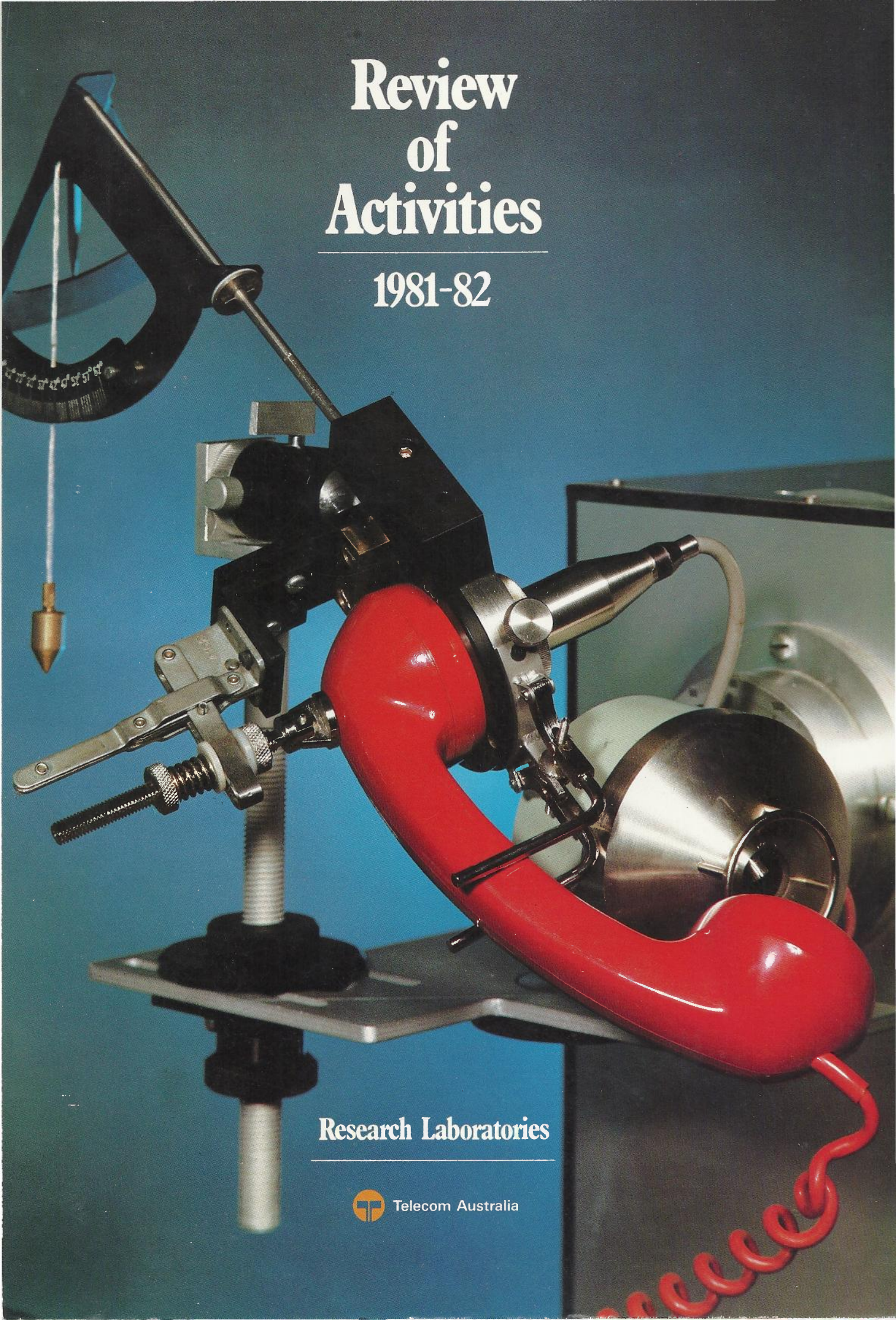
Review of Activities

1981-82



Research Laboratories

Telecom Australia

Review of Activities

1981-82

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770 Blackburn Road Clayton, Victoria 3168 Australia

Telecom Australia

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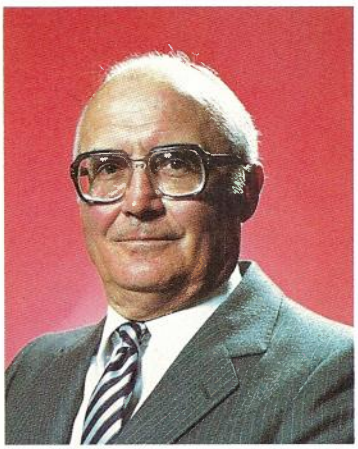
Foreword



This Review describes some of the projects and activities of Telecom Australia's Research Laboratories. It illustrates how the Laboratories fulfil their role of providing other Departments of Telecom Australia with technical advice on the latest developments in telecommunications science and technology or with assistance in the solution of technical problems arising in network operations. In this way, the Laboratories contribute to the planning, development and improvement of the telecommunications services provided by Telecom to the people of Australia.

Telecom Australia, like other administrations, is entering an era of rapid technological change made possible by the continuing "silicon revolution". This revolution has yielded microelectronic devices on one hand and optical fibres on the other. In turn, microelectronics technology has paved the way for the adoption of digital signal handling and computer control techniques, both of which are finding expanding application in telecommunications and computer-based services.

The silicon revolution is continuing apace. It promises a convergence of telecommunications and computer-based services because of their mutual interdependence for the realisation of their full potentials in the coming "information age". It also promises a diversification of the types of services which might be needed for future business, community or domestic purposes, and which might be provided in the future over public or private integrated services digital networks.

The future therefore presents a challenge to Telecom, which looks to its Research Laboratories to provide, through selective R&D activity, timely and competent advice on emerging technologies and their implications for future customer services and for the technological development of the network over which these future services will be provided.

R.G. Martin

R.G. Martin – Chief General Manager

The instrumental measurement of the Loudness Rating of telephones using an artificial voice and artificial ear is being applied in the Laboratories in relation to Telecom's reference standards for telephone transmission performance. Before the carbon microphone of a telephone is subjected to performance measurements using the Loudness Rating technique, it must be carefully pre-conditioned by subjecting it to a programme of precise rotations. The cover photograph shows a microphone conditioner developed in the Laboratories for this purpose, with the telephone handset clamped to the conditioner, with the artificial ear clamped to the telephone receiver, and with the whole assembly precisely positioned in relation to the artificial voice.

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 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, and the Director, Research, 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, will or could change the telecommunications services provided by Telecom to its customers, the technological nature or the technical performance standards of the systems used in the ongoing development of the telecommunications network, or the operational efficiency by which Telecom provides 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, seek to ensure that Telecom has available the necessary advice in the relevant fields of advanced science and technology to assist in the formulation and implementation of policies and plans for new or improved services, systems, service standards and operational practices. Through the application of their special expertise and facilities, the Laboratories also provide assistance to other Departments in Headquarters and the 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.

To fulfil these responsibilities, the Laboratories try to maintain 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 can 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 relevant technological or scientific fields.

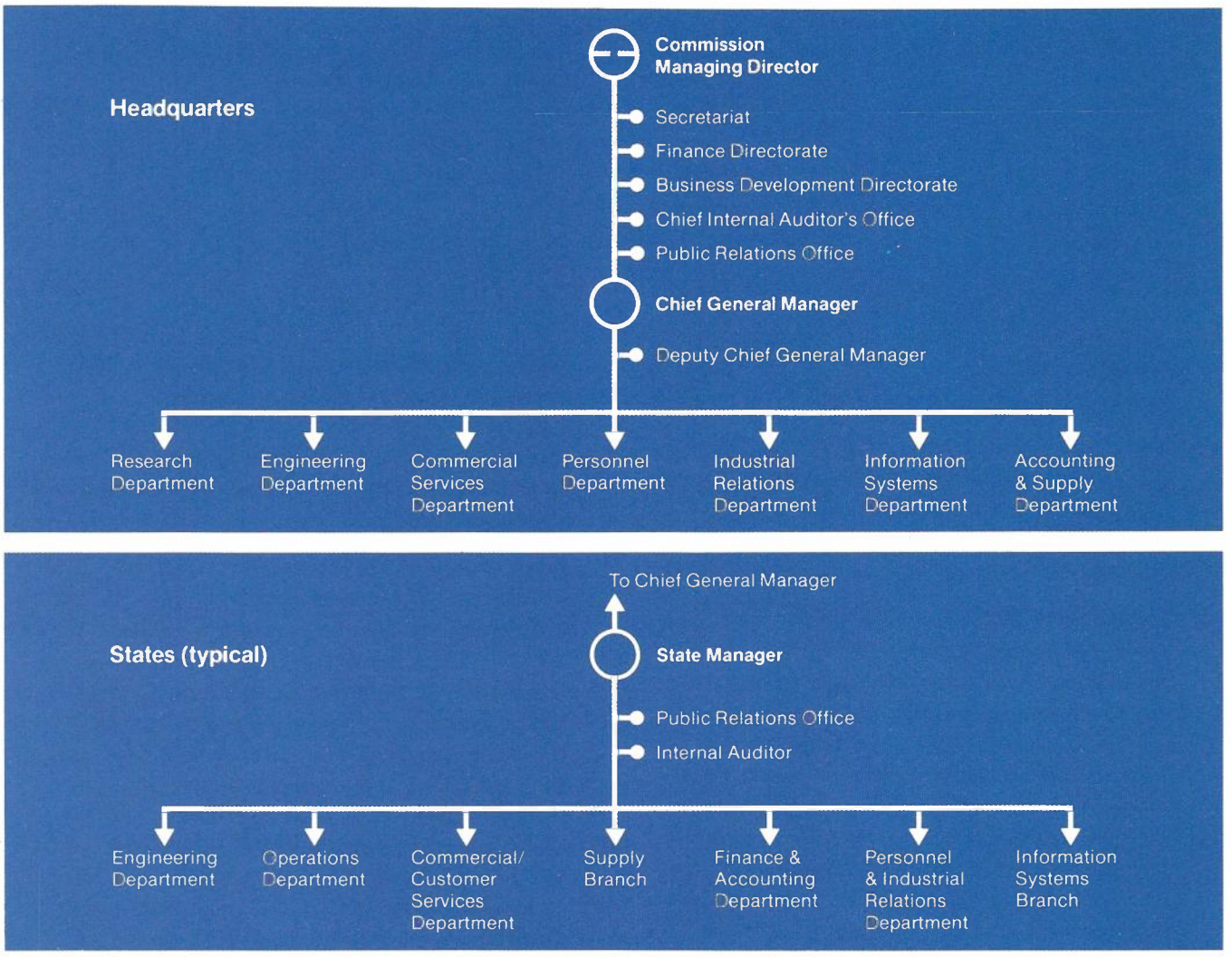
Most of the projects undertaken by the Laboratories, rather than being directed at product specifications, find their ultimate expression in the performance requirements incorporated in procurement specifications for the systems and equipment which are bought by Telecom from the international telecommunications 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. The Laboratories are also responsible for Telecom's scientific reference standards for the measurements 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 1981/82.



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

Items of Special Interest

Honours for Research Laboratories Staff

During 1981, two officers of the Research Laboratories were awarded Queen's Birthday honours. Each was admitted to membership of the Order of Australia (General Division).

Mr Kevin Bartlett, a Technical Officer in the Standards and Laboratories Engineering Branch of the Laboratories, received his award for services to Australian Rules football. The award was well deserved. Kevin is unique in the Australian Rules football world, in that at 35 years of age, he is still a top class footballer and is looking forward to at least two more seasons with the Richmond club. In his long League career, which began in 1965, Kevin has played continuously with the Richmond club. Among Kevin's records and notable successes are:

- the most (361) Victorian Football League games played by an Australian Rules footballer
- winning the Richmond club's Best and Fairest Award five times
- winner of the Norman Smith medal for Best Player in the 1980 Grand Final.

On the national scene in Australian Rules football, Kevin has played for Victoria in interstate matches on 20 occasions and in 1980, he captained the Victorian team in the State-of-Origin Carnival.

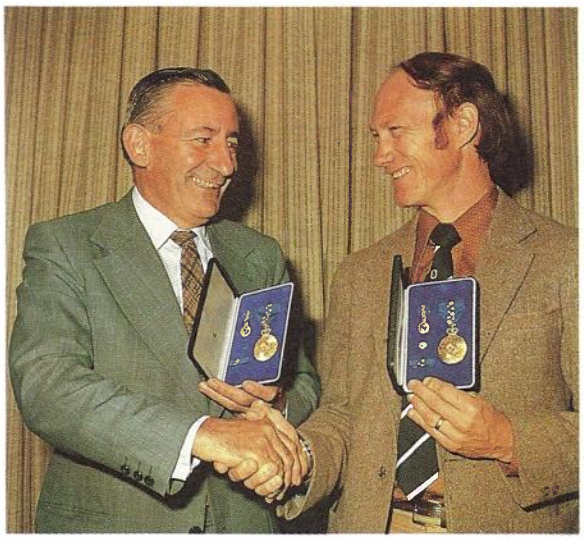
Mr Ed Sandbach, the Director of the Research Laboratories, received his award for public service. Mr Sandbach has spent most of his professional career as an Engineer in the Laboratories.

After graduating as a Bachelor of Science from Melbourne University, Ed joined the Research Laboratories in 1944 as an Acting Engineer in the Radio Section. Following a period of absence as a Cadet Engineer, during which time he also acquired the degree of Bachelor of Arts, Ed returned to the Laboratories in 1947 as an Engineer to engage in VHF and UHF multi-channel radio system developments. He was successively promoted to higher positions in the Laboratories and in 1964, he became Assistant Director-General, Apparatus and Services. In this position, he guided the activities of the Laboratories' Sections concerned with Physical Sciences and Standards and Laboratories Services.

From 1962, with the impending operational development of satellite communication techniques, Mr Sandbach became extensively involved in the activities of International Radio Consultative Committee (CCIR) Study Group IV (Space Systems and Radio Astronomy) and in Intelsat conferences, in association with personnel of the Overseas Telecommunications Commission (Australia). He led the Australian delegations to CCIR Plenary Assemblies in 1966, 1970 and 1974. He also participated in International Telecommunication Union (ITU) Administrative Space Conferences in 1963 and 1971, and the Plenipotentiary Conference during 1973.

At the inception of the Australian Telecommunications Commission on 1 July 1975, he was appointed Director, Research, assuming responsibility for all operations of the Research Laboratories.

