services which currently include voice, data, teletex, videotex, facsimile, electronic mail, conferencing and store-and-forward facilities. In the past, some of these services have been carried on public automatic networks while others have been provided over private lines on a point-to-point basis. However, the acceptance of, and demand for, the newer services is increasing rapidly and there is continually increasing pressure for their provision via the automatic networks in both point-to-point and conference modes.

In order to rationalise the study of these services and also to provide a framework for future work, the various services are now being considered on a number of levels:
- services – features and facilities;
- standards – performance and equipment;
- terminals – techniques and realisation;
- integration into public networks.

Network integration is a particularly important consideration, in view of the various ways in which services are currently being carried through public networks. The most usual vehicles are private lines, the public switched telephone network, fixed-connection digital data networks and packet switching networks. These media require different interconnection methods and inhibit the integration and interconnection of services.

Developments are now under consideration in many parts of the world which are aimed at the provision of an integrated services network which will be based on through-switched 64 kbit/s circuits. If the various services can be readily connected via a standardised interface and if each uses a sub-set of a standardised set of procedures (protocols), considerable flexibility will be obtained and many incompatibilities will be avoided. This standardised form of interconnection to the digital network is now generally referred to as "customer access" and is one of the key aspects of any future integrated service digital network. Such a network is currently regarded as a long term objective in network development by many administrations.

Prior to finalising customer access requirements for all services, it will be necessary to standardise further the features and facilities of the various services and to establish performance standards, in order to provide a realistic framework for the development of approaches towards customer access. This objective underlies most of Telecom's research activities in the customer services field, some of which are described further in the following articles.

Psychological Research in Telecommunications

It is now recognised that recent technological advances have presented a wide range of possible new developments in telecommunications services and systems. In choosing from among these possibilities, it is important to ensure that the characteristics of the technical systems involved are compatible with the characteristics and needs of the human users. This compatibility can be safeguarded by appropriate research both to determine whether and how any proposed new services or facilities can beneficially affect the user's overall activities, and which interface conditions between the user and the equipment provide the optimum match.

The scientific study of human behaviour lies in the domain of psychology. To investigate and understand the requirements for new telecommunications services, the insight and knowledge of that discipline needs to be allied with telecommunications engineering. Without this alliance, engineering decisions may well reflect the capabilities of the highly trained technician rather than the needs of the technically naive customer.

Recently, a small group of psychologists has been established as part of a multi-disciplinary team, in the Research Laboratories to develop a programme of psychological research on telecommunications. This work is reported in later articles entitled "Field Investigation of New Customer Services" and "Teleconferencing Experiments in the Laboratory".

Telecom's research activities in this programme take prospective new telecommunications facilities to the potential user in the field. This permits people to experience new experimental facilities in their day-to-day tasks, so enabling evaluations of the user-telecommunication relationships in real situations. In this way, a more complete understanding of the needs of the potential users should be gained. Consideration of these needs and the users' environment will help to identify the requirements to be met by new telecommunications services and facilities and the equipment used to provide them.

Psychological and technical knowledge must be combined to give new Telecommunications Services a human aspect.

Worldwide, psychological research in telecommunications covers areas as diverse as the spatial relations between displays and controls, the ergonomic design of a telecommunications work station or terminal instrument, the cognitive requirements for the use of equipment or facilities, and the social psychology of telecommunications - the latter being the area into which much of our work falls. Many of the studies by telecommunications administrations, by the telecommunications industry and by universities working in the field are reported at the triennial International Symposia on Human Factors in Telecommunications. Research Laboratories' staff have attended many of the nine Symposia held so far, including the latest which was hosted by Bell Telephone Laboratories in New Jersey, USA, during October 1980.

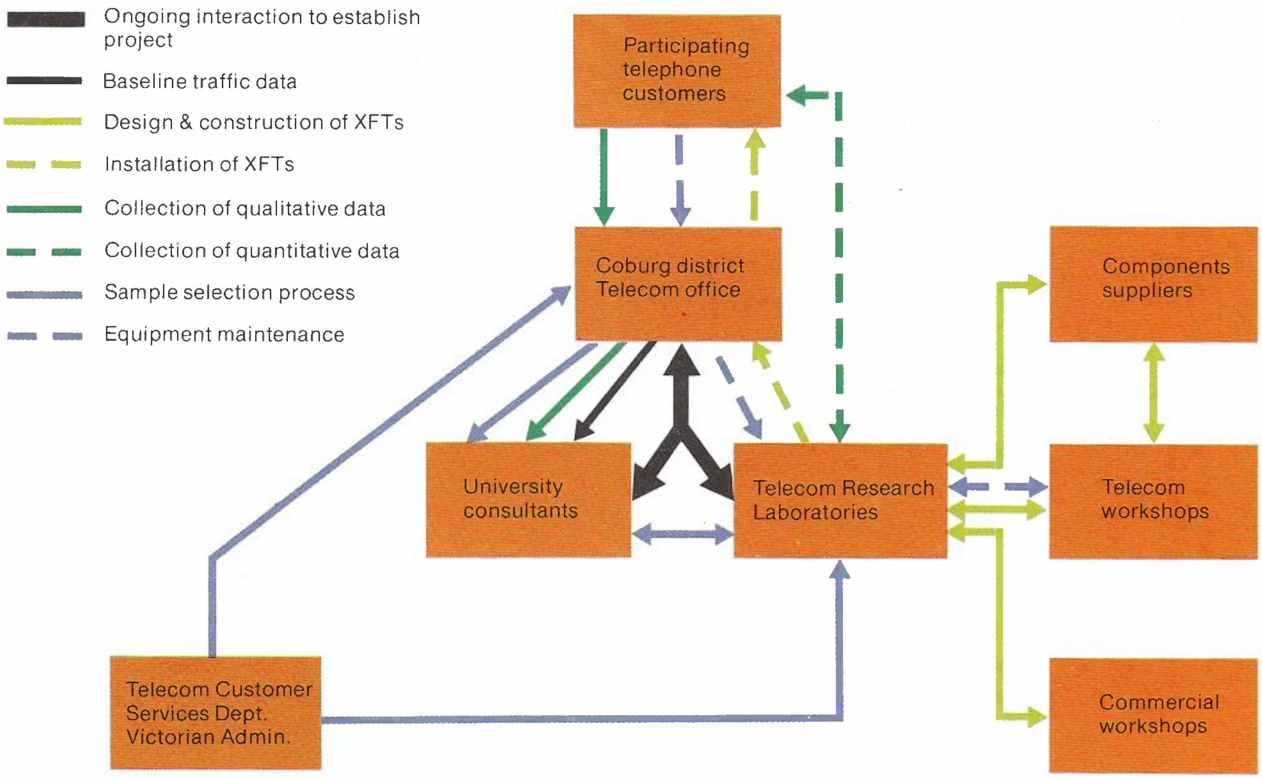
The increasing emphasis, both in Telecom Australia and elsewhere, on research into the psychological aspects of telecommunications represents an acknowledgement of the danger that the potential complexity of future telecommunications services and equipment could overwhelm the average citizen. The knowledge gained from the research will help Telecom Australia to ensure that any future new services are developed and implemented in such a way that they will be readily integrated into the fabric of people's daily lives.

Field Investigation of New Customer Services - Management and Co-ordination

As reported in the 1979/80 Review of Activities, the Research Laboratories have been undertaking a project, "The Field Investigation of New Customer Services (FINCS)". The project's specific goal is to investigate customer response to some new telephone facilities such as abbreviated dialling, called number display and call charge information. The project also has a broader goal to develop generally applicable mechanisms for handling customer field trials.

The telephone facilities under investigation can be expected to be provided from stored program controlled exchanges, but for the purpose of the trial, an experimental facilities telephone (XFT) was designed in the Research Laboratories and constructed in Telecom Australia's Victorian Workshops. The trial was conducted in the Coburg district of Melbourne, where XFTs were placed with fifty customers who had agreed to participate.

Field research has been identified as providing the best opportunity to gain insight into, and information about, service provision and customer reaction to novel facilities at a deeper level than can be expected from market research or conventional laboratory studies. However, this



Interactions in the management of the FINCS project

project has demonstrated that even medium scale field research is a complex task requiring significant resources.

The problem lies in the need to co-ordinate three processes, each of which are complex and time consuming in themselves. The processes are:

(i) the design and production of reliable although novel, experimental technical equipment;

(ii) the installation and field maintenance of the experimental equipment at a number of volunteer customer premises, requiring non-standard procedures in a normal working situation;

(iii) the social psychological study of the group of customers using the experimental facility.

Four groups of people were involved in the design, conduct and support of the study. These were from the Research Laboratories, Telecom's Victorian Workshops, the Coburg District Telecom Office and the University of Melbourne's Public Policy Research Unit. A complex division of responsibilities between these groups was established, evolving in detail through all phases of the project. A diagrammatic representation of the interactions between the major groups and a number of other critical contributors clearly suggests the complexity of the management task in a field research project.

Pilot studies during October 1980, using a production prototype XFT and Research Laboratories' staff, achieved the following objectives:

- a check of the adequacy of the XFT user's instruction manual;
- a check of the adequacy of the procedure to instruct users in the operation of the XFT;
- a test of pre-installation and post-installation questionnaires;
- familiarisation of the Coburg District Office staff with the XFT;
- training the District staff in the administration of interviews and user instruction.

Field installation of XFTs commenced in late November 1980 and continued until March 1981. The phased installation programme enabled variations to be made in the trial procedures and enabled some design deficiencies and manufacturing faults in the first batch of XFTs to be rectified. The technical problems only became apparent after a period of field operation.

Data collection finished in May and detailed analysis and a final report will be completed by Research Laboratories' staff and the University consultants early in the last half of 1981.

Impact of Subscribers Digital Reticulation on the Provision of Enhanced Customer Facilities

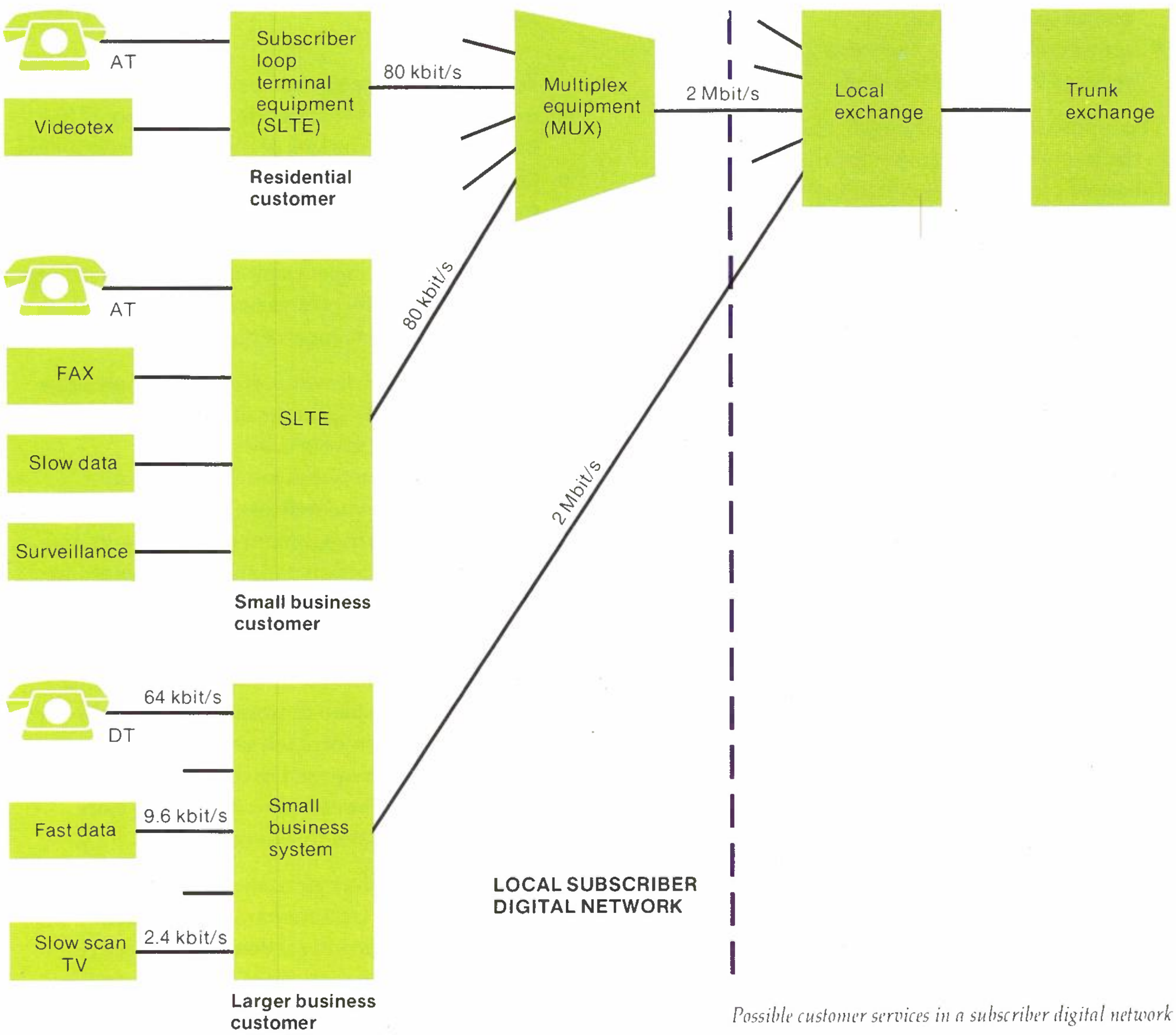
Many telecommunications administrations are planning for the rapid application of digital techniques in various segments of their telephone networks. As a result of these plans, the trend during the 1980s will be that increasing proportions of their national telephone networks will contain fully digital transmission paths between local telephone exchanges.

Particular attention is currently being directed toward the local transmission network and the extent to which the existing subscriber distribution plan could support digital transmission. Questions which arise are concerned with the benefits of the extension of digital working into the subscribers' premises, and the services which could be supported.

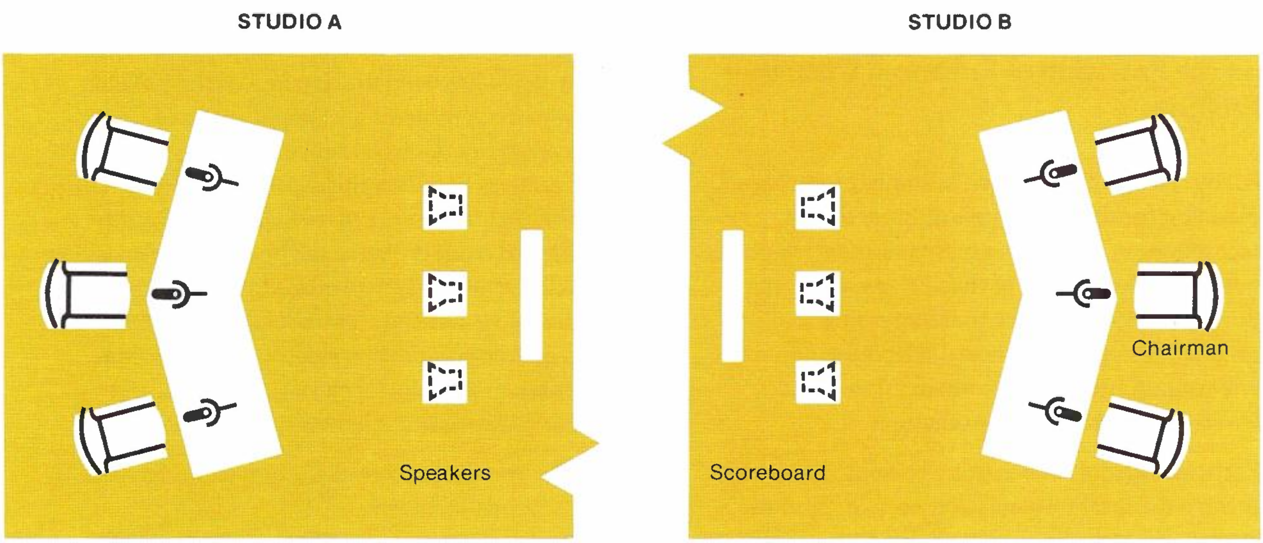
A study has been undertaken of the possible benefits, problems and implications of the availability of digital reticulation to subscribers' premises based on the capability of an 80 kbit/s channel. The services included in this study ranged from ordinary telephones, loudspeaking telephones and small office intercom and key-phone systems to word processing systems, facsimile equipment, videotex services, low, medium and high speed data services, and surveillance and telemetering systems.

The specific aspects of the services addressed in the study included:

- signalling and operating protocols;
- service quality – in terms of error rates and set-up times;
- interfaces and protocols for multi-instrument terminals;



Possible customer services in a subscriber digital network



Spatial arrangement: group-to-group audio conference (the group-to-group video conference was arranged similarly, with a video monitor and single speaker replacing the scoreboard and multiple speakers in each studio).

- signalling and control flexibility during conversation - as applicable to a change of mode or change of terminal;
- consideration of the likely demand for the services included in the study.

The motivation for studying digital transmission in the local area is to provide for the support of enhanced communication facilities. With marginal addition of digital capability above the requirements for telephony and signalling, a network capable of simultaneously supporting a subscriber's telephone service and a wide range of other services such as word processing, videotex and facsimile can be obtained.

Digital telephones with enhanced facilities, such as the ability to display the calling subscriber number or to record the number should the called number be unattended, are the subject of field trials in a number of overseas countries. It is expected that in Australia, by the late 1980s, some residences, most small businesses and other larger business subscribers will have their telephony and data needs serviced by a common integrated digital link to the local exchange.

While there is some doubt about the need for digital techniques for the ordinary telephone service, there is a high degree of confidence that future services will require the application of transmission techniques involving data rates of 80 kbit/s or higher in the local area. This is seen as a major direction for the future evolution of national networks and hence an important area for ongoing research activity in Telecom.

Teleconferencing Experiments in the Laboratory

Equipment and people can be combined in numerous ways to create a teleconference. This multiplicity, and the lack of detailed understanding of what occurs in teleconferences, make it difficult for psychologists to contribute to improving system design and use. The Laboratories have therefore begun experimenting with small groups to explore the effects of various combinations of systems, spatial arrangements and tasks.

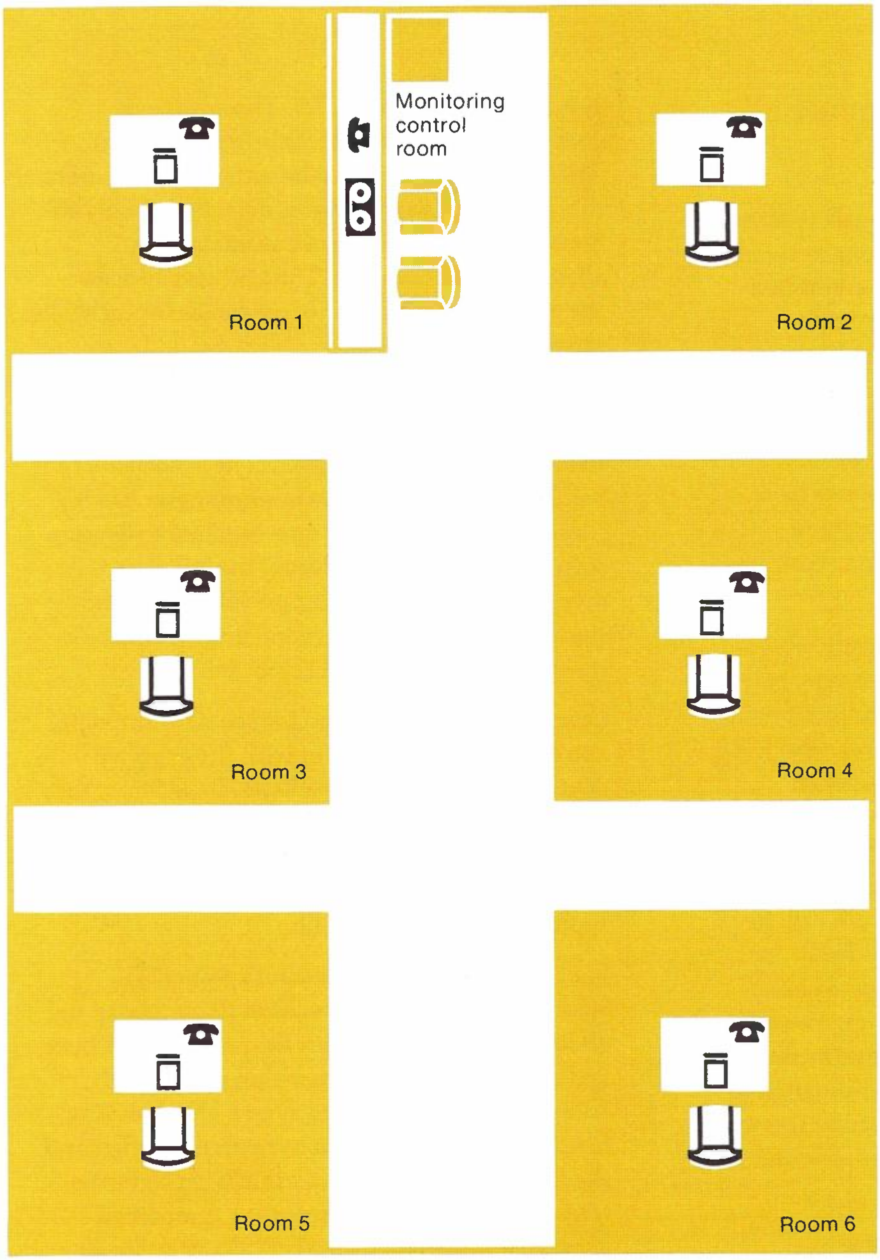
The experiments draw upon existing knowledge about the psychology of small groups. The teleconferencing group is seen as a communication network in which certain interactions are rendered less probable by the imposed spatial arrangement of participants and equipment. Interaction patterns are expected to affect task performance.

A pilot study employed three teleconferencing systems: a group-to-group audio conference, a group-to-group video conference and a multi-part telephone conference. Each group of six participants was required to complete two tasks, one simple and one complex. Six groups were tested on each of the three systems.

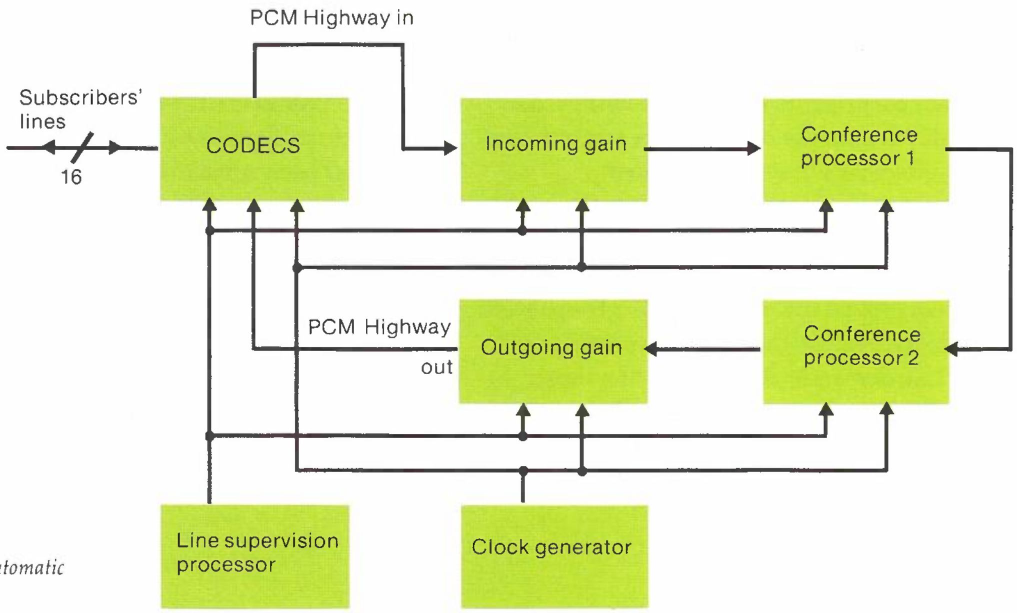
Several types of data were analysed: objective data on task outcome (accuracy and time to solution), measures of group interaction, and subjective data derived from participants' opinions and assessments. There were no significant differences in task outcomes between the three types of system, although group interaction patterns differed for the complex task. Audio conference participants spoke more within their own studio than to the other studio, and although a similar effect was observed for video conferences, it was less pronounced. In the multi-part telephone conference, participants spoke predominantly to the whole group. Unexpectedly, this system proved the most flexible; groups were more able to organise themselves according to varying task demands. Attitudes to the three systems were similar, and were mostly favourable.

The pilot study results provided sufficient grounds to warrant detailed investigation with more systems, spatial arrangements, groups and tasks. Face-to-face meetings using several different spatial arrangements were included for comparison with the experimental teleconferences. The experimental programme has been substantially completed and data analysis is now proceeding.

Although teleconferences conducted in the laboratory allow the psychologist to control and manipulate key variables, such teleconferences are inherently artificial. In a final phase of the study, therefore, the laboratory experiments will be supplemented with field research, which can also explore how teleconferencing comes to be adopted and what new opportunities it can generate.



Spatial arrangement: multi-part telephone conference



Schematic diagram of the automatic conference bridge processor

An Automatic Network Conference Facility

When more than two people wish to talk together simultaneously over Telcom's telephone network, they must presently use an operator-connected conference bridge. Since more people are expressing a wish to use such a facility, it is desirable that they should be able to set up a multi-point telephone conference automatically, just as easily as they can set up a two-person telephone call. The Research Laboratories have therefore commenced a project to study the requirements for such an automatic network conference facility.

Initial studies are being based on a facility which can be dialled using a two-tone multi-frequency signalling push-button telephone. The facility will be operated by the conference convener who will first obtain connection to it via the switched network. The convener will then signal those numbers which are to be connected for the conference, using the multi-frequency signalling telephone. The facility will automatically call the wanted numbers until connection has been established, and will consequently record line charges for later billing of the convener. The user protocols employed in this experimental facility are very simple and the ultimate determination of the most appropriate protocols for regular use will depend on the outcome of field experimentation.

The equipment is controlled using a stored program digital processor called the line supervision processor (LSP). This approach enables the user protocols to be readily varied. The LSP interprets the codes entered by the users through their telephone sets, detects on-hook/off-hook status and supervises automatic gain adjustment for each line. The LSP also informs the bridge of the number of conferees for each separate conference.

A Nova minicomputer presently performs the tasks of the LSP since these tasks are not required to be performed at high speed. The availability of high level languages in the minicomputer has considerably reduced the time required to develop software for the facility during the initial investigation. Later production versions would use a microprocessor or several units would be controlled by a single minicomputer.

Digital techniques are used for speech processing, as a digital bridge fits better with the expected development of a digital network. In addition, the expected production of LSI semiconductor devices for conferencing at some point in the future suggests that digital techniques are more appropriate in this application.

For the initial study, an "instant speaker" algorithm was chosen because of its simplicity and effectiveness in coping with the problem of echoes and additive noise. The algorithm requires all audio signals to be sampled at an 8 kHz sampling rate. The samples are then compared together and the sample with the largest value is chosen to be transmitted to all other conferees. A modified version of the "instant speaker" algorithm having a variable threshold window is used to eliminate high echoes. Microprocessors are used to perform the algorithm.

The initial evaluation of the experimental facility has been encouraging. Speech performance proved satisfactory, although proper siting in the network, probably at a 4-wire exchange, will be necessary. More work will now be undertaken to determine more precisely which facilities are needed to enable Telecom's customers to use the facility with ease and simplicity of instruction.

A Telephone for the Disabled

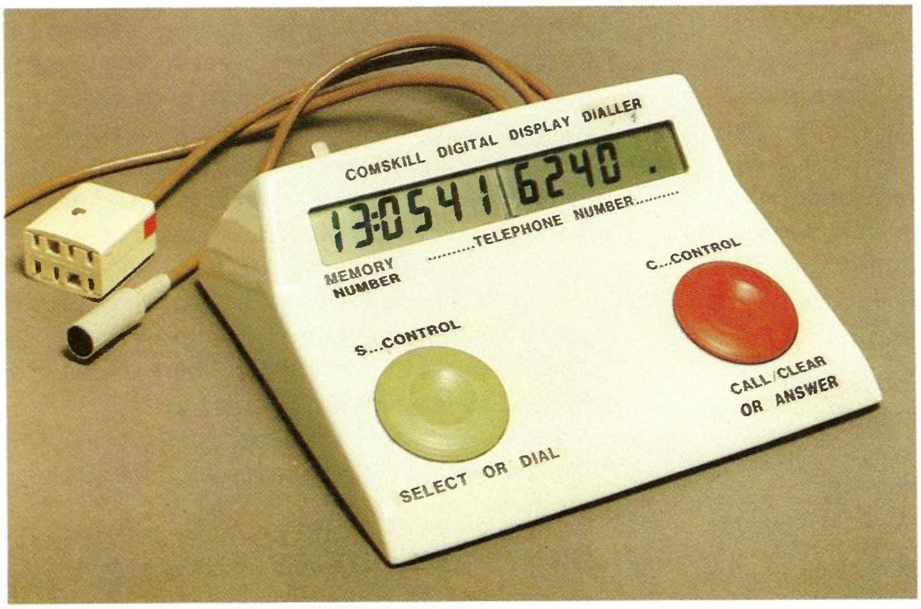
Persons with limited or spasmodic muscle control have great difficulty initiating a telephone call using a conventional dial or push-button telephone.

A solution to this problem has been developed which uses a Digital Display Dialler in conjunction with either a standard telephone instrument or a loudspeaking/hands free telephone. The Dialler, which is a co-operative development of COMSKILL (a volunteer group of designers), Telecom's Commercial Services Department and the Research Laboratories, allows complete operation of all normal telephone functions by the use of two large rubber pad switches.

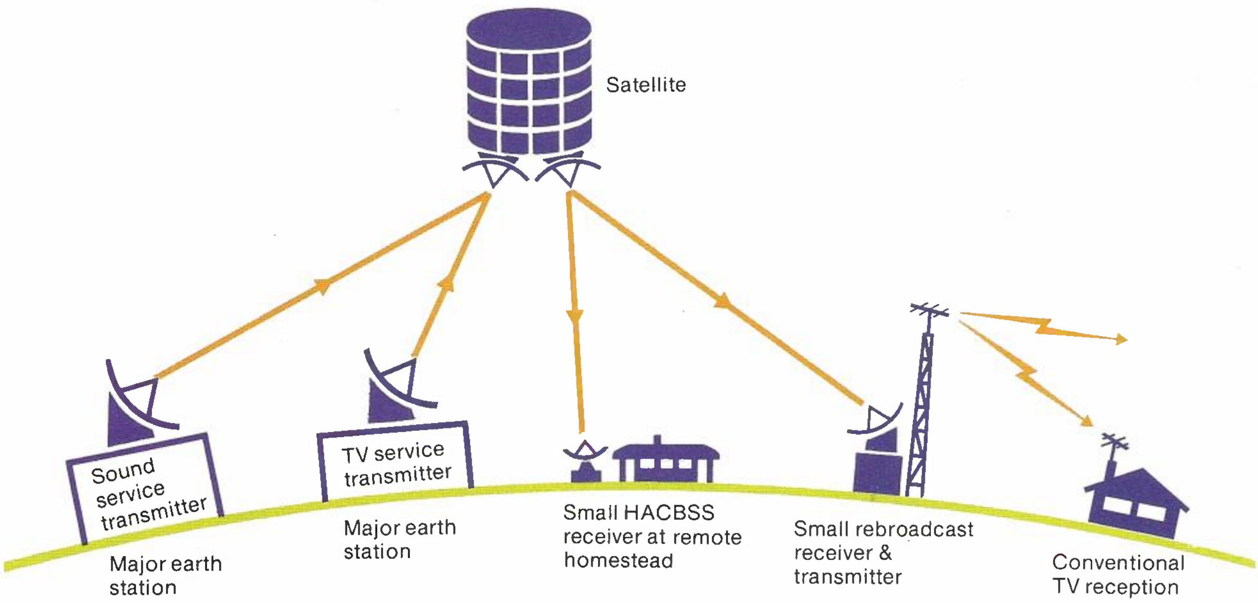
The Dialler stores 15 telephone numbers in its memory which, by operating the "S" (select) control button, are sequentially displayed on the unit's liquid crystal display. The period for which each number is presented is pre-adjusted in accordance with the severity of the user's disability. Subsequent operation of the "S" button freezes a telephone number in the display and operation of the "C" (call) control button initiates dialling of the chosen number. In addition, the user may enter new telephone numbers, change existing numbers or dial any number which is not in memory. Provision is also made for the addition of extra facilities such as the actuation of external devices and the remote triggering of emergency number dialling.

COMSKILL has, over the past few years, developed the concepts and circuitry of the Digital Display Dialler. The Research Laboratories developed a feasibility model of the Dialler based on these original concepts. The first model was contained in a clear perspex case to allow consideration of the relationship between the internal component assemblies necessary for the operation of the Dialler and its external case shape which is dictated by the functional and ergonomic requirements of the operator.

In an effort to enable the Dialler to be applied to the widest field of use, the method of actuation was chosen to be suitable for varying stages and degrees of disability. A minimum operating force of 50 grams was specified, with an upper limit being that of an uncontrolled fist striking the actuating pad, as a result of a muscle spasm. A range of designs and ideas for actuators incorporating magnetic, optical and mechanical switches were evaluated. The most successful



The prototype digital display dialler



Schematic diagram of TV and sound service HACBSS system

device, and the simplest, was a spring lever operating a microswitch.

The actuating pad is large to enable easy sighting, has a location for the insertion of fingers, head or mouth sticks, etc, and has tactile operation from any position on its surface. The pads are also self-sealing and retentive in the case. The actuating pads were moulded in silicon rubber which cured at room temperature. This material enabled simple mould manufacture and easy modification.

A production prototype of the Dialler was subsequently developed to demonstrate the technical and functional feasibility. The requirements were for a compact functional design offering a minimum approach angle. A shape was styled in polystyrene foam, from which a fibreglass case was produced. The display angle allows horizontal or vertical operation.

The Digital Display Dialler incorporates modern technology, a CMOS microprocessor and a liquid crystal display. This allows it to be powered from the telephone line. Internal lithium batteries act as a power supply backup, maintaining the number memory should the Dialler be temporarily disconnected from the telephone circuit for transport or other reasons.

Following successful demonstration of the prototype Dialler and the completion of mechanical and electronic documentation, the unit has been handed to Telecom's Commercial Services Department to arrange manufacture and subscriber trials.

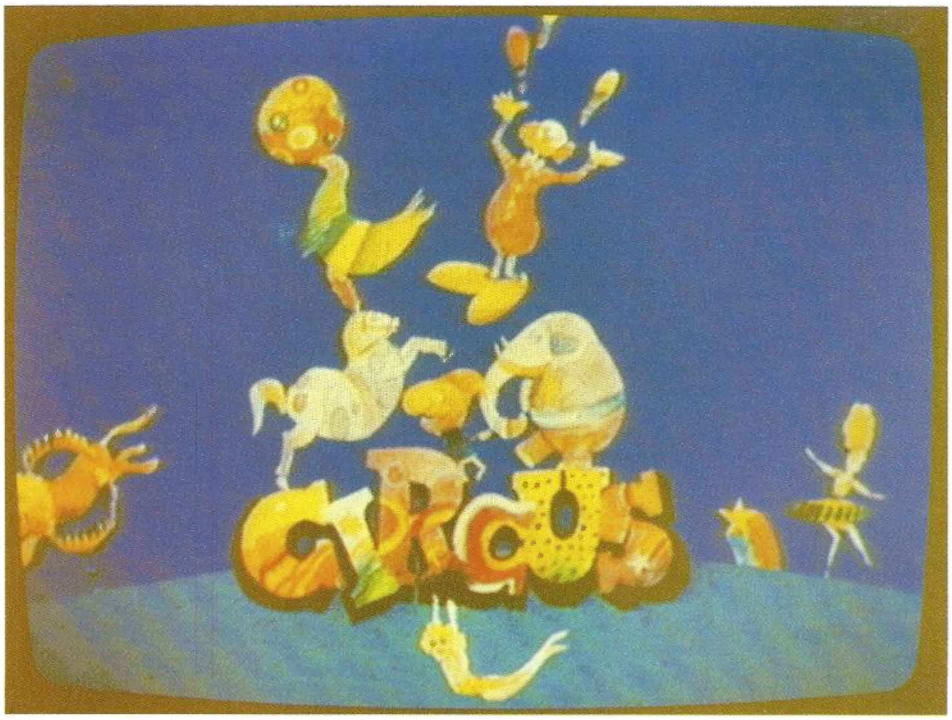
Simulation of a Satellite Transponder

An important service being considered for the proposed Australian National Satellite Communications System is the broadcast of TV programmes to homes in remote areas. This service is commonly known by the acronym HACBSS (Homestead And Community Broadcasting Satellite Service).