For some years, he has been actively involved with various committees of the Standards Association of Australia and is currently Chairman of its Telecommunications and Electronics Standards Board. He is also Chairman of the Electrical Registration Advisory Committee of the National Association of Testing Authorities. Mr Sandbach is the Telecom representative on both the Radio Research and Australian Computer Research Boards, and is currently the Chairman of the Radio Research Board. He is also a Fellow of the Australian Academy of Technological Sciences.



Ed Sandbach (left) and Kevin Bartlett share congratulations

Distinguished Visitors

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 six notable visits which occurred during the year.

Visit by Mr. R.W. Brack, AO, Chairman of the Australian Telecommunications Commission
On 1 December 1981, Mr. Robert W. Brack, AO, the Chairman of the Commission, visited the Research Laboratories. The visit was a particularly significant occasion as Mr. Brack's appointment to this position had only been announced by the Minister for Communications on 15 November 1981.

Mr. Brack was welcomed to the Laboratories by Mr. E. Sandbach, the Director of the Laboratories and the six Assistant Directors. The ensuing discussions encompassed the role and functions of the Laboratories, its work programme, and its working relationships with other Departments of Telecom, other statutory bodies, private industry, research institutions and academia.

Mr. Brack also took the opportunity to meet a number of the staff of the Laboratories and to discuss with them particular projects and activities which they demonstrated in the laboratory. These included:

- the use of scanning electron microscopy for refractive index profiling of optical fibres and for other applications such as the detection of whisker growth in transistors
- optical fibre transmission techniques and systems and their potential future application in the Australian telecommunications network
- studies related to present and future stored program controlled switching systems, in particular those relating to investigations of the overload capacity of processors controlling large exchanges, which had made use of a processor monitoring instrument purpose-designed in the Laboratories for these investigations
- investigations of both human behavioural and technical aspects of teleconferencing and the potential of various possible service offerings in the Australian environment
- laboratory evaluations of the performance of solar cells in the Australian environment, conducted under the sponsorship of the National Energy Research, Development and Demonstration Council of Australia
- experimental work in thick and thin film technology and the general implications of microelectronics for telecommunications equipment of the future
- a range of projects concerned with the application of polymers in telecommunications cables, plant and equipment.

Visit by Associate Professor Sha Yu-Jun of the People's Republic of China
Associate Professor Sha Yu-Jun from the Radio Engineering Department of the Nanking Institute of Technology was accompanied by Dr. N.A. McDonald and Mr. Dan Kan Hu from the Department of Communication and Electronic Engineering, Royal Melbourne Institute of Technology, when he visited the Laboratories on 29 October 1981. The visitors discussed the role and activities of the Research Laboratories with staff of the Research Secretariat, before visiting the Radio Systems and Solid State Electronics Sections.

The staff of the Radio Systems Section outlined and discussed their project activities relating to the development of a digital radio concentrator system to provide automatic telephony services to customers in the remote parts of Australia. Laboratory investigations concerned with various aspects of the introduction of digital radio systems in the junction and trunk routes of the Australian network were also outlined.

In his visit to the Solid State Electronics Section, Professor Sha Yu-Jun met Dr. Y.H. Ja of the Laboratories and this provided one highlight of the visit, in that they confounded others present by discussing the work of the Section, in the Chinese language. The visitors discussed work related to investigations of optical devices and signal processing techniques, the potential application of holographic techniques in telecommunications, the use of optical techniques to derive refractive index profiles of optical fibres and developments of laser devices. The latter subject was of particular interest to Professor Sha Yu-Jun.

Visit by Mr. Malcolm King

Mr. M.G. King, accompanied by Mr. E.R. Banks, the Director of Telecom's Business Development Directorate, visited the Laboratories on 9 October 1981. Mr. King's visit was associated with his appointment by the Minister for Communications to report and make recommendations on the question of whether and to what extent competition should be permitted in Australia in the provision of telecommunications terminal equipment and related questions. Mr. King and Mr. Banks discussed the functional responsibilities of the Research Laboratories in Telecom Australia with the Director, Mr. E. Sandbach, and senior management of the Laboratories. They then inspected and discussed a number of laboratory projects, including those relating to the field investigations of new customer telephone services, the potential applications of optical fibre transmission systems in various parts of the Australian network for various purposes, developments in business communications systems and other studies related to the likely progression of developments of the Australian network and services in the ultimate realisation of the Integrated Services Digital Network (ISDN) concept.

Visit by Mr. J.S. Whyte, Deputy Managing Director, British Telecom

Mr. Whyte visited the Laboratories on 10 June 1981. After the usual welcome, the Director and Assistant Directors joined with Mr. Whyte to discuss the role and work programme of the Laboratories. Projects of mutual interest were those concerned with the adoption of digital techniques in the Australian network and the consequent progression from separate analogue telephony and digital data networks towards the ultimate realisation of the ISDN concept.

Aspects of particular interest were the synchronisation of digital networks and the extension of digital techniques into the local subscribers reticulation network to provide enhanced and diversified telecommunications services. Mr. Whyte also visited a number of laboratories, where staff demonstrated projects such as the refractive index profiling of optical fibres by scanning electron microscopy, digital radio system studies for junction and trunk applications, and the testing of the transmission performance of experimental optical fibre systems.

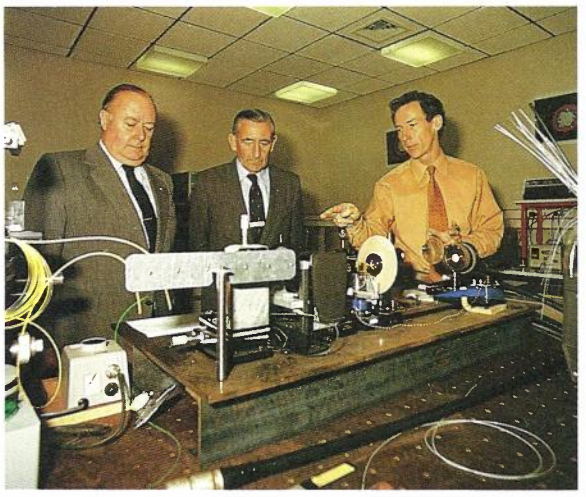
Visit by Dr. John Midwinter of British Telecom's Research Laboratories

Dr. Midwinter, Head of the Optical Communications Research unit in British Telecom's Research Laboratories, visited the Laboratories in December 1981. Dr. Midwinter was in Australia to participate in the 6th Optical Communications Workshop held at Monash University, Melbourne. During the Workshop and his visit, he exchanged information with Telecom Australia staff on research activities concerned with multi-mode and single mode optical fibres, systems and associated devices.

Visit by Mr. Alex Curran, Assistant Deputy Minister, Space Programs, Department of Communications, Canada

On 20 November 1981, Mr. Curran visited the Laboratories in the company of Mr. Leon Stryker of the Canadian Consulate in Melbourne. The visit was part of a more extensive programme of discussions between Mr. Curran and Telecom management.

After general discussion of the role and activities of the Laboratories with Mr. Ed Sandbach and senior Laboratories' management, the visitors toured a number of Laboratories' Sections and discussed a range of typical projects with investigatory staff "on site" in the laboratory. The projects of major interest to the visitors concerned investigations of digital radio transmission techniques and systems, antenna design and radio propagation studies, and work concerned with new types of microwave component technology and its application in satellite communications systems.



Mr. Robert Ayre (right) outlines techniques used in the Laboratories to characterise the transmission performance of optical fibres to Mr. Robert Brack (left) and Mr. Ed Sandbach

Visitors and host (from left to right): Mr. O. Lobert, Research Laboratories and visitors, Professor Sha Yu-Jun, Mr. Dan Kang Hu and Dr. N.A. McDonald

Extension Course on Basic Digital Transmission System Theory for Telecom Australia Engineers

The adoption by Telecom Australia of various digital transmission systems is increasing in momentum. The use of data modems and pulse code modulation line systems in junction cables is well established. High speed data-above-voice and data-in-voice transmission systems are being evaluated for adoption in the new digital data networks planned for implementation in 1982/83. Digital techniques applicable in the near future in short or long haul transmission over radio, coaxial cable or optical fibre systems are under active study, and techniques for digital subscriber reticulation in the longer term are also the subject of Telecom's research.

Against this background, the management of Telecom recognised a need to take urgent action to develop its engineering knowledge-base in digital transmission theory and techniques. Consequential discussions with Monash University led to the collaborative development in 1981 of a two-week full-time extension course for Telecom engineers on "Basic Digital Transmission System Theory". The development of the course was led by Dr A.J. Gibbs of the Transmission Branch of the Laboratories and Professor W.A. Brown of the University's Electrical Engineering Department, both assisted by their colleagues.

The content of the course was carefully chosen to reflect the special interests of Telecom Australia, to provide an effective means of delivering an essential knowledge of the topic in the limited time available, and to relate the content of the course to the needs of Telecom engineers working in the transmission field at Headquarters or in the State Administrations. Special emphasis was given to the presentation of examples to link basic and applied theory with its application to the engineering of Telecom's present or future digital transmission systems.

The course was also structured with a strong emphasis on tutorials to support lectures. About half of the available course time was set aside for the discussion and solution of systems and network-oriented problems in small groups, providing for a more complete understanding of the course material.

Comprehensive lecture notes were prepared for participants and they were also provided with a supporting up-to-date reference text on the course topic.

The course covered the following aspects:

- theory and techniques for the time and frequency domain analysis of linear systems and their application to digital transmission systems
- probability theory applied to random time processes, including auto-correlation, power spectra and the response of transmission systems to random inputs
- digital transmission theory and techniques, including the fundamental properties of digital signals, time and frequency domain representations and performance parameters
- applications of fundamental theory and techniques in typical digital transmission systems (cable, radio and optical fibre) and analysis of factors important in system performance.

In May 1981, the first course was presented at Monash University to 25 Telecom engineers by Professor W.A. Brown and Doctors D. Keogh and Kee Pang of the University and Doctors A.J. Gibbs, B. Smith and R. Coutts and Mr A. Quan of the Transmission Branch of the Laboratories. The course was presented again in September 1981 and in February 1982, each time to a further group of 25 Telecom engineers, thereby contributing to a timely and significant expansion of Telecom's competence in the digital transmission field. The Headquarters Engineering, Commercial Services and Personnel Departments assisted with internal arrangements for the presentation of the course on each occasion.

Further courses are planned for the future, at a rate of presentation matched to the need to develop this competence further as Telecom's digital transmission engineering activities expand.

Broadcasting Trials through the Orbital Test Satellite

By 1986, Australia is expected to have a national satellite communications system. One unique feature of this system will be the direct broadcast of radio and TV services from the satellite to individual small earth-station receivers at isolated homesteads or very small communities in the more remote parts of the Australian continent. This direct broadcast service is known as the Homestead and Community Broadcasting Satellite Service (HACBSS) and it is intended that the small earth-station receivers for this service should be individually purchased and owned as relatively low cost consumer items. While Telecom Australia will not be responsible for this service, the Research Laboratories, by virtue of their expertise and facilities, were requested to investigate some of the problems encountered in providing a HACBSS service.

The 1980/81 Review of Activities described investigations which the Laboratories had made using a simulator of a satellite transponder. These investigations were conducted in collaboration with the Australian Broadcasting Commission (ABC), the Department of Communications (DoC) and the Overseas Telecommunications Commission (Australia) (OTC(A)), and they sought to measure in the laboratory the effects of intermodulation when the sound service was combined with the TV service.

Following these investigations, it was decided to verify the conclusions drawn from the laboratory simulation by conducting further tests using an operational satellite system. The European Space Agency made the Orbital Test Satellite (OTS) available and the Laboratories were engaged under a consultancy arrangement with DoC and OTC(A) to carry out the measurements. Some 1400 kg of equipment was air-freighted from the Laboratories to the major OTS control station at Fucino, Italy, where the work was carried out with the assistance of officers of the ABC, DoC and OTC(A). The Telecom transponder simulator was included in the equipment taken to Italy, where it was re-assembled for comparison purposes, and measurements were taken using both the simulator and the OTS system. Measurements over a ten day period showed that the two approaches to measure the intermodulation effects gave generally similar results, with the OTS system producing slightly more intermodulation than the simulator. Other measurements were also made with a prototype HACBSS small earthstation receiver provided by DoC and good quality pictures were received.

The OTS trials were very useful in that the Telecom simulator was validated against an operational satellite transponder, thereby enabling Telecom and other interested parties to use it with confidence for future measurements.

The Laboratories' satellite transponder simulator assembled at Fucino earth station

NERDDC Awards the Laboratories a Grant for Solar Cell Evaluation

In the formal agreement signed in 1980 by the Governments of Australia and Japan for co-operation in energy research and development, Telecom Australia was nominated as the Australian lead agency for investigations involving "Solar Cells and Their Peripherals". The particular project identified in the agreement required the Australian participant to assess the performance and expected service life of Japanese solar cell modules in remote areas of Australia. The nomination recognised Telecom's pioneering work in the use of solar cell power systems for communications in Australia and its background experience in solar module evaluation and failure analysis.

The Australian National Energy Research, Development and Demonstration Council (NERDDC) subsequently accepted a proposal from Telecom that the Research Laboratories should be given the task of setting up and operating the necessary specialised facilities. NERDDC subsequently made a grant of up to $782 000 over four years towards the costs involved. Although the laboratory facilities have not yet been fully established, investigations have been commenced on batches of modules from four Japanese manufacturers. These are being evaluated in direct comparison with samples of a module type that Telecom has found to perform well in service in remote areas of Australia. The assessment programme is based both on laboratory work and field exposure trials.

When completed, the laboratory will have facilities of a standard comparable to those of similar photo-voltaic test laboratories overseas. The key item of equipment in the laboratory will be a medium-area pulsed solar simulator which will enable solar module characteristics to be measured under reproducible conditions at all times, irrespective of the prevailing weather conditions. The spectral response of modules will be determined and the spectral distribution of the light used for module performance measurements will be closely monitored by instruments whose accuracy is traceable to national standards. Accelerated climatic test equipment will be used to simulate the effects on modules of 200 km/h wind gusts, hailstone impacts, heat, humidity, temperature change and ultraviolet radiation exposure.

Field testing of the modules is being conducted at sites with harsh climatic conditions typical of those found in remote areas of Australia. These outdoor sites are being fully instrumented to gather data continuously on the climatic conditions at the sites and the electrical performance of the exposed solar modules. Data will be collected under microcomputer control, stored on-site during the day, and each night, transmitted automatically over the switched telephone network to the Laboratories for analysis.

Reliability and performance data on particular module types will be the major output from the project, but additional important information should be gained from the analysis of any module failures which occur during the accelerated laboratory tests or the field site exposures.

Solar modules set up for normal operating cell temperature measurement

Collaborative Research with CSIRO Division of Computing Research

A collaborative research programme was formally initiated in July 1981 between the Telecom Research Laboratories and the CSIRO Division of Computing Research (DCR). The programme covers R&D in the general areas of communications software methodology, inter-networking techniques and communications hardware technology.

The objectives of the collaborative research programme are:

- in the research areas of common interest, to carry out R&D collaboratively, so as to take maximum advantage of existing resources (expertise, manpower, software and equipment), increasing the productivity of individual projects and avoiding the unnecessary replication of effort or duplication of resources

- to share the results of R&D carried out in DCR and the Laboratories within the areas of common interest, and to share information relating to these areas
- to work closely together on standardisation efforts, particularly on topics related to the activities of the International Organisation for Standardisation (ISO) TC97 Sub-committees 16 and 6 (Open Systems Interconnection Network Architecture and Data Communication Networks).

The projects that will be carried out collaboratively include:

(i) Communications Software Methodology
- modelling, analysis and verification of communications software and protocols
- computer aids for the CCITT Specification and Description Language (SDL), Numerical Petri Nets (NPNs) and other formal description techniques
- improvements and extensions to SDL and NPN methodology
- computer-aided specification, implementation, simulation and analysis of switching systems and networks.

(ii) Inter-working Techniques
- trial implementation and testing of the ISO/CCITT Reference Model services and protocols
- analysis and measurement of communications network performance.

(iii) Communications Hardware Technology
- evaluation of design techniques
- trials of prototype devices and sub-systems, encompassing aspects such as protection, performance and reliability
- technology forecasting and evaluation.

The Telecom Liaison Officer for the programme is Mr Peter Gerrand, Head of the Signalling and Control Section in the Research Laboratories and the CSIRO Liaison Officer is Dr Garth Wolfendale, Principal Research Scientist in the Division of Computing Research. Regular management meetings will be held every six months to review progress of work in hand and to plan in detail the future work to be encompassed by the collaborative programme.

The collaborative agreement will remain in force while it continues to be seen to be of mutual benefit. The scope and benefits of the agreement will be formally reviewed by the Director of Telecom's Research Laboratories and the Chief of CSIRO's Division of Computing Research after a three year period.

Meetings of CCITT Study Group VII, Working Parties VII/3 and VII/5, and International Data Communications Standards Seminar

In March 1982, Telecom Australia hosted a meeting of CCITT Study Group VII, Working Parties VII/3 and VII/5, in Melbourne. Telecom also took the opportunity presented by the presence of international experts to sponsor a seminar on international data communications standards.

The CCITT Study Group VII on "Data Communication Networks" is responsible for the development of recommendations for data communication networks, with emphasis on networks employing digital rather than analogue technology. The X-series recommendations promulgated by Study Group VII cover user facilities, interfaces for data terminal equipment and networking aspects of data networks. The standards have won international acceptance and, in particular, recommendation X.25 is the basis for connection of computer systems to the Australian public packet switched network 'AUSTPAC'. Study Group VII comprises five Working Parties, two of which met in Melbourne.

Working Party VII/3 is concerned with network interworking, switching and signalling. It is responsible for the development of signalling schemes and protocols for the international interconnection of data networks. Recommendations from Working Party VII/3 are primarily of interest to network administrations to increase the scope and flexibility for interworking between different networks.

Working Party VII/5 is concentrating on the development of new protocols for the introduction of advanced services such as electronic message handling. Structured and formal techniques for the design and specification of complex data communications procedures are also under study to facilitate these developments. Results of these studies, in particular the layered Reference Model, will also benefit the users of public data networks in the development of distributed computer processing.

A total of 110 delegates from 16 countries attended the meetings in Melbourne, which were held over a period of three weeks.

Telecom's Research Laboratories and Headquarters Secretariat were jointly responsible for the organisation of the meetings, the Laboratories concentrating on technical matters and the Secretariat on administrative matters. Mr. J. Park (Research) was the Chairman of the Organising Committee and Mr. W.J. Hurren (Secretariat) was the Conference Manager.

Mr. T. Okabe, CCITT Counsellor, Mr. V. MacDonald, Chairman CCITT Study Group VII, and Mr. H. Bertine and Mr. M. Kato, Vice-Chairmen of CCITT Study Group VII, were among those attending the meetings.

Delegates had an opportunity to visit the Research Laboratories between meetings and to inspect a variety of projects. Fourteen delegates, including Mr. Okabe and Mr. Bertine, were able to visit the Laboratories.

Following the CCITT Study Group VII Working Party meetings, Telecom arranged for seven of the international experts to present papers on their work at a seminar for the Australian data communications community.

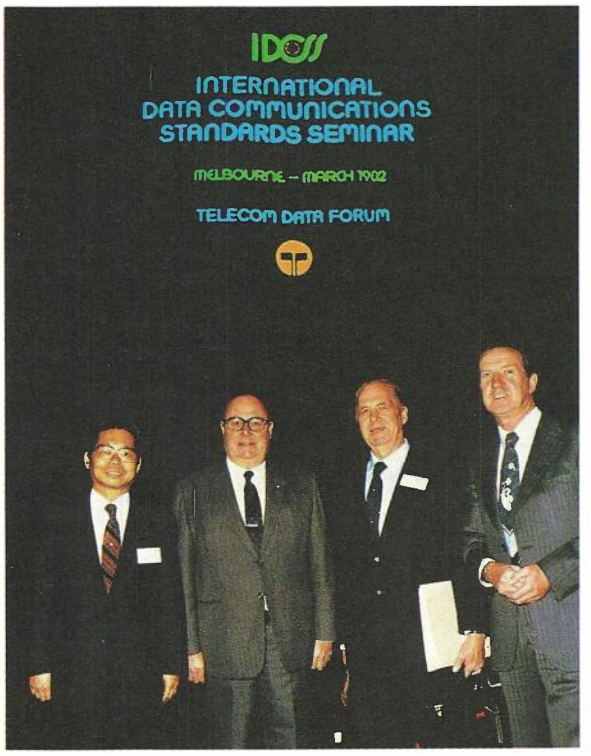
The Seminar was held at the Wentworth Hotel, Melbourne on the 30th and 31st March, 1982 and it was also organised by the Research Laboratories and the Headquarters Secretariat. Dr. F.J.W. Symons (Research) was Chairman of the Organising Committee and Mr. W.J. Hurren (Secretariat) was Seminar Manager. A capacity attendance of over 450 indicated the positive interest in data communications standards in Australia.

The Seminar was formally opened by Mr. Robert W. Brack, AO, Chairman of the Australian Telecommunications Commission. The topics covered were wide ranging and of interest to users, suppliers, manufacturers and network providers alike. Speakers and their topics were:

- Mr. V. MacDonald, Department of Communications, Canada – "CCITT Data Transmission Studies and Results"
- Mr. T. Steel, AT&T, USA – "CCITT Reference Model for Open Systems Interconnection"
- Mr. K. Knightson, British Telecom – "Evaluation of the X.25 Interface"
- Mr. K. Knightson, British Telecom – "The Transport Layer"
- Mr. P. Guinaudeaur, CNET, France – "Operation of Packet Switching Public Data Networks"
- Mr. T. Okabe, Counsellor, CCITT – "Issues in Standardisation Arising in Implementation of Public Data Networks on a Wide-World Basis"
- Mr. G. Dickson, Research Laboratories, Telecom Australia – "Contribution of Formal Description Techniques to the Specification of International Data Communications Standards"
- Mr. P. Bartoli, Bell Laboratories, USA – "CCITT Message Handling Facilities".

Several discussion sessions were also held, enabling participants to question the guest speakers and representatives from Telecom Australia and industry.

Following the one and a half day Seminar, Telecom's Commercial Services Department held a half day Telecom Data Forum which introduced some of Telecom's new data services, especially the Digital Data Service and the AUSTPAC packet switching network, to an audience of about 600 people representing both telecommunications customers and industry.



Distinguished participants at the Seminar included (left to right): Mr. T. Okabe (CCITT Counsellor), Mr. R.W. Brack, AO (Chairman, Australian Telecommunications Commission), Mr. V. MacDonald (Chairman, CCITT Study Group VII, and Senior Advisor, Department of Communications, Canada), Mr. W.J.B. Pollock (Managing Director, Telecom Australia)

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. A more comprehensive list of current projects is issued in the "Research Quarterly" and this is available to selected bodies with 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, industry and 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.

Studies for the Australian National Satellite Communications System

For many years, the Research Laboratories have been studying various aspects of the provision of telecommunication services to the community via satellite. One important aspect has concerned services to remote areas which would be difficult to reach by normal terrestrial means. In this context, the Laboratories have been evaluating telephony performance of small earth-stations, have installed an experimental receive-only earth station, and have been continuing their long term investigations of rain attenuation on earth-space paths.

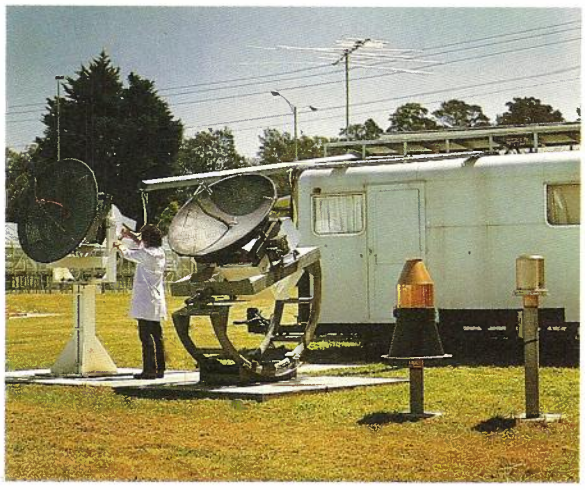
A satellite telephony service for remote subscribers is radically different from the international satellite services. Australia relies upon three large and expensive high capacity earth-stations for its international satellite connections. In contrast, a Telecom remote telephony service would have numerous small and low cost earth-stations with low traffic capacity. In their studies of suitable systems for remote telephony, the Laboratories have concentrated on the subjective assessment of circuit quality for various system parameters and configurations. Of particular concern has been the effects of pre-emphasis and companding on FM system performance, but other aspects such as echo control and voice-operated carrier have also been investigated. Comparable investigations are now under way on various digital methods, including delta-modulation.

During the past year, a television receive-only earth-station using a 6.5 metre diameter antenna was installed at the Research Laboratories for experimental purposes. The station is similar to those presently being installed by the Broadcasting Branch of Telecom throughout remote areas of Australia. They are designed to receive television transmissions from the INTELSAT IV satellite located over the Pacific, with sufficient quality for re-transmission at VHF

or UHF to small communities. The Laboratories' installation provides a test-bed for the study of various aspects of outback TV services, including equipment characteristics, monitoring of satellite radiated power level and measurement of earth-station performance parameters. In the future, it will also facilitate investigations into novel satellite communications techniques for various applications.

The Laboratories have been studying the effects of rain on microwave radio signals along earth-space paths since 1971. Above about 10 GHz, rain can at times severely attenuate the signal strength received from a satellite. This problem may be overcome by using either a large earth-station or a space diversity pair of earth-stations, but this would significantly increase the cost of the service. Initial investigations were carried out in tropical areas of northern Australia using radiometers designed and built in the Laboratories. A radiometer measures the noise temperature of the sky, and this in turn provides a measure of the effective path attenuation at the elevation angle of the antenna. Two radiometers are presently operating side by side at the Laboratories to obtain rain attenuation data in a temperate climate. They are set at elevation angles of 45° and 15° in order to determine the effects of elevation angle dependence. The correlation of these radiometer measurements with simultaneous rain-gauge measurements of rain intensity has been used to establish a semi-empirical rain attenuation prediction model. Using Bureau of Meteorology rain-rate data, this model will allow earth-station designers to estimate the rain margin that would be required anywhere in Australia.

6.5 metre experimental receive-only earth station



Radiometers and rain-gauges used in the study of microwave signal attenuation due to rain

Field Trial of Portable Telephone Hearing Aid Coupler

The portable telephone hearing aid coupler under trial is a self-contained, battery-operated, acousto-magnetic coupler which can be fitted to the receiver end of a telephone handset to convert the acoustic signal to a magnetic field, so that it, in turn, can be coupled to the pick-up coil of conventional ear-level hearing aids. Some of the early laboratory prototypes of this coupler were described in the Review of Activities for 1978/79.

As a consequence of the early assessment of the laboratory prototypes, production prototypes were developed to meet a Telecom Specification by an Australian company early in 1981. In order to optimise gain settings and to assess practical difficulties in their use, a series of experimental trials using these couplers were then carried out by the Research Laboratories in collaboration with other Departments of Telecom and interested external organisations.

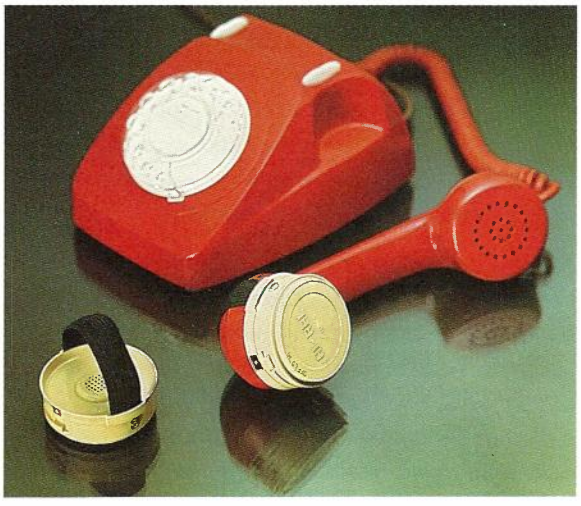
A total of 49 hard-of-hearing people using ear-level type hearing aids were recruited to participate in the trials through the National Acoustic Laboratories and the Australian Association for Better Hearing. These organisations also provided venues for briefing and de-briefing.

The couplers were adjusted to provide approximately equal numbers in two groups having a small but significant sensitivity difference. Each participant was given in succession a coupler from each group, each for a period of 3 weeks. All participants were

encouraged to use the couplers whenever they made use of a telephone and to record details of each call experience.

From individual call records, and subsequent group and individual de-briefings, it was possible to compare the performances of the two groups of couplers and to evaluate general problems encountered in their field use. It was found that there was a wide range of sensitivities among the hearing aids used. Taken together with other variables such as the type and degree of hearing impairment and the transmission quality variation on different telephone connections, it was concluded that it would be difficult to specify the characteristics of a single coupler which met all requirements. However, it was apparent that the higher gain coupler was better suited to the needs of those who could not use the telephone without some form of aid. Although some difficulties were experienced in the initial stages of the trial, almost all participants were enthusiastic about the benefits they derived from the use of the coupler as their confidence in the use of the coupler increased.