Initial feasibility studies conducted by engineers of the Satellite Project Office of the (then) Postal and Telecommunications Department and of other Government Departments showed that, for HACBSS to be practical, the output power from the satellite transponder must be very close to maximum. However, a satellite transponder, which is that part of the satellite which receives the signals transmitted from the earth, frequency shifts and amplifies them, and then re-transmits them back to earth, has the characteristic that it becomes non-linear close to its maximum output power. With two or more separate input signals, this non-linearity will cause the re-transmitted signal output to contain not only amplified versions of the original signals but also unwanted signals having frequencies which are various combinations of the frequencies of the original signals. This phenomenon is known as intermodulation and it can be a major limitation on the maximum usable output power from a transponder.

After planning studies had commenced, it was proposed that a second service, sound broadcasting, be incorporated with HACBSS. Various methods for achieving this were considered and a single channel per carrier (SCPC) sound broadcasting system was proposed. To provide the required television programme and three sound broadcast programmes, including one stereo, five signals would be transmitted to the satellite to pass through the same transponder. These signals, incidentally, could be transmitted from different earth stations – in a multi-access use of the satellite. Due to intermodulation effects, these five signals appear at the output combined with sixteen major intermodulation products. The planners were therefore faced with the problem of establishing whether such a system was feasible and if so, to determine its optimum parameters. An initial report based on computer studies by COMSAT was inconclusive and a laboratory simulation of the system was recommended.

Consequently, the Research Laboratories developed a hardware simulation of the proposed system and conducted measurements, both objective and subjective, to determine the best operating parameters for the system. The hardware was assembled using a variety of laboratory test instruments and a Varian travelling wave tube amplifier (TWTA) to represent the satellite output amplifier. In addition, waveguide filters, which reproduced the channel amplitude and group delay response characteristics specified for transponders in the national satellite, were designed and built by the Laboratories. As the system was being assembled, a number of objective measurements were made to ensure that its parameters were close to those expected or specified for both the satellite transponder and HACBSS. Once this had been achieved, subjective measurements were made, by a panel consisting of engineers from Telecom, the Australian Broadcasting Commission and the Department of Communications, on the effects of the intermodulation products on the TV picture received for various system operating parameters. Early measurements showed that, because the COMSAT computer studies had not considered the effects of thermal noise, the service most affected was the HACBSS TV service and not, as originally thought, the TV relay application. This occurs because the HACBSS service is an FM system operating close to threshold and further noise such as that due to intermodulation degrades the picture far more than if the system was well above threshold. It also became clear that a TV signal, with its complex characteristics, must be used as the test source, because certain TV pictures can yield worse results than those predicted assuming only simple signals. Accordingly, all measurements on TV intermodulation were made using a still picture containing large areas of saturated blue. Subjective and objective



Excessive intermodulation in the HACBSS transponder causes "stress" in the received TV picture

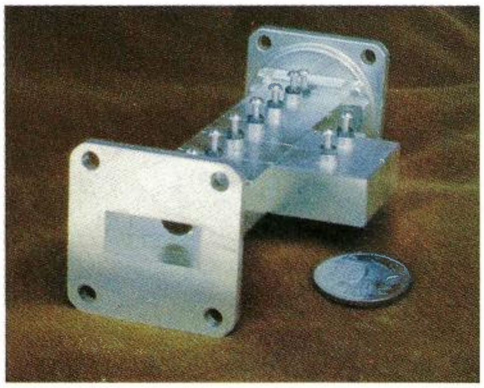


Photo: *Waveguide bandpass filter for HACBSS simulation*

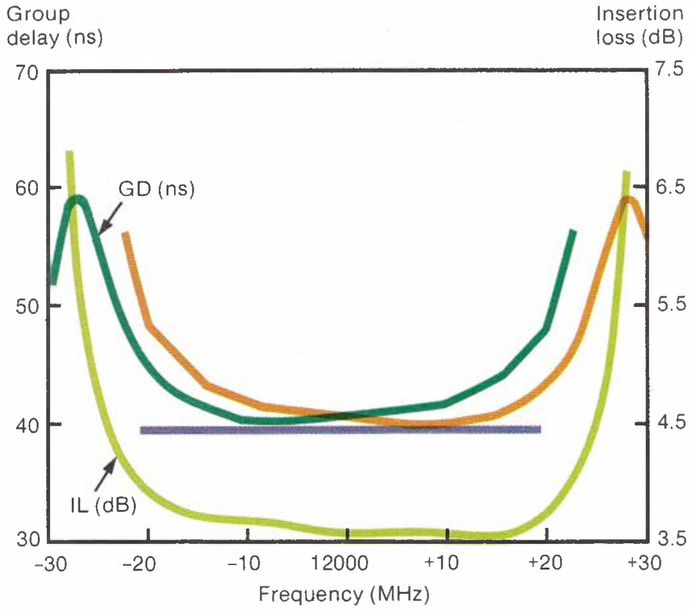


Diagram: *Loss and delay characteristics of the waveguide bandpass filter*

measurements were also made on the sound service.

The tests concluded with the proposed SCPC system being shown to be feasible, the optimum operating parameters determined, and the order of the penalty for combining the two services measured. Subsequent to the laboratory simulation, measurements are being undertaken in Europe using the Orbital Test Satellite (OTS), to verify that the results obtained with the laboratory simulation agree with those from an operational satellite.

The results of this work are also relevant to studies related to the proposed Remote Telephony Satellite Service (RTSS) being considered by Telecom. This service could use an SCPC system for the telephone channels, and intermodulation will again limit the maximum power which can be transmitted. If necessary, the same simulated transponder used for the HACBSS measurements can also be used to investigate this aspect of the development of the National Satellite Communications System.

Waveguide Bandpass Filter with Phase Compensation

A travelling-wave tube amplifier is highly non-linear and generates intermodulation products which not only distort the wanted signal but which would, if transmitted, interfere with other channels. A filter is used at the output of the travelling-wave tube amplifier to prevent the transmission of the out-of-band intermodulation products.

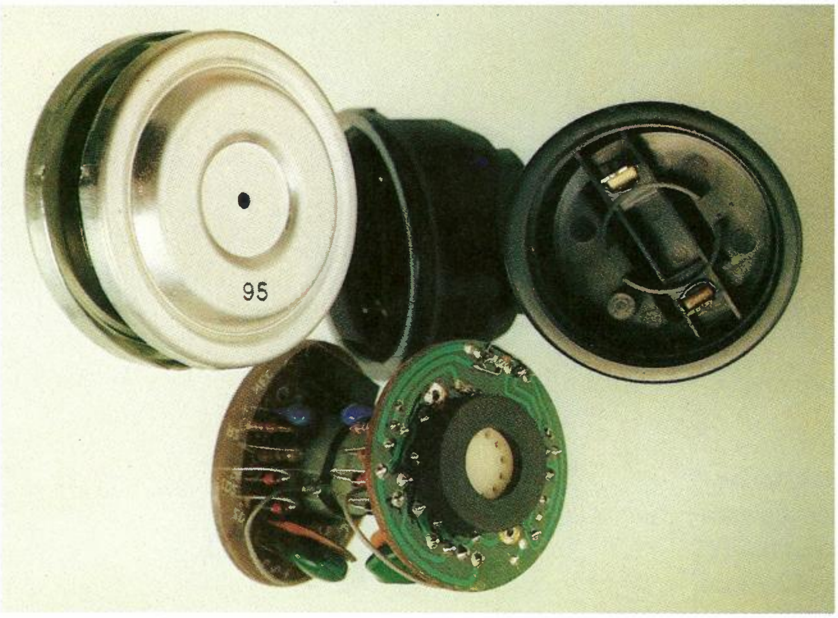
The HACBSS simulation experiment described earlier required the use of such filters. These were designed and made in the Laboratories because suitable filters were not readily available from elsewhere. An important and unusual requirement was for low group delay variation with frequency, in order to avoid non-linear distortion of the frequency-modulated television signal.

The filters were constructed from waveguide cavity resonators, with couplings between resonators provided by apertures in the dividing walls between adjacent cavities. These were designed to achieve a flat, low loss, bandpass characteristic 45 MHz in width and centred at 12 GHz, and having out-of-band rejection of up to 50 dB. A flat group delay was achieved by using a small by-pass aperture which bridged over the two centre cavities.

The design of the filter applied Laboratories' collective skills in:

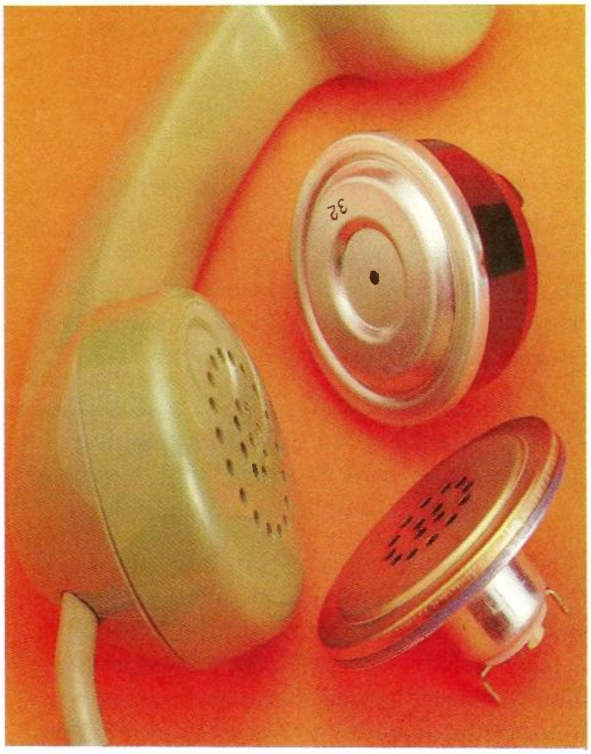
- modern network synthesis techniques to produce a suitable circuit design;
- field theory to translate the desired electrical parameters into aperture and resonator dimensions and tolerances;
- machining and assembly of components to achieve the necessary dimensional tolerances and surface finish.

The diagram and construction of the filters was completed in the very short time of six weeks, meeting the tight schedule of the overall HACBSS experiment.



Left: Prototype transmitter – disassembled

Below: Existing No. 13 carbon transmitter (lower) and prototype replacement transmitter



Evaluation of a New Telephone Transmitter

Maintenance costs necessitated by the field replacement of failed carbon transmitters is an annual expenditure that could be reduced if a "drop-in" replacement with a greater reliability could be found. Furthermore, if this replacement transmitter is an active device, other characteristics such as a relatively easily varied sensitivity could offer advantages.

Such a transmitter would need to be cheap to manufacture, yet rugged enough to perform well for many years under the diverse and often harsh conditions that can be found in Australia – a challenging requirement. During 1980, the Laboratories received a batch of 100 prototype transmitters for evaluation against criteria specified in a development contract let by Telecom to an industrial company.

One of the accompanying photographs compares one of these transmitters with a No. 13 carbon unit, whilst the other shows a transmitter partially disassembled. The transmitter utilises a moving coil transducer coupled to an internal amplifier and diode steering bridge, the diode bridge ensuring that the transmitter is a non-polar device.

To evaluate the performance of the prototype transmitters, it was necessary to subject them to two basic types of tests.

(i) **Absolute Tests**
In these tests, some performance characteristics of the transmitter were measured and compared against specified requirements. Examples of such characteristics include the dc V/A behaviour and the RF demodulation level.

(ii) **Relative Tests**
These tests were used to determine the ability of the transmitters to withstand environmental conditions likely to be met in service. The specification required that the

transmitter sensitivity (measured at a variety of discrete frequencies) should not vary by more than 0.5 dB after the transmitter has been subjected to a number of simulated environmental conditions. Examples of some of the conditions that the transmitters were exposed to include:

- 2 kV impulses;
- abnormally high feed-currents;
- mechanical shock;
- climatic sequencing;
- low pressure/low temperature cycling;
- damp and dry heat storage.

Facilities were developed within the Laboratories such that sensitivity changes of the order expected could be reliably detected over periods of as much as 56 days. When implemented, the test procedure utilised computer-controlled instrumentation designed to be capable of rejecting spurious measurements.

The results of the laboratory evaluations of the prototype transmitters have been encouraging, and with the resolution of some minor outstanding problems, an Australia-wide trial will commence shortly to assess the performance of the transmitters under field conditions.

Loudness Rating of Telephones

The CCITT currently recommends that telephone sets and systems be rated in terms of reference equivalents, which are determined subjectively using a voice-ear test team of about five or six persons. However, the method has several shortcomings, of which the two major ones are that reference equivalent measurements have poor repeatability, particularly by different laboratories using different team members, and that instrumental methods which simulate the subjective technique have not been very accurate.

A new rating method, known as Loudness Rating, is currently under study. It is expected that with this method, the shortcomings of reference equivalents will either be avoided or greatly reduced.

A major feature of the new Loudness Rating method is the use of a stable reference system, known as an Intermediate Reference System (IRS), which is similar in both electro-acoustic and physical aspects to a typical handset telephone. This has the advantage that it is easier to obtain

Loudness balancing using the intermediate reference system

consistent results from both subjective and instrumental methods, because biases in the subjective technique and inadequacies in the instrumental technique tend to cancel out. The characteristics of the IRS have been standardised by the CCITT in Recommendation P48.

The Research Laboratories recently purchased an IRS in anticipation of the CCITT adopting the new rating method, so that an early assessment of the method and its ramifications may be made.

In principle, the Loudness Rating is defined as the amount of loss which needs to be inserted in series with the IRS to make speech sound equally loud via it or via the unknown telephone system which is being rated. In practice, however, to reduce measurement bias and to avoid a non-linear effect present in reference equivalents, the direct balance is not carried out. Instead loss is inserted in series with each system in turn and adjusted until each is equally as loud as a third invariant system which is merely used as a transfer standard. The difference between the inserted losses then gives the loudness rating. This is repeated several times with different talker/listener combinations and the results averaged and analysed to derive the confidence limits for the result.

During the measurement of Loudness Ratings, an individual balance is subject to considerable variability; standard deviations are typically 2 to 3 dB. In addition, an occasional "rogue" value is possible if a listener or talker momentarily loses concentration.

In the automated measurement system in use in the Research Laboratories, the balances are checked for consistency, and if outside an arbitrary limit, for example 4 dB, repeat balances are automatically made. The system automatically changes between the IRS and unknown telephone and also as required, performs sending, receiving or sidetone determinations.

The test data is stored by the computer controlling the measurement system and subsequent analysis of variance is carried out and confidence limits computed. The time required for manual data collection and analysis is thus saved and possible human error avoided.

With the new Loudness Rating technique, ratings made on telephones should be more repeatable and better approximated by practicable instrumental methods. The automation of the measurement technique should increase productivity, provide more reliable data and give prompt and convenient analysis of the results.

Secure Communications Using Public Networks

During the next decade, it is likely that services provided via public communications networks will proliferate at a rate which many will find astonishing. By tapping into these public networks, the technically sophisticated criminal could gain access to telephone conversations, facsimile and Teletex transmissions, security alarm status indicators and a whole range of electronic funds transfer mechanisms. These services will be operated at both personal and corporate levels.

In order to circumvent such unauthorised access, a number of encryption techniques have been developed in recent years. The Data Encryption Standard (DES) algorithm is probably the one most widely employed at present, due, in part, to its ready availability in commerical hardware implementations. However, its range of application is somewhat limited by the necessity for a network security centre, in the role of a trusted intermediary, to convey session keys between communicating parties.

Various forms of public key systems have been proposed so as to enable any pair of network users to communicate without the prior delivery of a session key. A powerful form of signature verification is also supported.

An experimental microprocessor-based encryption unit is being developed in the Laboratories for evaluation and possible application in public packet switching data networks using an X.25 protocol. The unit employs a high-speed DES device and will operate at speeds up to 9600 bit/s. The DES algorithm is used in block-chaining mode; that is, each 64 bit block to be encrypted is mixed by an exclusive-OR operation with the previously output block in order to circumvent identical clear text blocks appearing in identically encrypted form.

The encryption unit employs a memory to retain feedback blocks used during the transmission of previous data packets, thereby enabling reconstruction of the latter should re-transmission be solicited. In addition to direct transmission employing a pre-set master key, the unit will also allow operation via a network security centre using a session key.

An on-going dialogue, relating to the selection and application of encryption and other security-related procedures in the Australian environment, is being maintained by the Laboratories' staff involved in this work with several other government departments and commercial enterprises.

Protocol Analysis and Verification

Telecom will introduce a public packet switched data network at the end of 1982 and has made a policy decision to plan future voice network development on integrated digital network principles. These developments foreshadow added complexity and sophistication of signalling schemes and data protocols to handle an increased variety of services including voice, data, facsimile, telex, teletex and viewdata.

At present, these protocols and signalling schemes are designed using engineering intuition and many have been relatively successful. However, almost all have failed unexpectedly in unforeseen circumstances due to logical errors in their procedures. Thus there is a need for formal design rules which can guarantee the proper functioning of protocols. Before these design rules can be derived, there is also a requirement for general methods of specifying, modelling and analysing protocols.

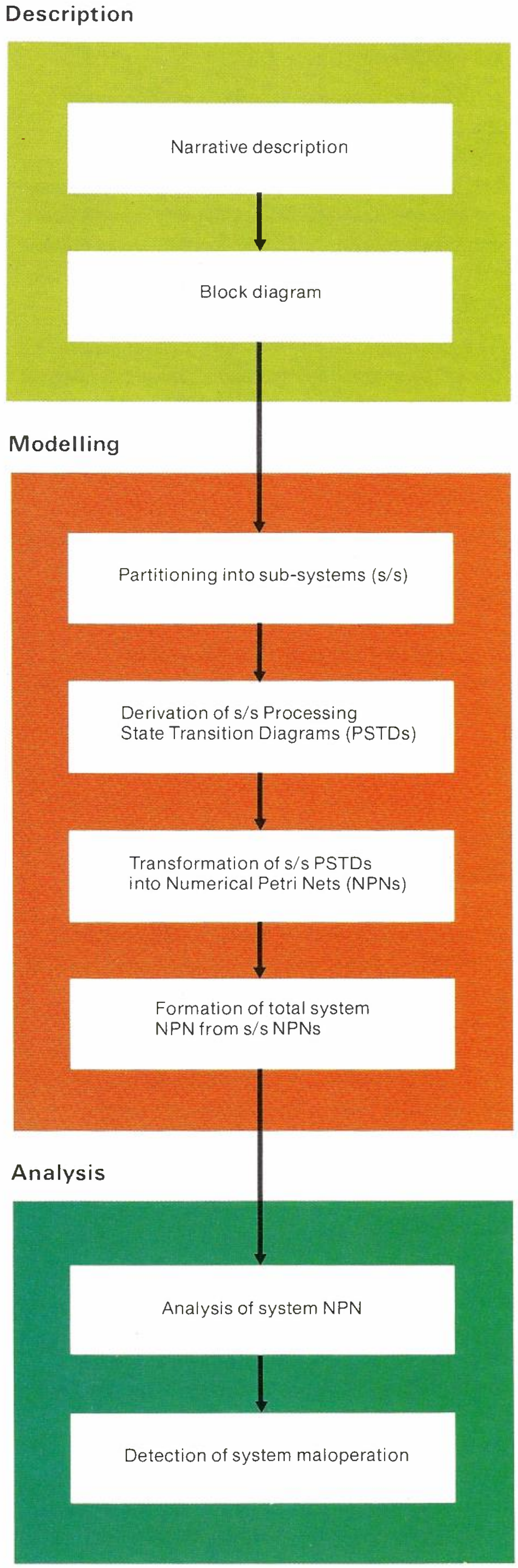
Within the Research Laboratories, a methodology has been developed which can be used to specify, model, analyse and verify the operation of communication protocols. This methodology uses the techniques of Processing State Transition Diagrams (PSTDs) and Numerical Petri Nets (NPNs) which are generalisations of classical state transition diagrams and Petri Nets respectively. PSTDs are used to model the procedures occurring in each of the sub-systems governed by the protocol under study. NPNs then allow the total system to be modelled and analysed. Following this, the analysis of practical protocols, which is too complex and error prone to be done manually, is completed by computer simulation. The simulation also allows the protocol to be tested under a wide variety of conditions.

The methodology is presently being used to model and analyse protocols and signalling schemes recommended by the International Telegraph and Telephone Consultative Committee (CCITT). It is expected that use of this methodology will allow a better understanding of protocols and their design, and will reduce future operating failures in the field.

X.25 Protocol Modelling Experiments

Telecom's planned introduction of a public packet switched data network will allow nation-wide interconnection of different types of computer equipment. In order to establish calls and transfer data, computer systems and terminals connected to the network will be required to observe a set of rules and procedures, known as data communication "protocols", which govern the exchange of data between interconnected systems. To provide a wide range of services and facilities economically via a data network, standardisation of protocols is essential, and the CCITT (International Telegraph and Telephone Consultative Committee) and the ISO (International Organisation for Standardisation) have formulated a number of standard protocols.

Because of their complexity, specification of the protocols using natural language descriptions can lead to mis-interpretations, and formal techniques which provide unambiguous and concise protocol specifications are required. A standardised formal specification technique would assist Telecom Australia, manufacturers and customers to



Protocol verification methodology

provide compatible interfaces and equipment for public data networks. The Research Laboratories have therefore devised a formal protocol specification method based on the existing Specification and Description Language (SDL) which was developed by the CCITT for specification of stored program controlled switching systems. With a number of straightforward extensions for data applications, SDL can be used to achieve unambiguous, complete and formal specifications as complements to protocol descriptions in natural language.

SDL specifications have been produced for CCITT Recommendation X.25, which is a standard interface and protocol for connection of computer systems to packet switched networks. The X.25 protocol is defined by its set of states and the transitions between these states. In the Recommendation, the protocol specification takes the form of a state diagram supplemented by a natural language description of the states and transitions. In contrast, SDL is a formal technique which combines state diagrams with a definition of the actions required in the transitions between states. All actions relevant to the protocol are shown explicitly on the SDL diagrams, resulting in less ambiguous specifications.

Based on the SDL specification of X.25, an interface for a mini-computer system is under construction in the Laboratories. The system will be used as a model to study the behaviour and performance of X.25 and will include extensive monitoring and diagnostic facilities. It will be tested with a range of operating parameters to gain experience with X.25 in preparation for the introduction of the public packet switched data network.

SDL is used to specify the protocol and also for the description of the logic processes necessary to implement the specification in the minicomputer. The software for the X.25 interface consists of a set of programs or modules; each module is specified in detail using SDL. The structure of the software and its documentation closely reflect the original protocol specification.

The consistent approach to documentation using SDL and the structured, modular software results in an implementation of the complex X.25 protocol which is relatively easy to experiment with and understand. As well as demonstrating the applicability of SDL to data communications, the model will serve as a vehicle for gaining experience with X.25 and for a range of future data communications experiments.

10C Exchange - Data Link Interface

The need for fast, efficient data transfer between telephone exchanges and centralised processing centres is increasing. The latest generation stored program controlled (SPC) telephone exchanges are designed with data transfer systems, but few early generation SPC telephone exchanges have such facilities. Within Telecom Australia, a need has developed for data links to be provided between the seven early generation Metaconta 10C trunk exchanges and centralised processing centres, such as:

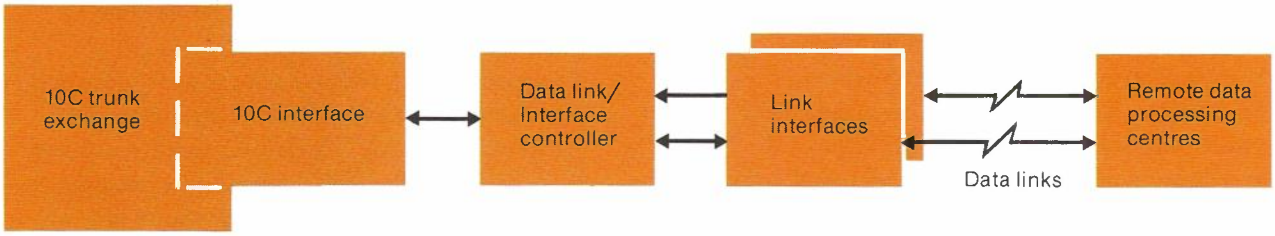
- traffic data collection and analysis centres;
- call charge recording centres.

Future applications for data links are also possible for purposes such as incorporation into a No. 7 Common Channel Signalling Network and expansion of operations and maintenance facilities.

At the request of the Engineering Department, Headquarters, the Laboratories have studied alternative methods of providing data links from 10C exchanges, with the constraint that the call handling capacity and the reliability of the 10C exchanges should not be significantly reduced. In order to do this, the data link facility was partitioned into the following functions:

- the interface into the 10C system;
- the data link(s);
- the data link/interface controller.

Several optional interface methods were considered which involved either monitoring each activity in the 10C system or using the 10C processors to gather the required information. Monitoring of activities could have been implemented without changes to, or the knowledge of, the 10C system. However, this method does not permit the gathering of all the required data in a practical manner and only provides a uni-directional data flow from the 10C exchange. This would prohibit bi-directional uses, such as for commands from remote processing centres, to control the nature of the data being extracted. An alternative method, using the 10C processors and specially developed software to extract the required data from the extensive data base within 10C, has been recommended. In order to minimise the effect on the 10C call handling capacity, the method requires that only minimal formatting is performed on the data before it is presented to the data link/interface controller (DLIC) via a duplicated interface.



Functional arrangement of 10C data link interface system

The DLIC will accept and buffer data from the 10C system, format that data appropriately for the particular remote processing centre, and send the data on the data link using a standard protocol. The DLIC will be comprised of minicomputer hardware controlled by software written in a high level language, and can be duplicated for high reliability applications.

The data link protocol options are basically either the CCITT X.25 or the CCITT No. 7 Common Channel Signalling System (CCSS). The No. 7 CCSS protocol provides greater overall advantages from a networking point of view, but the ultimate decision will be made by the Engineering Department and will be based upon planning studies of the desired evolution of the Australian network in the late 1980s.

Software Engineering Research for Switching and Signalling Systems

Computer hardware technology, currently referred to as the "silicon chip", was quickly adopted by the telecommunications industry for application in the control of switching systems. The Bell Laboratories of USA, the birthplace of both the transistor in 1948 and within a decade, the transistorised computer, also developed telephone switching systems as one of their major outputs. The first of these Stored Program Controlled (SPC) switching systems appeared in 1965, and the technology spread rapidly to other equipment manufacturing companies. The advent of the semiconductor integrated circuit (IC) hastened the proliferation of this new technology in new and more advanced computer and telecommunications systems applications.

The introduction of SPC techniques required a new discipline, "program development", in the, telecommunications industry. The stored program is a large, intricate system – generally called software – and the relative cost of its production quickly rose as ICs fell in price and labour costs rose. Currently, the development costs of a new system are apportioned about 80% for software and 20% for hardware. Of overall system maintenance, which includes the continual changes carried out in telephone exchanges, about 60% is software-related. Data switching system software costs are about 90% of the total costs, as there is relatively little hardware involved and the system software is very complex.

The requirement to handle large intricate software systems in a consistent and methodical way required an engineering approach and hence the term "software engineering" was introduced. Telecom's Research Laboratories have been conducting research in this field for some time, but its growing importance has been recognised by the recent establishment of the Software Engineering Research Section as a centre of expertise in the field within the Switching and Signalling Branch of the Laboratories.

The Section has, as one of its primary objectives, the development of expertise in techniques for the specification, design, documentation and maintenance of SPC system software. Another aspect of these systems being given particular attention is their real-time nature, with studies directed at determining their ability to respond to many simultaneous external events in a very short time. This factor affects system capacity and hence the results of the studies will assist Telecom's planning for the introduction of additional facilities to its SPC switching systems and in the determination of equipment provisioning requirements and programmes.

The new Section has a secondary role of providing general assistance and advice on the software aspects of research projects in the switching and signalling field, and it also supports the processor facilities used in the conduct of these projects.

Delay Studies in Digital Networks

The introduction of digital switching will bring a new source of transmission delay to the network. This delay is introduced mainly by the use of time division switching which stores octet speech samples in order to re-assign the time slot or channel identity of a call.

Echo occurs on any two-wire or combination of two-wire and four-wire telephone circuits, and the degrading effect of this echo depends on the end-to-end transmission delay. When transmission delay exceeds a certain limit, the transmission performance is significantly impaired. An echo suppressor or canceller is then required to be connected into the circuit.

Recent Research Laboratories' investigations have determined the various sources of delay which can be expected in mixed analogue and digital networks. Particular attention has been given to new sources of delay due to digital equipment. Emphasis has been placed on the characteristics of digital AXE switching systems, which are of immediate interest to the Planning Division of the Headquarters' Engineering Department of Telecom.

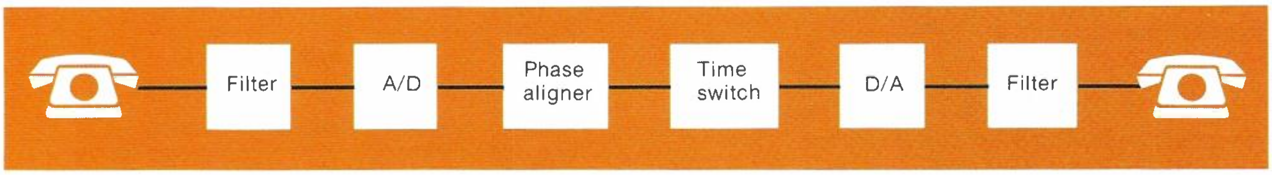
The delay in a digital transmission system (PCM) is caused by the sampling-coding-decoding process, the group delay of low pass filters and the delay occurring in regenerators, if any. In a digital switch, delay due to buffering (for phase alignment and time slot interchange) is a random variable. It is important to notice that the distribution of this variable delay can be controlled by the designer. In AXE switching systems, a rectangular delay distribution results. The delay has a maximum and a minimum value and an equal probability of being anywhere in between these limits. In common with the approach now being used in CCITT delay specifications, the average, 95 percentile and maximum delays have been estimated for various network configurations.

The research studies have concluded that transmission delays of up to a few milliseconds can be expected in metropolitan networks, with some increase in the number of echo suppressors needed on long distance connections as the network is converted to mixed analogue - digital working. A wholly digital network will however have reduced transmission delay compared with the present all-analogue network.

Teletraffic Studies

The Traffic Engineering Research Section was established in the Laboratories' Switching and Signalling Branch at the end of May 1980, following re-organisation of traffic engineering work in the Engineering Department. The new Section is charged with the responsibility of serving as a national reference authority for teletraffic theory and education, and for the development of traffic engineering models and techniques for use in dimensioning and optimisation of telecommunications networks. The Section is headed by an Engineer Class 5 and is currently staffed by an Engineer Class 3 and two Mathematicians.

Traffic engineering has only been in existence as a distinct scientific discipline for about 60 years. During its short life, it has attracted many talented engineers and mathematicians into the field, who have developed a range of theoretical models and techniques for the analysis of teletraffic and the switching systems designed to carry it. The main tasks of traffic engineering research are to develop the best methods for recording and analysing the parameters of telecommunications traffic, predicting its future growth, and determining how the network should be dimensioned to carry the offered traffic at minimum cost for a specified grade of service.



Sources of transmission delay in digital systems

Since its establishment, the work undertaken in the Traffic Engineering Research Section has included analysis of complex queueing systems, network optimisation studies, estimation of end-to-end congestion in the network, and an investigation of a new method for computing a reference traffic base for planning and dimensioning. In addition, consultations have occurred on the dimensioning of the AXE switching system, Automatic Call Distributors (ACDs) and line concentrators.

Studies of delays in switching systems and searches for suitable mathematical models to represent them have been going on for some time. Most recently, this work has concerned the Manual Assistance Centres associated with 10C trunk exchanges and ACD systems. These studies have now been completed and reports published.

The aim of network optimisation studies is to develop a procedure for designing minimum cost switching networks for any desired origin-to-destination probability of congestion. A mathematical programming model for use in full availability networks has already been developed and more recent work has been directed towards applying it to Telecom's existing networks, where less than full availability is provided at most switching stages. To facilitate this project, computer algorithms for estimating end-to-end congestion probability in our conventionally designed, existing networks have been programmed in Fortran and Pascal high level languages. The Fortran version is restricted to hierarchical networks, while the Pascal one can be applied to any network.

The traffic base investigation explored the alternatives to the time-consistent busy hour (TCBH) reference traffic base. Traffic intensity profiles from various parts of Telecom's trunk and local networks were analysed and a distribution-based reference traffic estimation method was proposed as the best alternative. An internal report has been prepared.

Local Integrated Services Digital Networks

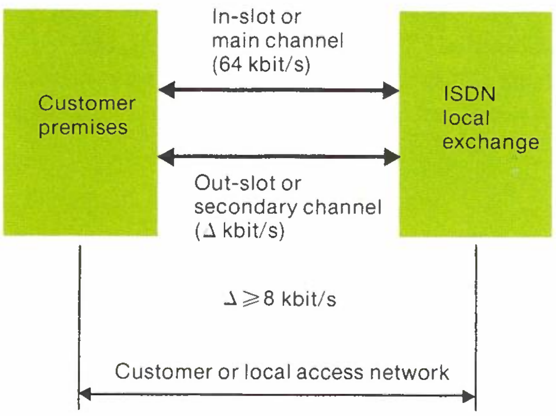
Economic advantages of digital switching and transmission have created a tendency for telephone networks to evolve gradually towards an Integrated Digital Network (IDN) based on circuit switching of 64 kbit/s Pulse Code Modulation (PCM) channels. This concept of an integrated digital network is now being increasingly seen as a transitory step towards the establishment of an Integrated Services Digital Network (ISDN).

The ISDN concept relies for its attraction upon the value of the new services which it provides, together with the expected economic use of a single conventional two-wire line to provide network access. Formulation and development of a flexible customer access arrangement to the ISDN is therefore one of the dominant issues for research study in Telecom Australia.

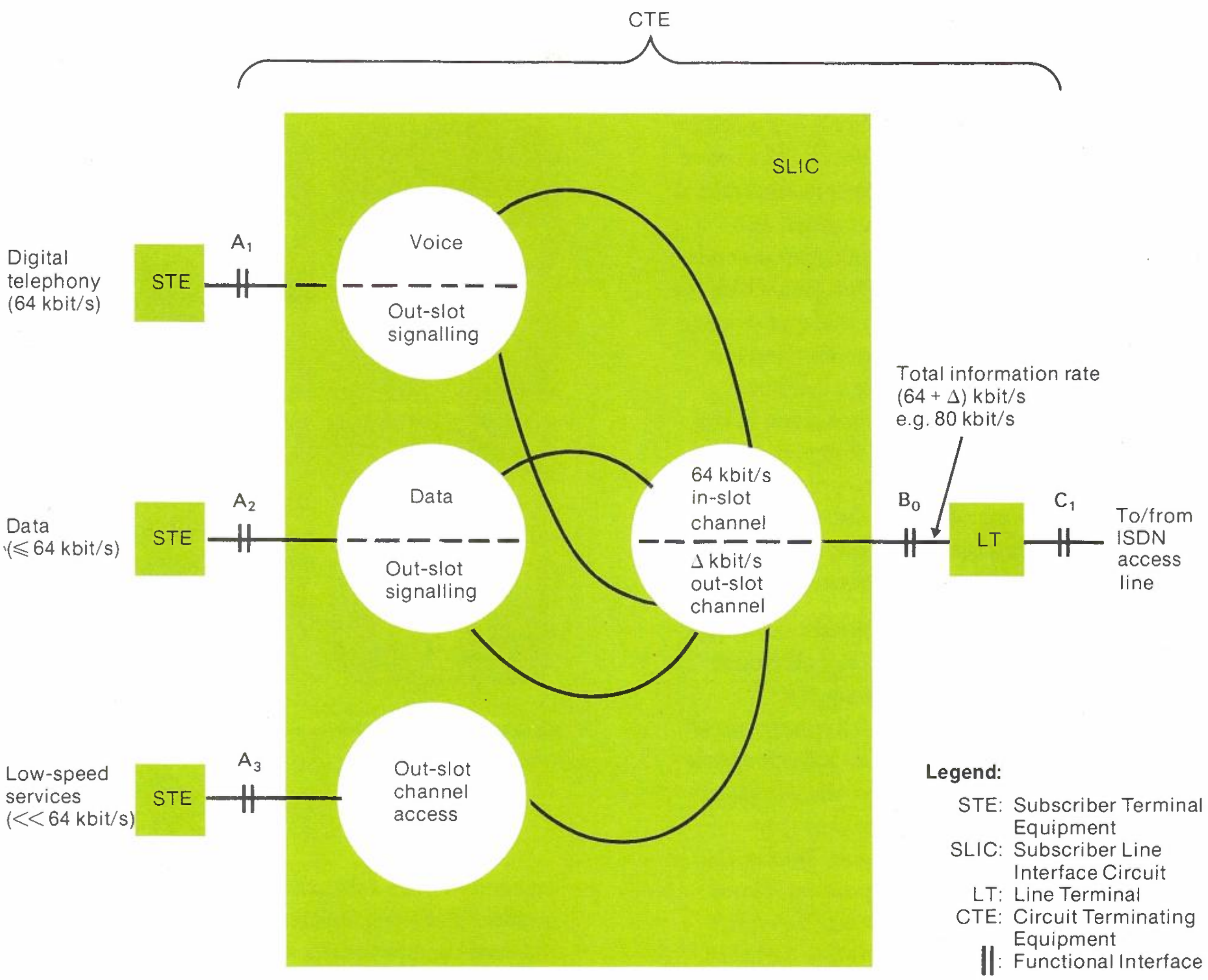
A large number of diverse ISDN services are expected to be possible. These could include presently available services (such as telephony, data and other non-voice services) and various new services, many of which are not yet well defined. The services may have different transmission rates and different performance requirements. A customer access arrangement to the ISDN therefore needs to be flexible. In particular, if a telephony-based IDN is to evolve to an ISDN, customer access will need to be achieved without penalising existing services, in particular telephony which is expected to remain a dominant service for many years to come.