As a result of the trial, a revised specification for the coupler was prepared and the manufacturer, HI-REL Pty. Ltd. of Sydney, has sought and been granted Telecom's permission to market the coupler as an approved attachment.



The portable telephone hearing aid coupler

Field Investigation of New Customer Services

Between December 1980 and May 1981, in the Coburg district of Melbourne, Telecom Australia made available a number of experimental telephones incorporating new facilities to selected subscribers who had previously used only standard telephones. Some of the new facilities provided would, if generally offered, be implemented through new generation exchanges; some could only be provided by new generation telephones; and others would require both enhanced telephones and support from new generation exchanges. The selected subscribers then participated in a field research project conducted by Telecom.

The project was known as the Field Investigation of New Customer Services (FINCS) and it had the following broad goals:

- to develop and evaluate procedures suitable for the field investigation of new telecommunication services
- to gain an understanding of how customers evaluate and use new telecommunication facilities
- to investigate the applicability of field study results to wider marketing issues
- to provide Telecom with information concerning the potential of a number of new or enhanced telephone facilities.

The Research Department had overall responsibility for and management of the project. Other major contributors to the study were the Coburg District Telecom Office and a consultant group from the University of Melbourne Psychology Department.

Recent editions of the Review of Activities have highlighted various aspects of the project. In the 1978/79 Review, attention was given to the hardware approach; in 1979/80, to research design considerations; and in 1980/81, to management and co-ordination requirements.

Between May 1981 and February 1982, the final phase of data analysis was undertaken by the consultants working in close collaboration with Research staff. Some of the conclusions from the study are as follows:

- A combination of subjective measures (i.e. user interviews) and objective measures (i.e. logged usage data) taken before, after and during the users' experience of new facilities, can yield a

rich data base on which to analyse user perceptions, user behaviour and the inter-relationship between them. Such data bases can prove valuable for subsequent investigations not envisaged as part of the original project.

- Because of the diversity of activities required for field research, project management (particularly in matters of overall project co-ordination) is critical, complex and time consuming.
- Generally, users reacted favourably to all facilities provided and rankings of usefulness were obtained between the various facilities.
- Results were obtained which indicated how the facilities should preferably be implemented, if a decision to implement them is taken in the future.
- Initial estimates by participants of how much they might use specific facilities did not prove an accurate guide to their actual usage rates once the facilities were available.
- Reports by participants of their use of the facilities while they were available and in use did not accurately correspond to their actual use of the facilities.

One major result of the study was that the total number of calls made by participants during the project was significantly increased compared with that measured prior to the facilities being made available. However, the implications of this result on network traffic must be viewed with caution, since the limitations of the study, in terms of sample size, etc, suggest that this finding requires further investigation.

One of the intentions in undertaking the FINCS project was that the experience gained would be applied to other field research projects and to user trials of new facilities. These are likely to remain a continuing activity both within the Research Laboratories and in other areas of Telecom. One immediate example of a smaller scale project is an in-house trial of a novel, user-controlled telephone conference bridge that commenced in March 1982. Many of the practical lessons learnt in the FINCS project are being applied to it with benefit.

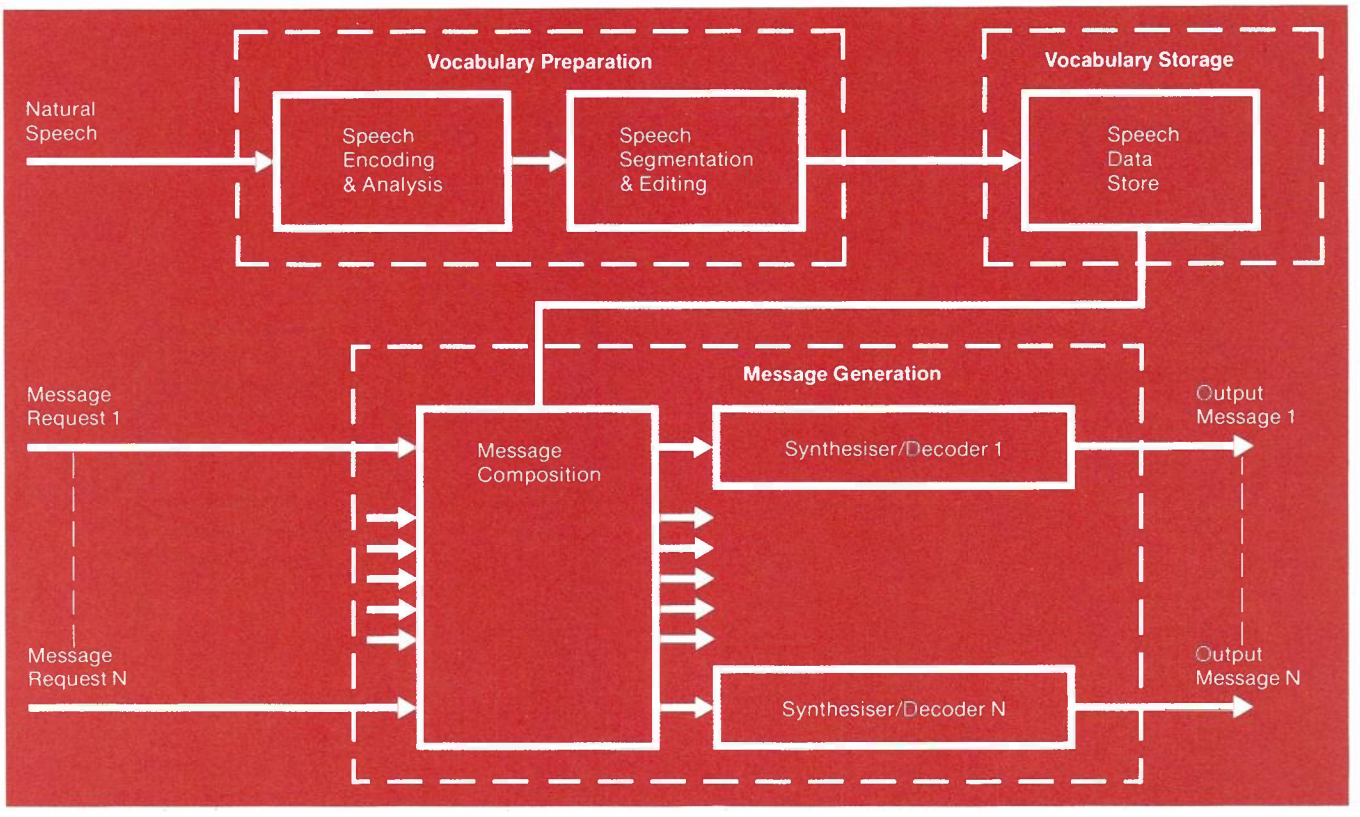
Automated Voice Responses for Directory Assistance

The provision of subscriber trunk dialling (STD) and international subscriber dialling (ISD) facilities within the Australian telecommunications network has brought the world closer to Australian telephone users. However, printed telephone directories can contain only a fraction of the numbers now accessible to users and invariably contain out of date information at the time of publication. An undesirable consequence of this situation is an increasing number of calls for directory assistance.

Recent overseas experience and the results of an Australian field trial conducted in 1979 have shown that the introduction of computerised directory data storage and retrieval systems greatly improve the directory assistance service (DAS). In addition, access to such computerised systems facilitates the application of new technologies for further improvements. Of particular interest is the application of speech technology for the production of automated voice responses.

There are many alternative ways of implementing a voice response system but all essentially contain three components. A vocabulary preparation component enables the input and encoding or analysis of speech segments, the editing of these segments and also the selection of the desired vocabulary units. A vocabulary storage component saves and indexes the speech data for easy access. A message generation component extracts the appropriate vocabulary elements and synthesises the desired messages.

A voice response system for directory assistance services could be used as an aid to the operator, for example, to announce the retrieved number to the caller, and could be initiated by a single keystroke at the operator's keyboard. This would significantly reduce the time spent by an operator in attending to individual enquiries and would consequently increase the number of calls which could be handled by an operator. An extension of this system is one where the customer would be given direct access to the DAS data base. At each stage of the information retrieval process, the customer could be prompted, by synthetic voice messages, to enter appropriate information, as required, via a keypad. This keypad might be provided as an adjunct to the telephone or integral with it.



Components of a voice response system

The two systems outlined above are under study in the Laboratories. A prototype single channel synthetic voice announcement system employing 64 kbit/s PCM-encoded speech has been constructed to assess the potential of the former application. An interactive system as outlined for the latter application is also under investigation.

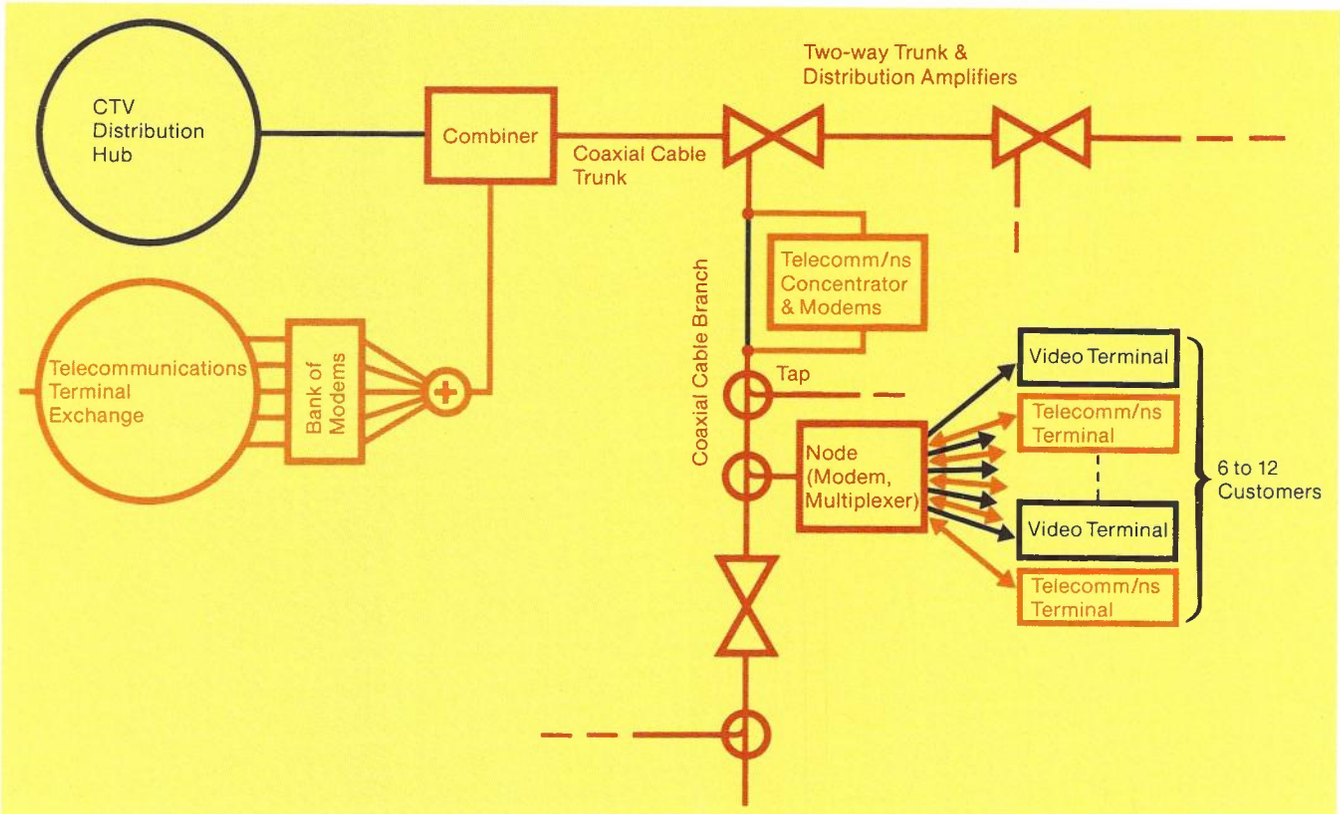
The systems are being applied to studies of their potential for further development and application in the Australian telecommunications environment. Particular attention is being given to factors governing the acceptance of voice response systems by the telephone customer. Subjective factors such as the naturalness and quality of the synthesised voice announcements are important aspects of the current studies, as also is the interface between the systems and the telephone user.

Reticulation of Telecommunications Services over Coaxial Cable Networks

The use of coaxial cable based networks for the downstream broadcasting of video services is well established. Such cable television (CTV) networks also have the capability of providing two-way telecommunications services (for telephony, data, etc) to customers and they are therefore of research interest in Telecom Australia, since new networking concepts are involved.

A telecommunications network must support the transmission of unique messages to and from each customer. Historically, this has been provided by a star network, with a dedicated pair of wires from the exchange to each customer. In contrast, the CTV network is designed for simultaneous downstream (only) broadcasting of video signals to a multiplicity of customers and a tree network, consisting of a single coaxial cable with a simple tap for each customer, is adequate.

The use of a CTV distribution network for two-way telecommunications requires a method of accessing a part of the transmission capacity of the CTV cable passing each customer to transmit the customers' unique two-way messages. The method must yield a virtual star network.



Basic structure of a combined CTV and telecommunications distribution network

The Laboratories have carried out a technical feasibility study of the use of a CTV distribution network to reticulate telecommunications services. For the purposes of the study, it was assumed that:

- the telecommunications network was digital, with a customer access rate (for telephony, data and information-based services, etc) of 144 kbit/s for each customer
- the CTV network was a two-way single coaxial cable system, with four 7 MHz video channels in each direction provided for telecommunications
- the system should provide for a high degree of privacy between customers and should have the flexibility to provide for a significant number of leased-line customers.