Depending on the needs of the individual ISDN customer, flexibility is also required to provide various types of access to the above services. For example, the customer may require dedicated access to a particular service (telephony or data) or alternative access to two or more services on a call-by-call basis.

Furthermore, flexibility is desirable to permit the



A possible basic customer ISDN access – channel arrangement



A possible basic customer ISDN access – service and signalling arrangements

implementation of the customer access network using present and future technologies and techniques. It is therefore useful to structure conceptually the access network into independent but inter-working functional layers in order to take advantage of technological evolution and new techniques. Such a layered structure would be very helpful in the study of signalling procedures (or protocols) and functional interfaces associated with customer access networks. This technique has already been successfully applied by the International Telegraph and Telephone Consultative Committee (CCITT) in its studies of Public Data Networks and Common Channel Signalling System No. 7, and also by the International Organisation for Standardisation (ISO) in the investigation of Open Systems Interconnection.

Within the CCITT, the study of customer access to the ISDN is conducted jointly by a number of Study Groups (SGs) in particular SG VII (Data Communication Networks), SG XI (Telephone Switching and Signalling), and SG XVIII (Digital Networks). The latter SG co-ordinates the overall investigations. The basic conceptual principles of the ISDN study have been formulated as Recommendation G.705. However, much more work is required to define the fundamental aspects of ISDN customer access. These include customer services and facilities, access types, terminal equipment, network aspects, signalling protocols, functional interfaces, transmission techniques and many other related topics such as operations and maintenance, testing, performance and numbering.

Work has recently commenced in the Switching and Signalling Branch of the Laboratories on the study of ISDN local networks with special emphasis being placed on the network aspects, signalling protocols and functional interfaces. It is hoped to submit results of this investigation to the CCITT ISDN study for consideration.

Digital Transmission in the Subscriber Network

The influence of digital technology is being felt in many areas of the telephone network. The use of PCM junctions and SPC exchanges in Australia is a reflection of a world wide trend which also includes high capacity digital trunk systems and fully digital switching centres. One area which up to now has remained aloof from these advances is that which lies between the subscriber and his local exchange, referred to as the subscriber network. However, for the reasons given in the adjoining Table, the application of digital techniques in the subscriber network is currently being studied by a significant number of telecommunications administrations and manufacturers of systems, equipment and devices.

The pair of wires which connects each subscriber to his local exchange must carry signals to and from the subscriber simultaneously. The separation of these directions with conventional analogue transmission techniques is fairly simple but if digital transmission is used, the increased frequency bandwidth required makes this separation more difficult. However, Telecom's subscriber cable network is its most significant single investment containing 30% of Telecom's fixed assets. It is therefore imperative that this existing network should be used in any future digital transmission schemes.

A number of transmission methods have been proposed to achieve this end and have been the subject of study in the Laboratories. At this stage of the studies, two methods look very promising, although work on them is still in its infancy. The two methods are the digital echo canceller/hybrid technique and the burst technique.

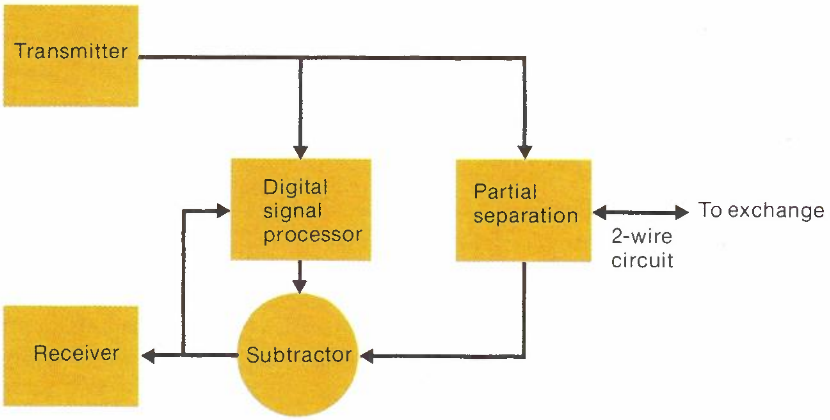
The first method separates the directions of transmission by subtracting a delayed and scaled version of the transmitted signal from the received signal by using digital signal processing.

In burst technique, transmission occurs in only one direction at any time. Bursts of information (for example digitised speech) are stored and re-assembled and then transmitted much faster than the rate at which they were stored. Bursts are then transmitted alternatively in each direction, to give the effect of simultaneous two-way transmission. A variation of this technique is being evaluated by the Research Laboratories.

The Research Laboratories are also studying the

Reasons for Digital Techniques	Digital Advantage Over Conventional Techniques
Provision of extra services	High signalling capability
Economics	Economies through very large scale integration (VLSI) of digital circuitry possible.
Quality of transmission	Inherent improvements using digital techniques.
Utilisation of cable plant	Digital multiplexers, and concentrators yield gains.

Table summarising reasons for applying digital techniques in the subscriber network



A schematic digital echo canceller/hybrid

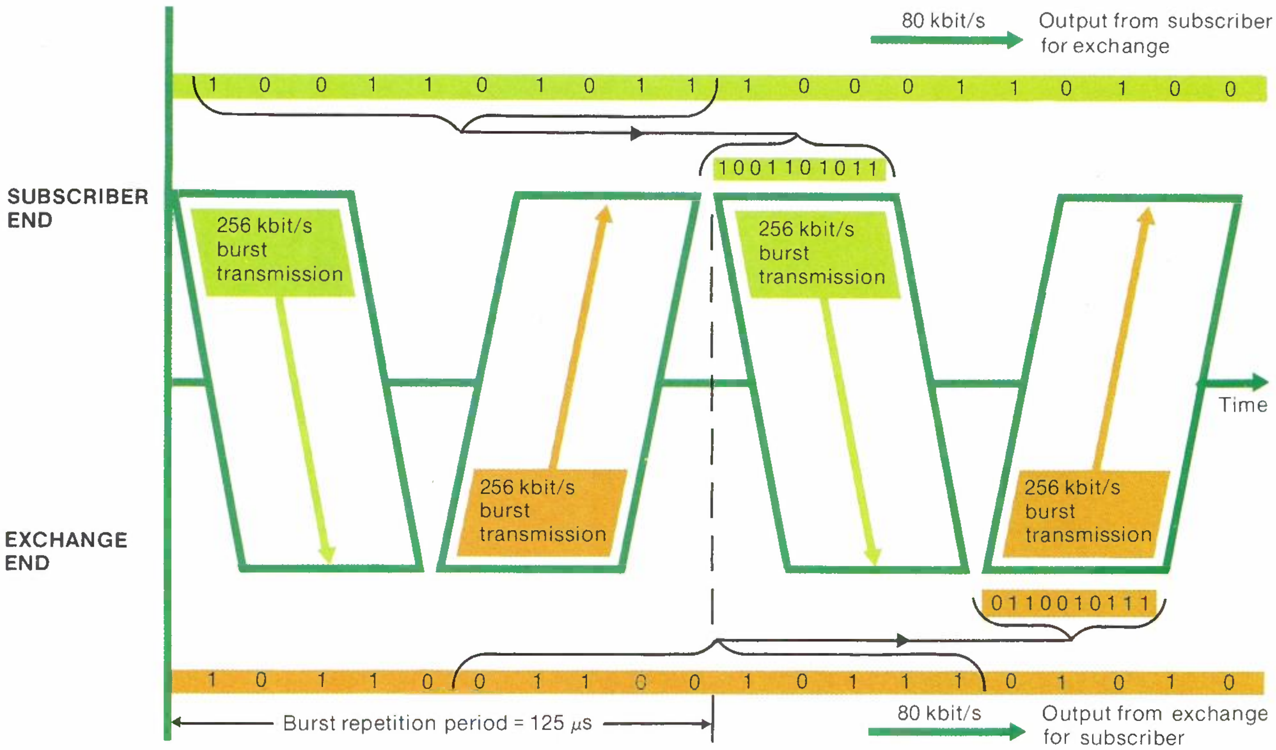


Diagram illustrating the burst transmission method

potential application of these and other techniques in the Australian network. Factors such as interference between pairs of wires in the same cable, the effect of cable design practices and compatibility between different services in the same cable have yet to be thoroughly investigated before digital transmission can be introduced with confidence in the subscriber network.

High Capacity Digital Radio Transmission Studies

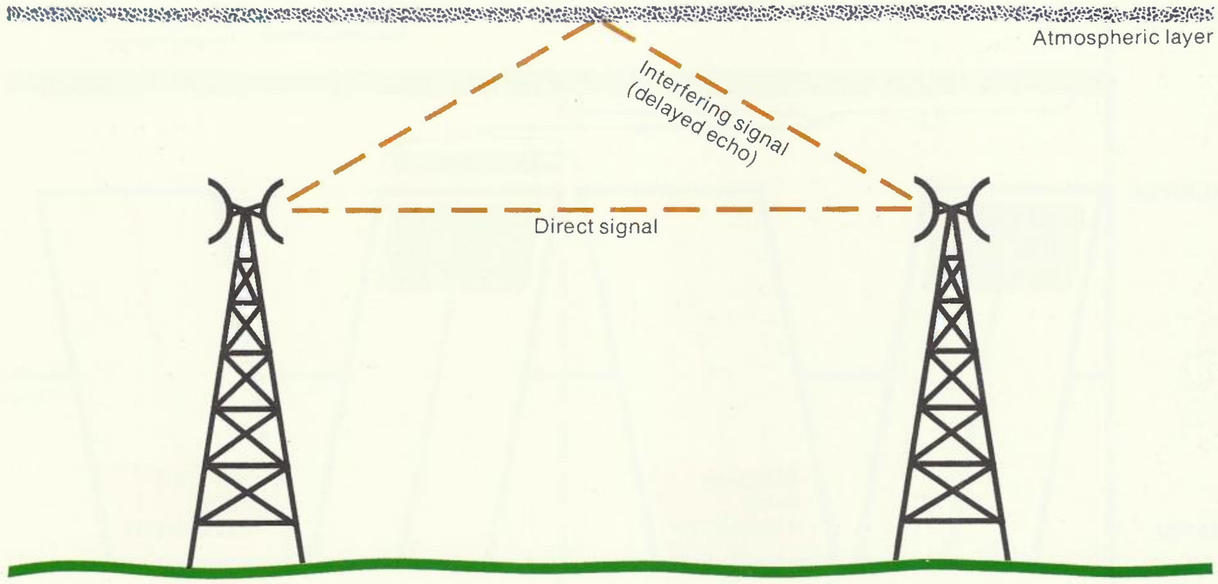
In digital radio transmission, the carrier is modulated with digital signals to transmit time division multiplexed information. This modulation technique contrasts with the analogue modulation techniques employed on the microwave radio systems that connect the major cities in the Telecom Australia network. However, digital radio systems are rapidly penetrating the world's telecommunications networks since they offer economic advantages as well as increased network flexibility, and Telecom is engaged in research studies of a number of facets of digital radio transmission in anticipation of the introduction of such systems into Telecom's high capacity trunk network.

High capacity digital radio systems operate at 140 Mbit/s in the hierarchy adopted by Telecom. This is equivalent to 1920 voice channels encoded into a digital form. Digital radio systems are being initially designed to co-exist with current analogue radio systems, using the same repeater stations, and they will later replace older analogue equipment.

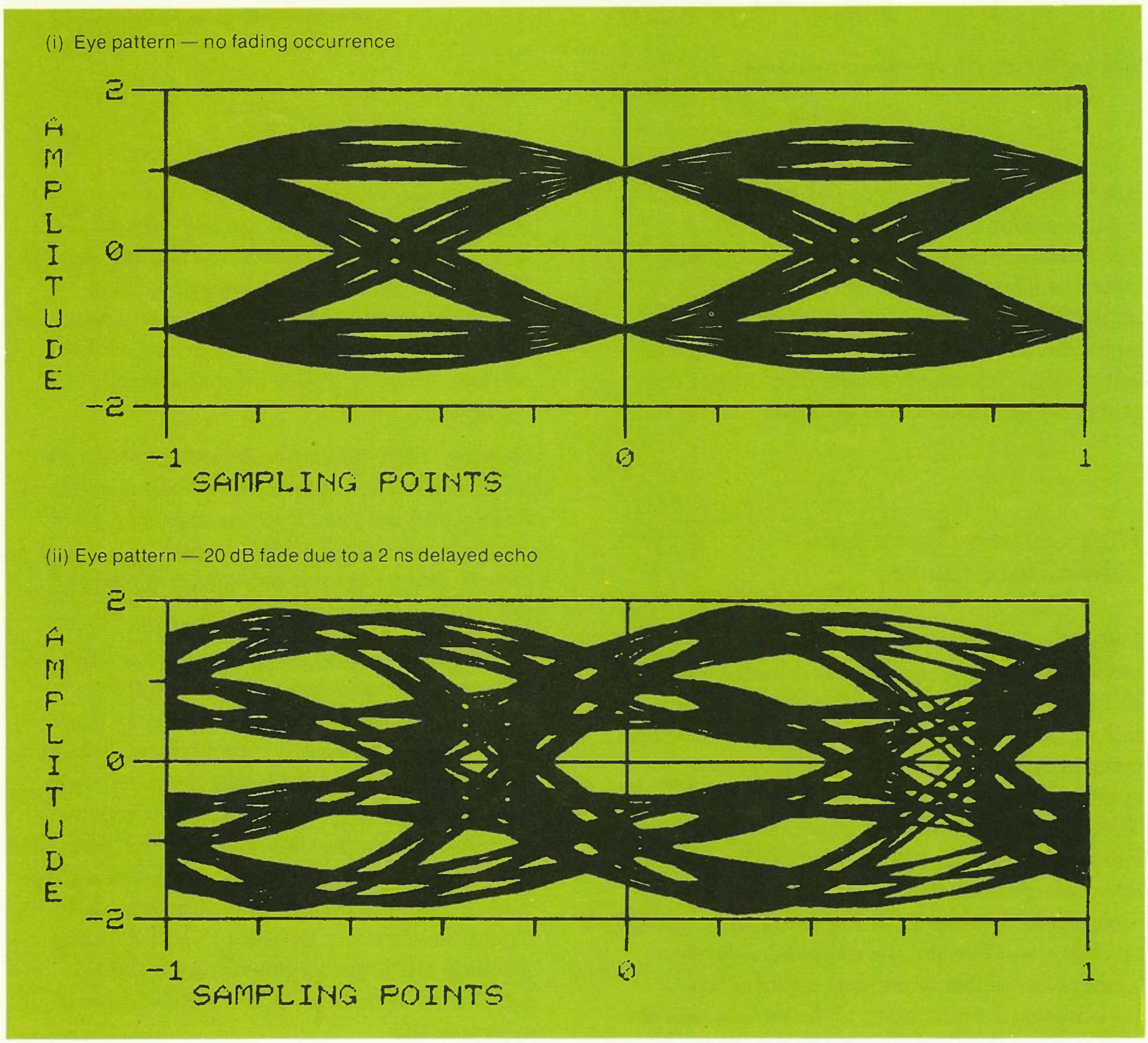
However, high capacity digital radio systems are more sensitive to the frequency selective nature of multi-path fading and their use requires a more detailed understanding of multi-path characteristics to enable cost-effective system design.

The adjoining diagram illustrates how an elevated reflecting layer produces interference at the receiving antenna of a radio system. For a digital radio system, this interference produces distortion in the received pulses, such that they over-lap at the decision or sampling instants. This is termed inter-symbol interference. The reflected "echo", as it is termed, distorts the pulse shapes, causing "eye closure" and thus data errors. For high capacity digital radio systems, frequency selective fading results in inter-symbol interference and this, rather than thermal noise, is the major cause of system outage.

In order to quantify how techniques such as



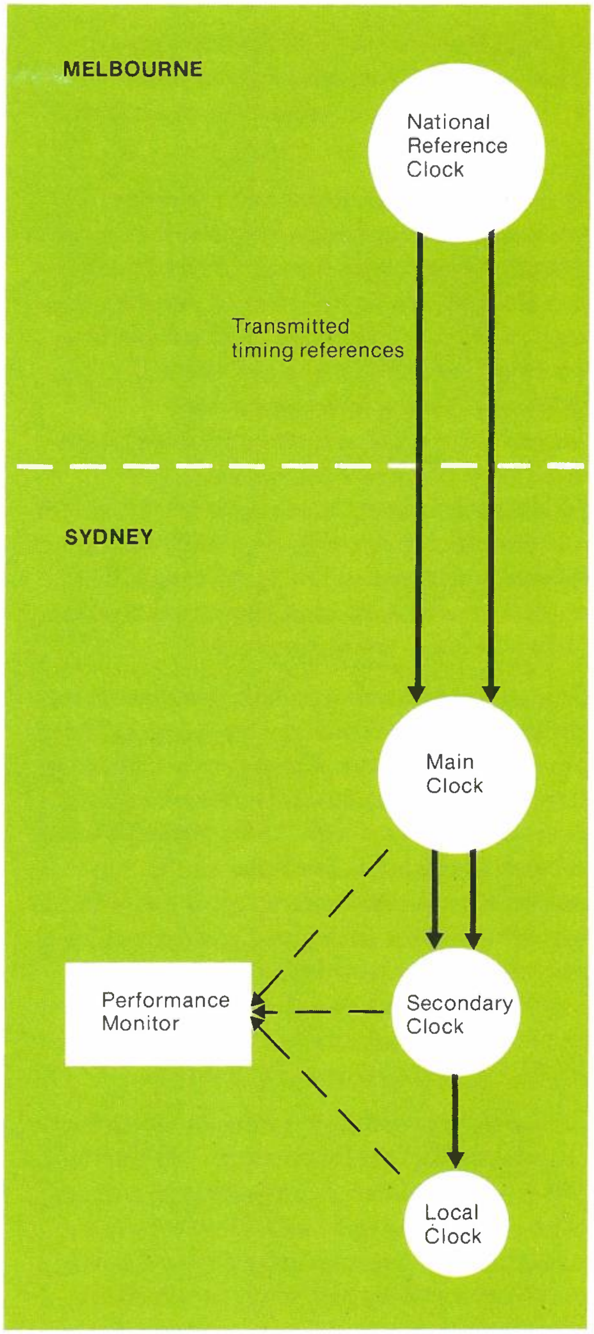
Fading is caused when delayed echo reflected from atmospheric layer interferes with direct signal



Diagrams showing eye closure caused by multipath fading effects diversity and equalisation can be used to overcome frequency selective fading, the Research Laboratories are preparing to mount a field experiment early in 1982, using commercially available digital radio equipment. Relevant data will be measured at the field site and telemetered back to the Research Laboratories using a remote data acquisition system. The data will then be analysed by computer to provide a more detailed understanding of the effects of frequency selective fading on the transmission performance of high capacity digital radio systems. In addition, diversity techniques and adaptive equalisation techniques will be tested in parallel with the non-diversity receiver. From these measurements, it should be possible to assess the degree of improvement that can be gained from these techniques and to determine where further improvements are possible by other methods still under development.

In addition to preparing for the field experiment, the Research Laboratories are assessing the applicability of the measured effects of frequency selective fading on analogue systems to enable prediction of digital radio system performance. The results of these predictions will then be compared with the actual digital equipment performance recorded during the field experiment. Results from a broadband propagation experiment which has been conducted over the last two years by the Laboratories will also supplement these studies, to provide much needed information on the propagation mechanism causing this phenomenon and to enable extrapolation of the results to other locations in Australia.

From these studies, Telecom Australia hopes to develop its expertise to enable it to introduce high capacity digital radio systems to link our major cities by the mid 1980s with confidence.



Trial synchronisation network

Digital Network Synchronisation Field Trial

Telecom Australia is preparing for the widespread application of digital techniques for the transmission and switching of customer information. As part of these preparations, the Research Laboratories are investigating means of controlling timing in the evolving digital network.

A method of clock control has already been proposed for Telecom's network. In the method, a hierarchy of clocks is to be established, with a National Reference Clock (NRC) at its head. Main Clocks (MC) form the second level in the hierarchy and are synchronised to the NRC, and each supplies synchronising information to Secondary Clocks (SC) in the third level of the hierarchy. Local Clocks (LC) are synchronised from SCs and represent the lowest hierarchical level. In this way, all timing in the digital network will originate from the NRC. To ensure reliability, the method proposes that the NRC and transmission links conveying timing references are replicated and that controlled clocks use a Prior-Assigned-Alternative-Master-Slave (PAAMS) algorithm to select the best available timing reference.

To assist with the development of Telecom Australia's synchronisation network, the Research Laboratories are co-ordinating a field trial of a skeleton synchronisation network. For the trial, a complete NRC will be constructed and operated from the Research Laboratories' site in Melbourne. Timing information will be transmitted to a MC in Sydney, from which it is hoped to synchronise a SC and a LC. Transmission links in the analogue trunk network between Melbourne and Sydney will be duplicated and each will carry two timing references. The MC will use a PAAMS algorithm switch to select the best available timing reference.

After its commissioning in 1982, the operation of the field trial will be continuously monitored for a period of at least a year so that data is available to design a synchronisation network with national coverage. Experience with the PAAMS algorithm, and with methods and hardware for the transmission of timing references, will determine their suitability for widespread application. The trial will also yield basic data such as the magnitude of variations in transmission delays, the reliabilty of equipment and transmission links, and the long term behaviour of the NRC.

Following the period of performance monitoring, it is expected that the trial network will form the basis of a synchronisation network with national coverage. The final network is likely to have a second NRC for improved reliability, and it will provide timing to the facilities of the Overseas Telecommunications Commission (Australia) as well as to those in the Telecom Australia network.

A National Reference Clock for a Digital Network

The primary controlling clock for Telecom Australia's proposed digital network is designated the National Reference Clock (NRC). Its function is to provide a satisfactory timing reference for control of the network and it must meet stringent specifications for reliability, frequency accuracy and phase stability. The long term frequency accuracy requirement is 1 part in 10^{11} and demands the use of caesium atomic clocks. Because caesium clocks have a relatively poor reliability and a long mean time to repair, an ensemble of three caesium clocks will be used in the NRC to obtain the necessary 50 years mean time between failure.

Reliability is not the only reason for having three clocks. Such an ensemble allows the making of majority-logic decisions in the choice of the operating clock. The group contains a reference against which the performance of the operating clock can be compared. Even so, the detection of a 1 part in 10^{11} frequency error in a reasonable time requires careful design. The logical location for such an NRC is in the Research Laboratories where the expertise exists to ensure its satisfactory operation.

The design philosophy adopted for the NRC is to drive a clock from each caesium clock at the mean phase of the three caesium clocks, to give three mean phase clocks. In this way, a group reference is set up, and switching can be done between the synchronous mean phase clocks without a phase step of the output. Selection of the operating clock is initially made by manually setting the preferred first, second and third choices. The three mean phase clocks are compared for errors in rate, phase and output level by appropriate alarm circuitry. The selection of the operating clock is then determined by the status of the alarms.

The mean clocks are maintained under the control of three phase comparators, which compare the clocks in pairs, and phase steppers, which move the phases to the mean. The phase steps must be small compared with the allowable phase discontinuity of the control signal of 61 nanoseconds. Three nanosecond steps are to be used. The selector switch is duplicated in part for reliability and fault repair without service interruption. It is make-before-break so that, for the faults most likely to occur, the switching change-over does not insert or delete a pulse. In the event of two caesium clocks becoming faulty, the third clock is selected and left in service. Alarms inhibit phase comparator operation to prevent erroneous phase movement.

With the mean clock system proposed, it is a simple matter to include an external phasing input to take account of international timing. This could be done via the standard time-keeping operations of the Research Laboratories, or via the international digital network, if such information were included in it at some future time.

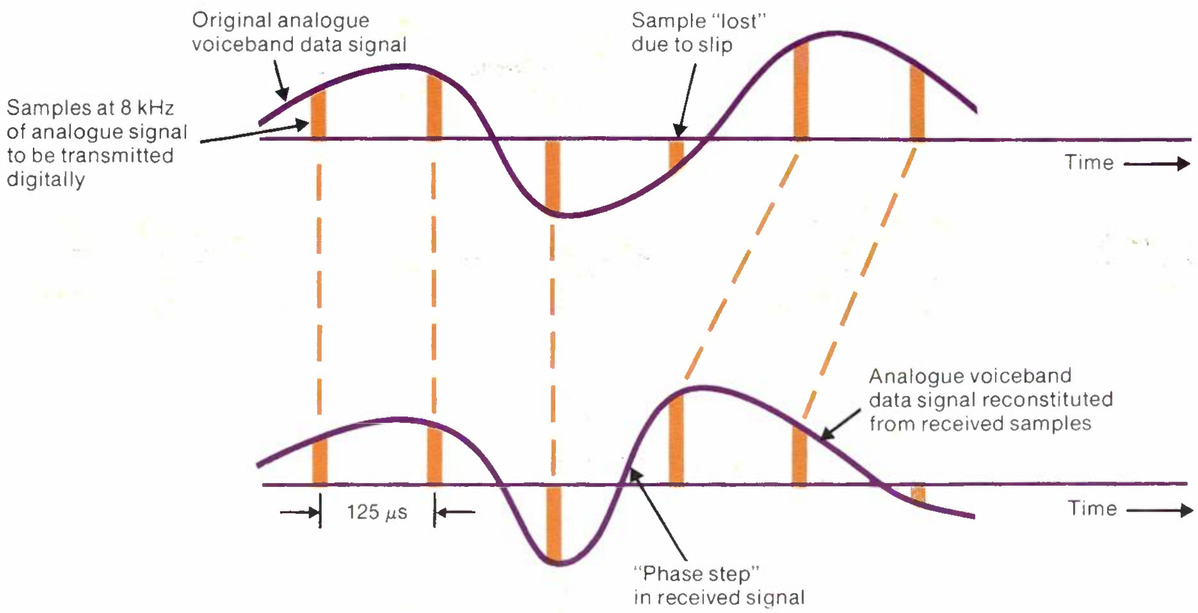


Illustration of how sample slip causes a "phase step" in the reconstructed voiceband data signal

The Effect of Sample Slip in a Digital Telephony Network on Voiceband Data Modems

During the period of evolutionary introduction of digital switching and transmission techniques into the Telecom network, it will be possible that the information signal in a particular connection – for example, speech, voiceband data or facsimile – will be in either analogue or digital form, depending on which part of the network the signal is traversing.

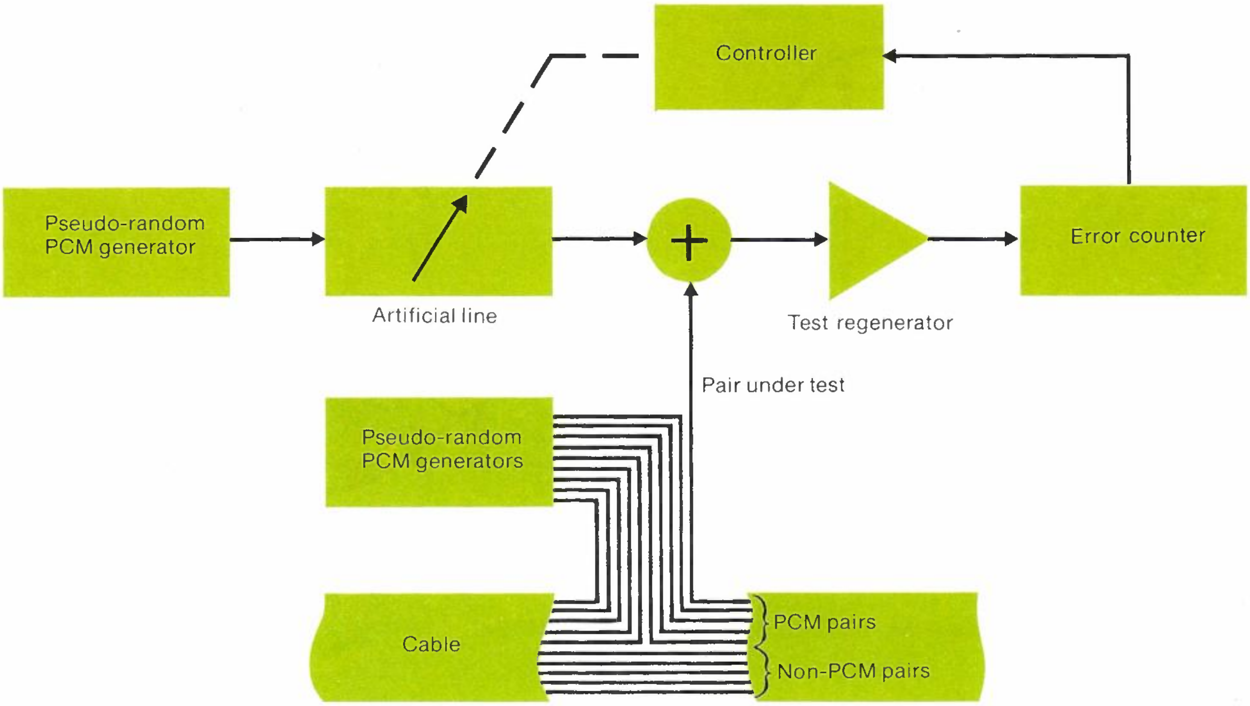
When in digital form, the signal consists of samples at a nominal rate of 8 kHz which is determined by the clock in the transmitting exchange, and the receiving exchange interprets these samples at a rate determined by its own clock. Should the clocks in these exchanges run at slightly different frequencies, samples will be occasionally lost or repeated and slips are said to occur. The adjacent diagram illustrates a slip where a sample has been lost.

In the initial stage of developing a digital telephone network, it is likely that exchange clocks will run independently and that slips will occur at a rate determined by the frequency differences between clocks. Fortunately, slip has little effect on the quality of speech transmission. However, voiceband data signals can be more sensitive to transmission impairments than speech signals, and to determine whether this is so in the case of a network having independent clocks, the Research Laboratories have experimentally investigated the effect of sample slip on voiceband data modems operating at rates from 1200 to 9600 bit/s.

The major conclusion from the experimental measurements was that a slip in the digital telephone network does not cause a slip in the received data signal. This is explained by the fact that the symbol period for each modem is greater than twice the sample period, namely 125 microseconds. In addition, a slip causes no data errors for data transmission at 1200 bit/s, one error at 2400 bit/s, and a longer burst of errors at 4800 and 9600 bit/s.

The measured results at 1200 and 2400 bit/s agreed completely with those predicted by a simple approximate model of the slip process. This model treats the slip – which is a loss or gain of one sample – as a time step, and then approximates this step as a phase step at the carrier frequency of the voiceband data signal. This process is illustrated by the adjoining diagram. For example, the 1200 bit/s data modem uses frequency modulation and the phase step appears at its decision point as a noise pulse but of insufficient height to cause an error.

At the higher data transmission rates, where sample slip does cause error in the received data, the expected frequency of occurrence of slips, as determined by the difference in frequencies of the exchange clocks, gives a negligible error rate. For example, in a case with two transmission links involving three exchange clocks, at least 99.88% of seconds are expected to be error free.



Measurement of maximum regenerator section length

An Instrument for Measurement of Maximum PCM Regenerator Section Lengths

Pulse code modulation (PCM) line systems, providing 30 voice circuits over two cable pairs, are now being increasingly installed on inter-exchange junction cables in Australia. PCM regenerators, which reconstruct the transmitted signal, are required to overcome cable loss and minimise the effect of crosstalk. The crosstalk at any PCM regenerator location is difficult to estimate, and depends on the cable type and other signals carried by the cable.

Consequently, an instrument has been developed by the Research Laboratories for application at PCM regenerator housings to assess the effect of crosstalk, including both near-end and third-circuit crosstalk. The instrument is to be used by field staff for acceptance testing of installed regenerator housings and to check for faulty or unusual pairs in cables. The tests will provide an information base for planning PCM routes and give forewarning of any future utilisation problems on various types of cable.

In the field application of the instrument, the regenerators at a housing are replaced by modules which simulate normal regenerator operation. In the instrument, the crosstalk noise from one pair in the housing is combined with a PCM signal fed through a selectable-loss artificial cable and the resultant signal is applied to the input of a regenerator. By varying the loss of the artificial cable, the maximum regenerator section length, for a specified error rate, is obtained for that cable pair. The measurement approach assumes little about the nature of the crosstalk, but gives a maximum regenerator section length which is directly applicable to checking PCM design rules and to route planning.

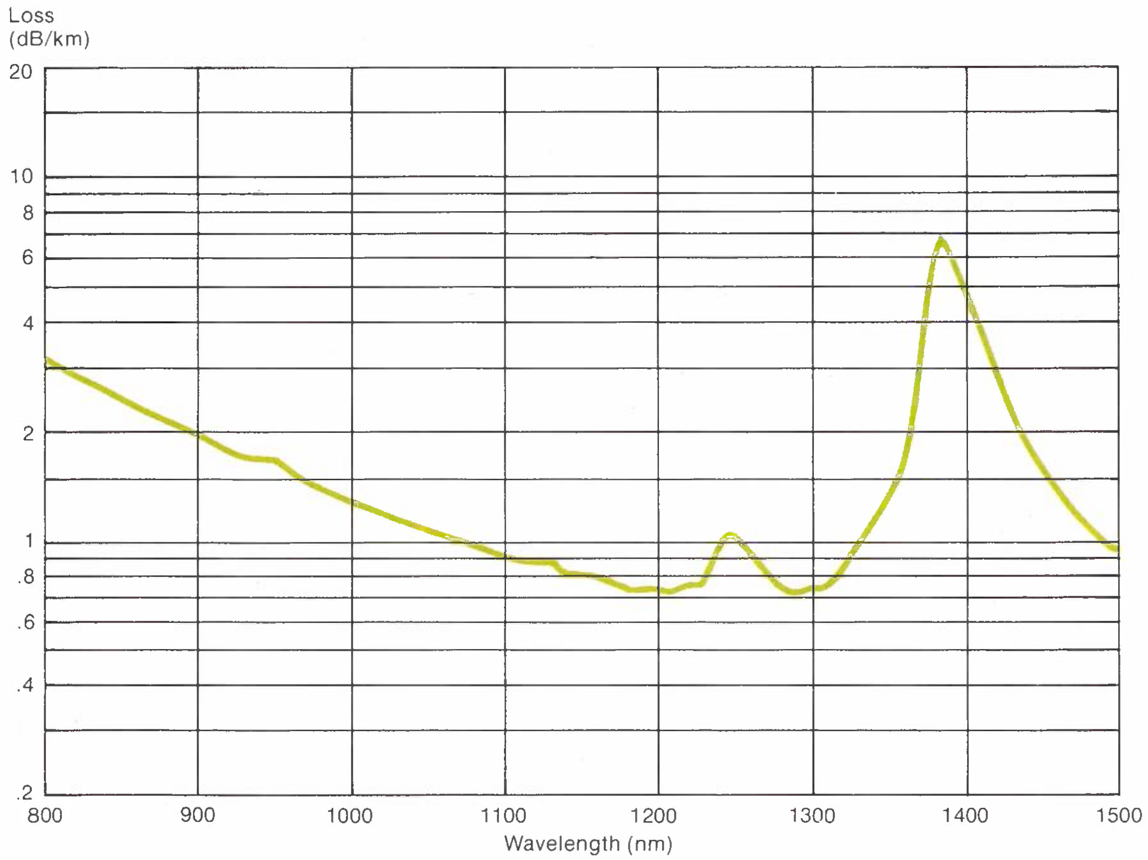
Optical Fibre Transmission Measurement Techniques

It is expected that the continuing development of optical fibre technology will enable the introduction of optical transmission systems in high growth rate areas of the metropolitan junction network by about 1985. In order to gain experience with this new technology, a field experiment is currently in progress. As part of this experiment, the Research Laboratories have developed semi-automated test equipment to measure the fundamental transmission characteristics of multi-mode optical fibre cable namely, optical loss, baseband frequency response and impulse response.