Based on the above assumptions and the characteristics of a typical exchange area, a conceptual system design was then developed. Some key features of the design are that:

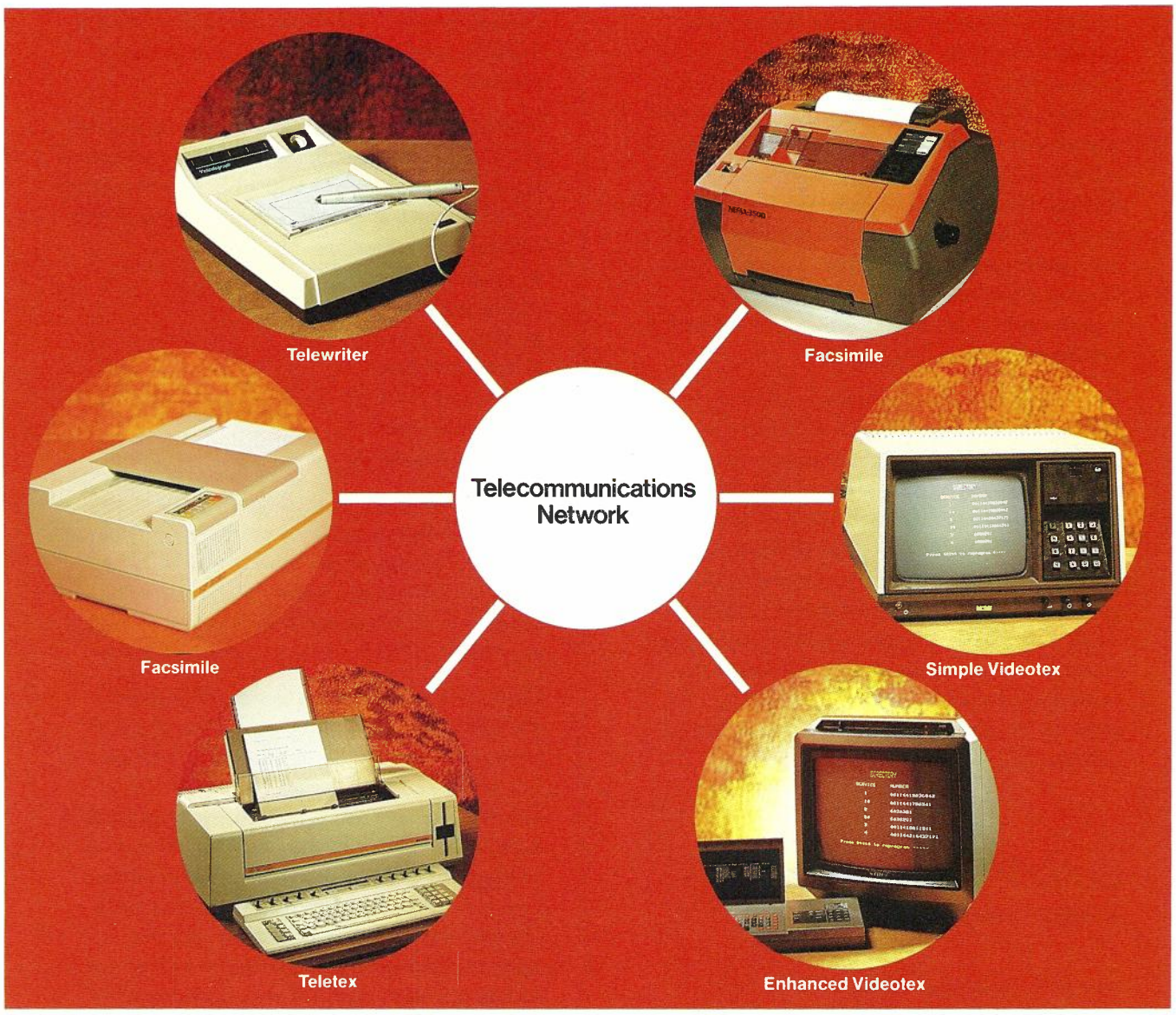
- unique message transmission to each customer is provided by frequency separation
- digital data modems – a well established technology – provide digital transmission on the bandpass channels provided by the CTV bearer
- high quality transmission performance is expected
- concentration of the switched part of the customers' traffic is performed to make efficient use of the limited capacity of the trunk part of the CTV network, with each concentrator serving at least 144 customers
- nodes serving 6 or 12 customers are used to minimise costs by sharing the relatively expensive modem costs and to ensure privacy.

In summary, the technical feasibility study has identified some of the more significant parameters involved in reticulating telecommunications services over a CTV network. The major functions that determine the capital cost per customer have been especially noted for further study.

Performance of Telematic Services in the Telecommunications Network

Over the next few years, services enabling the transmission of information in textual or graphical form over the telecommunications network will be increasingly in demand. These services, generically called the telematic services, include:

- facsimile, the oldest of the telematic services and that which enables documents to be copied to a remote receiver
- teletex, effectively a high-speed, enhanced telex service



Some typical telematic services terminals

- videotex, a service providing simple access from special visual display units via the telecommunications network to centralised computer data bases
- telewriting, whereby the movements of a special pen or stylus are systematically transmitted to a distant receiver, enabling hand-drawn sketches or handwriting to be reproduced remotely.

The Laboratories are studying various aspects of the technology and operation of telematic services over the public telecommunications network. Ultimately, it can be expected that different telematic services and terminals will be integrated. To date, however, the only procedures specified internationally are peculiar to each of the services. Hence, the studies being undertaken in the Laboratories will also provide a basis for Telecom Australia's contributions to the relevant Study Groups of the CCITT which are concerned with the recommendation of standards and protocols to enable future telematic services to interwork over the network.

Studies conducted to date on sub-minute (group 3) facsimile terminals have demonstrated the value and importance of evaluating operational performance and interworking compatibility in the early stages of technological development. Tests have revealed incompatibilities that prevent operation between two machines of different manufacture, the problems arising in the setting-up stage. Whereas some of the difficulties are due to equipment design errors, others are traceable to inadequacies in the relevant CCITT recommendations. The problems identified have been drawn to the attention of the manufacturers and to the CCITT.

During the coming decade, both analogue and digital communication channels will be used for telematic service transmission. In the current analogue network data rates as high as 9600 bit/s will be required for various services. Although these rates have been achieved already in parts

of the network over leased lines, it is unclear whether or not such a figure is generally achievable throughout the present Australian network. The ramifications of transmission line imperfections and disturbances on high data rate, sub-minute facsimile transmission have been studied. The data rate of 9600 bit/s is indeed required in this case and it has been found that only under conditions of unusually poor signal-to-noise ratio would the service be impaired. In such cases, it would be necessary to fall back to lower signal transmission rates.

Future network developments are likely to involve the simultaneous use of different services, particularly in business office environments. The need may well arise for a teletex terminal in one location to interwork directly with a facsimile device elsewhere. The need for clarification of this and other types of service interworking problems has been identified by the CCITT. Studies are proceeding on aspects of protocol and message content conversion associated with several service interworking situations: particularly teletex/facsimile and teletex/videotex interworking.

ISO/CCITT Open Systems Interconnection Studies

One of the fundamental problems in data communications is the interconnection and interworking of heterogeneous information processing systems from different manufacturers. These systems include computers, data terminals and associated devices.

With the advent of experimental packet switching data networks in the late 1960s, the International Organisation for Standardisation (ISO) recognised the urgent need to standardise the rules associated with such interconnections. In 1977, it commenced formulating the so-called "Reference Model of Open Systems Interconnection". The model serves two basic purposes, namely:

- to provide a common basis for the co-ordination of international standards development for the purpose of interconnection
- to allow existing standards to be placed into perspective within the model.

The ISO model has been adopted by the International Telegraph and Telephone Consultative Committee (CCITT) as a basis for the study of its own "Reference Model for Public Data Networks". When developed, the ISO and CCITT models are expected to be technically identical.

Within the ISO/CCITT models, an information processing system is represented by a conceptual structure of seven independent but interworking functional layers (or levels). Beginning with the highest layer, these are:

- application layer (7)
- presentation layer (6)
- session layer (5)
- transport layer (4)
- network layer (3)
- data link layer (2)
- physical layer (1)

With the exception of the highest (application) layer, each functional layer provides a number of "services" to support the layer above it. The upper three layers deal with information processing activities, while the lower four layers are concerned with communication activities.

Communicating systems as represented above are interconnected at their respective physical layers via a physical interconnection medium (e.g. cable, radio). Although the actual information flow takes place between source and destination entities (or functional units such as computer programs, residing in the application layers) via the respective lower layers and the physical interconnection medium, any two systems communicate according to a set of rules and procedures associated with each pair of corresponding entities within each of the layers. These information interchange procedures between peer (or equivalent) entities are known as "peer protocols".

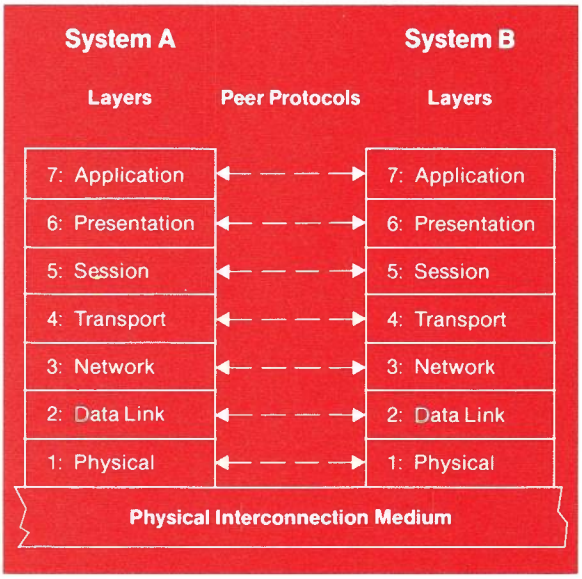
The main purpose of the studies being conducted in the Laboratories is to develop an understanding of the ISO/CCITT Reference Model and associated concepts and features, in sufficient depth to enable the study of services, protocols and interfaces associated with any given functional layer. The transport layer is of particular interest at present since its basic functions include the provision of reliable and cost-effective communication services on an end-to-end basis between corresponding systems over any communication network (e.g. circuit switched or packet switched). Experimental implementation of the transport layer is initially being carried out on commercial minicomputers with CCITT X.25 packet-mode data communication capabilities. The existence of the transport layer will then allow the development of other higher-level facilities (such as file

transfer, teletex, electronic mail) for study within the Laboratories.

To date, good progress has been achieved in clarifying several fundamental aspects associated with the ISO/CCITT Reference Model. These results have been submitted as Australian contributions to ISO/TC 97/SC16 (Open Systems Interconnection) and to CCITT Study Group VII (Data Communication Networks).

The Reference Model has also been found to be useful, for example, within the CCITT in the study of the Common Channel Signalling System No. 7 and of customer access to an Integrated Services Digital Network (ISDN). It is expected that the impact of the Open Systems Interconnection project will have effect within the ISO and CCITT, and thus within Telecom Australia, for many years. The benefits to Telecom will include:

- a greater understanding of the protocols for new services in advance of their implementation, facilitating their specification in tender schedules and the evaluation of tenders
- ease of specification of a standard transport service
- greater ease in developing ISDN access interface specifications
- the development of a general technical knowledge base which will be of longer term benefit as the ISDN concept approaches realisation in Australia.



The ISO/CCITT Reference Model of Open Systems Interconnection

Development of Data Communication Standards

A rapid growth in the number of computerised information systems using advanced communications networks is being experienced in many countries. Incompatibilities in the equipment used in these networks has limited the extent to which computer systems can be interconnected to perform new tasks and provide wider access to information. The current development of public data networks, such as Telecom Australia's packet switched network, AUSTPAC, will increase the potential for interconnection of computer systems and the entrepreneurial opportunities for provision of new services. A flexible set of data communications standards is therefore essential for the development of new services to avoid the further proliferation of incompatible systems.

Study Group VII of the CCITT has already developed a number of standards for the connection of computer systems to public data networks, for example, those of Recommendations X.21 and X.25. These define the establishment of a connection and the transfer of data through the network. Standards governing the communications between end-user systems are also under development.

Because the implementation of AUSTPAC, particularly in regard to its interface with customer's equipment, and the development of new data services are dependent on these standards, a number of projects are being pursued in the Laboratories to monitor and contribute to the CCITT activities. Project objectives include the experimental and theoretical assessment of CCITT standards before their application in Australian networks and the pursuit of investigations which will provide, inter alia, a basis for future Australian contributions to the development of new standards by the CCITT. Combined with the Laboratories' previous experience in the development of specification techniques for telephone systems, the projects are also generating expertise in the area of communications protocol specification and verification.

Short term benefits of this work include the assistance already provided by the Laboratories to the Commercial Services Department in the production of the customer interface documentation for AUSTPAC. Longer term benefits are expected to result from the

appointment in May 1981 of Mr. Gary Dickson of the Laboratories to the position of Special Rapporteur for CCITT Question 39/VII to co-ordinate the development of formal specification techniques for data communications protocols. The development of such techniques will assist Telecom Australia, equipment manufacturers and Australian network users to ensure that compatible equipment is used for data communications.

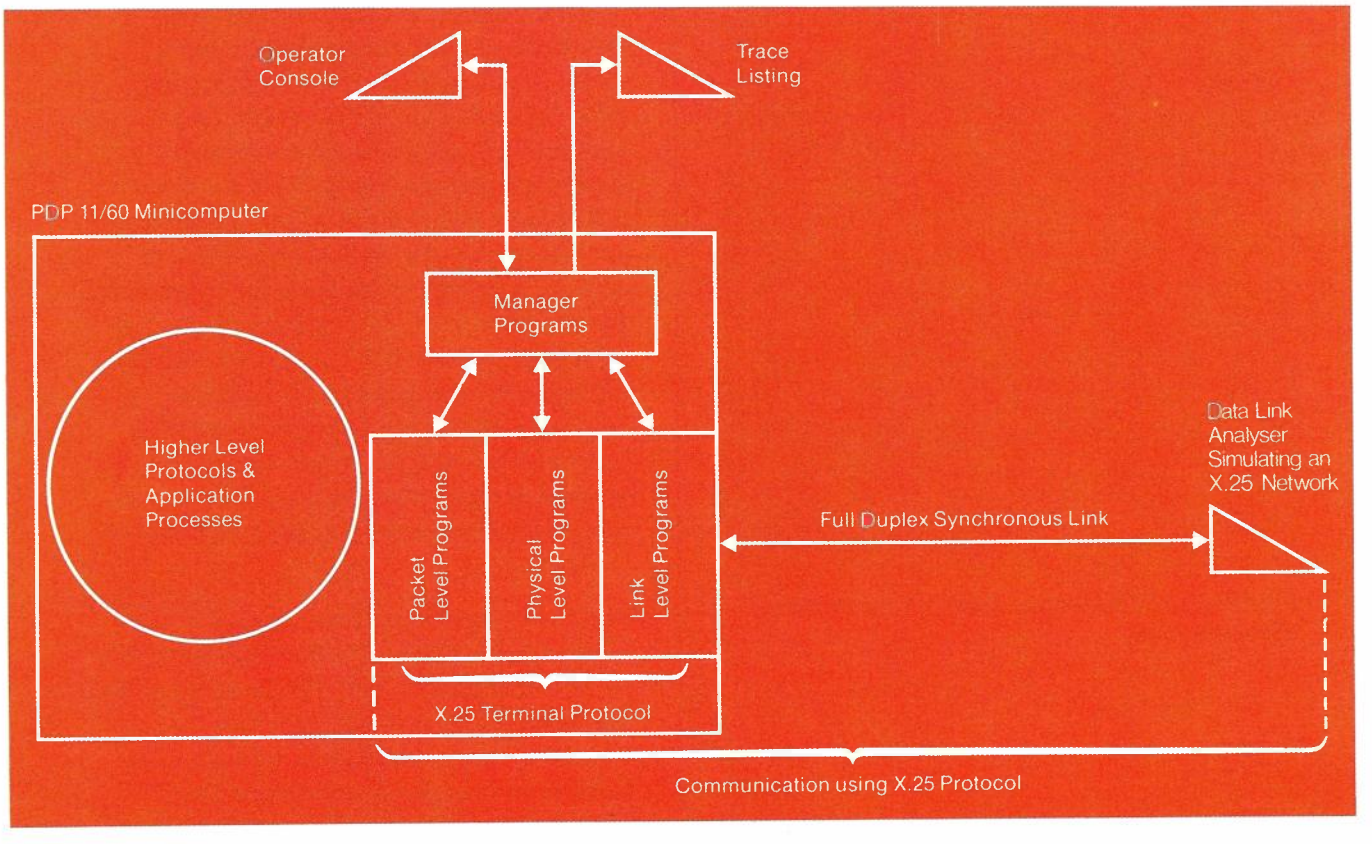
An important event in the CCITT calendar for 1982 was an international meeting of Study' Group VII experts hosted by Telecom Australia in Melbourne during March. The meeting provided a valuable opportunity for discussion of the latest developments in data communications and of various contributions to the work of the Study Group in areas related to its current concerns. Telecom Australia also took advantage of the opportunity presented by the availability of international experts in Australia to sponsor a public Seminar on the theme, "International Data Communications Standards". The Seminar was well attended by almost 500 people, representing local industry and user groups as well as Telecom Australia staff.