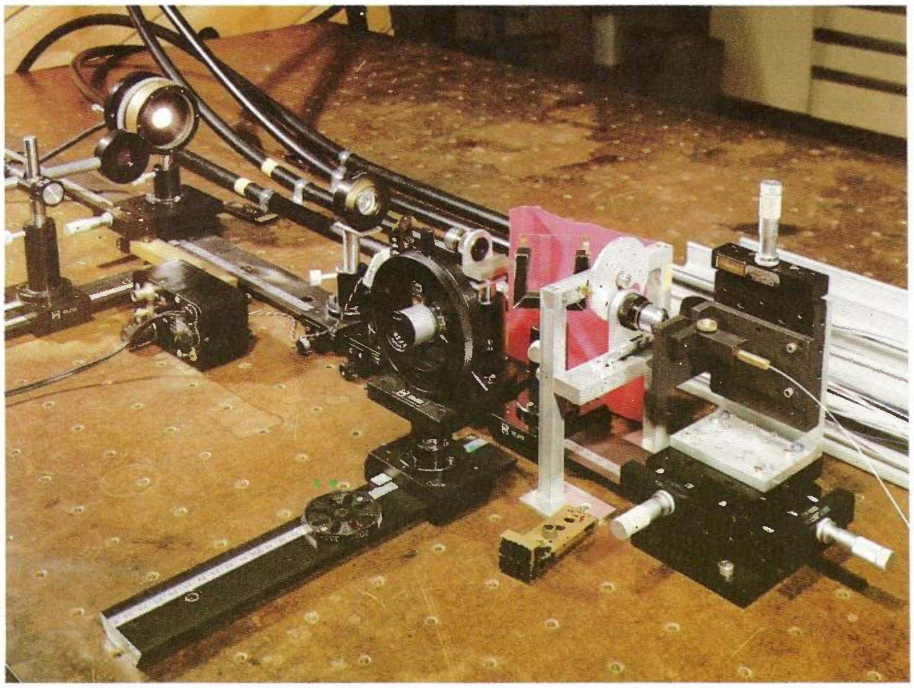
The current generation of high capacity optical fibre systems is based on graded-index fibre which typically propagates several hundred modes. The power propagating in each of these modes suffers different loss rates and time delays which are characteristic of the individual modes. In testing the fibre transmission performance, an ensemble of these individual modal effects is measured, and so the results are strongly dependent on the distribution amongst the modes of the optical power launched into the fibre. The choice of these "launching conditions" will therefore affect the reproducibility of the fibre measurement. In addition, the need for meaningful attenuation figures, that is, those enabling an accurate prediction of the losses of a route of concatenated fibres from measurements on individual fibres, necessitates the standardisation of launching conditions in fibre measurement apparatus.

When a fibre is used in a communication link, the preceding fibre in the route acts as the source – with its core diameter, numerical aperture (NA) and modal power distribution forming the launching conditions. After the first section of fibre nearest to the semiconductor source, light scattering processes in the fibre establish an equilibrium modal power distribution which is essentially invariant with distance, apart from the continuing reduction in overall amplitude. Thus by simulating this equilibrium power distribution when launching into the individual fibres under test, the resulting loss figures can be added to predict the cumulative route loss.

The measurement systems developed within the Research Laboratories simulate the required source conditions by using a launch NA less than that of the fibre under test and by confining the light to a circular region on the fibre face which is smaller than the core. This restricted launching arrangement is achieved by using a dual lens system to form an image of a source aperture or fibre end on the entrance face of the test fibre. This technique also enables the alignment of the launching optics to be inspected using a simple telescope with white light sources, or an infra-red sensitive video camera for semiconductor sources. The use of these alignment aids, together with data acquisition and measurement control by desk-top computers, greatly simplifies the investigation of optical fibre transmission properties in the Laboratories.



Variation of optical fibre transmission loss with wavelength



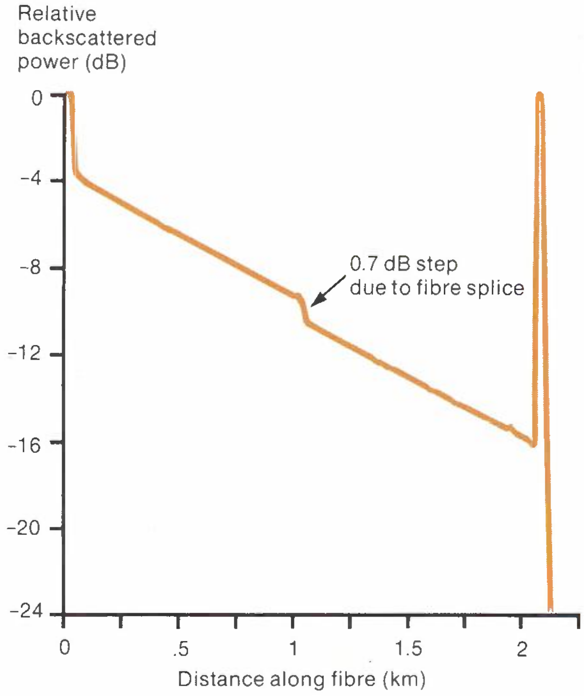
Launching apparatus for measurement of optical fibre loss spectrum

Optical Fibre Backscatter Measurements

Significant progress in optical fibre systems over the past decade has brought about the emergence of fibre systems from laboratory experiments to fully engineered systems for telecommunication applications. Consequently, work to improve the convenience of techniques for measuring attenuation characteristics of optical fibres has been conducted worldwide in the last few years and a wide range of measuring instruments is now commercially available.

As part of a measurement programme for the characterisation of optical fibres, the Research Laboratories employ an optical time domain reflectometer (OTDR) for determining the attenuation characteristics of optical fibres. The use of an OTDR is similar to that of a time domain reflectometer for metal pair conductors in that only one end of the guided medium under test needs to be accessible to conduct a measurement. OTDR measurements are based on the analysis of backscattered light from optical pulses launched into one end of the fibre. The light which propagates in the fibre is attenuated mainly by two loss mechanisms. The first is absorption, due to light photons exciting electrons of the constituent materials of the fibre core. This results in the conversion of optical power into heat. The second is Rayleigh scattering, by sub-microscopic inhomogeneities (fluctuations in material composition) in the core material. Rayleigh scattering causes a small proportion of optical energy to return in a direction opposite to that of signal transmission. An OTDR uses this back-scattered signal to examine attenuation characteristics along a length of fibre.

In the Research Laboratories' OTDR arrangement, a commerical OTDR is employed under the control of a desktop computer. Results are stored in computer memory, updated and analysed by software. Final results are presented as plots of attenuations against fibre length and displayed on a visual display unit or an X-Y plotter. Attenuation characteristics can be measured for fibre lengths corresponding to one-way optical losses of up to about 12 dB. Discontinuities arising from fibre splices or fibre fractures can be located in fibres for a one-way optical loss of up to about 25 dB. One useful feature of this OTDR technique is that attenuation "signatures" of each fibre can be recorded from time to time. Examination of these signatures can reveal any significant changes in fibre attenuation characteristics with time or under different environmental conditions.



Backscatter measurements yield plot of fibre attenuation as a function of length

Stimulated Raman Scattering in Single Mode Optical Fibres

Around 300 years have passed since Newton set down his thoughts on how "The Rays of Light, by impinging on any refracting or reflecting Surface, excite vibrations in the the refracting or reflecting Medium or Substance". Then Raman, just over 50 years ago, showed how light can indeed cause atoms to vibrate and with frequencies characteristic of the way they are bound together. These frequencies lie, as Newton suggested, in the infra-red or heat part of the spectrum.

These thoughts may seem hardly relevant to modern highly transparent optical fibres, where light appears to pass from one end to the other without any interaction with the material or generation of heat. But the fact remains that light is conveyed in a material only by the movement of charges in sympathy with the instantaneous field and the study of Raman scattering does therefore have relevance to the application of optical fibres in telecommunications.

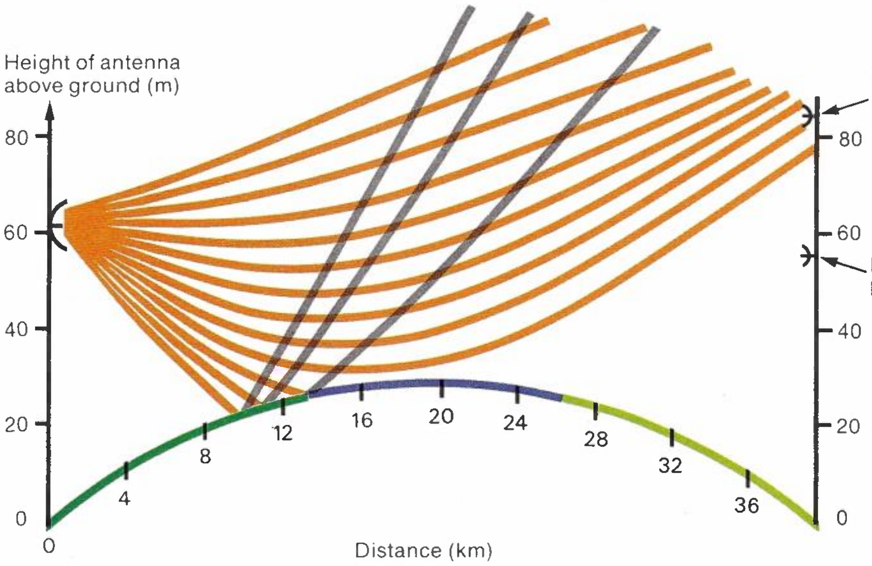
The displacement of the charges is not strictly proportional to the field, so that, at sufficiently high intensities, observable coupling into the infra-red vibrations can occur. In taking this energy from the incident wave, the infra-red vibrations reduce the frequency of the light since the energy of a photon is proportional to frequency. It can therefore be expected, on the basis of this model, that the spectrum of the Raman scattered light will appear on the low frequency or long wavelength side of the source. The demonstration of this scattering is made easier if a means is available to maintain a high optical intensity over a long distance, so as to increase the probability of the scattering of a particular photon. A low loss single mode fibre provides such an opportunity. Focussing a moderate laser power into the small core creates the high intensity, and the low loss ensures a long interaction length.

With a core diameter of 10 μm, a power of several watts can stimulate the scattering up to levels comparable with the source. This stimulation is the same process as occurs in the active material of a laser. Thus, if a pulse of light is launched into the fibre, the scattered wave builds up as a coherent wave, growing in amplitude along the length of the fibre at the expense of the energy in the input pulse. It is quite common for the scattered wave to increase to sufficient amplitude to become the source for a second Raman scattering, which can in turn produce further scatterings. On some locally produced fibre, the process has been seen to cascade up to the twentieth order, giving a spectrum covering almost an octave in optical wavelength from the input wave at 0.53 μm.

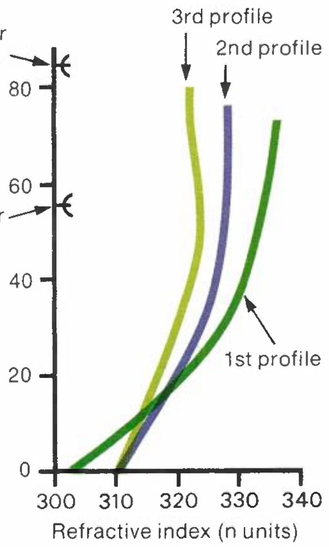
Further study of Raman scattering is expected to yield important information concerning fibre materials and crosstalk in wavelength multiplexed systems. Already the stimulated scattering from single mode fibres has increased the versatility of existing laser systems by producing coherent power at a variety of additional wavelengths.

Estimation of Sub-Refractive Fading on Terrestrial Radio Relay Systems from Surface Meteorological Data

Severe fading, causing loss of traffic on radio systems, has occurred in Queensland under particular atmospheric conditions. This effect had also been noted on a test path at Julia Creek operated by the Research Laboratories between 1969 and 1971. Laboratories' studies have shown that the fading can be due to "sub-refraction", which causes the radio waves to curve upward, leaving the receiver in a shadow zone. The



Ray trace of Julia Creek path using profiles on right



Refractive index versus height for each third of path

received signal level then consists only of a diffracted component from the earth's surface.

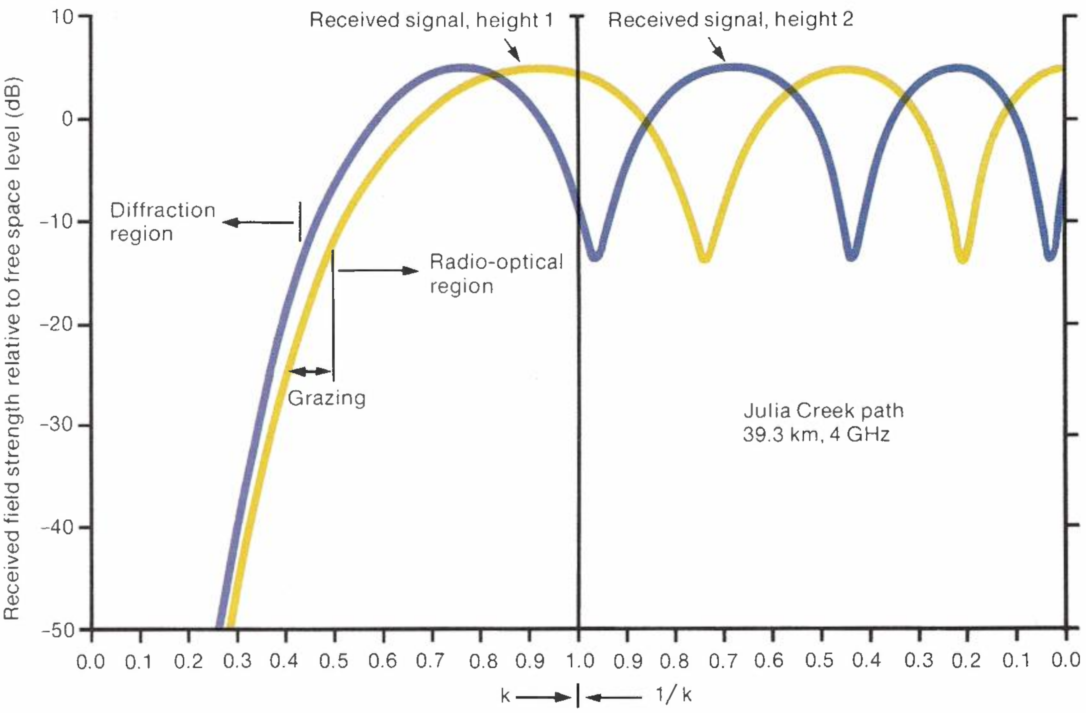
To assist in the design of microwave systems, the Laboratories have developed a method of estimating the probability of this sub-refractive fading which uses surface meteorological data provided by the Bureau of Meteorology. The method was outlined in a paper given at the Telecom Colloquium on "New Propagation and System Techniques for Non-Trunk Radio Applications in the 1980s" held in Melbourne during 1980.

Radio ray curvature depends on the atmospheric refractive index variation with height. Severe sub-refraction occurs when moist air moves in over a nocturnal temperature inversion which already has trapped dry air existing at the time of its formation. The moist air slowly mixes down by diffusion into the cooler stable air beneath. For cases in which the moist air reached ground level, the Julia Creek results, from the more severe events, showed that the refractive index varied with height in an approximately linear relationship at the lowest median signal level. This linear change in refractive index can be described in terms of the relative ray curvature between the ray and the earth's surface, and can be simply related to a parameter "k".

Assuming a simple sub-refractive model, the refractive index is calculated from dewpoint, temperature and pressure estimates at ground level and at the top of the inversion layer. These meteorological estimates are derived from surface analysis (weather) maps of the area, suitably interpolated. The temperature inversion height and strength are estimated from the surface wind velocity. The difference in refractive index over the layer height produces the worst (minimum) k-value. This value may be compared with that derived from the diffracted radio signal levels.

The statistics of this mechanism for a given location can be extracted from the long term surface meteorological data accumulated by the Bureau of Meteorology. The overnight increase in ground level dewpoint, in the presence of a strong temperature inversion, can be used as an indicator of the occurrence of a sub-refractive event. Considering only the larger dewpoint increase (to keep the number of events manageable), the date of each event can be obtained and data extracted for use in the model. This approach yields the probability of occurrence of the minimum k-values of severe sub-refractive events at the chosen location.

To find the probability distribution of effective k-values, corresponding to the low radio signal levels caused by sub-refraction, requires a knowledge of the duration and fade shape of an event. As these are highly variable, it is necessary to derive this knowledge from statistics of a large number of recorded sub-refractive fading events. By superimposing the tail of the effective k distribution on the graphs of theoretical signal level plotted against k for chosen paths and antenna heights, the radio system designer can ensure that the system's reliability objective can be met.

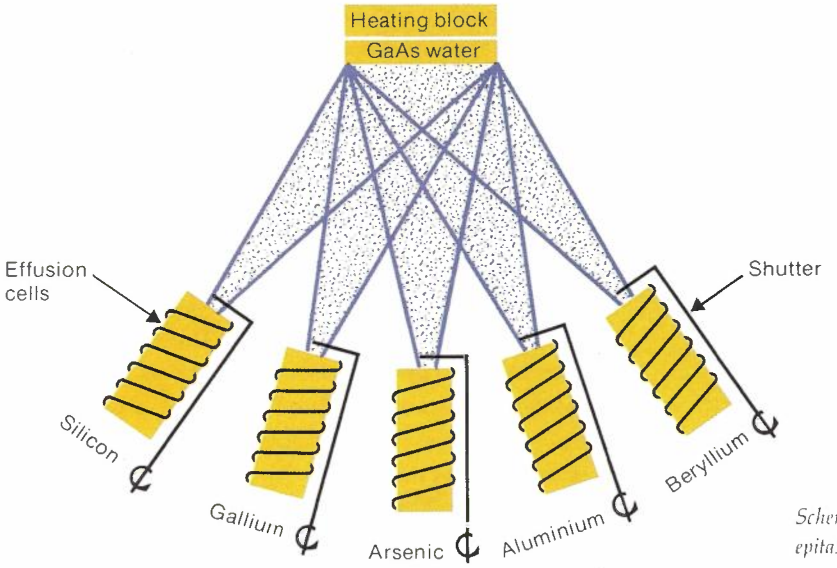


Theoretical relationship between received signal level and "k" (where "k" is a parameter which is a function of the relative curvature between the ray and the earth's surface).

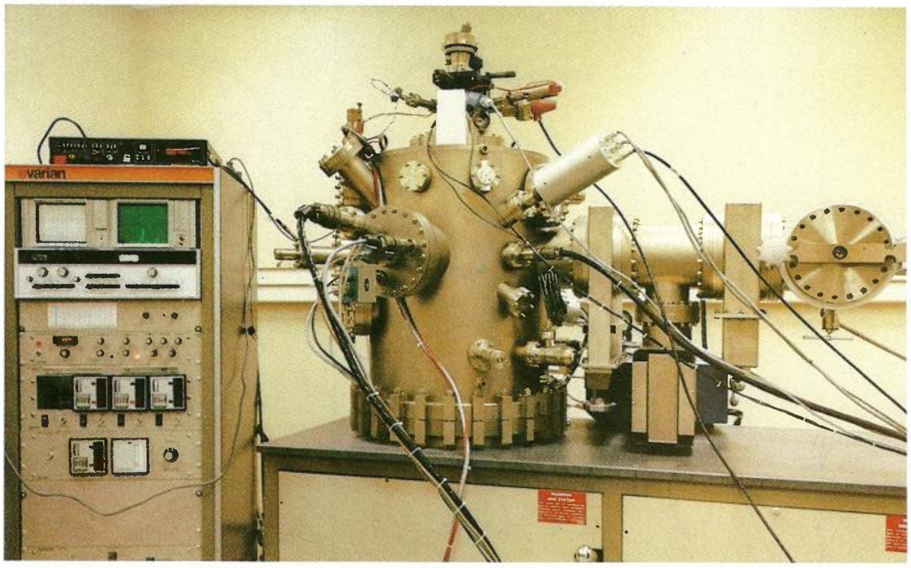
Molecular Beam Epitaxy Machine

Epitaxy is the growth of a single crystal film on a similar substrate and it is the fundamental process in semiconductor device manufacture. Until recently, the most usual manufacturing processes were based on liquid or vapour phase epitaxial growth. In the last few years, the new technique of molecular beam epitaxy (MBE) has emerged as the most flexible method of growing epitaxial materials with the thin planar structures required for the advanced opto-electronic and microwave devices used in telecommunications.

The first MBE machine in Australia has been acquired by the Research Laboratories. The essential functions are shown in the adjoining schematic diagram. In the MBE technique, the elements of the semiconductor compound required are heated in separate shuttered ovens, forming molecular beams which condense onto a



Schematic illustration of functions of molecular beam epitaxy machine



The molecular beam epitaxy machine

single crystal substrate. The elements shown in the diagram would be used to make 'p' or 'n' doped Gallium-Aluminium-Arsenide/Gallium-Arsenide (GaAlAs/GaAs) heterostructures. A feature of MBE is the slow rate of growth of about one atomic layer per second. This enables control with precision of the order of atomic dimensions over the thicknesses of the various layers.

In order to prevent contamination, the growth takes place in an ultra high vacuum – less than 10^{-13} atmospheres. This allows the use of the powerful techniques of modern surface science to monitor the growth in situ. One such technique, which is installed on the machine, is reflection electron diffraction, which monitors crystallinity and topography. Another technique is Auger electron spectroscopy, which gives an elemental analysis of the surface atomic layer, and together with an ion mill, can give a depth profile of the semiconductor. With these facilities, the machine provides the capability of both growing and analysing complex semiconductors to an atomic precision.

Automatic Calibration Techniques

Much time and effort is expended each year ensuring that the Research Laboratories' measuring capability is maintained at an acceptably high standard. This effort takes the form of a regular instrumentation calibration programme, covering most of the measuring instruments used in the Laboratories. In the past, instrument calibration was largely a manual task, but the combined influences of increasing instrument complexity and a growing tendency towards systems orientation in measurement design has led to the need for computer-assisted calibration techniques. Accordingly, much of the development in the Laboratories' calibration facilities now takes the form of software composition, designed to make best use of the varying array of commercially-available instrumentation controllers.

In theory, an automated system is the total solution to problems associated with calibration. It provides, for example, more efficient use of available staff, essentially operator-independent accuracy, and the production of detailed documentation. In practice, however, its application is by no means universal. Specifically, the cost of software development must be considered.

The Laboratories have many varied types of instrumentation of which few are sufficiently similar to allow use of previously written software, thereby allowing software costs to be amortised. Many instruments, while still perfectly capable of performing the functions required of them, are not programmable and therefore lend themselves only to minimal automation of the calibration process – in the form of messages to the operator to change instrument functions or to enter data obtained from the instrument. These limitations will undoubtedly disappear in the future as newer instruments replace the old. An indication of this trend may be seen in the software library which is being created as a by-product of the normal acceptance test procedure applied to all new equipment purchased by the Laboratories. Here, as software is written to test a particular instrument, additions are incorporated which allow subsequent use of that program for calibration purposes.

Within the calibration facility itself, automated techniques have been adopted for a variety of functional applications. Typical of this approach is a method by which the performance of an existing dc source is upgraded. This is achieved by a computer-controlled measurement and adjustment process in which the dc voltmeter accuracy is imparted to the dc source.

Automated measuring and recording techniques have also been applied to the collection of data in long term stability studies of instruments. The training of new staff has also been assisted by making use of automated calibration procedures, particularly through the use of programs especially developed to illustrate, on a step-by-step basis, the calibration procedures required for various types of instrument.

Electro-discharge machining of waveguide component

The ongoing effort to automate the Laboratories' centralised instrument calibration facilities has paid, and will continue to pay, dividends in the form of more regular and more accurate calibration of the instruments used throughout the Laboratories – with shorter instrument down-times and without increase in the number of calibration staff.

Mechanical Aspects of Complex Microwave Components

The Laboratories have an in-house design, development and fabrication capability for the physical realisation of a wide range of prototype devices and equipment for experimental purposes. So that this capability has the flexibility to meet the diversity of requirements encountered in main-line Laboratories' investigations, facilities have been established for such diverse manufacturing processes as laser and micro-plasma welding, electro-discharge machining, copy milling, sheet metal and structural steel fabrication, and conventional milling, lathe turning and grinding. High precision machinery operated by technical staff with extensive trade and formal technical training is used to achieve the necessary high tolerances often needed in the development of advanced or complex componentry.

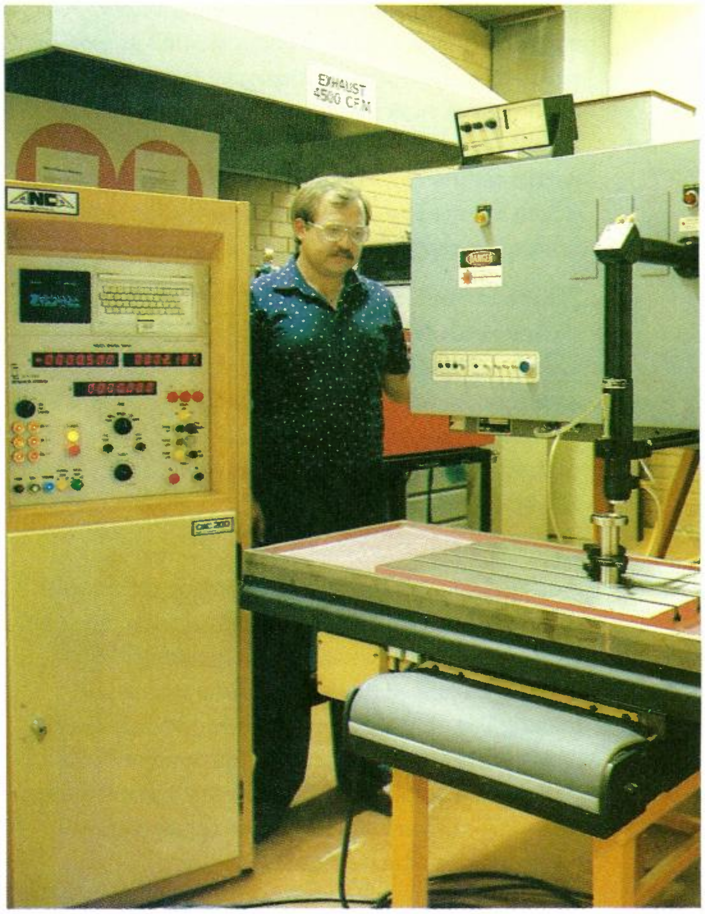
One particular area of frequent application of these various facilities is in the development of complex and experimental microwave components.

The Laboratories' micro-plasma welding capability has been developed to the stage where metals as thin as 0.05 mm, and as diverse as mild steel, stainless steel, tungsten, brass, and copper are being successfully welded. This capability is extremely valuable in the realisation of complex waveguide components.

The electro-discharge machining (EDM) technique has been used extensively in the manufacture of various cavities, flanges and micro-size components, and for the drilling of holes as small as 0.12 mm in diameter in metals and non-metals. This technique offers the advantage of being able to produce intricate and very accurate holes and cavities – for example, relatively deep, square, blind holes with minimal corner radii and a smooth, flat bottom. The technique has been applied in the realisation of microwave filters and helical resonators.

The size and shape of many microwave components necessitate their manufacture by fabrication rather than by machining out of solid blocks of metal. The skill levels achieved in this field have enabled the duplication of gain-standard horns, the fabrication of antenna feed units, tapered waveguide transitions, waveguide filters and diplexers, and the assembly of widely assorted waveguide components. Any fabrication process depends on the joining of component details to produce a finished article. Conventional welding techniques (brazing, silver soldering, electric arc, gas tungsten arc, etc.) have proved satisfactory in many cases, but associated problems such as heat distortion have led to studies to determine the most suitable joining method in particular cases. The studies have shown, for example, that the use of a low melting point silver solder is the most satisfactory method of joining small waveguide flanges and sections.

When combined with the more conventional engineering processes of milling, lathe turning and grinding, the specialised capabilities and skills developed in the Laboratories for the realisation of hardware for use in the microwave field provide valuable in-house support to a range of transmission network oriented projects, which sometimes require the timely development of otherwise unavailable prototype components.



CO_2 laser and numerically controlled work table

Processing Materials with a Carbon Dioxide Laser

The Research Laboratories recently acquired a Coherent Radiation Everlase 525 Carbon Dioxide Laser, and investigations have been commenced to apply it to extend the Laboratories' capabilities in precision welding, cutting, drilling and heat treatment processes for specialised application in the manufacture of experimental hardware prototypes.

In continuous wave operation, the laser operates between 200 and 575 W, but peak output powers up to 3500 W can be achieved when it is operated in a pulsed mode at a very low pulse rate and with short pulse duration. In pulsed operation, the pulse rate can be varied from 1 Hz to 2500 Hz and pulse durations can be controlled over a range from 100 μs to 10 s.

The laser operates at a wavelength of 10.6 μm, which is in the invisible part of the spectrum. The application of the laser therefore requires special attention to operator safety aspects.

The useful feature of the laser is that the laser beam can be focussed onto a very small area of pin point dimensions above, on or below the surface to be worked. This results in very high, controlled energy concentration that either heats or vaporises the material being worked.

Some brief discussion of the features and applications of the laser which are being evaluated follows:

Welding

The main advantages of laser welding stem from the minute beam diameter and its high, localised energy. It can be focussed onto a minute spot on the work-piece to provide a minimal, but adequate, heat to fuse two surfaces in a welding process. Distortion of the material is thereby reduced, and the ensuing heat-affected zone is minimised. The result is often a stronger weld than that obtainable with conventional methods.

Cutting
Laser cutting offers several advantages over mechanical and other thermal methods, among them being an extremely narrow cut (about 0.1 mm), yielding the ability to produce narrow slots and to cut closely spaced patterns. As the beam vaporises the material, it is carried away from the work piece by the gas stream from the cutting nozzle, producing a clean finish that does not, in most cases, require further working.

Drilling
As the laser is a non-contact process, there is no wear factor or risk of breakage or slippage of the work piece. The drilling of very hard materials, such as ceramics and tool steels, is a simple operation. The drilling of holes in irregular or curved surfaces and at any angle to the surface, which would be virtually impossible by conventional drilling methods, is readily achieved.

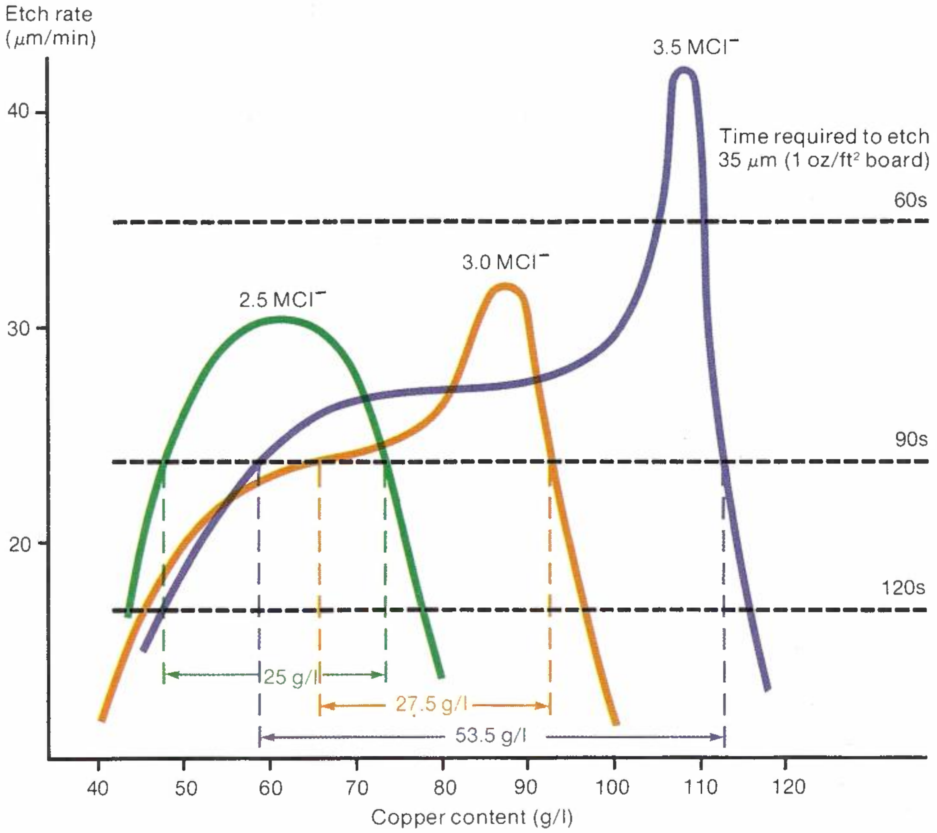
Heat Treatment
The ability to directly focus the beam onto the actual areas to be specially hardened, while leaving adjacent areas untreated, is an important feature. With localised and controllable heating, there is no surface distortion, alleviating the visual need for grinding to final tolerance after heat treatment.

To add to the flexibility of the ultimate facility, the laser is fitted with an x-y numerically-controlled table. This will simplify the task of producing replicas or slight variations of original prototypes and reduce the duration of such tasks to a fraction of the time taken with conventional manually-operated tables.

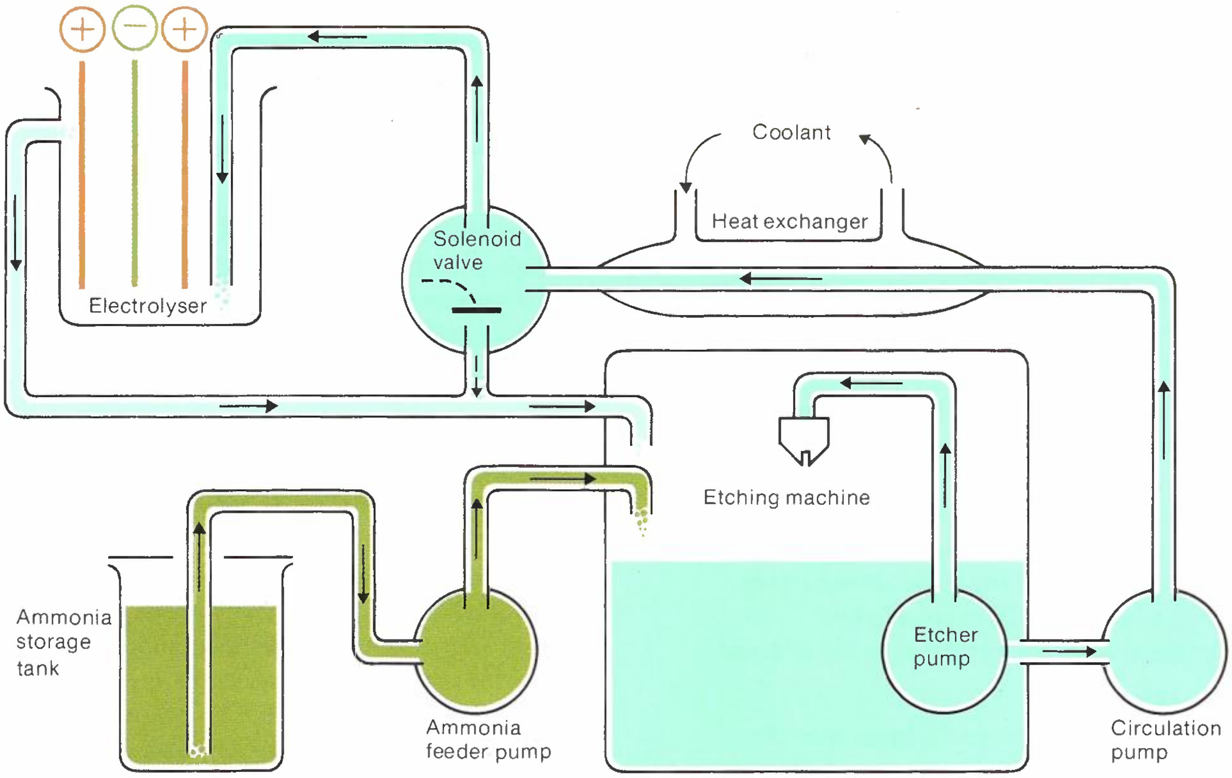
The introduction of the laser will enable studies to be made of such topics as cutting, drilling and machining ceramics and deep hole drilling of very hard materials.