Data Switching Studies

Packet switched data networks allow efficient use of network resources and can provide network users with enhanced flexibility of service. These attributes require the use of complex protocol procedures to control the establishment of connections and the transfer of data between computer systems.

Future developments in protocol design and service expansion are likely to be based on the CCITT X.25 protocols which define procedures for the interactions between packet mode terminal computer systems and packet switched networks. Within the X.25 recommendation, a variety of protocol procedures are described for the control of connections and transfer of data. The X.25 recommendation does not, however, define how these procedures should be used for specific applications or what actions should be taken under a variety of error conditions. To resolve these issues and to gain experience with the specification, operation and testing of complex protocol systems in general, an X.25 terminal system is being developed in the Laboratories as a flexible experimental test-bed for future work in this field. A structured approach to documentation and extensive diagnostic and maintenance facilities are particular features of this work.

Schematic outline of the experimental X.25 terminal system



The X.25 terminal system is being implemented as a number of programs on a PDP 11/60 minicomputer, using a multi-tasking operating system to co-ordinate the many protocol operational, management and maintenance processes necessary. Initial testing and evaluation is being performed using a commercially available data link analyser to simulate network behaviour. The project is being carried out in three phases corresponding to the three levels of protocol described in X.25 (physical, link and packet levels). Implementation of the physical and link levels has been completed and these parts of the system are now undergoing extensive testing and evaluation.

An important part of the project is the consideration of appropriate testing strategies that can be used to establish:

- that the protocol specification is satisfactory
- that the protocol implementation works
- what levels of performance can be achieved.

This work will have a long term impact on studies relating to the interfaces and protocols necessary for the operation of new services. The experience gained from this project to date has enabled the Laboratories to assist the Commercial Services Department in the preparation of customer interface specifications for the Australian packet switching service, AUSTPAC.

Formal Description Techniques for Data Communication Protocols

Data communication protocols are complex systems to specify. When described in an informal manner by narrative text, protocols are usually misinterpreted due to the ambiguity and incompleteness of the description. More formal techniques are therefore required to overcome these problems.

The CCITT and ISO have recognised the need for a Formal Description Technique (FDT) which will specify unambiguously, completely and accurately the interactive aspects of the Open Systems Interconnection Reference Model, namely, services, protocols and interfaces. The selection of an FDT will significantly assist telecommunications administrations, network operators, manufacturers and customers to provide compatible interfaces and equipment for operation over public data networks. The CCITT and ISO have also agreed that the same FDT should preferably be chosen by both organisations to maximise benefits to all parties concerned, with early standardisation considered vital. Present efforts are being concentrated on the development of an extended finite state machine approach as the most suitable basis for an FDT. Two forms of FDT will be used, namely:

- a graphical form (GR-form), which will show all the control/logic flow in the specification and will cater specifically for human readers in relation to ease of understanding
- a program-like form (PR-form), which will show all the detailed data description, data handling and logic flow, and will be machine-readable to cater for automated formal analysis.

One technique which incorporates both forms is the CCITT Specification and Description Language (SDL) with its GR-form, SDL/GR, and PR-form, SDL/PR.

Telecom Australia, through the work of its Laboratories, has been very active in presenting SDL as a candidate FDT to both international standards organisations. SDL was initially designed to cater for the specification of stored program controlled telephone exchanges. Telecom has proposed that, with enhancements for data applications, SDL will be a suitable candidate FDT. The proposed enhancements are based upon data concepts of high-level programming languages. The contributions to the CCITT and ISO have been related to:

- the requirements to be met by an FDT
- the selection procedure for an FDT
- a tutorial paper on SDL
- an analysis of SDL as an FDT, in relation to the requirements
- a demonstration of the application of SDL to the CCITT/ISO test examples, namely, to the transport layer of the Reference Model and to X.25
- suggested enhancements to SDL for data applications.

Conformance between the GR-form and PR-form of the final FDT is important and SDL already caters for this. Further contributions being submitted by Telecom to the CCITT regarding extensions to SDL for data applications will greatly assist the case for SDL as an FDT for protocols.

Data Transport Service and Protocols

Throughout the world, data communications between remote information processing equipment and peripherals is provided by a variety of public and private data communications networks. These networks use various techniques, such as packet switching, circuit switching and dedicated leased lines. The quality of service, measured in terms such as the accuracy of the data transferred and the reliability of the connection, may vary from network to network.

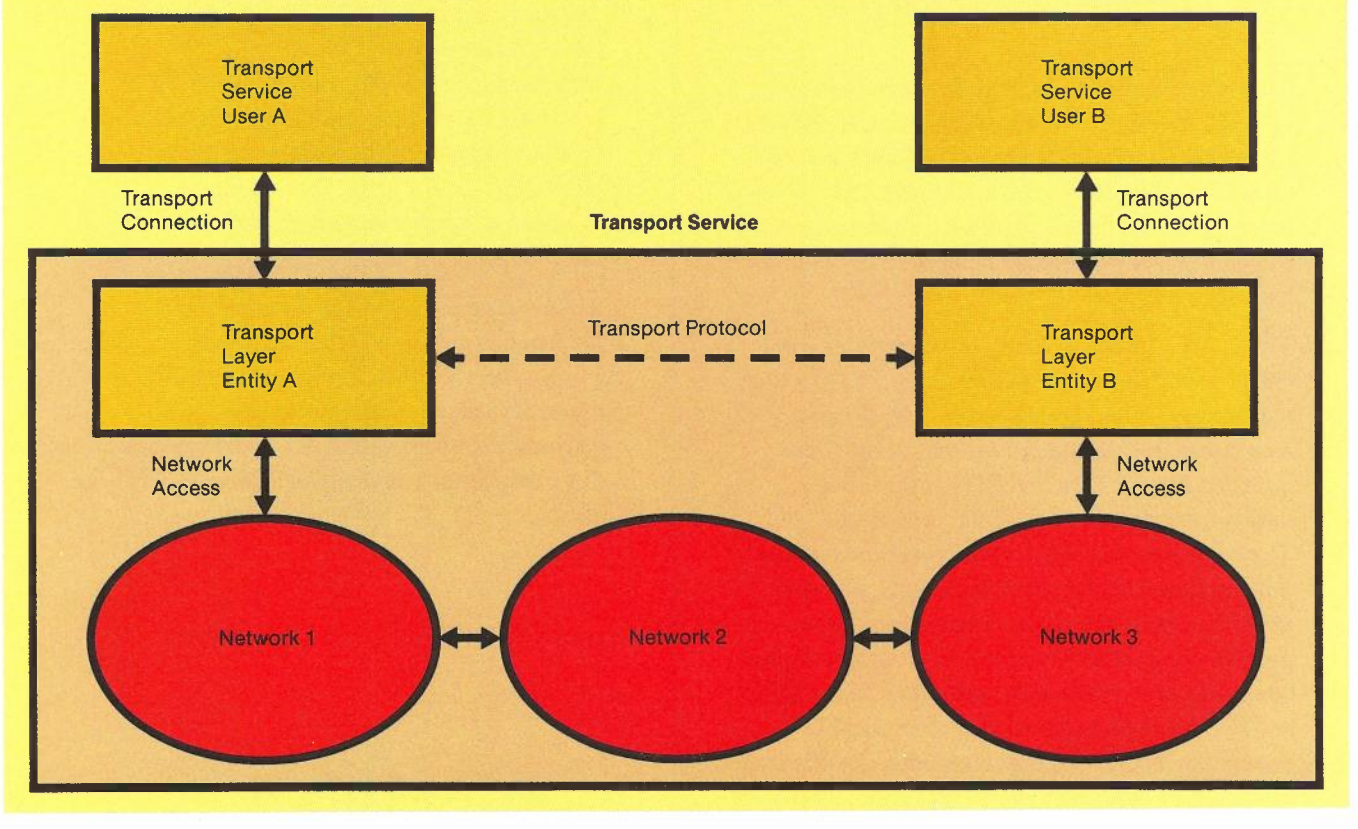
In order to facilitate the development of distributed data processing, the ISO and CCITT are developing a specification for a standard Data Transport Service of uniform quality which will relieve data processing programs from the responsibility for ensuring accurate and reliable data transfer between distributed systems. No knowledge of the underlying network technology or quality will be required. Like other administrations, Telecom Australia is vitally interested in the outcome of this ISO/CCITT activity and is making inputs to the development of the specification through its relevant research work.

The Data Transport Service consists of the lower four layers of the ISO/CCITT Reference Model of Open Systems Interconnection. It consists of a transport protocol (layer 4) operating between the communicating end-systems. This contrasts with underlying network access protocols (layers 1 to 3) such as X.25, which operate between an end-system and a data communications network. The transport protocol is built on top of any underlying communication networks which are involved in setting up a connection between the end-systems. There could be several such networks involved in an international call. The end-to-end transport protocol enhances the quality and optimises the costs of the underlying networks to bring the overall transport connection up to a satisfactory quality for the user.

In order to achieve this, five different classes of protocols have been defined. The choice of protocol is based on the degree of quality enhancement and cost optimisation required by the user. One such protocol is used to provide the proposed Teletex service for communicating word processors.

Telecom Australia, through its Laboratories, is playing an active role in the international standardisation of the Data Transport Service. Contributions have been made on techniques for formally specifying the service. The formal description technique being developed by the Laboratories uses the graphical CCITT Specification and Description Language as a basis. Additional features, such as data description techniques, have been included to ensure that all aspects of data communication protocols can be

Structure of the Data Transport Service showing the end-to-end transport protocol built on top of several underlying tandem networks



specified in an easily understood manner.

The Laboratories are also investigating appropriate ways to partition the transport layer functions in order to implement a trial Data Transport Service. This experimental service will consist of a transport layer built on top of an X.25 based network service, utilising minicomputers. The Laboratories' studies encompass both commercially available X.25 software and X.25 software developed in-house as a means of providing a suitable network service. One objective of this project is to gain experience with the problems involved in operating transport protocols between different computer systems.

A longer term objective of the work is to provide a basis for future studies of new applications of data communications, such as electronic mail. Such studies and the provision of such services will be significantly helped by the standardisation of the Data Transport Service.

High Level Language Interface to X.25 Link Control Software

In investigations of the X.25 protocol by the Laboratories, it became obvious that the protocol had immediate application to remote data logging. Allowing near error-free transmission of data blocks, the protocol relieves the applications programmer from much work concerned with information transmittal and is standard across many applications.

Telecom Australia utilises many minicomputers in data logging and control applications. The majority of these machines have been supplied by one manufacturer, who also provides a FORTRAN IV derivative of the standard FORTRAN language. Recently, the supplier also offered a set of utility routines to enable use of the X.25 packet level protocol. Unfortunately, the offered routines do not support link level working in the high level data link control (HDLC) form as recommended in X.25. While provision is made to call these routines from assembly language and from another of the supplier's FORTRAN variants, no provision exists for calling them from the commonly used FORTRAN IV.

It was considered that the package could be doubly useful both as a tool to allow further investigation of higher level protocols and as a vehicle to allow ready data transfer. Hence, work was commenced during the year to write a suite of assembly language routines which provided all calling facilities of the more complex high level language offerings of the supplier but which was easily integrated into future application programs.

The routines provide, by means of standard sub-routine calls, all X.25 packet level commands required to initialise links, open channels, send and receive data blocks, close channels and disconnect links. They have been so designed that they can be incorporated into application programs at compile time, with little knowledge being required by the applications programmer regarding the actual means by which the data is transmitted.

Currently, these routines are in use in at least one Laboratories experiment to acquire data remotely and log it on magnetic tape at a central site. Their development is also part of the continuing work being carried out in the Laboratories on higher level ISO/CCITT data protocols and communicating word processor investigations.

Work is currently in hand to investigate the modifications required of the level 2 portions of the supplier's software utility routines to make the package compatible with AUSTPAC link protocols utilising HDLC. Should this be possible, the usefulness of the package will have been increased markedly by eliminating the need for dedicated data links.

Network and Exchange Dimensioning Studies

Australian telephone and telex networks are designed so that, for most calls, there is more than one path through the network available between the origin and destination points. In networks where this alternative routing facility is provided, calls are first offered to the most direct (and economical) route available. If this route is congested, the call is then offered to the next most direct route accessible from the originating exchange. If both first and second choice routes are congested, the call is offered to the third choice route, and so on. A small segment of a metropolitan telephone network, offering three routing choices from exchange I to exchange J is illustrated in the adjoining figure; b_1 to b_5 are the blocking probabilities expected on the individual links of this network.