Regeneration of Etching Solution

In the Laboratories printed wiring board production facility, as elsewhere, alkaline cupric chloride solution is at present the most popular etchant for printed boards because of its high retention of copper, high etch rate, low cost and its ability to re-oxidise cuprous ion by air. However, once it is saturated by copper, there is no economical method of regeneration by chemical or physical means. The solution must be discarded and replaced by fresh etchant. The Laboratories have therefore studied the process of etchant regeneration and have devised a method



Graphical illustration showing dependence of etch rate on copper content of etchant



Schematic of closed loop electrolytic regeneration system

which promises to be both economical and practicable.

Various economic methods of regeneration are known and applied to other types of etchants, but such regeneration is never complete and regular adjustments are necessary. Electrolytic regeneration is no exception as 100% anodic efficiency cannot be achieved and oxidising agent must be added regularly to maintain the desired equilibrium.

In electrolytic regeneration of alkaline cupric chloride etchant, anode efficiency is not critical, as the ammonia complex is readily oxidisable by air. The electrolysis of this etching solution is a complete reversal of the etching reaction, resulting in full reconstitution of the original formulation and removal of excess copper in the form of high purity metal. The only additions required are those to balance losses due to evaporation and dragout.

When electrolytic regeneration is performed in a "closed loop" arrangement encompassing the etching machine, the etching solution can be maintained at an optimum composition at all times, resulting in a continuous peak etch rate. To achieve such operation, the copper concentration must be monitored continuously and reliably, as it is the fundamental sensing operation in the automatic control of the regeneration process.

In the Laboratories' development, suitable monitoring of the copper concentration in the etching solution is achieved by narrow-band spectrophotometry, adjusted to the extremely high optical absorption of the etching solution. The photometric signal from the monitor, apart from providing a direct readout of the copper concentration, controls the electrolytic regeneration process so that the copper concentration is maintained within a preset optimum range. The same signal also controls periodical ammonia additions.

Electrolytic regeneration of alkaline cupric chloride etchant, on a batch basis, has been operating in the Laboratories for several years. During this period, no fresh etching solution has been required. A fully automatic "closed loop" system is now being developed and its design is based on the experience gained from the batch operation. This system, apart from raising the maximum throughput of the etching machine by over 100%, also saves the time and cost of maintenance, eliminates the need for etchant replacement, and recovers all copper in metallic form while upgrading the quality and uniformity of printed boards.

Failure of Polyethylene Insulation at Telephone Cable Conductor Joints

In 1974, the first of numerous examples of a particular type of fault in joints in plastics-insulated cable was submitted to the Research Laboratories for examination. Attention had been drawn to the joint by an electrical fault, and inspection revealed embrittlement of the insulation and extensive cracking which had exposed the copper conductors. Some colours of insulation had been affected worse than others. Chemical analysis showed that little, if any, active antioxidant remained in the insulation. The joint had been housed in an above-ground jointing post and all subsequent examples received have been from such enclosures or from untailed boxes mounted on poles. No cracked insulation has been observed in joints installed underground.

Similar degradation of polyethylene wire insulation had been experienced in the USA in the late 1960s. Embrittlement of insulation was occurring in joints housed in above-ground pedestals within 6 to 10 years after installation. The cause was said to be depletion of antioxidant by copper-catalysed air oxidation occurring at the elevated temperatures existing within the enclosures. Claims were made that the oxidation process was accelerated by the presence of titanium dioxide pigment in the polymer and that antioxidant was being removed by condensed water. The corrective measures taken included an increase in the density of the polyethylene and an improvement in the quality of the polymer stabilising system, mainly by the inclusion of a metal deactivator. However, the mechanism causing premature depletion of the antioxidant does not appear to have been positively determined or eliminated.

In the Telecom Australia experience, studies suggest that insulation cracking is most prevalent in cables installed between 1967 and 1975, and an intensive study is currently under way to find the initiating cause or causes which apply in the Australian situation. The present assumptions are that premature oxidation is not due to an inherent failing of the base polyethylene polymer or due to impurities in it, but that the oxidation is more likely the end result of a reaction catalysed by a constituent in the colour masterbatch added to the base material, and is accelerated by the high temperature conditions which occur in above-ground jointing enclosures. A more simple explanation may be that the amount of antioxidant included to protect the polymer is inadequate in adverse environments. The temperature inside untailed boxes and above-ground jointing posts is being monitored continuously on-site at the Research Laboratories in Melbourne. Peak temperatures in the 50-60° C range have been found to be a common occurrence on days with a maximum ambient shade temperature of 37-39° C.

Anti-Static Packaging for Semiconductor Devices

Some solid state devices and components, including MOS and bipolar microcircuits, are very prone to damage by static electricity discharge. They are especially at risk during transport and handling. Persons walking on carpet, sliding out of chairs or wearing synthetic underwear can build up very high body potentials which can subsequently be discharged through the component.

To protect susceptible components and printed circuit board assemblies during transport, conductive packaging is used to minimise charge build-up. The protection can be provided by aluminium foil or conductive plastics foam or film in sheet or bag form.

Two general methods are used to increase the conductivity of the plastics materials. Either a conductive additive, usually carbon black, is finely dispersed at high concentration throughout the material, or the plastics composition is modified so that the material attracts and retains a thin film of moisture on its surface.

Various proprietary materials have been evaluated in the Laboratories by measuring their resistivity and the time taken for a 5 kV charge on them to decay. The carbon-filled materials were found to be the more conductive (with typical surface resistivity under 1 MΩ and decay time 1 to 40 μs) than the surface moisture type (10 000 MΩ, 2 s). By comparison, untreated plastics have surface resistivities greater than 100 TΩ and decay times of at least several minutes.

Materials of the surface moisture type were also found to be affected by humidity. Most were about one order of magnitude more resistive at 30% RH than at 70% RH, but their resistivity did not increase significantly after accelerated aging. The carbon-filled material was unaffected by humidity or accelerated aging. There are reports, however, that component leads embedded for long periods in carbon-filled foams have corroded due to galvanic action. This latter aspect has yet to be investigated.

Insulation Displacement Connection Systems

In present Telecom Australia practice, cables are terminated in customers' buildings on connection blocks by using a twist and solder technique. However, solderless connection systems now available require only a simple hand tool to force unstripped wire into slots in flat metallic terminals. The edges of the slot slice through the plastic insulation to make electrical connection with the conductor. Excess wire beyond the joint is trimmed off by the tool as the joint is made. Such systems reduce the time to terminate cables or modify connections and occupy less space than the existing connection blocks. Some of the connection systems available also incorporate contacts which permit insertion of a plug for temporary interconnection or test purposes.

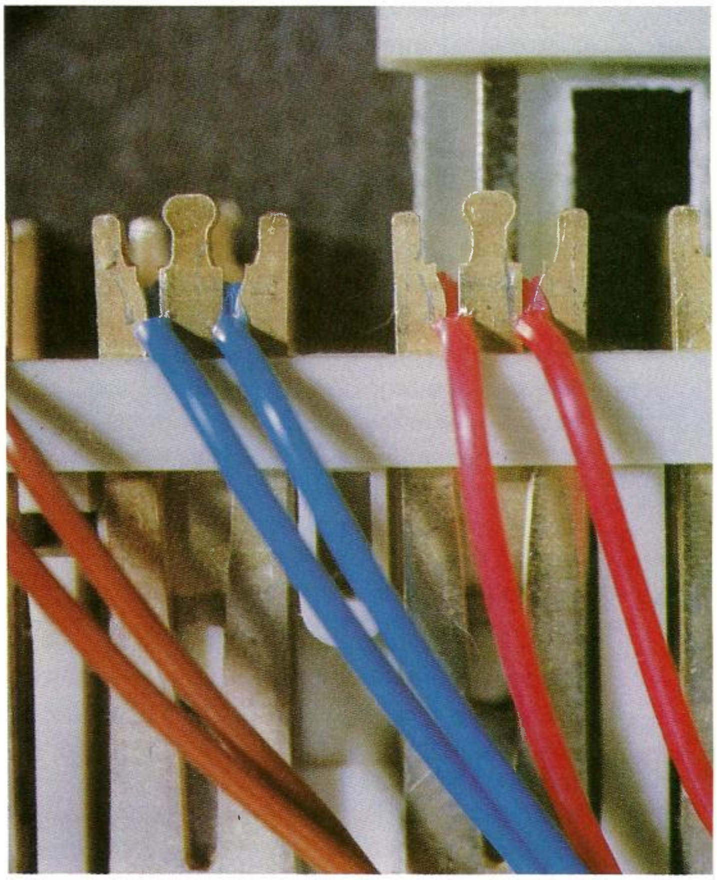
Seven of these systems have been evaluated by the Research Laboratories to determine their reliability. The general suitability of all materials used in each system for various applications was assessed and their ability to withstand the expected range of usage conditions was determined by appropriate physical, chemical and mechanical tests. Their expected aging behaviour was also investigated by accelerated environmental tests. High temperature, cyclic temperature variation, high humidity and industrial atmosphere exposure were the accelerated stress factors used. Contact resistance and insulation resistance measurements, made by microprocessor-controlled data logging equipment, were used to monitor the performance of the system during the tests.

Consequently, recommendations regarding the relative merits of the various systems were forwarded to Engineering Department.

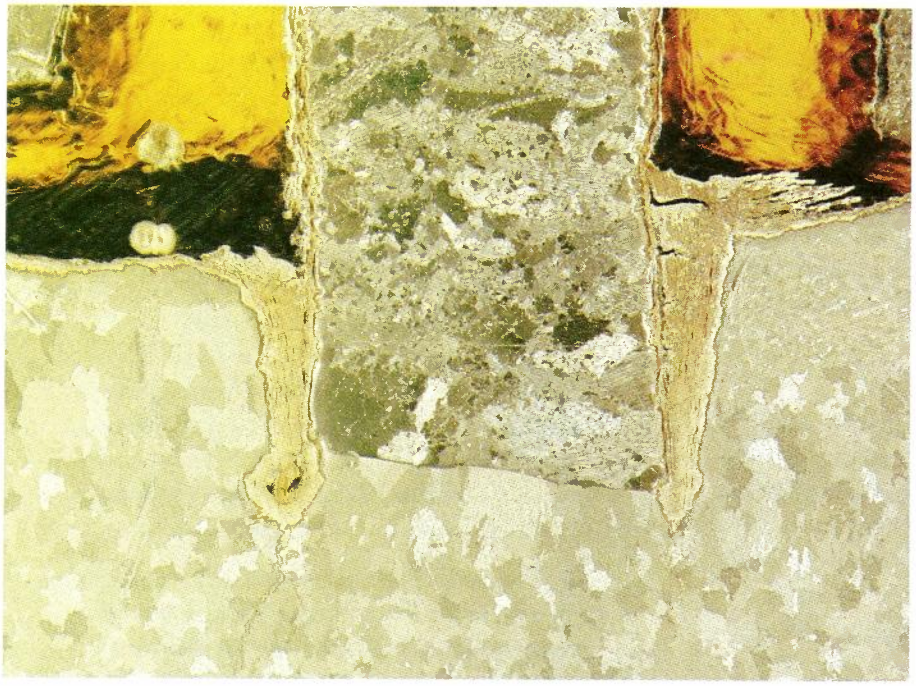
Failure of Stationary Lead-Acid Batteries

The Research Laboratories and the Buildings Sub-division at Headquarters and several State Administrations recently co-operated to determine the cause of unexpected failures of stationary lead-acid batteries in telephone exchanges. At the same time, the condition of similar batteries still in use was evaluated. In this application, the batteries are used on float service to provide no-break emergency power for the telephone exchanges.

The condition of the batteries, often not apparent from a visual inspection, was determined from the results of capacity tests and measurements of plate potential behaviour in controlled discharge tests. Acid density measurements and float voltage readings were also taken. Any cells with



A typical solderless connection system



Yellow-brown area shows corrosion due to differences in metal composition at busbar-grid interface

significantly atypical values or visible signs of corrosion were removed from service for a thorough examination.

Many of the cells tested had very low capacities. One of the contributing factors was thought to be the practice of maintaining cells at full capacity by floating the exchange battery at 52.08 V on the assumption that this voltage is equally divided amongst the 24 cells to give 2.17 V/cell. In time however, variations develop between cells. If this is not corrected by a boost charge, some cells can float at too low a potential, lose capacity and effectively limit the total capacity of the battery to that of its weakest cell. These faulty cells can even be overlooked at the routine 2-yearly test discharge, if the boost charge given just prior to the discharge restores the capacity lost during the preceding period. As a consequence, the final discharge measurements often do not distinguish between faulty and good cells, and the battery appears to be quite acceptable.

Corrosion was found to be a major factor contributing to the failure of many cells. Some corrosion was attributed to the low voltages at which some cells can float, as discussed above. This condition tends to reduce the continuity, and hence the protection provided by, the coherent lead dioxide layer on the positive grid, post and busbar surfaces. Other corrosion had occurred because antimonial lead grids had been inadvertently used in some cells for the positive busbars. The galvanic potential formed between the antimonial lead busbar and the pure lead grids promoted corrosion. The attack was concentrated on the under-surface of the busbars, in cavities produced along the grid/busbar interface by an unsatisfactory fabricating technique. In many cases, the severity of corrosion had caused the separation of the busbar from the grid assembly.

A similar form of corrosion was observed on some negative plate assemblies where pure lead busbars had been used with antimonial lead grids. Severe intergranular attack along the welded grid/busbar interfaces, again initiating in deep cavities, had also caused complete separation of the grids from the busbars.

The positioning of electrolyte level markers on some of the older cells allowed the busbars to remain exposed above the electrolyte. The resultant three phase junction (liquid, gas, metal) intensified the corrosion between the grid and busbar on both the negative and positive plate assemblies. In extreme cases, corrosion in this area could cause arcing and in consequence, possibly lead to ignition of explosive gas mixtures inside the cells.

Overall, the investigation has led to a revision of battery maintenance procedures, which should improve the reliability of stationary batteries on float operation.

Plastics Fuel Tanks for Motor Vehicles

The introduction of plastics fuel tanks in motor vehicles occurred in Europe many years ago and they have been standard equipment in one German car since 1973. Advantages claimed for the use of a thermoplastic moulding material like polyethylene over metal in this application are freedom in design, economy, corrosion resistance and safety.

The suitability of plastics fuel tanks for motor vehicles in Australia was first questioned in 1979 during an Engineering Department investigation into motor vehicles offered on tender for Telecom's use. Concern about such tanks arose from the known variation in performance of plastics in Europe compared to Australia because of the harsher environmental conditions in Australia, and also from the knowledge that the Commonwealth Fire Board had, at that time, recommended against the purchase of vehicles fitted with plastics fuel tanks for Government use. Consequently, an examination was conducted in the Research Laboratories on the plastics compound used and its long term performance as a moulded tank.

The Laboratories' tests indicated that the specific type of plastics compound had several unsatisfactory characteristics for use under Australian climatic conditions. These included inadequate stabilisation against thermal oxidative degradation and solar radiation, and the tendency of the polymer to change structure at a molecular level during processing. This made processing more difficult and hence increased the stress level in a moulding produced in an already highly stress-inducing process.

It was shown that the compound could be improved to an acceptable level by the incorporation of specific additives. In the first instance, this has been done by the moulder, via the masterbatch technique, but the best long term solution is seen to be the incorporation of the additives into the compound at the time of its manufacture.

Location and Tracking of Lightning Strikes

The conventional method of specifying thunderstorm activity (keraunic level) does not take into account many of the lightning and thunderstorm parameters necessary to achieve effective lightning protection for customers, telecommunications plant and equipment.

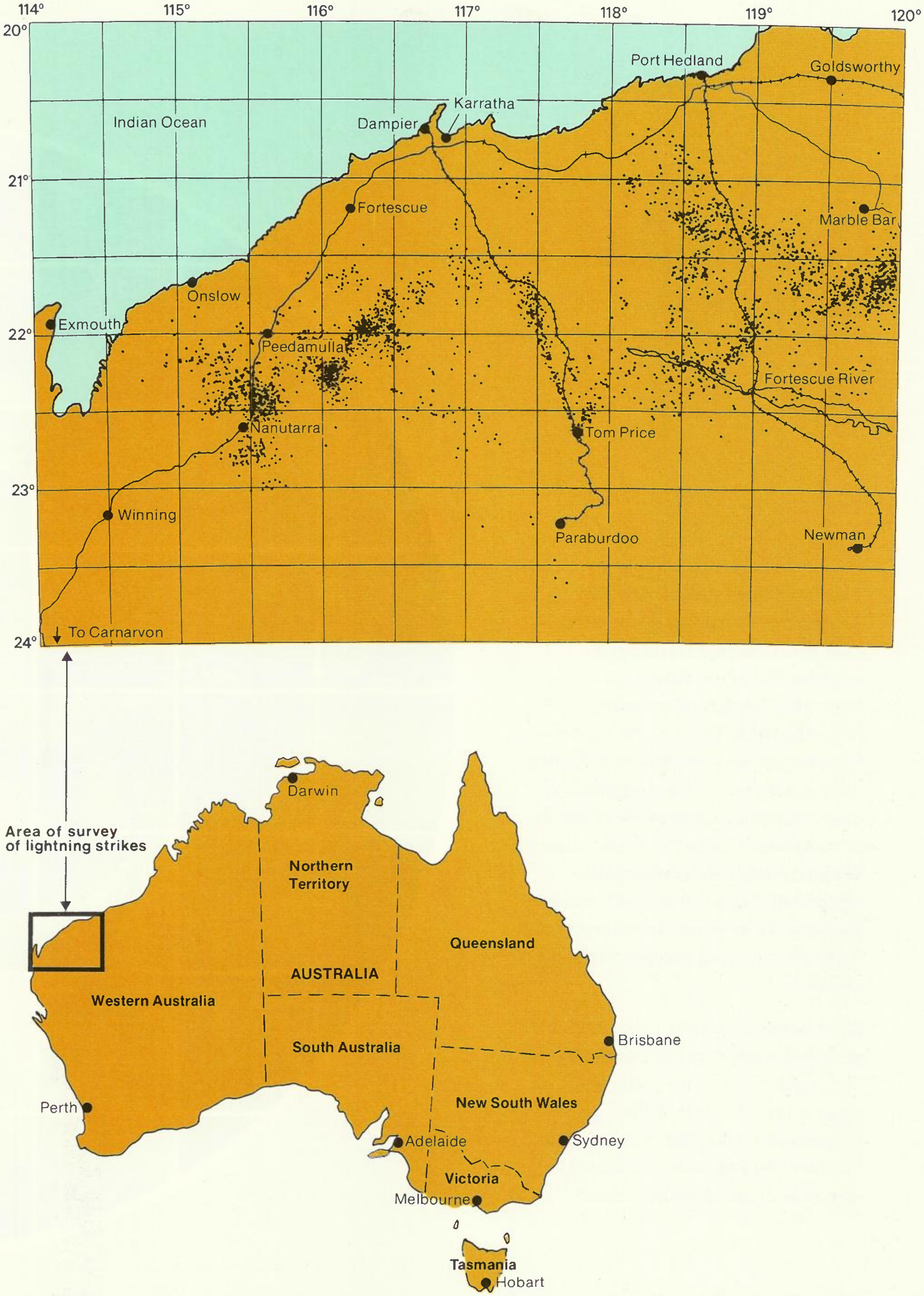
In the past, Telecom, and other authorities concerned with thunderstorms and their effects, collected the data with a large variety of recording instruments which had to be installed in numerous locations in the areas under surveillance. Much of this information can now be collected with centralised monitoring systems which are capable of surveying thunderstorm activity over areas of several hundred thousand square kilometres.

The Research Laboratories recently installed such a system in the Hammersley Ranges area of Western Australia to monitor the lightning activity over the whole length of the Port Hedland to Mount Newman coaxial cable and a 600 km long section of the Port Hedland to Carnarvon coaxial cable.

The occurrence of a strike is detected by directional antennas located at Dampier and Tom Price. These respond to the electromagnetic radiation and electric field changes associated with the strike. The data from the antennas is analysed by a microcomputer controlled processor.

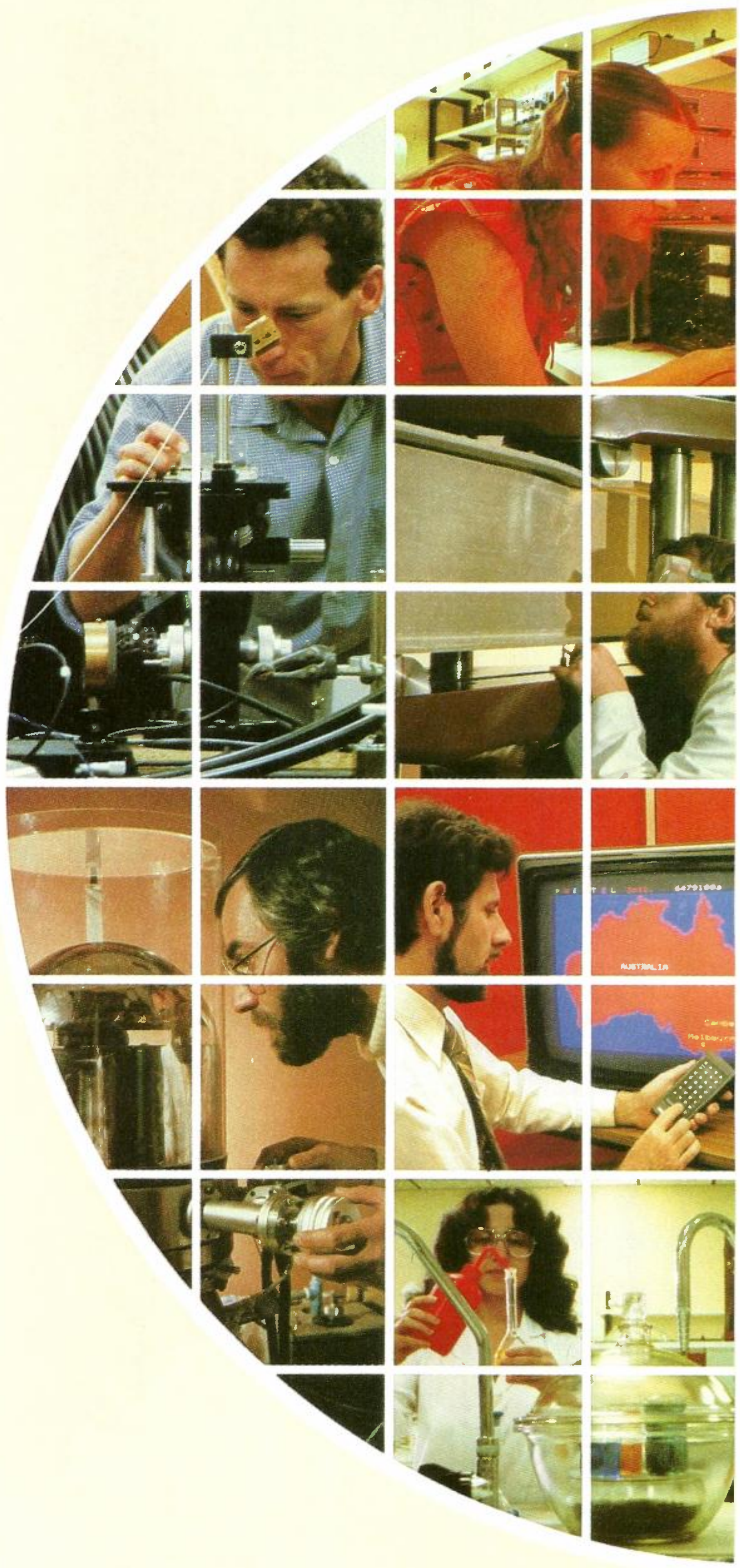
The system is designed to discriminate between inter and intra-cloud lightning discharges and lightning discharges to ground. It is claimed to detect 90% or more of the lightning strikes to ground within a preselected radius. The data recorded by the system includes the location of strikes to ground, the number of strokes in the strike, the time intervals between strokes and strikes, the relative magnitude of the strikes, and the time and date of their occurrence.

In its present location, the system is surveying an area of approximately 250 000 square kilometres. Since its installation just prior to the most active period of the 1980 local thunderstorm season, the system has provided a considerable amount of data. This data has been of great value in explaining some of the peculiar distributions of faults in the coaxial cables laid in the area and in assessing the effectiveness of the protective measures recently adopted, as well as contributing to the general understanding of thunderstorm activity in the area. The system will also provide data which will be of general assistance in improving and rationalising future lightning protection policies and practices.



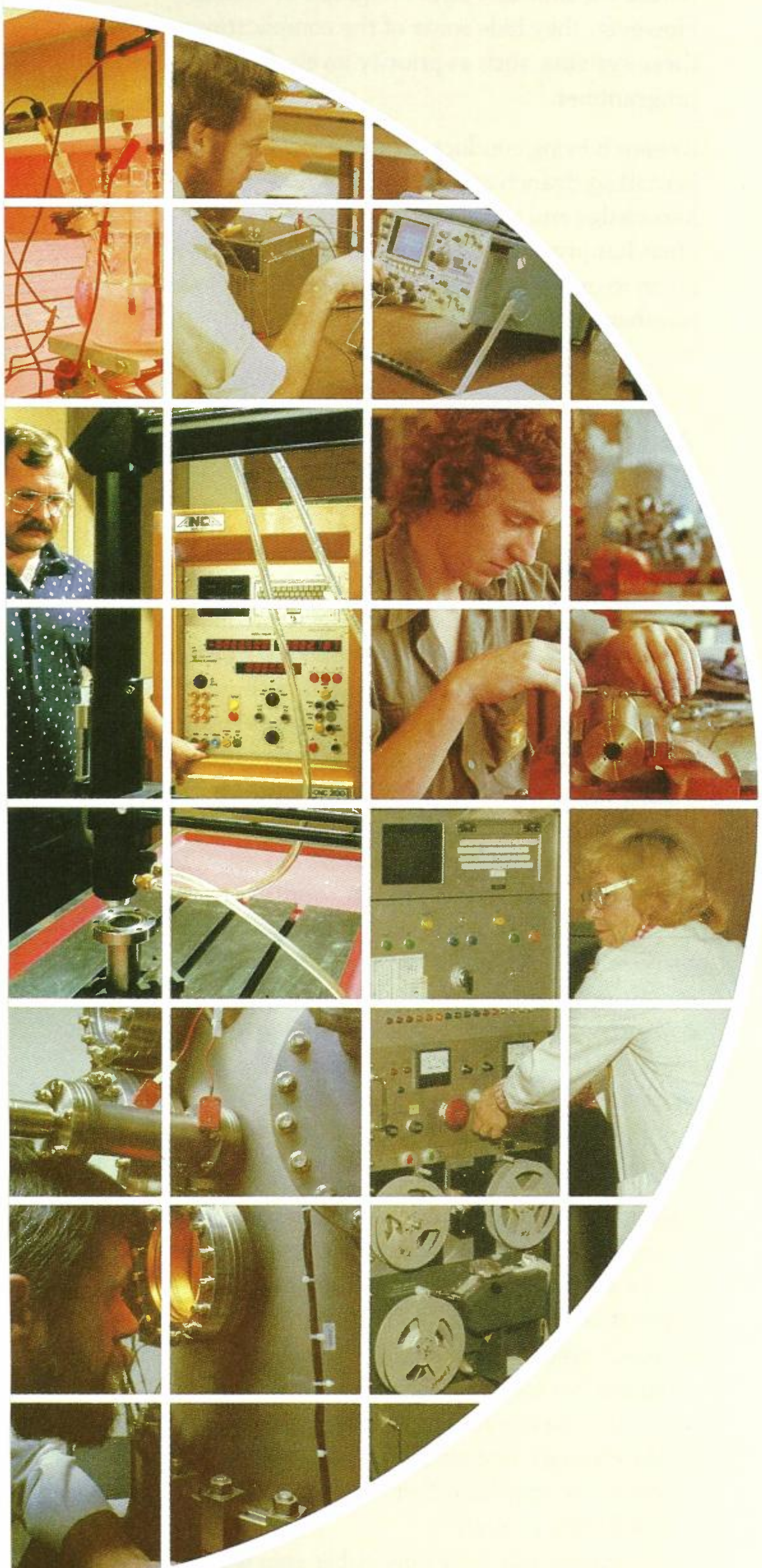
Dots superimposed on map of survey area indicated lightning strikes to ground over a test period of 24 hours

Consultative Activities



The Laboratories are continually developing expertise and laboratory facilities in the engineering and scientific disciplines which are somewhat special and uniquely concentrated in Telecom. As can be seen from the earlier sections of this Review, these are necessary for the pursuit of major technical and scientific research projects which cover the whole range of advanced materials, components, equipment and systems which make up the network by which Telecom provides Australia's internal telecommunications services.

It can be expected that, in addition to performing larger project-scale research investigations in an on-going work programme, the staff of the Laboratories will often be called upon by other Departments of Telecom to give ad hoc consultant advice and



assistance on problems which arise in their day-to-day activities and which can be quickly and effectively solved by such calls.

The following items provide examples of such consultancy calls made on the Laboratories during the past year. They range from assistance in the design and specification of specialised equipment; to assessment of the reliability of materials and components; to evaluations of the adoption of particular process technologies in equipment manufacture; or to assessments of the likely causes and effects of problems arising in field operations through component or equipment failures, through the adoption of particular operational practices, or as the result of accidents or equipment malfunctions.

These smaller scale tasks undertaken by the Laboratories do not attract the same "prestige" as the larger-scale R&D projects, in terms of their effect on the Laboratories' contributions to major corporate decisions. Nevertheless, they are regarded as an essential part of the Laboratories' role to provide cost-effective and speedy assistance, where possible, to other Departments of Telecom – to avoid or solve minor, but often costly, problems arising in the operation of a large telecommunications network.

Telemedicine

Although one of the oldest sciences, medicine is continuously advancing rapidly on many fronts, but nevertheless is lagging in its use of modern telecommunication facilities.

In fact, the use of medical communication facilities varies widely from region to region and depends to a great extent on the practitioners' own awareness of available equipment.

With this in mind, discussions have been conducted with the Victorian Academy for General Practice, and two particular communications facilities have been singled out for further evaluation by the Academy. These facilities are aimed primarily at the transmission of images over the telephone line – namely by facsimile and by slow scan television.

Slow Scan Television (SSTV) has particular application in its ability to augment a telephone conference, for example, in a country regional telephone conference. It is also of use in a direct consultation situation where X-rays, photographs or even the patient can be seen directly – in close up if necessary. Experiments, centred on a Victorian country hospital, are under consideration to further identify the potential applications of SSTV.

Facsimile is able to meet a slightly different need. It offers higher resolution of picture detail than SSTV and is suited to the immediate transfer of urgent written information – prescriptions, drug information and advice, patient records and the like. A trial facsimile network is under consideration in an outer metropolitan area to support a medical consultancy service to schools.

Software Specification and Design for SPC Switching Systems

The major problem in the specification and design of software for SPC switching systems is to cope effectively with the large amount of detail and interaction in the programs required. Although many methodologies have been proposed, none has yet solved this problem completely. In addition, the nature of the processor's method of operation creates special problems in the programming task. The processors operate on a number of levels of priority, suspending a low priority task when tasks of a higher priority are required to be performed, and returning down the priority levels as tasks are completed. Special high level languages with an English-like syntax and special facilities, known as concurrent programming constructs, have been developed to reduce the time and effort required in coding. However, they hide some of the complications of these systems, such as priority levels, from the programmer.

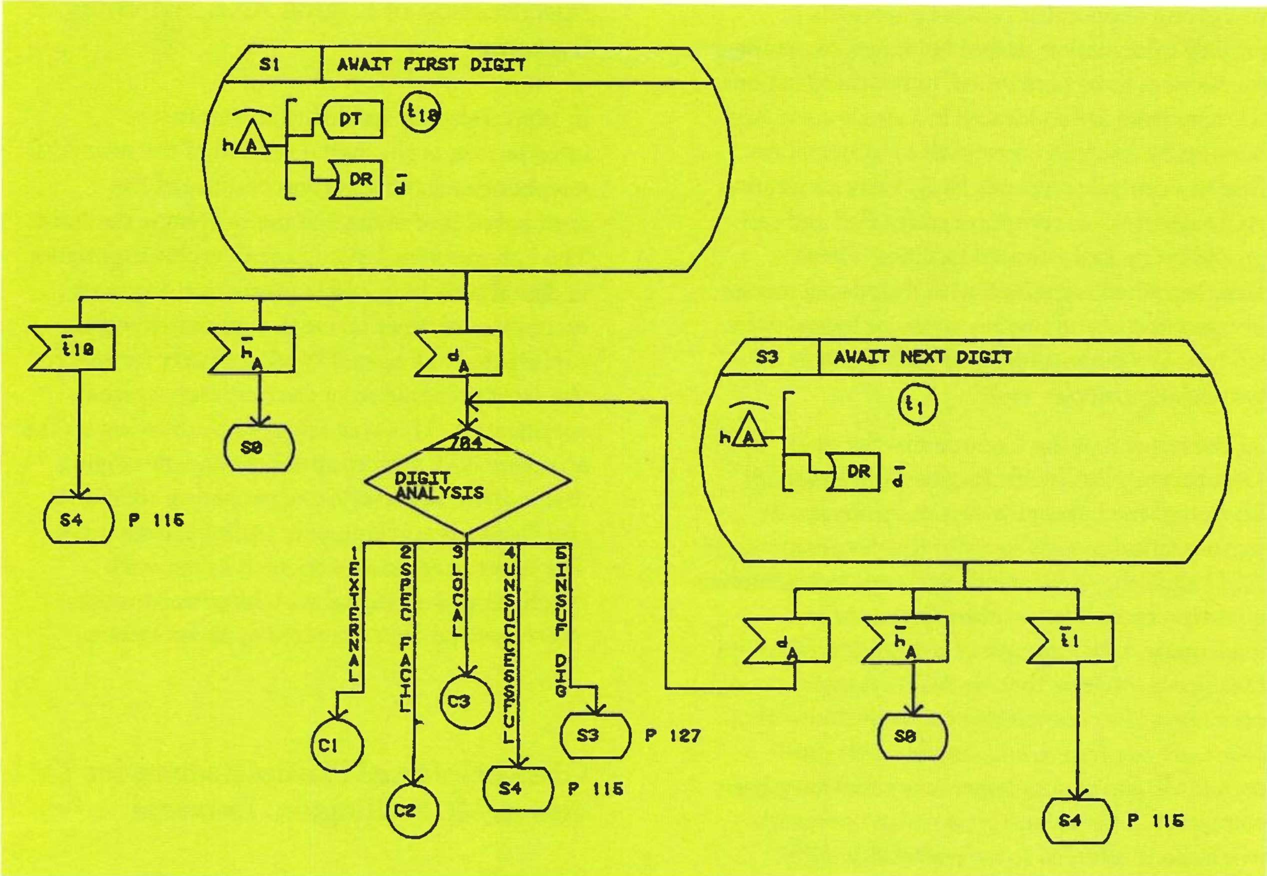
Research being conducted by the Switching and Signalling Branch and aimed at developing knowledge and improved techniques in these areas has provided a basis for consultative advice given to operating areas of Telecom Australia on a number of occasions.

Application of the Specification and Description Language (SDL)

In the current rapidly changing technological environment, where great emphasis is being placed on satisfying customer requirements, it is advantageous to be able to describe the functions which must be performed in a telecommunications system both from the customer's viewpoint and independently of any particular technology. SDL is a graphical language, standardised by the CCITT, which can be used to describe telecommunication systems in just this way. The Research Laboratories have contributed to the development of SDL since 1973, and continue to provide expert consultative advice on functional specification techniques, including the use of computer-aided specification techniques, to the rest of Telecom. An example of part of an SDL diagram, produced by the Laboratories' interactive computer graphics system (CADDIE), is shown in the adjoining illustration.

Over the past seven years, the Research Laboratories have provided consultant assistance on the use of the SDL in a wide range of applications including:

- specification of new kinds of telephone subscriber facilities (for example, the call-waiting service for local exchanges);
- the efficient, fast testing of subscriber's lines in the Subscriber Line Test Access Network (SULTAN) project;
- the specification of a new public coin telephone;
- the specification of how different parts of a network carrying data must "talk" to each other, in the application of CCITT's X.21 and X.25 protocols; and



Part of SDL diagram for the specification of call handling conditions in a local exchange

- the production of higher level, more readily intelligible system documentation for the computer controlled trunk exchanges in the Australian telephone network, as an aid to the field operation and maintenance of these exchanges.