Alternative routing is the most efficient method of trunking, but for the same reason, it is also very

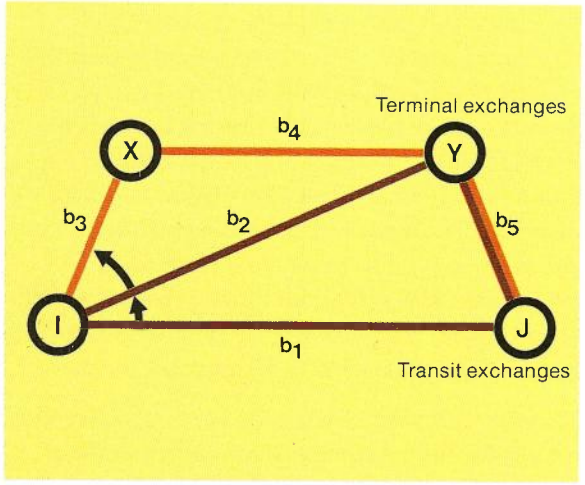
sensitive to traffic overloads — that is, the grade of service experienced by subscribers deteriorates very rapidly even with moderate overloads. This is illustrated in the network congestion graph. Serious rises in network congestion also occur with changes in traffic dispersion and circuit outages.

These effects have recently been studied using models of Telecom Australia's local and trunk networks. The studies showed that each of the above three conditions has a significant effect on end-to-end grade of service, the most significant being produced by circuit outages, even minor ones. It was also found that the trunk network is more susceptible to overload than a local network. More complete details of the study method and the results obtained have been published as Research Laboratories Report 7485.

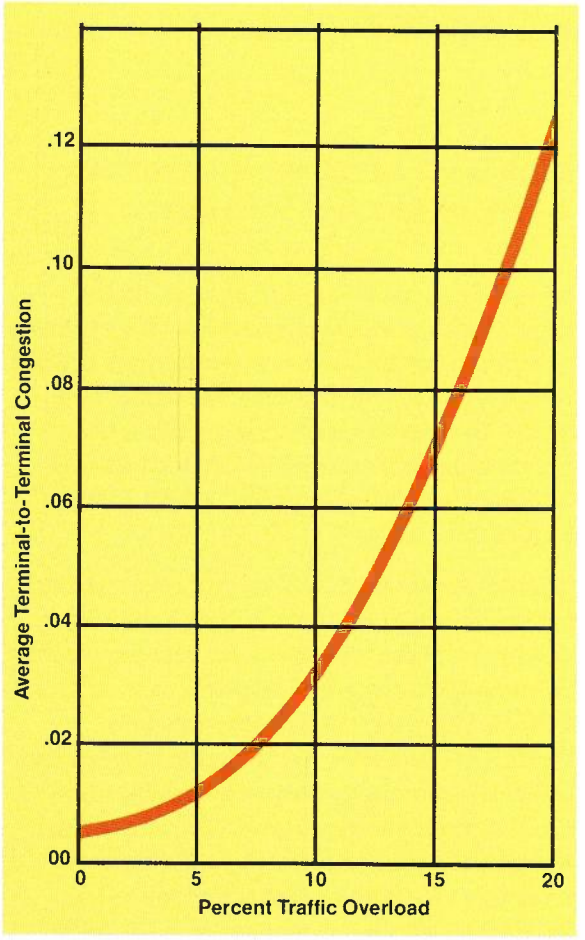
The standard method used for dimensioning alternative routing networks optimises the outgoing routes of individual exchanges, one by one. However, this method does not lead to a minimum-cost total network. It also generally results in wide distribution of end-to-end design grades of service for the various telephone connections possible in the network.

To a large extent, the grade of service depends on the number of parallel paths provided in the network between any given pair of terminal exchanges. For example, in the adjoining diagram, there are three parallel paths from exchange I to exchange J. If the routes I-J and I-Y-J were not provided, there would be only one path, I-X-Y-J, presenting a higher probability of congestion than would prevail if the other two paths were also there.

Recent studies performed by the Research Laboratories in collaboration with the University of Adelaide have resulted in the development of a new method for total network design. The method uses mathematical programming techniques to design a minimum-cost network for any given traffic distribution and specified end-to-end grades of service. The network can be dimensioned either for a uniform grade of service between every origin and every destination, or for any arbitrary set of origin-destination grades of service. As the design grade of service standards for Australian telecommunications networks are specified in terms of overall end-to-end congestion probabilities, the new design method is ideally suited to satisfy these standards. Even more importantly, the method of total network optimisation permits substantial savings in circuit requirements to be achieved, while still satisfying the specified network design grade of service. Studies of the practical implementation of the new network design method are continuing.



Part of an alternative routing network



Network congestion as a function of traffic overload

The adoption of the AXE switching system as the new standard for Australian local exchange networks has made it necessary for the Laboratories to investigate suitable traffic capacity and performance models and to develop the necessary aids for dimensioning the various traffic-dependent device groups. Computer programs, based on appropriate traffic distribution models, have been written and used

to plot dimensioning graphs, at specified grade of service standards, for the provision of AJC, BJC, KRD, CRD and CSD device groups in AXE exchanges. The graphs have since been forwarded to the Headquarters Engineering Department for publication and distribution to Planning Branches in the Engineering Departments of the State Administrations.

Traffic Simulation of the CCITT No. 7 Common Channel Signalling System

The CCITT No. 7 Common Channel Signalling System (CCSS) makes use of high speed (typically 64 kbit/s) data links between stored program controlled (SPC) switching systems to transfer signalling messages required for handling telephony, circuit-switched data connections and, in the future, a potentially wide range of other telecommunications services in an Integrated Services Digital Network (ISDN).

The No. 7 CCSS is expected to be introduced into the Australian telecommunications network with the introduction of the Integrated Digital Telephony Network (IDTN), commencing in the mid-1980s. It will provide the most likely mechanism for the introduction of automatic network management in the Australian network in the late 1980s, and will provide a mechanism for the probable evolution of the ISDN from the IDTN in about the same timeframe. By the year 2000, it is expected to be the dominant inter-exchange signalling system in the Australian telecommunications network.

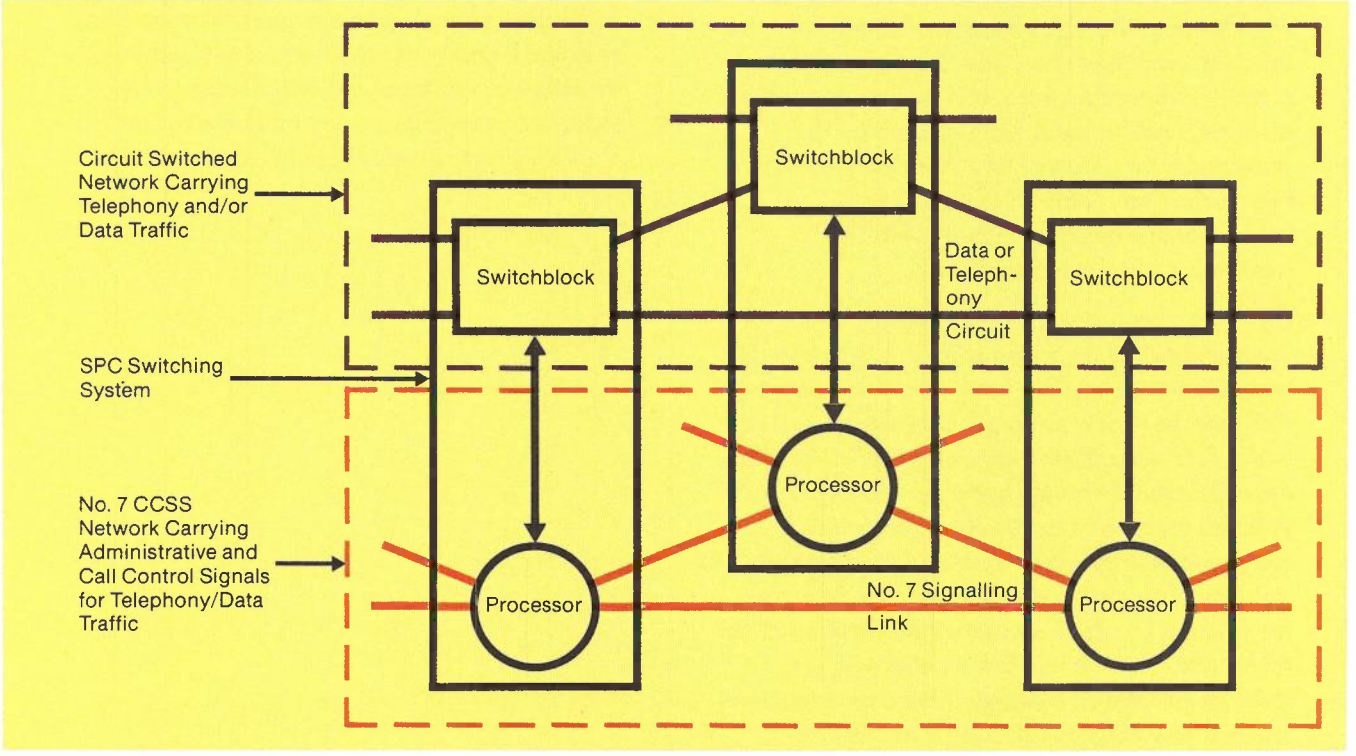
Study of the No. 7 CCSS has been pursued in the Laboratories for several years, as has Telecom's consequent participation in CCITT activities related to its further development. Mr. M. Subocz, Principal Engineer in the Switching and Signalling Branch, is the CCITT Rapporteur for No. 7 CCSS aspects of the CCITT Study Question 14/XI.

In 1981, work commenced to gain a more thorough understanding of the fundamental traffic behaviour of the No. 7 CCSS. This included the understanding of:

- the characteristic relationship between the end-to-end message transfer delay and the traffic level of each signalling node as a function of the network path used
- the effects of signalling traffic overload and the evaluation of the effectiveness of control mechanisms such as flow, routing and congestion control.

It is expected that the results of these investigations will enable Telecom's network planners to specify appropriate performance criteria for, and to estimate the capacity of, the No. 7 signalling system, as well as to develop methods for designing and dimensioning the probable future No. 7 CCSS national network structure for Australia.

Future telecommunications network using the No. 7 Common Channel Signalling System



The theoretical model used by the CCITT for the analysis of message transfer delay is also being studied in the Laboratories but more work is necessary to solve the complex capacity estimation problem.

A computer simulation model of a simple No. 7 CCSS network is presently being constructed to study its fundamental traffic behaviour and to evaluate the effectiveness of some simple traffic control strategies. The model is structured in a modular fashion to allow flexibility for future expansion to simulate more complex network structures. The simulation is implemented on Telecom's computer network, using the General Exchange Simulator software package developed by the Laboratories.

Developments in Subscriber Line Interface Circuitry

In most telecommunications networks, the interfacing point between advanced technology equipment and external transmission lines represents a vulnerable link in the communications chain. In particular, the interfacing circuitry between the terminal telephone exchange and the line to each customer connected to that exchange must comply with extraordinary design constraints when semiconductor circuit technology is used. Since approximately seventy percent of the current capital costs of exchange equipment are attributable to the line interface functions, considerable effort is being devoted worldwide to the improvement of circuit reliability and the reduction of the costs of providing these functions. It is now recognised by major equipment manufacturers and by the semiconductor industry that a less expensive, high technology solution to providing the subscriber line interface circuit (SLIC) is inevitable in the longer term.

However, a number of questions must be investigated and answered confidently before the expected semiconductor implementation of the SLIC will be widely accepted. One such question is whether monolithic technology will provide the desired circuit operation in the presence of voltages ranging from 50 volts to 400 volts, a constraint introduced by ringing and subscriber signalling functions. Another question concerns the manner by which secondary protection will be achieved for anticipated line transients of the order of 1500 volts. More generally, the question arises as to whether and to what extent the Australian local network specifications should be modified to satisfactorily accommodate the semiconductor SLIC. The answers to these and other questions will determine whether an entirely monolithic SLIC realisation is feasible.

These questions are being studied in the Research Laboratories from two alternative points of view.

On one hand, developments in monolithic semiconductor SLIC designs and in potentially applicable integrated circuit technologies are under evaluation. The only commercially available attempt at such a design has been rigorously evaluated and dialogue established with the manufacturer on performance requirements. The SLIC application is currently the most difficult integrated circuit design problem throughout the industry and considerable improvements are anticipated over the next five years.

The alternative application of advanced, discrete, semiconductor components and of hybrid microcircuit technology to the SLIC realisation problem is also under investigation. High performance MOS devices with high power ratings for protection, high speed bipolar switches for test access, and high precision integrated circuits for two-wire/four-wire balance networks are being studied. The most recent generations of switching equipment utilising design solutions based on these hybrid technology approaches are also being evaluated.

The requirement for a low cost, high technology means for providing the subscriber line function is expected to continue for the next few decades whilst the telecommunications network continues to operate in analogue and transitional analogue/digital modes. This research work is therefore of significant potential value in the reduction of capital costs and the maintenance of high performance standards in these networks.

Local Digital Reticulation Studies

The economic advantages of digital transmission and switching will ensure that a growing proportion of links between local exchanges in telephone networks will become fully digital during the 1980s. Questions relating to the benefits of extending digital transmission from the local exchange to the customer have resulted in the concept of an integrated services digital network (ISDN). This concept is attracting considerable interest within telecommunications administrations around the world, including Telecom Australia.

An important element in the evolution towards an ISDN is the two-way digital transmission path linking customer and local exchange. It is imperative that such paths should initially be provided over the existing network because it represents a significant investment. In Telecom Australia's case, it is 30% of the total network asset.

Considerable overseas resources have already been devoted to this area of investigation and a number of alternative digital transmission techniques, capable of operating on existing local cable networks, have been proposed.

To facilitate the assessment and comparison of the various digital transmission techniques proposed, the local loop must be accurately known in terms of its physical and electrical characteristics. Within Telecom Australia, information of this type has been obtained from a local loop survey recently conducted by the Engineering Department. In addition, the Research Laboratories have developed a computer model of the local loop. The model combines network composition data with data concerning the transmission parameters of local cables (obtained from open and short circuit measurements on short lengths of each cable type) to produce a number of important electrical parameters. These include:

- customer to exchange impulse and/or frequency response
- customer end and exchange end echo impulse and/or frequency responses
- eye patterns for a number of given line codes and insertion loss.

The outputs from the model have been verified by measurements performed in the laboratory. By combining the information obtained from the local loop survey with the local cable computer model, the transmission limits of the different transmission techniques can be established, to assess their viability as a means of achieving customer access to a future ISDN.