As well as providing consultative advice, the Laboratories have also provided training courses in the use of the SDL, the most recent being a 2-day course held during November 1980.

Teletraffic Engineering Course

The Seventh Advanced Traffic Engineering Course was held in July 1980. It was attended by 30 Engineers, 25 from Telecom Australia, one from OTC and four from overseas telephone administrations. Of the Telecom participants, five were from the Switching and Signalling Branch of the Laboratories.

These two-week, live-in, intensive training courses have been held at about two-year intervals since the inaugural course was launched in 1967. They were initiated by the Engineering Planning Branch at Headquarters to give specialised advanced training in teletraffic engineering to Headquarters and States planning engineers. The courses proved to be very effective in Telecom and soon became known to other telecommunications administrations, which now send their engineers to the courses.

The teletraffic course has now been incorporated in Telecom's Engineer Development Programme, administered by the Engineering Training Section. Three of the four lecturing staff were drawn from the Traffic Engineering Research Section of the Laboratories.

Dimensioning Aspects of Automatic Call Distribution Systems

Automatic Call Distibution systems (ACDs) are being introduced by many business organisations to provide a more streamlined service to their customers. Such systems provide customer access to a group of operators whose purpose is to provide information, accept bookings, or arrange for services to be performed. In typical situations, the operators are co-located in a single room and have access via VDU terminals to information held in a central computer bank. New generation ACD systems are computer controlled and can provide very sophisticated facilities. These facilities, when combined with the special modes of operation of the service, conspire to make the analysis and dimensioning of such systems a particularly complex task.

At the request of the Commercial Services Department, the Traffic Engineering Research Section of the Laboratories is developing new mathematical models to aid in the dimensioning of ACD and other delay mode systems, as traditional queueing models have often proven to be inadequate. One example of a deviation from the traditional model is that, in ACD systems, operators, after completing conversation with a caller, are not free to answer new calls until certain clerical or supplementary tasks have been completed. This second phase in an operator's workload is referred to as "post-call activity".

In order to dimension systems where this activity takes place, it has been necessary to develop a new mathematical model to represent them and to adapt it for dimensioning calculations.

Technical Specification of PCM Signalling Methods

With the expected heavy use of PCM transmission and digital switching in the voice network, a need has arisen for more economical PCM line signalling methods. Following examination of technical alternatives within the Research Laboratories, Telecom has adopted a CCITT standard known as the R2D line signalling scheme. This will form the basis of a new Australian standard, called T6 line signalling.

A characteristic use of T6 signalling will be on PCM junctions at AXE exchanges, with conversion to loop-disconnect signalling at ARE exchanges as necessary. Research Laboratories' experience in PCM signalling and in the development of the CCITT Specification and Description Language (SDL) has been used in definition of the T6 system. It will be the first Australian line signalling system to be specified in this new language.

Specification of Digital AXE Switching Systems

In 1980, Telecom decided to accelerate the introduction of the digital version of the new AXE telephone switching system because of the anticipated cost savings in the telephone network. The Laboratories, lending considerable experience in digital switching and transmission acquired through experimental work over many years, participated in a special Working Party formed for the rapid preparation of the necessary system specification. This was achieved by drawing on the analogue AXE system specifications, modifying them where necessary, and preparing additional specifications applying only to digital exchanges. The latter covered aspects such as network synchronisation, digital switching/transmission interfaces and digital switching performance.

Glass Reinforced Plastics Radome for TV Tower, Mt. Wellington, Tasmania

Prior to the construction of a radome to prevent snow and ice damage to both the TV and FM radiators on Mt. Wellington tower outside Hobart, preliminary advice was sought from the Research Laboratories on the properties of materials suitable for this application. Subsequently, assistance was also given with quality assurance tests on the materials chosen for construction and with the testing of prototype panels and structural support members.

The shell of the radome was built from panels of polyurethane foam sandwiched between two glass reinforced polyester skins. Each batch of resin used for the panels was sampled and its cure characteristics determined to ensure that the cured resin had optimum properties. The panels were fabricated by a hand lay-up technique. In order to monitor that they were produced to a consistent quality, a small sample of the glass reinforced skin was produced concurrently with each panel and its physical properties measured in the Laboratories.

The completed radome is required to withstand wind gusts up to 226 km/h, which would impose a pressure on the radome shell of 2.4 kPa and a suction of 5.75 kPa. To check the expected performance of the radome under these conditions, a full size prototype panel was mounted on a specially constructed frame and subjected to these pressures over a temperature

Bending/compression testing of pultruded beam of type used in radome support structure

range of- 5° to +31° C. The deflection of the panel at various points was measured and found to be within the required limits.

The support structure for the radome shell is comprised of a number of pultruded beams with U-channel, right angle and I cross-sections. (The term "pultrusion" is the name given to a continuous process where reinforcement, typically glass rovings, is impregnated with resin, usually polyester, and pulled through a heated die to produce the required profile).

The I-beam used was of special interest. It has cross sectional dimensions of 305 x 152 x 12.7 mm and it was produced by pultrusion as a special mill-run in the USA. It was the first time that such a large pultruded beam had been used by Telecom Australia.

The design of the support structure was based on manufacturer's data, but in the absence of previous field experience with pultruded beams, it was considered prudent to determine certain engineering properties by full-scale testing. Special jigs were constructed for use in a 60 tonne tension/compression testing machine. Bearing forces around bolt holes in the pultruded sections were determined and found to be well in excess of the values used in the design. Deflections of the I-beam under three-point bending were measured and, although they were found to be greater than the theoretical values calculated using manufacturer's data, the design requirements for the radome application were met.

Microsystem Development

During the year, the Laboratories continued to provide support to the many users of microprocessors throughout Telecom. To aid software development, further cross assemblers were provided on TACONET – Telecom's time sharing computer network. These were for microprocessors in the Telecom – preferred family and included one for a 16-bit microprocessor.

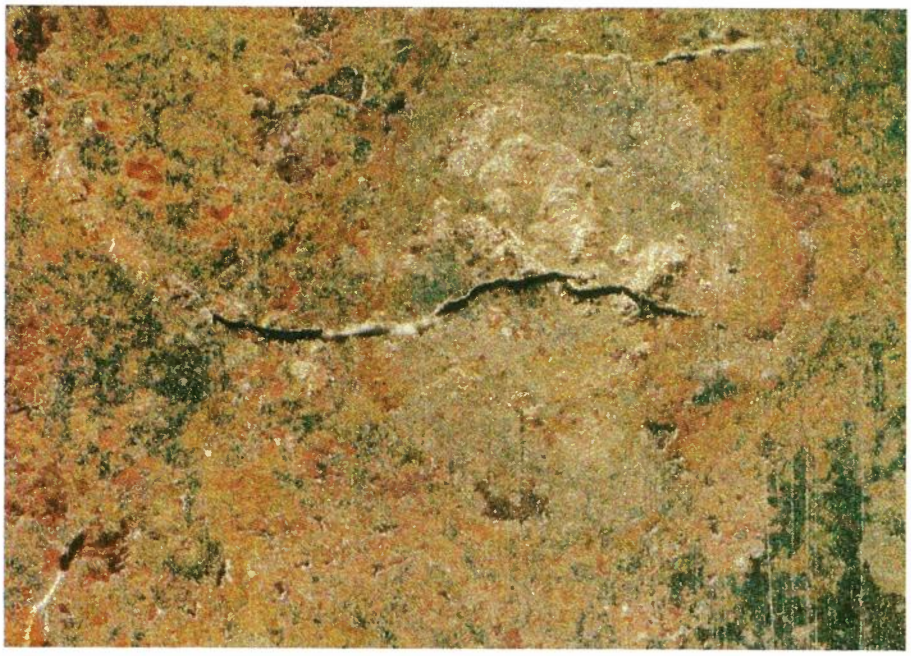
A program produced using the TACONET facilities must eventually be transferred to the target microprocessor. In the past, this has been done by first punching the program on paper tape, and then loading the tape into the microsystem. Downloading software has now been written by Laboratories' staff to allow direct transfer, via modems and a telephone line, of programs or data between TACONET and a number of different microsystems.

The range of microprocessor hardware and software available continues to increase rapidly. To fulfil their consultative role, the Laboratories kept a watching brief on this range and evaluated the products most likely to prove useful within Telecom. Those evaluated included both imported and locally produced hardware modules, monitor programs and operating systems. The results of these evaluations were reported to likely user areas of Telecom.

Stress Corrosion Cracking in Stainless Steel Bands

In a transmitter installation built at Carnarvon in Western Australia for Radio Australia, extensive use was made of stainless steel banding to attach the transmission line brackets to their support poles. The banding was wrapped twice around bracket and pole and fastened with a buckle. Because of the hot marine environment of the site, it was thought that the stainless steel could be affected by stress corrosion cracking.

Therefore, some years ago, the Laboratories conducted accelerated corrosion tests on the



Stress corrosion crack – magnified 30 times

banding and a slight loss of strength was found to occur. Although this was not of sufficient magnitude to stop the material being used, it was considered prudent to inspect bands from the actual installation at regular intervals.

Since then, a few bands have been removed yearly and examined for evidence of stress corrosion cracking. After three years, a number of fine cracks were noticed in corroded areas of the more highly stressed convex surfaces of the inner wraps of banding. Externally, the bands appeared to be in perfect condition, but between the two layers, moisture had been held by capilliary action and the build-up of salt concentration together with the high temperature environment had resulted in corrosion.

The Laboratories have advised the insertion of corrosion inhibiting tape between the wraps of the stainless steel bands. This will prevent a build up of salt and thereby avert a probable serious failure.

Study of Polymer Coatings on Optical Fibres

The strength of bare glass fibres can degrade very quickly after they are drawn, due to propagation of surface micro-cracks. These develop under the action of stress corrosion initiated by surface moisture and mechanical abrasion. It is common practice, therefore, to protect glass optical fibres with a primary coat of polymer immediately after drawing, by placing a coating station in tandem with the drawing line. A highly abrasive-resistant secondary coating, either close fitting or as a loose tube, is applied over the primary coat at a later stage to enable the fibres to withstand the handling of normal cabling procedures. Polymers have been chosen for both coatings because of their ease of application and availability.

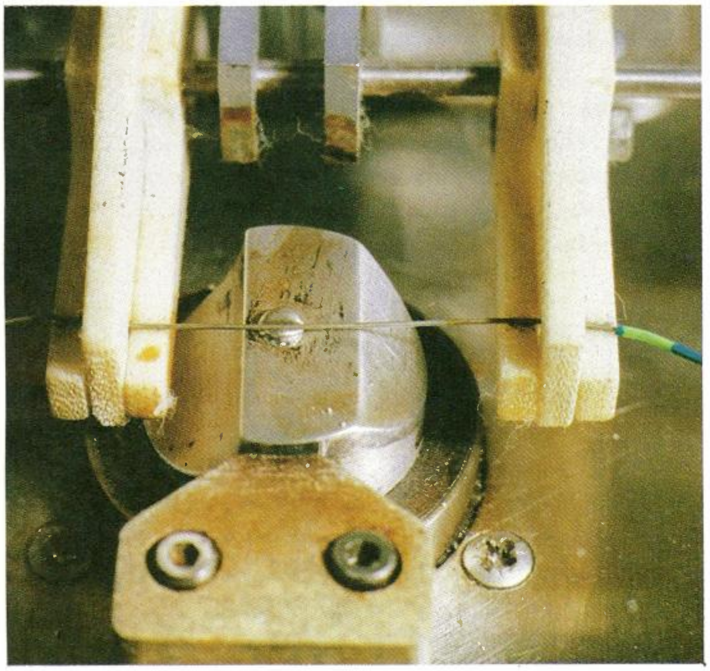
The coating and cabling processes, can degrade the optical performance of the fibres by causing micro-bends in them, which in turn cause leakage of light by out-scatter. This leakage can contribute considerably to the total attenuation loss of a cabled fibre. The problem is being overcome, wherever close fitting secondary coatings are used, by the application of a soft plastics material, usually silicone rubber, as the primary coat. It acts as a buffer which absorbs applied pressure and so prevents micro-bending of the fibre. Whilst these polymer coating systems may safeguard the transmission properties of newly coated fibres, little is known about the effect on transmission which occurs if the polymers' physical or morphological characteristics alter with time or in response to various physical and chemical stresses. Equipment has thus been developed in the Laboratories to measure transmission loss in short fibre lengths (1 to 10 m). Resolution of optical attenuation better than 0.1 dB/km on a 10 m length has been obtained. This equipment is being used to study the effects on coated fibre subjected to thermal aging water immersion, tension load, and compression load.

Solderability of Tin-Coated and Bare Copper Wires

Following some soldering difficulties in 1976 and 1977 with tin-coated copper conductors in telephone exchange cable, an extensive investigation has been conducted into the solderability of freshly stripped bare copper wires and tin coated wires from a number of cable manufacturers. Soldering problems can arise with tin-coated copper wires if the tin coating is thin. As a result of diffusion between the copper base metal and the tin coating, copper-tin intermetallic compounds are formed and these are difficult to solder.

Wires in new condition and others which had been stored for three years were tested for solderability. The results showed that naturally aged, freshly stripped, bare copper wire soldered readily, whereas some new tin-coated wires were unacceptably difficult to solder.

It was concluded that, provided insulation is stripped just prior to soldering, bare copper wire would be satisfactory for telephone exchange wiring. If wire must be stripped earlier, it needs to be coated with 5 μm of tin or 2.5 μm of solder to ensure long term solderability. A change from tin-coated to bare copper wire could save Telecom approximately $0.5M per annum.



Tin-coated copper wire unwet by the molten solder globule during solderability test

Sealing of Telephone Exchange Batteries

The lids and cases for stationary lead-acid batteries used in telephone exchanges are injection moulded from styrene-acrylonitrile (SAN) polymer and joined together with a solvent-based adhesive.

In plant applications, defects in the seal between the lid and case wall of batteries have been responsible for sulphuric acid leakages, which in turn have been associated with electric current leakages. Small fires have been caused by the flow of high currents across the case surfaces.

The Laboratories were therefore requested to evaluate the battery construction and the practices applying to their operation in plant situations. It was found that the faults were a result of the adhesives system chosen and the mode of adhesive applicaton. Numerous gas bubble voids were left in the completed seal, with the result that the bonded area between the lid and case was drastically reduced. In addition, the solvents associated with the adhesive system used were found to cause stress relief cracking in the moulded cases.

In lieu of solvent adhesion, hot air and ultrasonic welding techniques were suggested as alternative ways to overcome the problem.

Evaluation of Plastics Heat Exchanger Plates

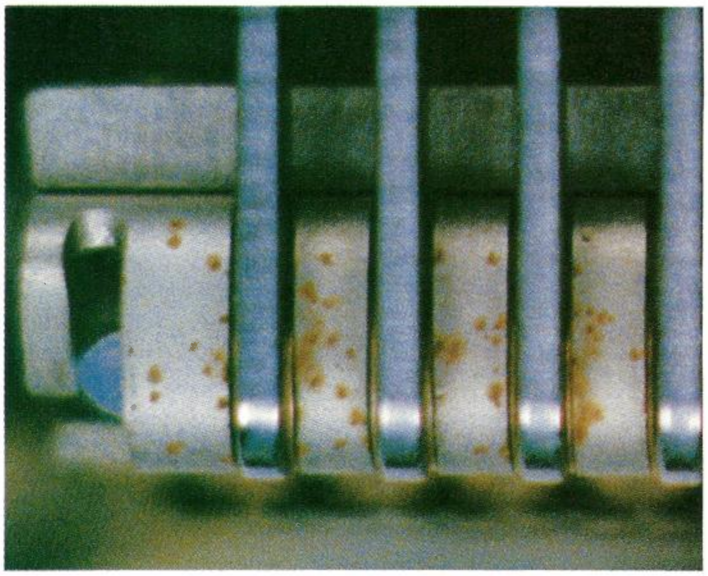
A new low energy evaporative air cooling system being investigated for use in Telecom buildings by the Buildings Sub-Division at Headquarters. It incorporates plastics plate heat exchangers which are subjected to constant wetting on one side and the passage of dry air on the other side when they are operated in the cooling mode.

As the effect of prolonged contact of these plates with air and water was not known, samples of very thin PVC sheet were obtained from Germany and Taiwan. The sheet was of the type being considered for use as the heat exchanger plates. The samples were analysed by Laboratories' staff for stabiliser and plasticiser types, and subjected to accelerated aging conditions in both air and water at elevated temperatures.

Only slight differences in chemical composition were found but evaluation of the aged samples indicated that the German material was superior to the Taiwanese. Polymer degradation, however, was evident in both materials after relatively short exposure periods, raising some doubt about their ability to withstand the environment in an evaporative air cooler for a prolonged period of time. The Buildings Sub-Division was advised of these conclusions.

Combustion Products Damage in PABX

A fire which recently occurred in a large Sydney office resulted in widespread damage to its private automatic branch exchange (PABX) and computer installations. The fire started in a room away from this equipment and there was only limited direct fire damage to it. However, a considerable amount of PVC sheathed and insulated cable was burnt and the highly corrosive combustion products were circulated to other rooms for some time by the building air conditioning system. When Research Laboratories' staff inspected the PABX soon after the fire, it was found that all external surfaces were covered with a layer of fine soot. All exposed metal surfaces were corroding and were expected to continue to corrode for some time because of galvanic action, absorbed hydrogen chloride and water contamination. This contamination could not be removed to the degree necessary to prevent corrosion continuing and to ensure the reliability of the PABX for the rest of its service life. Consequently, it was recommended that the PABX be replaced.



Continuing corrosion of a contaminated metal surface following a fire in a city office

Corrosion of Repeater Housings on Coaxial Cable Routes

The two most frequently used repeater housing materials are hot dip galvanised cast iron and mild steel which is cadmium plated after fabrication of the housing. The outside surface of the latter material is also further protected against corrosion by an oven-cured, coal tar-epoxy paint system. Both types of construction should give satisfactory service in non-aggressive or mildly aggressive underground exposures, but they both become severely corroded when immersed in heavily contaminated water. The protection of repeater housings located in manholes has therefore become the subject of Laboratories' studies.

The continuously changing water level in manholes accelerates the corrosion process. Galvanised surfaces without additional protection cannot be expected to withstand these conditions for very long. Oven-cured coal tar-epoxy is more resistant, but at pinholes or where the coating is chipped, the cadmium plating is consumed quickly, the paint loses its adhesion, and the corrosion process continues unhindered.

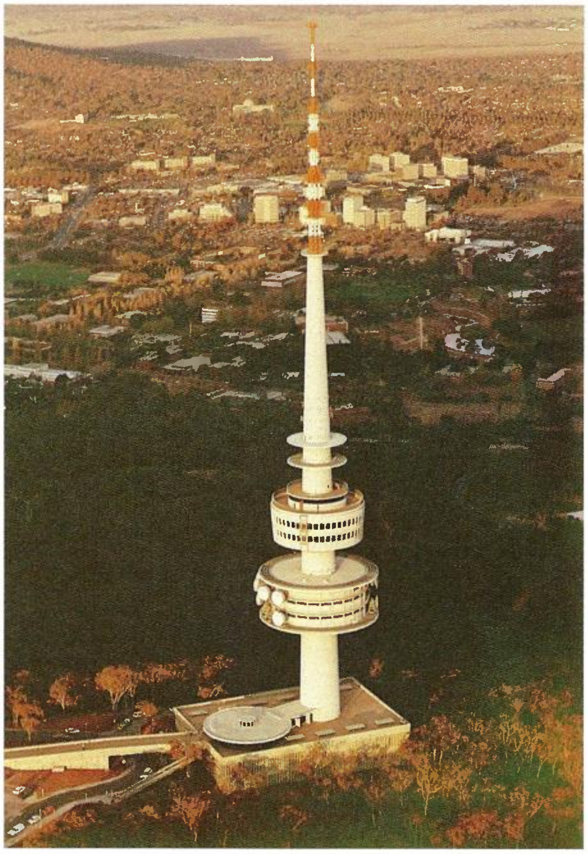
In manholes, repainting of corroded areas is not recommended because acceptable surface preparation cannot be effected in situ. The Laboratories' studies concluded that a petrolatum-based corrosion protection system using the recommended application method can be expected to extend the life of corroded repeater housings considerably.

Paint Durability Trials

In 1977, the galvanised steel tower atop the Black Mountain telecommunications tower complex in Canberra was painted with a water-borne acrylic latex paint. The paint system consisted of a corrosion inhibiting primer and two finishing coats in white and orange aircraft warning colours. Four years later, the painted tower stands as a landmark in Canberra and it is expected that the paint will give many years further service.

Left: Corrosion of cast iron repeater housing due to contaminated water immersion

Below: The Black Mountain telecommunications tower



The choice of the paint system for the tower was based on outdoor exposure trials of paint systems which were commenced by the Laboratories in 1969. The trials exposed samples of exterior gloss acrylic latex paints applied to galvanised steel at several sites across Australia. After seven years exposure, these initial trials showed the acrylics to have excellent resistance to solar ultra-violet light degradation and good adhesion to new (non-weathered) galvanised steel.

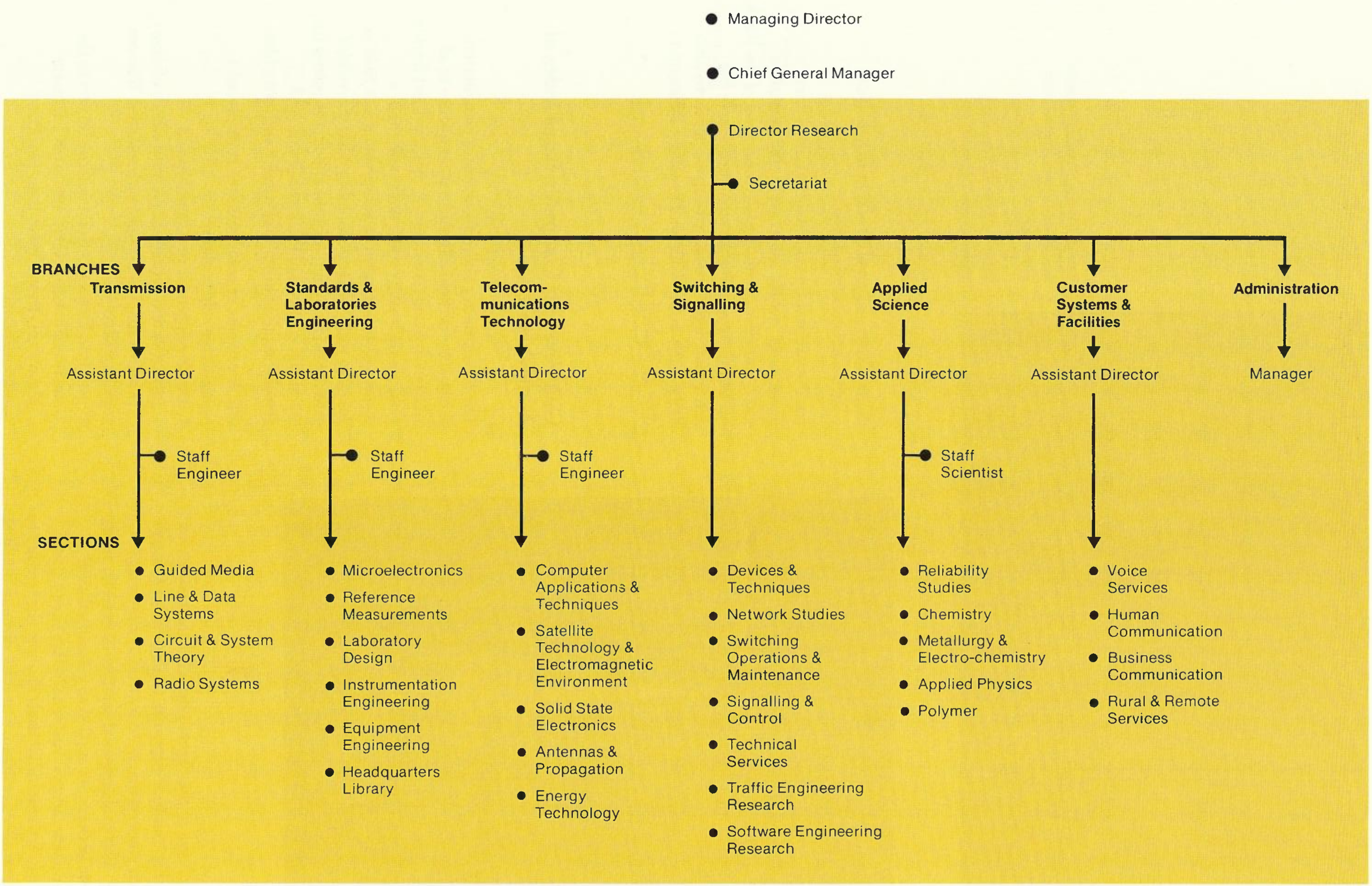
Further weathering durability trials of "new generation" acrylic paints were commenced in 1977, coinciding with the initial painting of the Black Mountain tower. Results to date confirm the continued high resistance of these paints to ultra-violet light degradation and excellent adhesion to new galvanised steel.

Guidelines for Computer-Based Index of Audio-Visual Aids

The Headquarters Library provides consultative services in the field of information science to all areas of Telecom Australia. A major project during 1980 was advising on the development of a computer-based index of audio-visual aids held in Telecom training sections. Library staff provided guidelines for layout, content and access points for the index, supervised the initial input, and established the author and subject authority files.

Other projects in which Library staff played a consultative role included:

- the development of a standardised identification process to identify which of many possible sources applies to a particular Telecom publication;
- assisting Telecom's State administration in the maintenance and development of adequate library services to meet their particular requirements.



The Research Laboratories' organisation

The Laboratories – Staff and Organisation

Organisation

The Research Laboratories are a Department at Headquarters. The Director, Research, heads the Laboratories' organisation. He is responsible to the Chief General Manager, who in turn is responsible to the Managing Director of Telecom Australia. The Laboratories comprise a Secretariat attached to the Director's Office, an Administrative Services Section and thirty one scientific and engineering Sections, grouped into six Branches. The scientific and engineering Sections comprise professional, technical and clerical support staff, with each Section possessing expertise in particular areas of the engineering and scientific fields.

Overall Objectives of the Laboratories

- 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.

Professional and Senior Staff

The names given below are those of the actual occupants of the positions (appointed or acting) at 30 April 1981.

Director: E.F. Sandbach, A.M., B.A., B.Sc., F.T.S.

SECRETARIAT

Secretariat Objectives
Provide executive assistance to the Director, Research, in the management of the Research Department, in matters relating to:
- corporate planning and work programming;
- technical information services and external relationships;
- staff development;
- industrial property;

Head, Secretariat: F.W. Arter, B.E.E., M.Eng.Sc.

Senior Engineer: L.N. Dalrymple, Assoc.Dip.Elec.Eng., Grad.I.E.Aust.

Engineer: O.J. Malone, B.E.E.

Executive Officer: A.B. Conroy

Senior Technical Officers:
P.F. Elliott
A.K. Mitchell
W.W. Staley

TRANSMISSION BRANCH

Branch Objectives
In the field of transmission, 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 signal transmission within the Telecom Australia network;
- new transmission systems and systems which are extensions of present techniques, with particular reference to their integration into the existing network;
- mutual compatibility of the various services and systems within the network;
- cost sensitivity studies.

Assistant Director: R. Smith, B.E.(Hons.), M.E., M.I.E.E., S.M.I.R.E.E.

Staff Engineer: R.J. Morgan, B.Sc.(Eng.Hons.), Ph.D.

Branch Administrative Officer: J.S. Sergeant

Guided Media Section

Section Functions
- Provide information, advice, consultancy and recommendations as defined in the Branch objectives.
- Conduct research and exploratory development into the transmission characteristics of guiding media such as optical fibres, waveguides and cables.
- Evaluate the potential applications and utilisation of such media for the transmission of wideband signals in the local, junction and trunk networks.
- Develop and advise on new techniques for the measurement of transmission properties and characterisation of guided media.
- Maintain an awareness of and evaluate and advise on emerging techniques relating to guided media transmission.

Section Head: R.W.A. Ayre B.E.(Elec. Hons), B.Sc.(Hons.), M.Eng.Sc.

Senior Engineer: E. Johansen, B.E.(Hons), Ph.D.

Engineers:
K.F. Barrell, B.E.(Elec. Hons.), Ph.D.
G. Nicholson, B.E.(Hons), M.Eng.Sc., M.I.E.E.E.

Scientist: J.L. Adams, B.Sc.(Hons)

Senior Technical Officer: J.H. Gillies

Circuit and System Theory Section

Section Functions

- Provide information, advice, consultancy and recommendations as defined in the Branch objectives.
- Conduct research into the theory and design of response shaping circuits which optimise the performance of transmission systems.
- Conduct research into the analysis and synthesis of filter-type circuits, including active and passive filters, equalisers, impedance simulating and compensating circuits, etc.
- Develop mathematical tools for the measurement, analysis and design of transmission circuits and systems.
- Provide a design and consultant service for filter-type circuits.

Section Head: I.M. McGregor, B.E.(Hons.), M.Eng.Sc., Ph.D.

Senior Engineers:
F.G. Bullock, B.E.(Hons.), Grad.I.E.Aust.
R.L. Gray, B.E.(Hons.), M.E., Ph.D., M.I.E.E.E.

Engineers:
M.D. Hayes, B.E.(Hons.), B.Sc.
A.J. Jennings, B.E.(Elec.Hons.), Ph.D., M.I.E.E.E.

Senior Technical Officer: R. Owers, M.I.T.E.

Radio Systems Section

Section Functions

- Provide information, advice, consultancy and recommendations as defined in the Branch objectives.
- Conduct research into transmission systems which utilise radio bearers.
- Investigate the interworking of such systems with other parts of the transmission and switching network.
- Investigate and develop appropriate bearer and system testing methods.
- Develop appropriate systems and testing apparatus which are not otherwise available.

Section Head: O.F. Lobert, B.E.E., M.I.E.Aust., M.I.E.E.

Principal Engineer: R. Horton, B.Sc.(Hons.), Ph.D., A.M.I.E.E. M.I.R.E.E.

Senior Engineers:
R.P. Coutts, B.Sc., B.E.(Hons.), Ph.D., M.I.E.E.E.
I.C. Lawson, B.E.E.

Engineers:
D.B. Albert, B.E.(Elec.), Ph.D.
J.C. Campbell, B.E., M.Eng.Sc.
J.C.N. Ellershaw, B.Sc., B.E.(Hons.), Ph.D., M.I.E.E.E.
A.L. Martin, B.E., Grad.I.E.Aust.

Senior Technical Officers:
M.J. Durrant
R.L. Reid
D.J. Thompson

Line and Data Systems Section

Section Functions

- Provide information, advice, consultancy and recommendations as defined in the Branch objectives.
- Conduct research into transmission systems which utilise metallic or optical bearers.
- Conduct research in modulation and multiplexing techniques and applications.
- Conduct research into methods of data transmission with particular reference to Datel type services and to dedicated data networks.
- Investigate the interworking of such systems with other parts of the transmission and switching network.
- Investigate and develop appropriate bearer and system testing methods.
- Conduct exploratory development of appropriate systems and testing apparatus which are not otherwise available.

Section Head: A.J. Gibbs, B.E.(Elec.Hons.), M.E., Ph.D., S.M.I.E.E.E. S.M.I.R.E.E.

Principal Engineers:
G.J. Semple, B.E.(Hons.), M.Eng.Sc.
B.M. Smith, B.E.(Hons.), Ph.D., M.I.E.E.E.

Senior Engineers:
R.A. Court, B.E.(Hons.), B.Sc., M.Eng.Sc., M.I.E.E.E.
N. Demytko, B.E.(Elec.Hons.), B.Sc., M.Admin.
L.J. Millott, B.E.(Hons.), M.Eng.Sc., M.I.E.E.E.
A.Y.C. Quan, B.E.(Hons.), M.E., A.M.I.E.E.

Engineers:
P.R. Hicks, B.E.(Elec.), B.Sc.(App.Maths.)
P.G. Potter, B.E.(Hons.), Ph.D.
T.D. Stephens, B.E.(Hons.)

Senior Technical Officers:
L.W. Bourchier
J.B. Carroll
R.B. Coxhill
J.L. Kelly
R.I. Webster

STANDARDS AND LABORATORIES ENGINEERING BRANCH

Branch Objectives

To ensure a sound scientific basis for all measurements made by and within the Australian Telecommunications Commission by arranging traceability of accuracy of measurement of fundamental engineering and physical quantities to the Australian National Standards. Conduct studies, exploratory development and field experiments, contribute to specifications and provide advice and recommendations as appropriate relating to:

- development and application of standards of electrical quantity, time and frequency within the field of telecommunications;
- telecommunication instrumentation and equipment engineering practices;
- development and application of microelectronics components.

Provide a mechanical, electrical and/or electronic equipment development facility for Telecom Australia.

Provide a laboratory design and instrumentation facility for the Research Department. Provide a comprehensive library service to all Departments and Directorates at Headquarters.

Assistant Director: L.H. Murfett, B.Sc.

Staff Engineer: G. M. Willis, F.R.M.I.T., M.I.E.Aust., M.I.R.E.E.

Branch Administrative Officer: T.H. Brown

Microelectronics Section

Section Functions

- Conduct research studies into the design and physical realisation of electronic circuitry, in particular that involving miniature and micro-miniature techniques and components, and into interconnection and mounting of these circuits.
- Provide in-house facilities for the production of prototype microelectronic circuits in experimental quantities; specify and develop test criteria and techniques for the control of quality and reliability of these circuits.

Section Head: D.E. Sheridan, Dip.Elec.Eng., Dip.Mech.Eng.

Principal Engineer: G.J. Barker, Assoc.Dip.Mech.Eng., M.I.E.Aust.

Senior Engineers:
G.K. Reeves, B.Sc.(Hons.), Ph.D., M.I.E.Aust.
H.S. Tjio, B.E.(Mech.), Assoc.Dip.Electron.Eng.

Engineers:
A. Brunelli, Dip.Electron.Eng., B.E.(Comm.).
G. Heinze, Dip.Electron.Eng., B.E.(Elec.).
D.R. Richards, B.E.(Elec.), M.I.E.E.E.

Scientist: Z. Slavik, Dip.Eng., A.R.A.C.I.

Senior Technical Officers:
M. Crarey
F. Gigliotti
D.P. Gordon

Instrumentation Engineering Section

Section Functions

- Study instrumentation trends relevant to present and future Telecom Australia applications; design and develop novel instrumentation systems for specific Telecom Australia 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 the Research Department's instrumentation.
- Conduct the procurement programme for all new equipment for the Department, including preparation of technical specifications, tender evaluations and technical reports; perform acceptance testing of new equipment.

Section Head: A.M. Collins, B.Sc.

Senior Engineers:
A.J. Stevens, B.E.(Elec.), M.I.E.E., M.I.E.E.E.
F.R. Wylie, B.E., M.I.E.E.E.

Engineers:
I. Dresser, B.E.(Elec.)
N.A. Leister, B.E.(Elec.), Grad.I.R.E.E.
A. Urie. B.E.(Elec.Hons.)
M.J. Valk, B.E.(Comm.)

Senior Technical Officers:
S.P. Curlis
P.J. Dalliston
P.S. Dawson
D.C. Diamond
B.K. Eley
D.G. Marshall
B.J. McEwen

Reference Measurements Section

Section Functions

- Plan and oversight the implementation, operation and further development of a system of engineering references and calibration facilities for Headquarters and all States.
- Operate, maintain and calibrate the Commission'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 the Commission'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: J.M. Warner, B.Sc., M.I.E.E.

Principal Engineer: R.L. Trainor, B.Sc.

Senior Engineers:
R.W. Harris, B.Sc.(Hons.), B.E.(Elec.Hons.), B.Comm.
E. Pinczower, Dip.Elec.Eng., M.I.E.Aust.

Engineers:
J.P. Colvin, B.E.(Elec.), Dip.Elec.Eng.
D.A. Latin, B.E.(Elec.),
R.W. Pyke, Dip.Elec.Eng., B.E.(Elec. Hons.), M.I.E.Aust.
B.R. Ratcliff, Assoc.Dip.Comm.Eng.

Senior Technical Officers:
J.B. Erwin
C.R. Flood
A.L. Forecast
J. Freeman
R.H. Yates

Laboratory Design Section

Section Functions

- Plan and specify, in conjunction with other Telecom Australia staff, accommodation requirements of the Department 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 Sub-Division to arrange all buildings and building services, repairs and maintenance required within the Department.
- Co-ordinate all safety, security, and fire protection matters within the Department.

Section Head: D.S. Geldard, M.I.E.E., M.I.E.Aust.

Engineer: R.J. Day, Dip.Elec.Eng., Dip.Mech.Eng., M.I.E.Aust.

Senior Technical Officer: J.T. Blake

Equipment Engineering Section

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 equipments and tools required within the Research Department and elsewhere in Telecom Australia.
- Provide for Telecom Australia a specialist design facility, including mechanical and electro-mechanical 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 the on-the-job training of apprentice artisans and trainee technical staff in the mechanical engineering field for the Research Department.

Section Head: F. Wolstencroft, C.Eng., M.I.Mech.E.

Senior Engineer: P.F.J. Meggs, Assoc.Dip.Mech.Eng., M.I.E.Aust.

Engineers:
A.R. Gilchrist, Assoc.Dip.Mech.Eng., B.E.(Mech.Hons.), Grad.I.E.Aust.
W.F. Hancock, Dip.Elec.Eng., M.I.E.Aust.
K. Ho-Le, B.E.(Mech.Hons.), Grad.I.E.Aust.
R. Proudlock, B.E.(Elec.)

Senior Technical Officers:
J.D. Kisby
D.J. McMillan
W.L. Reiners

Headquarters Library

Functions

- Provide a comprehensive library service to all Departments and Directorates at Headquarters.
- Co-operate with State Administrations and provide consultative services in regard to common standards and systems.

Principal Librarian: H.V. Rodd, B.A., Dip.Lib. A.L.A.A.

Senior Librarian: D.J. Richards, B.A., Dip.Lib.

Librarians:
A.E. Badrock, Dip.Lib.
G. Chua, B.A.P.(Lib.Stud.WAIT), A.L.A.A.
M. McAllister, B.Sc.(Hon.), Dip.Lib., A.L.A.A.
P. Millist, Dip.Lib., A.L.A.A.
E.M. Spicer, B.A., Dip.Lib.

TELECOMMUNICATIONS TECHNOLOGY BRANCH

Branch Objectives

Conduct studies, exploratory development and field experiments, provide advice and recommendations, and contribute to equipment specification and assessment relating to:

- the application of newly emerging, extended or improved technologies in telecommunication engineering;
- the characteristics and properties of new devices, circuits and techniques in communications applications;
- 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;
- maintain and develop liaison with appropriate research establishments in Australia and overseas to provide information and advice on emerging technologies of interest to Telecom Australia.

Assistant Director: E.R. Craig, B.Sc.(Hons.), M.I.E.E.

Staff Engineer: N.F. Teede, B.E.(Hons.), Ph.D., Dip.Mgt.

Branch Administrative Officer: C.J. Chippindall

Solid State Electronics Section

Section Functions

- Provide information, advice and consultancy as defined in the Branch objectives.
- Investigate and advise on the properties of materials and components that are applicable to the development and fabrication of devices and circuit elements which have functions based on the exploitation of these special material properties; conduct exploratory development and fabrication of such devices.
- Investigate and advise on active and passive circuit configurations, employing such devices for the generation, amplification, modulation and processing of signals and their application, especially in microwave and optical circuits and sub-systems.
- Develop and provide specialised facilities in the realm of engineering materials and devices arising from the above.

Section Head: W.J. Williamson, B.E.(Elec. Hons.), Ph.D.

Principal Engineers:
G. Rosman, B.E.E., M.E.
P.V.H. Sabine, B.Sc., B.E.(Elec. Hons), Ph.D.

Senior Engineers:
Y.H. Ja, B.E., Ph.D.
G.O. Stone, B.E.(Elec.Hons.), M.Eng.Sc., Ph.D., M.I.E.E.E., M.I.R.E.E.

Engineers:
A.M. Duncan, B.Sc., B.E.(Elec. Hons.)
J. Hubregtse, Fell.Dip.Comm.Eng., Grad.I.R.E.E.

Principal Scientist: G.L. Price, B.Sc.(Hons.), Ph.D., M.A.I.P., M.A.P.S., M.I.E.E.E.

Senior Scientist: P.C. Kemeny, B.Sc.(Hons.), Ph.D., Grad.A.P.S.

Scientist: B.J. Linard, B.Sc.(Hons.), Ph.D., Grad.A.I.P.

Senior Technical Officer: B.P. Cranston

Antennas and Propagation Section

Section Functions

- Provide information, advice and consultancy as defined in the Branch objectives.
- Conduct research and exploratory development in the field of freely propagated electromagnetic waves, including the study of propagation phenomena and of the interrelation of meteorological and other mechanisms, and make recommendations in relation to the performance and design characteristics of radiocommunication systems.
- Conduct research, undertake exploratory development and make recommendations on antennas for launching and receiving electromagnetic radiation, for application both in the design of antennas for experimental and practical engineering projects.

Section Head: J.H. Reen, B.E.E., M.I.E.Aust.

Principal Engineers:
J.V. Murphy, B.E.(Elec.), B.A.
S. Sastradipradja, B.E.(Elec.)

Senior Engineers:
W.S. Davies, B.E.(Elec.), M.Eng.Sc., Ph.D.
R.A. Harvey, Dip.Rad.Eng., B.Sc., A.M.I.R.E.E.

Engineer: E. Vinnal, B.E.(Hons.)

Senior Technical Officers:
E.D.S. Fall
R.J. Francis
S.J. Hurren
B.W. Thomas

Computer Applications and Techniques Section

Section Functions

- Provide information, advice and consultancy as defined in the Branch objectives.
- Conduct fundamental studies on and recommend or implement as appropriate, modelling and simulation methods, as applicable to telecommunication systems and techniques, and related activities.
- Investigate and make recommendations concerning processor technology, techniques and applications as they relate to telecommunications engineering.
- Investigate and make recommendations on methods of mathematical analysis best suited to the application of computers to problem solving in telecommunications engineering.
- Develop and provide computing facilities including hardware and software to meet special needs within Telecom Australia. Co-operate with the Instrumentation Engineering Section and Information Systems Department in provision of items of computer hardware for the Department's needs.

Section Head: P.J. Tyers, B.E.(Hons.), B.Sc., M.I.E.E.E.

Engineers:
L.A.R. Denger, E.N.S.E.M.N., M.I.E.E.E., M.Soc.Fr.de Elec., Grad.I.E.Aust.
R.A. Frizzo, B.E. (Elec. Hons.), M.Eng.Sc.

Senior Technical Officers:
D. Drummond
I.J. Moran

Satellite Technology and Electromagnetic Environment Section

Section Functions

- Provide information, advice and consultancy as defined in the Branch objectives.
- Conduct research into, and advise on applications of communication satellite technology in Australia from system and technique studies, hardware development and experimentation.
- Conduct research into the utilisation of the frequency spectrum by satellite systems, including frequency re-use, and their co-existence with terrestrial radio services.
- Investigate interference effects of radio frequency radiation on telecommunications equipment and make recommendations on electromagnetic compatibility as appropriate.
- Establish and maintain a knowledge base on the biological effects of electromagnetic radiation and evolve design practices to take account of best available information, in consultation with and with inputs from experts in relevant medical specialities.

Section Head: G.F. Jenkinson, B.Sc., M.I.R.E.E.

Principal Engineers:
R.K. Flavin, B.Sc., M.Sc.
I.P. Macfarlane, A.R.M.T.C., B.E.(Elec.), M.I.E.E.E.

Senior Engineers:
A.J. Bundrock, B.E.(Elec. Hons.)
D.J. Kuhn, B.E.(Elec.), M.Eng.Sc.

Senior Technical Officers:
D.K. Cerchi
D.M. Farr
B.C. Gilbert

Energy Technology Section

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'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's operations, particularly in remote areas.

(unstaffed)

SWITCHING AND SIGNALLING BRANCH

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 Australia 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.

Assistant Director: F.J.W. Symons, B.E.(Hons.), D.I.C., Ph.D., M.I.E.Aust., A.I.E.E.

Technical Co-Ordinator: J.L. Park, B.E.(Hons.), M.Eng.Sc., M.I.E.E.E.

Branch Administrative Officer: P. McStay

Software Engineering Research Section

Section Functions
- Study the characteristics and potential of new approaches in the field of SPC software technology.
- Conduct research into the basic nature of SPC software systems, and develop new techniques to exploit the potential of new software technology.
- Participate in the design and assessment of laboratory and field trials of new switching and signalling systems using novel software engineering techniques.
- Provide an SPC system software specification, design, production and testing capability for the Switching and Signalling Branch.
- Make recommendations concerning the provision of the Branch processor complex, provide a comprehensive software support capability, and co-ordinate the day to day operation of the Branch processor complex.
- Provide specialist consultative advice and assistance in relation to the progressive integration of new SPC software technology into the network.

Section Head: R.H. Haylock

Senior Computer Systems Officer: E.M. Swenson, M.Sc., Grad.Dip.Data Processing, M.A.I.P., A.A.S.C.

Programmers:
J.S. Drake
G.P. Rochlin, B.Sc

Engineer: N.W. Bergmann, B.Sc., B.E.(Hons.)

Devices and Techniques Section

Section Functions
- Assess the potential of new devices and techniques for application in switching and signalling systems.
- Develop new techniques to exploit the latent potential of new switching technology.
- Participate in the design and assessment of field trials of new switching systems and equipment which use novel devices and techniques.
- Prepare recommendations for the adoption or trial of new devices and/or techniques.

Section Head: P.S. Jones, M.Eng.Sc.

Senior Engineer: E. Tirtaatmadja, B.Eng.(Elec.)

Engineers:
D.M. Harsant, B.E.(Hons.)
P.L. Nicholson, B.E., M.I.E.E.

Scientist: C.J. Scott, B.App.Sc., Grad.A.I.P.

Network Studies Section

Section Functions
- Conduct research into the basic nature of switching networks and the manner in which changes in network parameters influence the technical and economic characteristics of the network.
- Assess the potential of future systems in relation to network needs.
- Provide specialist consultative advice and assistance in relation to the progressive integration of new switching systems into Telecom Australia's networks.
- Examine digital requirements for switching and signalling systems in future environments and conduct feasibility studies of possible approaches.

Section Head: R.J. Vizard, Dip.Elec.Eng., B.E.E.

Principal Engineer: M.A. Hunter, B.E.(Hons.), A.M.I.E.E.

Senior Engineers:
N.G. Gale, B.E.(Elec.)
G.K. Millsteed, Dip.Elec.Eng., B.E. (Hons)

Engineers:
J. Billington, B.E.(Hons.), M.Eng.Sc., M.I.E.E.E.
S.M. Jong, B.E.(Elec.)

Research Officer: G.R. Wheeler, B.Sc.(Hons.), M.Sc.

Switching, Operations and Maintenance Section

Section Functions
Within the fields of switching and signalling:
- Study the characteristics and potential of new approaches in the field of operations and maintenance.
- Develop models which will be used to validate theoretical studies of new operations and maintenance systems and techniques.
- Conduct field trials to assess the performance of new approaches and techniques in the field of operations and maintenance.
- Provide specialist consultative advice in matters pertaining to operations and maintenance.

Section Head: E.A. George, A.S.T.C., Post.Dip.Elec.Comp., M.I.E.Aust.

Principal Engineer: G.J. Champion, B.E.

Senior Engineers:
G.J. Dickson, B.E.(Hons.), M.Eng.Sc.
J.L. Snare, B.E.(Hons.)

Signalling and Control Section

Section Functions

- Study the characteristics and potential of new approaches in the field of control and signalling.
- Develop models to validate theoretical studies of new control signalling systems and techniques.
- Conduct field trials to assess the performance of new approaches and techniques in the field of control and signalling.
- Provide specialist consultative advice in matters pertaining to control and signalling.

Section Head: P.H. Gerrand, B.Eng.(Hons.), M.Eng.Sc., M.I.E.Aust.

Principal Engineer: M. Subocz, B.E.(Elec.), M.I.E.Aust.

Senior Engineers:
B.T. Dingle, Dip.Elec.Eng., B.E.(Hons.)
N.Q. Duc, B.E.(Hons.), Ph.D., M.I.R.E.E., M.I.E.E.E.

Engineers:
P.A. Kirton, B.E.(Hons.), Ph.D., M.I.E.E.E.
E.K. Chew, B.E., M.Eng.Sc., Ph.D.

Senior Research Officer: G.M. Codsi, B.Sc.

Research Officer: I. Chin, B.Sc.(Hons.)

Technical Services Section

Section Functions

- Provide field and laboratory planning, provisioning, investigational, developmental, production, testing and evaluation support for Branch activities.
- Install, operate and maintain equipment in field experiments.

Section Head: W. McEvoy, A.A.I.M.

Senior Technical Officers:
D.J. Duckworth
P. Ellis
H.G. Fegent
H. Meijerink
P.C. Murrell
A. Romagnano
B.J. Wilson

Traffic Engineering Research Section

Section Functions

- Serve as a national reference authority for traffic engineering theory and education.
- 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 for, and contribute to specifications for new switching and signalling systems being considered for adoption by Telecom.
- Serve as a consultant for the dimensioning of special systems and networks for Telecom's larger customers.
- Maintain a constant review of world developments in traffic theory and its application to telecommunications networks.

Section Head: J. Rubas, A.R.M.T.C.

Senior Engineer: R.E. Warfield, B.E.(Hons.), Ph.D.

Scientist: R.J. Harris, B.Sc.(Hons.), Ph.D.

APPLIED SCIENCE BRANCH

Branch Objectives

Conduct studies, exploratory development and field experiments, contribute to specifications, assist in the assessment of tenders and provide advice and recommendations, as appropriate, relating to:

- the properties of materials, components and equipment;
- the causes of degradation and failure, and the establishment of remedial measures;
- the influence of the environment on staff and plant and the required protective measures;
- the development and application of new materials and of new scientific test methods;
- the reliability of components and devices;
- participation in committees, conferences, etc., both national and international, and liaison with universities and research organisations.

Assistant Director: R.D. Slade, Assoc.Dip.Met., M.I.M., M.A.I.M.F.

Staff Scientist: G. Flatau, F.R.M.I.T. (App.Sc.)

Senior Physical Scientist: J.R. Lowing, Dip.Sec.Met.

Principal Engineer: A. Fowler, M.I.E.Aust.

Physical Scientist: C.G. Kelly, B.App.Sc.(App.Phys.)

Branch Administrative Officer: M.A. Chirgwin

Solar Module Evaluation Group
Group Leader: D. McKelvie, B.Sc.(Hons.)

Senior Physical Scientist: A.J. Murfett, B.Sc.(Hons.)

Reliability Studies Section

Section Functions

- Provide information, advice and consultancy as defined in the Branch objectives.
- Conduct exploratory research and investigation into the reliability of components, devices and assemblies to the depth necessary to enable this scientific knowledge to be applied to the solution of Telecom Australia's problems.
- Conduct scientific studies into the causes of failure or degradation of components, devices and assemblies.
- Conduct research leading to the statistical prediction of the life expectancy of components, devices and assemblies.
- Design and develop specialised test equipment.
- Develop special analytical techniques for failure analysis.
- Conduct scientific studies into the properties of materials and components.

Section Head: G.G. Mitchell, B.Sc.(Hons.), M.Sc.

Senior Engineer: I.K. Stevenson, B.App.Sc., Dip.Eng.(Electronic Eng.), A.R.M.I.T., Grad.A.I.P., Grad.I.E.Aust.

Senior Physical Scientist: S.J. Charles, B.App.Sc.

Senior Technical Officers:
R.A. Galey
J.F. Pidoto
R. Wilkinson

Chemistry Section

Section Functions

- Provide information, advice and consultancy as defined in the Branch objectives.
- Conduct exploratory research and investigations in the field of chemistry to the depth necessary to enable this scientific knowledge to be applied to the solution of Telecom Australia's problems.
- Conduct scientific studies into chemical phenomena and hazards.
- Develop specialised techniques and equipment for the analysis of materials.
- Provide the scientific backing for the operations of the Australian Government Stores and Tender Board, including the formulation of new specifications and approval testing of all relevant types of material and consumer products.

Section Head: F.C. Baker, Dip.App.Chem., Dip.Chem.Eng., A.R.A.C.I., A.A.I.S.T., F.C.S.

Senior Physical Scientist: R.N.M. Barrett, B.Sc.(Hons.), A.R.I.C.

Physical Scientists:
T.J. Elms, Dip.App.Sc., Grad.R.A.C.I.
Grad.Dip.Analyt.Chem.
P.W. George, Dip.App.Sc.(App. Chem.), Grad.R.A.C.I.
S. Georgiou, B.App.Sc.(App.Chem.)
Grad.Dip.Analyt.Chem.
F.M. Petchell, Dip.App.Chem., A.R.A.C.I.

Senior Technical Officer: R.R. Pierson, M.A.I.S.T.

Polymer Section

Section Functions

- Provide information, advice and consultancy as defined in the Branch objectives.
- Conduct exploratory research and investigation in the chemistry and application of polymeric and associated materials to the depth necessary to enable this scientific knowledge to be applied to the solution of Telecom Australia's problems.
- Carry out scientific studies of the properties of polymeric materials and develop methods for their application.
- Develop polymer materials with special properties for particular applications as required.
- Develop appropriate test methods and specialised equipment as required.

Section Head: H.J. Ruddell, Dip.App.Chem., A.P.I.A., A.R.A.C.I.

Senior Physical Scientists:
D.J. Adams, Dip.App.Chem., Grad.R.A.C.I.
B.A. Chisholm, Dip.App.Chem., M.Sc., Grad.R.A.C.I., Grad.P.R.I.

Physical Scientists:
R.J. Boast, Dip.App.Chem., Grad.R.A.C.I.
P.R. Latoszynski, Dip.App.Sc., Grad.R.A.C.I.
Grad.Dip.Analyt.Chem.
D.T. Miles, F.C.S., C.Chem., M.R.I.C., M.R.S.H.

Senior Technical Officer: S.D. Barnett

Metallurgy and Electro-Chemistry Section

Section Functions

- Provide information, advice and consultancy as defined in the Branch objectives.
- Conduct exploratory research and investigation in the fields of metallurgy and electro-chemistry to the depth necessary to enable this scientific knowledge to be applied to the solution of Telecom Australia's problems.
- Perform scientific studies involving electro-chemical phenomena in the fields of corrosion and electrical power sources.
- Conduct scientific studies into the properties of metals and alloys and their application.
- Develop appropriate test methods and specialised equipment as required.
- Conduct research into surface phenomena and electro-deposition; develop practices for the satisfactory protection of equipment and plant.

Section Head:
K.G. Mottram, Fell.Dip.Met.Eng., A.M.A.I.M.M.

Senior Physical Scientist (Metallurgy Group):
T.J. Keogh, Assoc.Dip.Sec.Met.

Physical Scientists:
J.R. Godfrey, Assoc.Dip.Met.
K. Keir, Fell.Dip.Met.Eng.

Senior Physical Scientist (Electro-Chemistry Group):
J. Der, B.Sc., A.R.A.C.I.

Physical Scientists:
P.J. Gwynn, Dip.App.Chem.

R.F. May, M.Sc., Dip.Sec.Met.

Engineer:
J.A.A. Lyimo, B.Eng.(Hons.)

Senior Technical Officers:
F.M. Hamilton
M. Jorgensen, Assoc.Dip.Met.
J.W. Smith

Applied Physics Section

Section Functions

- Provide information, advice and consultancy as defined in the Branch objectives.
- Conduct exploratory research and investigation in the field of physics to the depth necessary to enable this scientific knowledge to be applied to the solution of Telecom Australia's problems.
- Conduct scientific studies into the physical properties of materials and components.
- Conduct research into the effects of the natural and man-made environment on staff and plant; devise means of protection from any deleterious influences.
- Conduct research into high voltage phenomena and its effect on staff and plant; devise protection methods as appropriate.
- Design and develop specialised testing and measuring equipment as required.

Section Head: I.A. Dew, B.Sc., M.Sc., M.A.I.P.

Senior Physical Scientists:
E.J. Bondarenko, Dip.App.Phys., B.App.Sc., M.A.I.P., M.I.R.E.E., F.R.A.S.
G.W.G. Goode, B.Sc.

Engineer: P.W. Day, B.E.(Comm.)

Senior Technical Officers:
M.C. Hooper
G.C. McLean
I.M. Tippett

CUSTOMER SYSTEMS AND FACILITIES BRANCH

Branch Objectives

Conduct studies, exploratory development and field experiments, contribute to specifications, assist in the assessment of tenders, and provide other advice and recommendations as appropriate relating to:

- the needs and potential needs for communication within the community considering both human and technical aspects;
- user facilities and equipment which are new or which represent extensions of existing services;
- the interaction between users or users' equipment and the telecommunications system;
- performance criteria for user communication.
- cost sensitivity studies.

Maintain an awareness of:

- community and commercial initiatives in the area of customer facilities and equipment;
- actual and potential community needs for new, extended or improved customer facilities and equipment;
- local and overseas technical developments relevant to the provision of new, extended or improved customer facilities and equipment.

Assistant Director: H.S. Wragge, B.E.E.(Hons.), M.Eng.Sc.(Hons.), M.I.E.Aust., M.I.E.E.

Branch Administrative Officer: B.F. Donovan

Human Communication Section

Section Functions

- Provide information, advice and consultancy as defined in the Branch objectives.
- Undertake fundamental studies of the processes of human communication.
- Undertake the design, exploratory development and experimental assessment of group and other novel communication facilities.
- Investigate the social and organisational implications of such facilities.
- Investigate, develop where necessary, and apply the techniques of the social sciences to the assessment of the effectiveness and acceptability of communication facilities.
- Investigate the effects of signal transmission, presentation and processing on human communication, including the interaction between telecommunication technology and user perception and behaviour.
- Conduct studies and exploratory development of communication devices and techniques which meet the special needs of the handicapped.

Section Head: G.D.S.W. Clark, B.E.E.(Hons.), M.Sc., M.I.E.Aust.

Senior Engineer: J.K. Craick, B.E.(Elec. Hons.), B.Sc.

Engineer: D.Q. Phiet, B.E.(Elec. Hons.), Ph.D.

Senior Psychologist: L.A. Albertson, B.A.(Hons.) Dip.Ed.

Psychologists:
R.W. Hyland, B.A.(Hons.)
L. Perry, B.A.(Hons.), M.A.P.S.

Senior Technical Officers:
A.H. Borg
D.R. Potter

Voice Services Section

Section Functions

- Provide information, advice and consultancy as defined in the Branch objectives.
- Conduct studies and exploratory development of new telephone facilities and customer apparatus for voice services, taking account of switching, signalling, and multiplexing requirements of the telecommunication system.
- Provide standards for telephone transmission and make recommendations on the transmission performance criteria for voice services.
- Investigate the generation, transmission, perception, synthesis and recognition of speech signals in telecommunication networks.
- Conduct studies into audio frequency acoustic signal propagation and noise.
- Advise on methods for the quality control of the performance of customer equipment.

Section Head: D.A. Gray, B.E.E., Dip.Mech. & Elec.Eng., M.I.E.Aust., M.A.A.S.

Principal Engineer: E.J. Koop, Fell.Dip.Elec.Eng., B.E.(Elec.), M.A.A.S.

Senior Engineers:
P.F. Duke, Assoc.Dip.Maths., B.Tech.
R.A. Seidl, B.E.(Elec.Hons.), Ph.D.

Engineers:
G.M. Casley, B.E.(Elec), M.Eng.Sc., D.I.C., Ph.D., M.I.E.Aust., A.M.I.E.E.
J.P. Goldman, Assoc. Dip.Rad.Eng., Assoc.Dip.Comm.Eng., Grad.I.E.Aust.
P.I. Mikelaitis, B.E.(Elec.), M.Eng.Sc., M.I.E.E.E.

Senior Technical Officers:
T.R. Long
J.E.W. Lucas

TET/TAMS Task Force
Task Force Manager: R.W. Kett, Fell.Dip.Comm.Eng., M.I.R.E.E.

Engineer: B.W. Sneddon, B.E.(Elec.)

Senior Technical Officers:
S.G. Beadle
J.D. Hedger (Located in South Australia)
G.R. Leadbeater

Business Communication Section

Section Functions

- Provide information, advice and consultancy as defined in the Branch objectives.
- Provide specialist advice and assistance in the use of television and record systems.
- Conduct studies and exploratory development of integrated multi-functional business communications systems.
- Investigate hardware and software techniques relevant to the provision of customer information systems.
- Investigate questions of technical compatibility arising when new facilities are added to existing business systems.
- Conduct studies and exploratory development of terminal equipment for the generation and display of TV and record signals.
- Undertake investigations and exploratory development of the processing of visual and record signals so as to facilitate their transmission within the Telecom Australia network.
- Study and develop techniques for the conversion between various forms of visual and record signals.

Section Head: M. Cassidy, B.Sc., M.E., D.P.A., F.I.E.Aust. F.I.E.E.

Principal Engineers:
R.I. Davidson, B.E.(Elec.)
G.K. Jenkins, B.Sc., B.E.(Hons.), M.E., M.A.C.S.

Senior Engineers:
A.R. Jenkins, A.R.M.I.T.
W.E. Metzenthen, F.R.M.I.T., M.E., M.I.R.E.E.
P.F. Frueh, B.E.(Elec.), M.Eng.Sc.

Engineers:
P. Bernhard, B.E.(Elec.)
D.M. Blackwell, B.E.(Elec.)
R. Exner, B.Sc., B.E.(Hons.), M.A.Sc., M.I.E.E.E.
Y.T. Tan, B.E.(Elec.)
M.C. Wilbur-Ham, B.E.(Elec.)

Senior Technical Officers:
B.W. Booth
P.D. Jackson
A.M. McDonald

Rural and Remote Services Section

Section Functions

- Provide information, advice and consultancy as defined in the Branch objectives.
- Conduct studies and exploratory development of equipment for remote and rural subscribers.
- Contribute to specifications for remote and rural subscriber's facilities.
- Assess the potential of new technology and facilities for remote and rural subscribers and provide recommendations for appropriate applications.
- Study, assess and recommend protocols for facilities, operating procedures and interconnection of remote and rural subscribers equipment.

(unstaffed)

ADMINISTRATIVE SERVICES SECTION

Manager Administration: J.B. Sidbottom

Senior Planning Officer: J.F. Reid

Project Officer: T.W. Dillon

Budgets Officer: R.J. Beveridge

Staff Services Co-ordinator: G.N. Galvin

Papers, Lectures, Talks and Reports

Research Laboratories Reports are the vehicle by which the results of research studies and investigations, development projects and other specialised tasks undertaken in the Laboratories are officially documented. The 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. This list shows those papers, lectures, talks and reports presented or published during the last twelve months.

PAPERS

Addie, R.G, Codsi, G.M., Gerrand, P.H., (& Rubinstein, M., Engineering Department, Headquarters)	"A General Exchange Simulator for Capacity Studies of Telecommunication Systems", Australian Telecommunication Research, Vol. 14 No. 1, 1980.
Albertson, L.A.	"Telecommunications as a Travel Substitute: Some Psychological; Organizational and Social Aspects", Intercom: Readings in Organizational Communication, Ferguson & Ferguson (Eds) Hayden Books, New Jersey, USA, 1980.
Albertson, L.A.	"Future Teleconference Meetings: Pattern and Prediction", Teleconferencing and Interactive Media, Wisconsin, USA, 1980.
Albertson, L.A.	"Trying to Eat an Elephant", Communication Research, Vol. 7, No. 3, July 1980
Albertson, L.A.	"My Neighbour the Telephone", Telecom No. 57, October 1980.
Albertson, L.A.	"My Neighbour the Telephone", Repat Chat, April 1981, (Reprinted from Telecom No. 57, October 1980).
Albertson, L.A.	"The Bird and Beyond", Education News, October 1980.
Albertson, L.A.	"Historic Hook-Up for Symposium at Research Laboratories", Telecom No. 58, November 1980.
Barker, G.J.	"Planar Circuit Fabrication Facilities - Sputter-Etching in Microstrip Planar Circuit Fabrication", Microwave Technology Seminar, Monash University, December 1980.
Barrell, K.F. (& Pask, C., Australian National University, Canberra)	"Leaky Ray Correction Factors for Elliptical Multimode Fibres", Electronics Letters, Vol. 16, No. 14, July 1980.
Billington, J., Kirton, P.A. & Symons, F.J.W.	"Representation of Data Communication Processes", Australian Telecommunication Research, Vol. 14, No. 1, 1980.
Brunelli, A.	"Planar Circuit Fabrication Facilities - Processing Techniques Used in the Fabrication of Passive Microwave Integrated Circuits on Microwave Printed Board Materials", Microwave Technology Seminar, Monash University, December 1980.
Bundrock, A.J.	"Subsystem Design Concepts - Local Oscillators and Mixers", Microwave Technology Seminar, Monash University, December 1980.
Burton, J.M. & Vinnal, E.	"Radio Propagation Above 10 GHz Pt. 1: An Overview of New Frequency Bands", The Telecommunication Journal of Australia, Vol. 30, No. 3, 1980.
Cassidy, M., (Nowotny, G. & Mount, R.M., Engineering Department, Headquarters)	"Developing Engineers for a High Technology Industry: A Practical Approach to Rapid Change", IE Aust. Australasian Engineering Education Conference Brisbane, 1980.
Chew, E.K.	"Mathematical Modelling and Capacity Estimation of the IST System", Australian Telecommunication Research, Vol. 14, No. 2, 1980.
Clark, G.D.S.W.	"Conferencing and Teleconferencing", ANZAAS Conference, Adelaide, May 1980.
Craig, E.R. (& Lewis, J.A. Department of Communications)	"Space/Terrestrial and Space/Space Co-ordination Criteria", (Appendices 28 & 29), Description and Application Workshop Seminar and Radiocommunication for South Pacific Countries, Port Moresby, 31 March-10 April, 1981.
Craig, E.R.	Interim Meeting of CCIR Study Group 4, (ITU) Telecommunication Journal, Vol. 48, 111/1981.
Court, R.A.	"Alternative Burst Transmission Techniques for Digital Telephone Reticulation", Electronics Letters, Vol. 16, No. 15, July 1980.
Coutts, R.P. & Martin, A.L.	"High Capacity Long Haul Digital Radio", IE Australia/IREE Australia, Conference on Digital Systems Design, Sydney, May 1980.
Dew, I.A. & Murfett, A.J.	"LEDs as Replacement Lamps in Existing Switchboards", The Telecommunication Journal of Australia, Vol. 30, No. 1, 1980.
Dickson, G.J.	"Formal Specification Technique for Data Communication Protocol X.25 Using Processing State Transition Diagrams", Australian Telecommunication Research, Vol. 14, No. 2, 1980.
Dickson, G.J.	"A Method for Formal Protocol Specification", CCITT Study Group VII (Data Communication Networks), Kyoto, Japan, April 1981.
Dickson, G.J.	"Preliminary Plan for Study of Question 39/VII: System Description Techniques for X-Series Recommendations", CCITT Study Group VII, (Data Communication Networks), Kyoto, Japan, April 1981.

Dickson, G.J., Duc, N.Q. & Kirton, P.A.	"Functional Partitioning for the Specification of Services and Protocols", (OSI-81-8), CCITT Study Group VII, (Data Communication Networks), Kyoto, Japan, April 1981.
Duc, N.Q. & Dart, S.A.	"Selection of Formal Description Techniques for Specifying Services, Protocols and Interfaces", (OSI-81-11), CCITT Study Group VII, (Data Communication Networks), Kyoto, Japan, April 1981.
Duc, N.Q., Coxhill, R.B.	"A Performance Monitoring System for Data Transmission Circuits", Telecommunication Journal of Australia, Vol. 30, No. 2, 1980.
Duc, N.Q. & Kirton, P.A.	"A Unified Approach to Specifications of Services, Protocols and Interfaces for Open Systems Interconnection", (previously submitted to ISO/TC97/SC16 - Open Systems Interconnection), (OSI-81-7), CCITT Study Group VII, (Data Communication Networks), Kyoto, Japan, April 1981.
Ellershaw, J.C.	"Interference Aspects of VHF and UHF Radio Services", IREE Australia, Symposium, Problems in Radio Comm., Adelaide, 1980.
English, K.S.	"Super-Resolution Spectral Analysis Techniques for Processing Multi-Path Propagation Data", L'Aquila Workshop on Digital Signal Processing (Italy), September, 1980.
Flatau, G.	"Reliability and Environmental Testing", Microwave Technology Seminar, Monash University, December 1980.
Flatau, G.	"The International Electrotechnical Commission Quality Assessment for Electronic Components", Telecommunication Journal of Australia, Vol. 30, No. 2, 1980.
Flatau, G.	"Australia and the IEC Quality Assurance System for Electronic Components", IREE Monitor, October 1980.
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Flavin, R.K.	"R.F. Properties of Planar Circuits - Thick-Film Microstrip Circuits", Microwave Technology Seminar, Monash University, December 1980.
Flavin, R.K.	"Overview of Small Earth Station Microwave Subsystems", Microwave Technology Seminar, Monash University, December 1980.
Flavin, R.K.	"Prediction of Earth-Space Rain Margins Above 10 GHz in Australia", IREE Australia, Symposium on Problems in Radio Communication, August 1980.
Gale, N.	"Prospects for Digital Subscriber Lines in the Public Telephone Network", ANZAAS Conference, Adelaide, May 1980.
Gerrand, P.H.	"SDL in Australia", International SDL Newsletter, Issue No. 1, (CSELT, Turin, Italy), 1980.
Gerrand, P.H.	"Treatment of Data by SDL", CCITT Study Group XI, Temporary Document No. YY, March 1981.
Gibbs, A.J., Nicholson, G. & Potter, P.G.	"A Barrage Technique for Measurement of PCM Regenerator Section Loss Limits", Electronics Letters, Vol. 16, No. 21, October 1980.
Gray, D.A.	"Speech Communication with Machines: A Users Perspective", ANZAAS Conference, Adelaide, May 1980.
Gray, D.A., Koop, E.J. & Goldman, J.P.T.	"Australian Aids for the Hard of Hearing Telephone User", 10th International Congress on Acoustics, Sydney, July 1980.
Gray, D.A., Koop, E.J. & Goldman J.P.T.	"Australian Aids for the Hard of Hearing Telephone User", Bulletin of the Australian Acoustical Society, Issue 3, Vol. 8, December 1980.
Gray, R.L. & Jennings, A.J.	"Subsystem Design Concepts - Microwave Filters", Microwave Technology Seminar, Monash University, December 1980.
Hancock, W.F.	"Precision Applications of Micro-Plasma Arc Welding", IE Australia Conference on Manufacturing Engineering, Melbourne, August 1980.
Harris, R.W.	"Maintenance of ATC Time Scale", IREE Australia, Precise Time and Frequency Conference, Canberra, August 1980.
Harvey, R.A.	"Subrefractive Propagation in Outback Areas", IREE Australia, Symposium on Problems in Radio Communications, Adelaide, August 1980.

Hooper, M.C.	"A Microprocessor-based Temperature Controller", National Microcomputer Conference on Personal Computing for the Eighties, Canberra, July 1980.
Horton, R.	"Subsystem Design Concepts - The Impact and Opportunities Offered by Contemporary Technology", Microwave Technology Seminar, Monash University, December 1980.
Horton, R. & Lobert, O.F.	"Integration of Digital Radio Systems into Metropolitan Telephone Networks", IE Australia/IREE Australia, Conference on Digital Systems Design, Sydney, May 1980.
Horton, R., Coutts, R.P. & Martin, A.L.	"Digital Radio and the Challenge of Spectrum Conservation", IREE Australia, Symposium on Problems in Radio Communication, Adelaide, August 1980.
Hubregtse, J.	"Planar Circuit Fabrication Facilities - The Bonding of Metals to Alumina and Quartz for Microwave Integrated Circuits", Microwave Technology Seminar, Monash University, December 1980.
Ja, Y.H.	"Phase Center Location of a Paraboloidal Reflector Antenna with an Axially Defocused Feed", IEEE Transactions on Antenna and Propagation, Vol. AP-28, No. 6, November 1980.
Ja, Y.H.	"On the Horizontal Field Variation of a Discrete Circular Array Around a Large Cylinder", Proceedings IREE Australia, Vol. 41, No. 4, December 1980.
Ja, Y.H.	"Dependance of the Minimum Resolvable Separation of Two Coherent Point Sources on their Relative Phase", Communications in the Proceedings of the IREE Australia, September 1980.
Jenkins, G.K.	"Mohammed's Dilemma - The Wall-Socket Bulldozer", 1980 ACS National Microcomputer Conference, July 1980.
Johansen, E. & Reeves, G.K.	"Using a SEM for Electron Beam Writing", Journal of Applied Physics E: Scientific Instruments, Vol. 14, 1981.
Jolley, W.M.	"Analysis of Delays by Counting Events", Australian Telecommunication Research, Vol. 14, No. 2, 1980.
Jones, P.S. & Tirtaatmadja, E.	"The Field Investigation of New Customer Services", ANZAAS Conference, Adelaide May 1980.
Kirton, P.A., Dart, S.A. & Duc, N.Q.	"Application of Specification and Description Language (SDL) to a Draft Transport Service Specification" (OSI-81-10), CCITT Study Group VII, (Data Communication Networks), Kyoto, Japan, April 1981.
Lawson, I.C., Hicks, P.R. & (De Jong, H. Engineering Department, Headquarters)	"Field Strength Survey Techniques for Mobile Radio Services", Australian Telecommunication Research, Vol. 15, No. 1, 1981
Martin, A.L. (& Harrison, H.B., Royal Melbourne Institute of Technology)	"Electrical Properties of Proton and Deuterium Ion Implanted N-Type GaAs", Journal of Applied Physics 51(5), 1980.
Meggs, P.F.	"Mechanical Considerations", Microwave Technology Seminar, Monash University, December 1980.
Millott, L.J.	"A General Class of PAM Equalizers", IEEE Transactions on Communications, Vol. COM-28, No. 6, June 1980.
Millott, L.J. & Smith, B.M.	"The Calculation of the Mean Square Error of SSBAM Class 4 Partial Response Data Signals Due to Slope, Sag and Ripple Group Delay Components", Electronics Letters, Vol. 16, No. 13, June 1980.
Mitchell, G.G.	"Plastics Encapsulation of Integrated Circuits", Telecommunication Journal of Australia, Vol. 30, No. 2, 1980.
Morgan, R.J. (& Thurman, W.H., Engineering Department, Headquarters)	"Optical Fibre Transmission Systems. A Review of Present State of Development and Factors Related to Application in National Telecommunication Networks", IE Australia, Transactions on Electrical Engineering, Vol. EE16, No. 3, September 1980.
Murphy, J.V. & Bundrock, A.J.	"11 GHz Broadband Tropospheric Radio Propagation", IREE Australia, Symposium, Problems in Radio Communication, Adelaide, September 1980.
Reeves, G.K.	"Specific Contact Resistance Using a Circular Transmission Line Model", Solid State Electronics, Vol. 23, May 1980.
Reeves, G.K.	"Fabrication of a Gunn Effect Digital Device", IREE Australia,Proceedings, Vol. 41, No. 4, December 1980.
Reeves, G.K.	"Planar Circuit Fabrication Facilities - Thick Film Technology for Microwave Integrated Circuits", Microwave Technology Seminar, Monash University, December 1980.
Rubas, J. & Warfield, R.E.	"Determination of Confidence Limits for the Estimates of Congestion", Australian Telecommunication Research, Vol. 14, No. 1, March 1980.

Sabine, P.V.H., (Donaghy, F., AWA, & Irving, D., University of NSW)	"Fibre Refractive Index Profiling by Modified Near-Field Scanning", Electronics Letters, Vol. 16, No. 23, November 1980.
Sabine, P.V.H., (Donaghy, F., AWA, & Irving, D., University of NSW)	"Fibre Light Acceptance for the Modified Near-Field Technique", Electronics Letters, Vol. 17, No. 7, April 1981.
Sandbach, E.F.	"Computers and Communications - Some Policy Aspects", Public Service Board 2nd Division Seminar on National Science Policy: Implications for Government Departments, Canberra, August 1980.
Sastradipradja, S.	"Antenna Characteristics for Point-to-Point Radiocommunication Systems", IREE Australia, Symposium on Problems in Radio Communications - Adelaide, August 1980.
Sastradipradja, S.	"Antenna Testing Facilities - The Characterisation of Small Earth Station Antennas", Microwave Technology Seminar, Monash University, December 1980.
Slavik, Z.	"Electrolytic Regeneration of Etching Solution for Printed Wiring", 5th Australian Electrochemistry Conference, University of Western Australia, Perth, August 1980.
Smith, B.M.	"Mathematics in Transmission Systems", ANZAAS Conference, Adelaide, May 1980.
Smith, B.M.	"Data Communication: A Telecom Perspective", ANZAAS Conference, Adelaide, May 1980.
Smith, R., Millott, L.J. & Morgan, R.J.	"The Increasing Requirement for Precise Timing in Digital Telecommunications", IREE Australia, Precise Time and Frequency Conference, Adelaide, August 1980.
Steel, J.	"Digital Radio Concentrators for Remote Area Communication", IE Australia, General Engineering Conference, Canberra, March 1981.
Steel, J.	"Digital Radio Concentrator (DRC) for Remote Areas", IE Australia/IREE Australia, Conference on Digital Systems Design, Sydney, May 1980.
Steel, J.	"Digital Radio Concentrator System for Remote Areas", ANZAAS Conference, Adelaide, May 1980.
Steel, J. & Burton, J.	"Australian Engineering Innovation", The Commonwealth Professional, October 1980.
Stevens, A.J.	"Automated Battery Testing", Microprocessor System Conference, Sydney, November 1980, Sponsored by IREE Australia and IE Australia.
Stone, G.O.	"RF Properties of Planar Circuits - Performance Limitations Above 10 GHz", Microwave Technology Seminar, Monash University, December 1980.
Subocz, M.	"Proposed Corrections to Recommendation Q.703 (No. 7 Signalling Link)", CCITT Study Group XI, Com XI-No. 8, Geneva April 1981.
Subocz, M.	"Detection of Continuous Flag Transmission in the No. 7 Common Channel Signalling System", CCITT Study Group XI, Com XI-No. 9, Geneva, April 1981.
Symons, F.J.W.	"Representation Analysis and Verification of Communication Protocols", NATO ASI - New concepts in Multi-User Communications, University of East Anglia, Norwich UK, August 1980.
Symons, F.J.W.	"Introduction to Numerical Petri Nets, A General Graphical Model of Concurrent Processing Systems", Australian Telecommunication Research, Vol. 14, No. 1, March 1980.
Symons, F.J.W.	"The Verification of Communication Protocols Using Numerical Petri Nets", Australia Telecommunication Research, Vol. 14, No. 1, March 1980.
Tjio, H.S. & Richards, D.R.	"Planar Circuit Fabrication Facilities - Phototools for Planar Circuit Fabrication", Microwave Technology Seminar, Monash University, December 1980.
Trainor, R.L.	"Radio and Terrestrial Time Signals in Australia", IREE Australia, Conference on Precise Time and Frequency, Canberra, August 1980.
Trainor, R.L.	"Remote Control of Precision Oscillators", IREE Australia, Precise Time and Frequency Conference, Canberra, August 1980.
Wragge, H.S.	"The Architecture of Contemporary Telecommunication Systems", IE Australia/IREE Australia, Conference on Digital Systems Design 1980, Sydney, May 1980.
Wragge, H.S.	"Modern Trends in Customer Interconnection", ANZAAS Conference, Adelaide, May 1980.

LECTURES AND TALKS

Albertson, L.A.	"Tele-Education in Australia: The Bird and Beyond", Seminar, Deakin University, Geelong, November 1980.
Albertson, L.A.	"The Human Faces of Technology", IE Australia, Gippsland Group, Institute of Advanced Education Churchill, June 1980.
Albertson, L.A.	"The Human Faces of Technology", Engineer's Luncheon Club, Adelaide, August 1980.
Albertson, L.A.	"Insights into the Impact of Telecommunications Upon Society", S.A. Division of the Telecom Society, Adelaide, August 1980.
Ayre, R.W.A.	"Transmission Measurements on Optical Fibres: Two Practical Measurement Systems by Telecom Research Laboratories", 5th Australian Workshop on Optical Communications, Monash University, December 1980.
Ayre, R.W.A.	"Optical Fibres", Industrial Electrical Engineer's Society, Melbourne, February 1981.
Baker, F.C.	"Pyrolysis-Gas Chromatography: Some Observations on the Accuracy of Analytical Pyrolysis Temperatures", Analytical Chemistry Group of Royal Australia Chemical Institute, Clunies Ross House, Parkville, September 1980.
Barrell, K.F.	"Standardised Launching Conditions for Optical Fibre Transmission Measurements", 5th Australian Workshop on Optical Communications, Monash University, December 1980.
Campbell, J.C.	"Digital Transmission in Cables", Workshop on Digital Signals Transmission and Processing, Department of Electrical Engineering, Royal Melbourne Institute of Technology, September 1980.
Cassidy, M.	"Future Business Communications", St. Kilda Rotary Club April 1981.
Clark, G.D.S.W.	"Whither the City", Transport Branch, IE Australia, South Australia Division, Adelaide, May 1980.
Davidson, R.I.	"Public Information Systems", Presentation to Branch Executive Committee of Australian Computer Society Incorporated, Victoria Branch, October 1980.
Dickson, G.J.	"Use of State Transition Diagrams to Specify Data Protocols", Part of Packet Switching Course, Technisearch, Royal Melbourne Institute of Technology, February 1981.
Duc, N.Q.	"A Performance Monitoring System for Data Transmission Circuits", Technical Presentation at Meeting of the Special Interest Group on Data Communications (SIGCOM) of the Australian Computer Society, May 1980.
Fowler, A.M.	"A Multi-Microprocessor Controlled Relay Tester", Melbourne Division of IREE Australia, Clunies-Ross House, Parkville, February 1981.
Gerrand, P.H.	"An Overview of SDL and its use in Australia and Overseas", Headquarters Engineering and Research Departments, October 1980.
Gibbs, A.J.	"Crosstalk in Multipair Cable", University of New South Wales, August 1980.
Harris, R.J.	"Optimal Design of a Switching Stage in a Telecommunications Network", Australian Society for Operations Research, S.A. Chapter, Adelaide, October 1980.
Heinze, G.C.	"Recent Trends in Computer Graphics", Association of Computer Aided Design Seminar, Melbourne, May 1980.
Johansen, E., Hubregtse, J., Williamson, W.J. & (Kohn, E., AEG-Telefunken)	"YAG Laser Annealing of Germanium-Silver Based Contacts to GaAs", 6th European Specialist Workshop on Active Microwave Semiconductor Devices 1980, Darmstadt, Germany, May 1980.
Lowing, J.R.	"Applications of Secondary Ion Mass Spectroscopy", Seminar, Australian X-Ray Analytical Association, Victorian Branch, Monash University, September 1980.
Quan, A.Y.C. & (Hall, L., Engineering Department Headquarters)	"A High Capacity Optical Fibre Field Experiment", 5th Australian Workshop on Optical Communications, December 1980.
Rosman, G.	"Stimulated Raman Scattering from Some Experimental AWA Single Mode Fibres", 5th Australian Workshop on Optical Communications, Monash University, December 1980.
Sabine, P.V.H., (Donaghy, F., AWA & Irving, D., University of NSW)	"Tunnelling Attenuation and the Modified Near-Field Scanning Technique", 5th Australian Workshop on Optical Communications, Monash University, December 1980.

Sabine, P.V.H., (Donaghy, F., AWA & Irving, D., University of NSW)	"Modified Near-Field Scanning", 5th Australian Workshop on Optical Communications, Melbourne, December 1980.
Sandbach, E.F.	"Research and Development in Telecom Australia", Lecture Series, Physics in Australia, Physics Faculty, Australian National University, Canberra, February 1981.
Sandbach, E.F.	"Computers and Communications, Some Policy Aspects", Senior Management Conference, PSB Conference, Department of Science and Environment, Canberra, September 1980.
Sandbach, E.F. (& Martin, R.G., General Manager, Engineering, Headquarters)	"Forward Planning/Future Developments", No. 34, RAAF Course, (Staff College), Melbourne, September 1980.
Sheridan, D.E.	"Planar Circuit Fabrication Facilities", Microwave Technology Seminar, Monash University, December 1980.
Steel, J.	"Radiotelephone Services in Rural and Remote Areas", Eastern and Mountain District Radio Club, Victoria, Nunawading Civic Centre Complex, June 1980.
Stephens, T.D.	"Measurement of Optical Receiver Sensitivity Using a Fibre Impulse Response Simulator", 5th Australian Workshop on Optical Communications, Monash University, December 1980.
Stephens, T.D.	"Reduction of Distortion Using Multi-Loop Feedback", Department of Electrial & Electronic Engineering, University of Western Australia, February 1981.
Vizard, R.J.	"Integrated Services Digital Networks", Telecommunication Society of Australia, Victorian Branch, April 1981.
Vizard, R.J., Millsteed, G.K., Hunter, M.A.F. & Subocz, M.	"PCM Signalling", Development Division, Headquarters, August 1980.
Wragge, H.S.	"Overview of Communications in Australia", Australian Telecommunications User Group, Sydney Chamber of Commerce, March 1981.
Wragge, H.S.	"Future Developments in Telecommunications Technology", Data General Users Group, Melbourne, October 1980.

RESEARCH LABORATORIES REPORTS

Report No.	Author	Title
7009* Addendum 1	P.J. Gwynn	Earthing Materials for Lead Sheathed Cables
7089*	G.J. Barker	Processing of Prototype Plated-Through-Hole Printed Wiring Boards
7253*	R.B. Coxhill	Instrumentation Associated With Measurements on an Experimental Synchronous Digital Data Network
7254	R.I. Webster	Microprocessor Control of Clock Phase Measurements on an Experimental Synchronous Digital Data Network
7258	G.C. Heinze	Preparation of Microelectronic Phototools Using an Interactive Graphic System
7260	A.J. Stevens	High Speed Pseudo Random Binary Noise Generator
7263*	J.L. Snare & N.Q. Duc	Performance of two 64 kbit/s Baseband Data Modems Under Gaussian and Impulse Noise Conditions
7266*	G. Brinson	Report on Overseas Visit - July 1977

Report No.	Author	Title
7276	C.D. Barling	A General Purpose Test/Meter Unit
7283	G.K. Reeves	The Operation and Fabrication of a Schottky Barrier Gate Gunn Diode
7290*	J.C. Campbell	The Crosstalk Interference From Primary Level PCM Signals Into Other Services and Systems
7292*	G.W.G. Goode	Cable Pressure Alarm Transducers
7293	G.K. Reeves	A New Technique for the Measurement of Specific Contact Resistance
7297	R.N. Swinton	AMI/HDB3 Line Encoder and Decoder
7308*	I. Dresser	An Event Sequence Indicator for Control Circuits
7318	R.K. Flavin	Automatic Telephony to Remote Areas Using the Canadian Hermes Satellite
7320	N.Q. Duc & R.B. Coxhill	A Microprocessor Controlled Data Test Set: Facilities; Aspects
7323*	G.W.G. Goode	Heat & Noise Discomfort in Public Telephone Cabinets
7325*	R.A. Frizzo	A Microprocessor Based Telephone Metering System
7332*	S. Georgiou	A Survey of Insulation Materials Used for Integrated Circuit Sockets
7333	Z. Slavik	Electrolytic Regeneration of Etching Solutions for Printed Wiring
7338*	G. Nicholson	Timing Jitter in a Chain of PCM Regenerators
7341	Z. Slavik	Solvent Composition for Substrate Cleaning in the Production of Thick Film Circuits
7343	G.K. Reeves	A Fabrication Technique for GaAs MESFETS
7345*	R.N. Swinton & L.J. Millott	Test Modules for a Prototype Barrage Tester
7346	R.K. Flavin	Preliminary Prediction of Earth Space Path Rain Attenuation Above 10 GHz in Australia
7347*	G. Brinson	Profiling the Thick Film Furnace
7348*	E. Vinnal & D. Burger	Measurement of Electromagnetic Radiation Levels
7349*	A.Y.C. Quan	Optical Fibre Communication Systems - Report on Overseas Visit, September/October 1979
7351*	G.J. Dickson	Overseas Visit 1979 - Packet Switching Trends and Techniques
7355*	P.G. Potter	Measurement of Third Circuit Crosstalk Contributors on PIUT Cable
7356*	P.G. Potter	Crosstalk Measurements From PCM Housings on PIQL Cable
7358	R.K. Flavin	Earth Space Path Rain Margins Above 10 GHz in Australia
7359*	H.J. Ruddell, D.J. Adams & R.J. Boast	Comparison of Polymers for Telephone Handsets
7360*	F.C. Baker & K.G. Mottram	Evaluation of Aluminium Architectural Finish "Sanodal"
7361*	G.W.G. Goode	Insulation Repairs for Plastics - Insulated Cables
7362*	G.K. Jenkins	A Survey of Communicating Word Processors
7364*	J.C. Campbell	The Crosstalk Interference from Baseband Data Signals Into Other Systems and Services
7365*	R.L. Reid	2, 8 and 34 Mbit/s PRBN Generator
7368*	A.Y.C. Quan & J.B. Carroll	Optical Time Domain Reflectometry Measurements
7370*	R.A. Seidl	The TACONET Plot 10 Graphics Facility
7373*	G.W.G. Goode	Static Electricity on Laboratory Floors

Report No.	Author	Title
7374*	K.E. Keir	A Comparison of Specialised Phosphate Type Metal Protective Coatings
7375*	A.J. Murfett	Investigation of Degraded Photovoltaic Solar Modules from Papua New Guinea
7376	R.P. Coutts	Digital Transmission Over Radio Systems: Overseas Visit Report
7377*	Y.H. Ja	Report on Overseas Visit - October/November 1979
7379*	G.J. Barker	Report on Overseas Visit - September/October 1979
7380	F.J.W. Symons	Representation Analysis and Verification of Communication Protocols
7381*	H.J. Ruddell & L.G. Powell	Grilamid L20G Black 9563 - Nylon 12
7383*	R.A. Frizzo & A.I. Miles	A System for Downloading Microprocessor Object Code From TACONET
7387	R. Horton & M.J. Durrant	Digital Radio Test: Lonsdale Exchange to Mt. Gellibrand
7388*	R. Smith	Digital Systems & Networks - A Report on an Overseas Visit - March/April 1980
7390	G.J. Dickson	Formal Specifications of Data Communications Protocols Using the Specification and Description Language
7392*	R.J. Harris	Dimensioning of Queueing Systems
7393*	G.M. Codsi	Documentation of SPC Exchange Systems Using Processing State Transition Diagrams
7395*	G. Nicholson	Jitter Measurements of a Digital Line System Using Step Index Optical Cable
7396*	J. Der	Report on Overseas Visit - October/November 1978
7405*	P.R. Latoszynski	Accelerated Ageing of Plastic Heat Exchanger Plates
7407	K.G. Mottram	The Solderability of Bare Copper and Tin Coated Copper Wire
7408*	K.E. Keir	Stress Corrosion Cracking in Stainless Steel Bands at Radio Australia, Carnarvon
7410	K.F. Barrell & R.W.A. Ayre	Optical Fibre Transmission Measurements I: Loss Spectrum
7413*	G.M. Codsi	Introduction to Specification and Description Language: Australian Extended Version (SDL-A)
7415	F.J.W. Symons	Report on Overseas Visit Concerning the Analysis and Verification of Communication Protocols and Formal Description Techniques for the Specification of Data Communication Protocols
7416*	F.J.W. Symons	Report on Overseas Visit Concerning Layered Model Architectures and Formal Description Techniques for the Specification of Data Communication Protocols
7422*	E. Vinnal	Refinements to Rain Attenuation Prediction Method for Terrestrial Radio Paths
7423*	E.J. Bondarenko	Hazards and Precautions in Excavating Near Power Cables
7424*	R.J. Vizard	Overseas Visit Concerning Development of Techniques for Digital Local Areas and Integrated Services Digital Network
7427*	B.A. Chisholm	Investigation of Insect Damage to Nylon Jacketed Cable - Cungena, South Australia
7432	A.J. Jennings	Equivalent Circuits of Waveguide Irises

Note: The reports marked * are not available beyond Telecom Australia, in addition 7 reports of restricted distribution were produced.

Staff Affiliations with External Bodies

Some of the staff of the Laboratories are active members of the governing bodies of educational establishments, learned societies and professional bodies and institutions. Staff members also serve on a variety of national and international committees; these include:

NATIONAL PROFESSIONAL BODIES (EDUCATIONAL)

Victorian Education Department
Science Laboratory Standing Committee — G. Flatau

Victorian Post-Secondary Education Commission
Accreditation Board – Engineering Sub-Committee — M. Cassidy

Footscray Institute of Technology
Course Advisory Committee — H.S. Wragge, G.F. Jenkinson

Swinburne College of Technology
Electrical Engineering Departmental Advisory Committee — L.H. Murfett
Master of Engineering Ad Hoc Advisory Committee — L.H. Murfett

Caulfield Institute of Technology
Course Advisory Committee — H.S. Wragge

Royal Melbourne Institute of Technology
Special Funds Committee — M. Cassidy
Communication and Electronic Engineering Department Advisory Committee — M. Cassidy
Master's Degree in Systems Engineering Advisory Committee — M. Cassidy
Course Advisory Committee — R.D. Slade

NATIONAL & STATE PROFESSIONAL BODIES

Australian National Committee for Radio Science — E.R. Craig

Radio Research Board — E.F. Sandbach

Computer Research Board — E.F. Sandbach

Victorian CSIRO State Committee — E.F. Sandbach

Australian Institute of Science Technology
Victorian Branch Council — F.C. Baker

The Institute of Radio and Electronics Engineers, Australia
Publications Board — R. Horton
Melbourne Committee — R. Horton

Australian Acoustical Society
Victorian Division Committee — D.A. Gray
Federal Council — D.A. Gray

Telecommunications Society of Australia
Council of Control — E.A. George, H.S. Wragge

Board of Editors: "Australian Telecommunication Research" — H.S. Wragge, J. Billington, G. Flatau, P.H. Gerrand, A.J. Gibbs, G.F. Jenkinson, P.S. Jones, I.P. Macfarlane, L.H. Murfett

Board of Editors: "Telecommunication Journal of Australia" — D.A. Gray

Standards Association of Australia (SAA)
Council of Executive and Staff Committee — E.F. Sandbach
Telecommunications and Electronics Standards Board and Executive Committee — G. Flatau, E.F. Sandbach
Australian Electrotechnical Committee — E.F. Sandbach, G. Flatau
Acoustic Standards Committee — D.A. Gray
Plastics Industry Standards Board — R.D. Slade
Co-ordinating Committee on Fire Tests — F.C. Baker
Metallography Committee — T.J. Keogh

Technical Committees

Acoustic Standards
- Instrumentation and Techniques for Measurement of Sound — E.J. Koop

Chemical Industry Standards
- Adhesives — F.C. Baker
- Heavy duty Paints — F.C. Baker

Computers and Information Processing
- Data Communications — G.J. Dickson
- Open Systems Interconnection — P.H. Gerrand

Electrical Industry Standards
- Indicating and Recording Instruments — J.M. Warner
- Electrical Insulating Materials — G. Flatau
- Dry Cells and Batteries — G.G. Mitchell
- Electrolytes — F.C. Baker
- Control of Undesirable Static Charges — G.W.G. Goode
- Copper & Copper Alloy — K.G. Mottram

Mechanical Engineering Industry Standards
- "Engineers" Hand Tools — P.F. Meggs
- Tensile Testing of Metals — K.G. Mottram
- Solders — K.G. Mottram
- Vibration & Shock ME Measurement & Testing — I.A. Dew

Metal Industry Standards
- Zinc and Zinc Alloys — K.G. Mottram
- Lead and Lead Alloys — K.G. Mottram
- Coating of Threaded Components — R.D. Slade
- Galvanised Products — R.D. Slade
- Electroplated and Chemical Finishes on Metals — R.D. Slade
- Metal Finishes Sub-Committee — T. Keogh

Plastics Industry Standards
- Polyethylene Insulation of Sheath Electric Cable — H.J. Ruddell
- Methods of Testing Plastics — G. Flatau
- Outdoor Weathering of Plastics — G.W.G. Goode
- Polytetrafluoroethylene — B.A. Chisholm
- Flammability of Plastics — H.J. Ruddell
- Mechanical Testing of Plastics — B.A. Chisholm
- ISOTC 61 Plastics Advisory Committee — B.A. Chisholm, H.J. Ruddell
- Safety Helmets — R.J. Boast

Safety Standards
- Industrial Safety Gloves — F.C. Baker

Telecommunications and Electronics Industry Standards
- Capacitors and Resistors — G. Flatau, D. McKelvie
- Printed Circuits — D.E. Sheridan
- Wires and Cables — G. Flatau
- Semi-Conductors — I.P. Macfarlane
- Environmental Testing — G. Flatau
- Reliability of Electronic Components and Equipment — G. Flatau
- Electro-Acoustics and Recording — E.J. Koop

National Association of Testing Authorities (NATA)

Electrical Registration Advisory Committee	E.F. Sandbach J.M. Warner
Assessor for Environmental Testing	G. Flatau
Assessor for Laboratories Engaged in Testing Plastics	B.A. Chisholm
Assessor for Laboratories Engaged in Acoustical Testing	E.J. Koop
Assessor for Laboratories Engaged in Electrical Testing	J.M. Warner E. Pinczower J.B. Erwin

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 Electrotechnical Commission (IEC).
- The International Standards Organisation (ISO).
- The Asia Electronics Union (AEU).
- The International Federation of Documentation, Committee for Asia and Oceania (FID/CAO)

In particular, staff of the Research Laboratories held offices as listed in the following International Bodies during the year:

• Chairman, CCIR Study Group 4 (Fixed Service using Satellites)	E.R. Craig
• Chairman, CCITT Sub-Group XI/3-1 (Specification and Description Language for SPC Switching Systems)	P.H.Gerrand
• IEC Joint Co-ordination Group – Optical Fibres, Working Group 4	A.Y.C. Quan
• International Confederation for Thermal Analysis	F.C. Baker
• Teletraffic Engineering Training Project TETRAPRO, ITU/ITC	J. Rubas
• Special Rapporteur, CCITT SG XVIII	R. Smith
• IEC TC50, WG15	I.A. Dew

Industrial Property

It is a policy of Telecom Australia to protect its interests in any worthwhile industrial property, notably patentable inventions but also registerable designs, which might be generated by its staff in the course of their work. Many of the inventions patented by Telecom Australia have been made by the Laboratories' staff, and the staff of the Laboratories also contribute to assessments of the 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 industrial property held by Telecom Australia. The property includes applications for letters patent and registered designs.

PATENT APPLICATIONS AND PATENTS

	Patent Application Numbers			
Invention Title (Inventor/s)	**Provisional Specification**	**Complete Specification**	**Patent Number (if granted)**	**Country**
Method and Apparatus for Testing Subscribers' Telephone Instruments in Situ under Service Conditions (J.F.M. Bryant & R.W. Kett)		233699	3,261,926	USA
Self Adaptive Filter and Control Circuit (L.K. Mackechnie)	65671/69	23649/70 P2063183.8 60513/70 33,333A/70 70-45,859 17270/70 98800	448805 2063183 1,334,250 913733 70-45859 362,763 3,732,410	Australia Germany Britain Italy France Sweden USA
Tip Welding Means (E.J. Bondarenko)	49395/70	10361/70 4714/71	455004 3,657,512	Australia USA
Analogue Multiplier (H. Bruggemann)	43033/68	43033/68 855543	414207 3,629,567	Australia USA
Apparatus for Routing Discrete Telecommunication Signals (A. Domjan)	61428/69	19808/70	448958	Australia
Apparatus for Monitoring a Communications System and a Detector Therefor (J.A. Lewis)	PA1474/70	29415/71	458997	Australia

Invention Title (Inventor/s)	Patent Application Numbers Provisional Specification	Complete Specification	Patent Number (if granted)	Country
Monostable and Bistable Devices (I.P. Macfarlane)	PA2298/70	32612/71	465242	Australia
Control of Operation of a System (N.W McLeod)	PA2035/70	31550/71 166819 56442/71	466670 3,745,418 888597	Australia USA Japan
Apparatus for Use in Feeding Alternating Electric Current to a Load and an Antenna including such Apparatus (R.P.Tolmie)	PA7174/71	49340/72	484853	Australia
Smoke Detector (L. Gibson & D.R. Packham)	PA9230/72	56513/73 8221/73 25660/73 63703/73 367260	482860 564238 1,419,146 3,874,795	Australia Switzerland Britain Japan USA
Method and Apparatus for Detecting the Presence of Signal Components of Pre-determined Frequency in a Multi-frequency Signal (A.D. Proudfoot)	PB24/72	59138/73 387855 178402	480006 3,882,283 984,068	Australia USA Canada
Nephelometer with Laser Source (L. Davidovits)	PC4286/75	20511/76	507518	Australia
Tamperproof Telephone Apparatus (C.M. Hamilton & J.A. MacCaskill)	PC5285/76	23264/77	502780	Australia
Fault Monitoring Apparatus (R.W.A. Ayre)		17251/76	504585	Australia
Optical Waveguides and a Method of Manufacture Therefor (P.V.H. Sabine & P.S. Francis)	PC4499/76	21232/77	507723	Australia
Method and Apparatus for Reducing Phase Jitter in an Electrical Signal (K. Webb)		24926/77	510034	Australia
Programmable Digital Gain Control System for PCM Signals (A.M. Fowler)	PD3192/78	43735/79		Australia
Transversal Filter (K.S. English)	PD7273/79	54367/80 109589/80 00263/80		Australia USA Japan
Fibre Optic Termination (P.V.H. Sabine)	PD6157/78	50841/79 P2938649 G79271195 126329/79 078465		Australia Germany Germany Japan USA
Noise Assessment of PCM Regenerators (A.J. Gibbs)	PD6790/78	52160/79 793,025,727 339841 148305/79 093228		Australia Europe (designating: France Germany Britain Italy Holland Switzerland) Canada Japan USA

Visitors to the Laboratories

The work of the Laboratories often calls for close liaison with various Australian universities and other tertiary colleges 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 more directly to the work of the Laboratories as consultants.

Laboratories' activities are also demonstrated to specialist and non-specialist groups from professional societies, government departments, universities and other centres of tertiary education. This is achieved through arranged inspection tours and exhibitions, 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, universities, government departments and manufacturing companies have also visited the Laboratories. Other overseas visitors have participated in the work of the Laboratories for longer periods to further their training in telecommunications technology. Often, these visitors are UN/ITU and Colombo Plan Fellows, whose visit to the Laboratories is a part of a more extensive period of training in Telecom Australia.

Some of the groups and individuals who visited the Laboratories during the year ended 30 April 1981 are listed below:

All States Lightning Protection Conference - Delegates

Aeronautical Research Laboratories, Department of Defence - Staff

Australian Army, School of Signals, Watsonia Barracks - Final Year Students and Instructors

Australian Institute of Physics - Victorian Branch Members

Australian and Overseas Members of the Technical Co-operation Programme Sub-group S (Communications), during the 10th Meeting convened by Advanced Engineering Laboratory, Defence Research Centre, Salisbury, S.A.

Ballarat College of Advanced Education - Staff and Final Year Students

Dr. G.A. Burrell, Director of the Communications Advisory Council, New Zealand

Dr. G. Woffendale & Mr. P. de Chazal, CSIRO Division of Computing Research, Mr. T. Tsukamoto of FUJITSU/FACOM

Dr. P. Chung, University of N.S.W.

Deakin University - Dr. Tran and Engineering Students

Mr. R. de Graaf, Lecturer, Hobart Technical College

Mr. S.M. Eldredge, Telecom, S.A. (Development Training Programme -
GEC, UK)

External Plant Supervisors, Doncaster Lines School

Finance and Accounting Department, Victorian Administration

Dr. J. Fleming (Lecturer) and Senior Students - Department of Materials Engineering, Monash University

Messrs. Flor, Schwarz and Schmidt, Engineers from Deutsche Bundespost

Dr. R. Frater, CSIRO, Chief of Radiophysics Division

Graduate Officers - Induction Programme 1981

Mr. W. Griffiths (Philips, Australia) & Mr. E.S. Meijerink, (Philips, Holland)

Mr. Y. Higo, Optical Fibre Transmission Division, NEC, Japan

IFIP 8th World Computer Congress - Delegates

Mr. P. Lane, Technical Director, STC

Mr. R.B. Lansdown, CBE - and Senior Management from Department of Communications

Mr. Leithhead, Senior Lecturer, Department of Applied Chemistry, RMIT

Lines Supervisors from Supervisors Course at Doncaster Lines School

Mr. I. McKenzie, (General Manager) Philips (TMC) and Dr. de V. Gipps, Head, Research Department, Sydney (Philips)

Members of Industrial Electrical Engineers' Society

Monash University - Department of Physics, Staff and Final Year Students

Newly Appointed Engineers Class 1, Victorian Administration

Mr. R. Novak, Engineer from Swiss Posts, Telephones and Telegraphs

Plastics Technology Section RMIT - Staff and Students

Mr. Rosenhain (Managing Director) and Mr. Shea (Director) Myer Emporium Ltd., Melbourne

Senior Administrative Staff of Engineering Department, Development Division, Headquarters

Mr. J. Smirle, Department of Communications, Canada

Senior Staff of Industrial Relations Department, Headquarters

Dr. G. Starr, Senior Private Secretary to the Minister for Communications

Swinburne Institute of Technology - Staff and Final Year Electronics Students

Swinburne Technical College, Applied Science Department - Mr. J.D. Scott, Mr. D. Lyons and Senior Students

Supply Branch, Victorian Administration - Clerical Staff

Professor H.S. Tan, University of Malaya

Television Society of Australia, Melbourne Division

Dr. M. Terajima, Director, Electronic Equipment Development Division, NTTPC, Japan

Ms. H. Thyrvin, Mr. T. Norbye, Mr. Petersen, Exchange Students, International Association for Students in Business Administration and Economics (AIESEC)

Trainee Technical Officers - Victorian Administration - 1981 Intake

Overseas Visits by Laboratories Staff

It is an important responsibility of any viable organisation to keep abreast with developments and changes in particular fields of interest. To this end, the Laboratories arrange a programme of overseas visits each year during which members of staff interchange experience, technical knowledge, opinions and ideas. The visits are normally to other administrations, universities and industry, as well as to international forums and conferences of world telecommunications bodies and related organisations.

The following staff members have travelled overseas during the past year:
L.A. Albertson
A.J. Bundrock
G.D.W.S. Clark
E.R. Craig
G. Flatau
D.S. Geldard
G.F. Jenkinson
P.S. Jones
O.F. Lobert
G.L. Price
R.A. Seidl
G.K. Semple
R.D. Slade
R. Smith
I. Stevenson
F.J.W. Symons
E. Tirtaatmadja
R.J. Vizard

Assistance with Studies

The Laboratories have a policy of encouraging staff to further their educational qualifications and technical expertise by study in fields relevant to the work of the Laboratories. Professional staff are selected to pursue postgraduate courses, often leading to higher degrees, at universities and colleges of advanced education, or to broaden their expertise by working outside the Laboratories for short periods. Non-professional staff are also encouraged to seek higher technical or professional qualifications through part or full-time study. Incentives are offered in the form of paid study leave and other concessions for part-time studies, or of extended leave without pay for full-time studies.

The following professional staff have been encouraged to engage in postgraduate studies or to seek wider professional experience during the past year:

R.G. Addie, Postgraduate Scholarship, Monash University.

W. Cameron, Undergraduate Scholarship, R.M.I.T.

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 Radio Research Board and the Computer Research Board.

The Research Laboratories act as one channel for the provision of such support by Telecom, in particular, for research studies of 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 by usual sources of supply.

Current R&D contracts administered by the Laboratories concern the study topics or developmental projects listed below:
- Manufacturing Processes for Optical Fibres and Optical Fibre Cables
- Digital Reticulation in the Subscriber Distribution Network
- Speech Level Measuring Instrumentation
- Bird-proof Windows for Feeder Horns of Microwave Antennas
- A Video Switching Unit
- Ruby Laser Developments
- Test Instrumentation for PCM Systems
- A Phase Locked Loop Oscillator
- Automation of Printed Wiring Board Production Processes
- Resistance of Plastics to Termite Attacks
- Electric Field Strength and Noise Distributions Relevant to Mobile Radio Telephone Systems
- Proton Implantation in Gallium Arsenide
- Automated Generation of CHILL Code from Call State Transition Diagrams
- GaAs MESFET Modulation of Laser Diodes
- Pulse Dispersion in Optical Fibres
- Microwave Transistor Amplifiers
- Adaptive Digital Hybrids
- Social Network Analysis
- Software Reliability
- Field Investigation of New Customer Services
- Lidar Sounding of the Troposphere
- Fault Tolerant Microcomputer Systems
- Single Mode Transmission in Optical Fibres
- Time Reflectometry Techniques
- Optimal Dimensioning of Digital Networks

In addition, the Laboratories occasionally participate in joint projects with other national and international bodies such as the CCITT and CCIR.

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