At present, the local loop survey information is based on information from 423 randomly selected samples in three metropolitan areas, mostly near the city of Melbourne. Four types of loop distribution exist in the network between an exchange and the customer's premises, namely, direct, through cabinet only, through pillar only, or through both cabinet and pillar. To give a degree of flexibility, "bridged taps" or "multiples" may also be found in the network. In the initial survey, 54% of local loops were found to contain at least one multiple; and 66% of these were 0.4 mm polyethylene-insulated, unit-twin (PEIUT) cables. Multiples, which are open circuit at the distant end, predominantly branch off in the last link between cabinet or pillar and the customer. For local digital reticulation, the occurrence of multiples is important because they cause backward and forward reflections of signals and add attenuation.

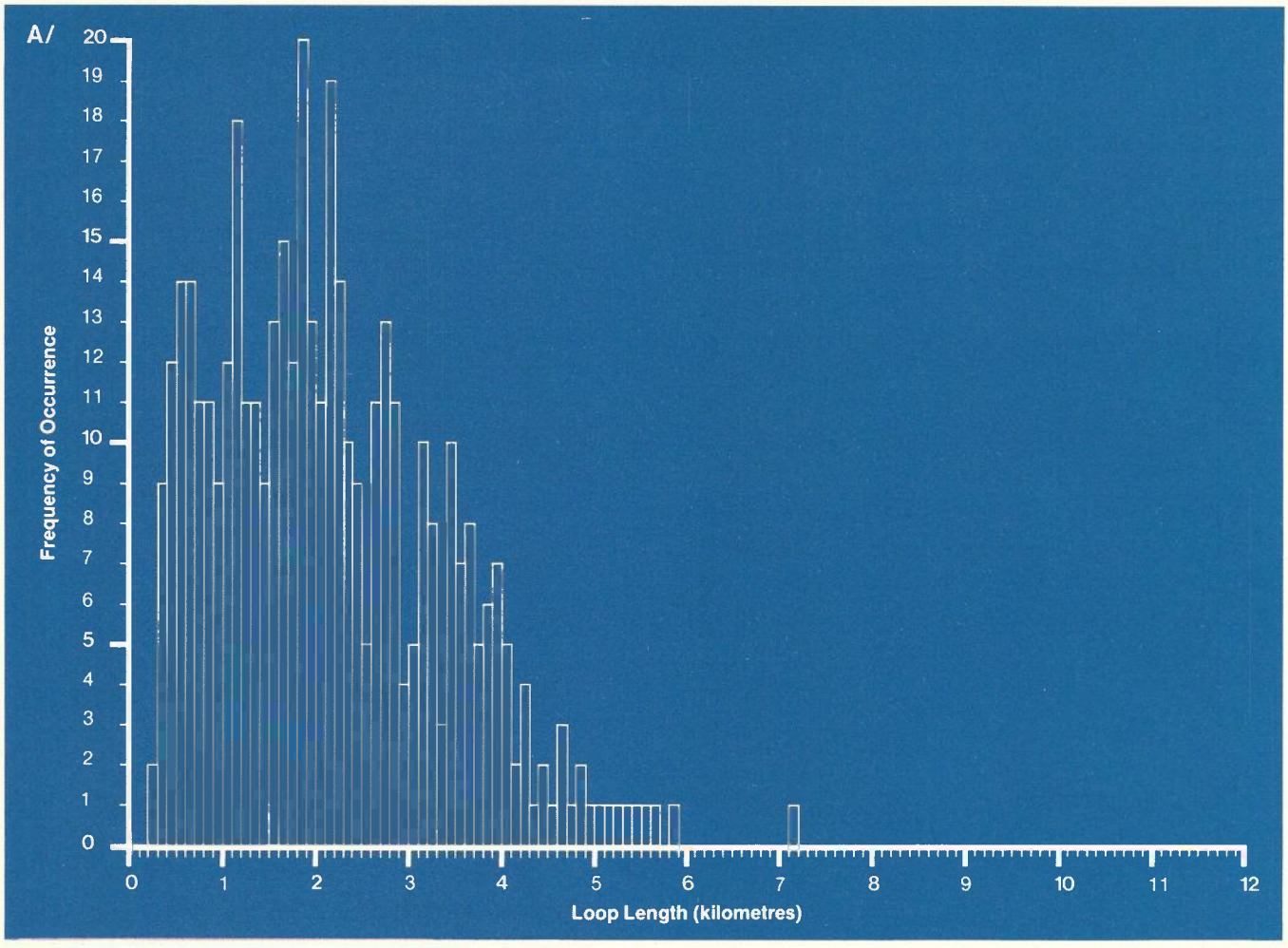
Another source of attenuation and backward reflection is the significant number of cable gauge changes occurring along the length of a typical loop. Analysis of the survey data has indicated that the number of gauge changes and loop length are uncorrelated. Hence, impedance irregularities can strongly influence the design parameters required by proposed digital line systems to achieve acceptable performance.

The Research Laboratories are currently investigating the effects that system parameters such as transmission rate, line code and signal equalisation, have on the transmission distance which can be achieved on each of the local loops obtained from the survey. By combining this information with cable crosstalk and impulse noise data, it will be possible to predict the percentage of existing customers who could obtain direct access to their local exchanges for the transmission method employed.

Number of Cable Gauge Changes per Loop	0	1	2	3	4	5	6	7	8	9	10	11
Frequency of Occurrence in 423 Samples	2	55	93	86	75	63	25	12	7	4	0	1

Note: The number of gauge changes in a loop is independent of its length

Table showing distribution of cable gauge changes per loop in a survey of 423 local loops


A/
Frequency of Occurrence
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
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0
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2
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6
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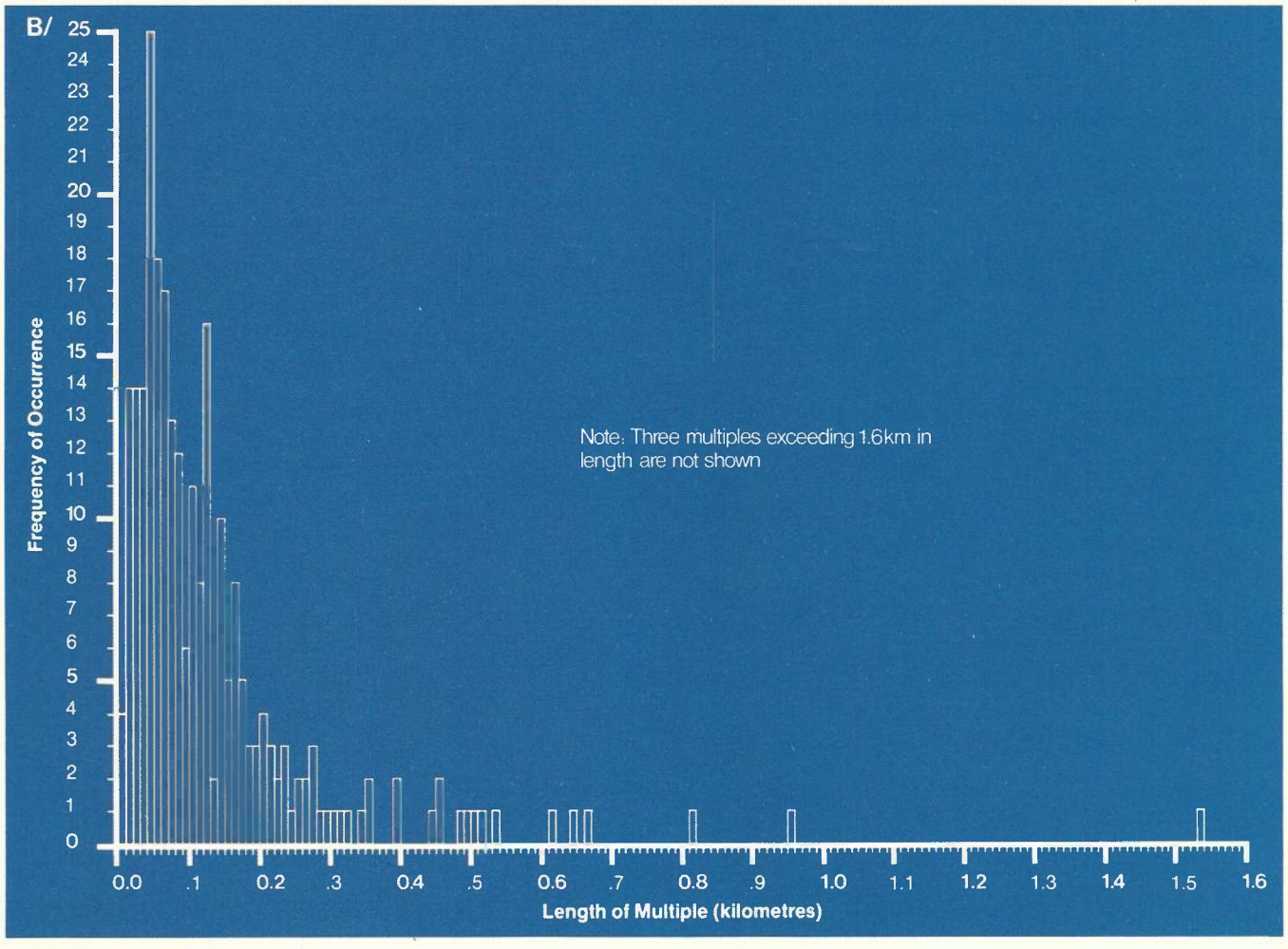
11
12
Loop Length (kilometres)


B/
Frequency of Occurrence
0
1
2
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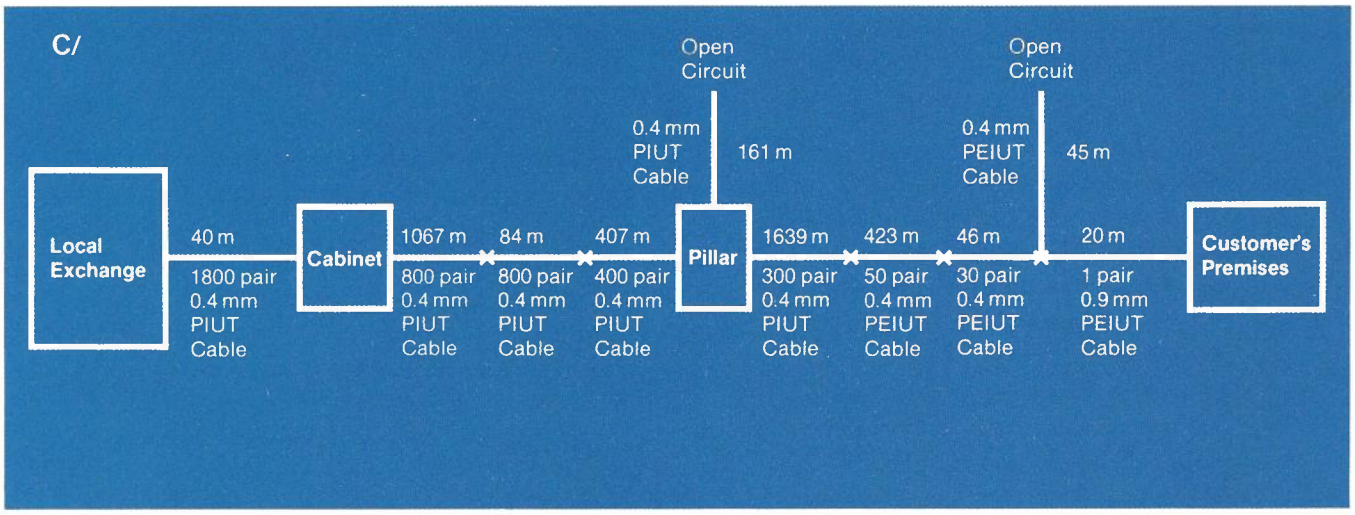
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
Note: Three multiples exceeding 1.6km in length are not shown
0.0
.1
0.2
.3
0.4
.5
0.6
.7
0.8
.9
1.0
1.1
1.2
1.3
1.4
1.5
1.6
Length of Multiple (kilometres)



A/ *Histogram showing distribution of lengths in a survey of 423 local loops*

B/ *Histogram showing distribution of multiples found in a survey of 423 local loops*

C/ *Schematic diagram showing the composition of a typical local loop*

Field Experiment in Digital Transmission over Graded Index Optical Fibres

Telecom Australia is investigating the possible use of high capacity transmission systems using graded index optical fibres in its network. The characteristics of optical fibres that make them attractive for telecommunications use are now well known. They are physically small and so use less space in expensive cable ducts; they are light and flexible and so are easier to install than conventional cables; they offer very low signal losses and therefore long separations between signal amplifying repeaters; and they offer high bandwidths, so that a large number of channels or signals can be carried simultaneously. Recent developments in long optical wavelength device technology have made optical fibres even more attractive, in that even higher bandwidths and lower losses appear possible.

In April 1981, Telecom Australia installed its first experimental graded index optical fibre link in order to gain experience working with this new transmission medium. The six-fibre optical cable joins the Clayton and Springvale telephone exchanges, with a spur cable running into the Research Laboratories to allow initial testing of the systems and terminal equipment from the laboratory. A total cable length of 8 km is involved, this total comprising eight individual cables in varying shorter lengths.

The cable lengths were purchased from Japan and an extensive programme of laboratory measurements was performed on the individual cables before their installation in the field. This necessitated the development of a range of test equipment capable of precise measurement of the very low fibre loss and the high fibre bandwidth. Measurements carried out since installation have indicated that the fibre characteristics altered only very slightly during installation. Techniques for locating cable defects have also been convincingly demonstrated.

The eight cable lengths are currently being spliced to form a continuous fibre link, and investigations into the accumulation of loss and bandwidth with length are being performed. From these investigations, the influence of measurement conditions on the results obtained will be established, and in particular, the degree to which measurements made in the laboratory on short cable lengths can be used to predict the characteristics of an installed and spliced fibre link will be determined.

Two sets of commercial digital optical line transmission equipment using laser diode sources have been purchased for the experiment. One of these operates at 140 Mbit/s, and the other at 34 Mbit/s. These are capable of carrying 1920 and 480 simultaneous voice channels respectively, or the equivalent in data traffic. This equipment will initially be used in transmission experiments conducted from the Research Laboratories and will later be moved to the two exchanges during the final phase of the experiment.

Lessons learned from this experiment will be applied in three forthcoming optical fibre field trials to be conducted by the Engineering Department. Once these are successfully concluded, it is expected that graded index optical fibres will be installed with confidence in the network as and where the need arises.

Interference into Digital Line Systems from Telephony Signalling

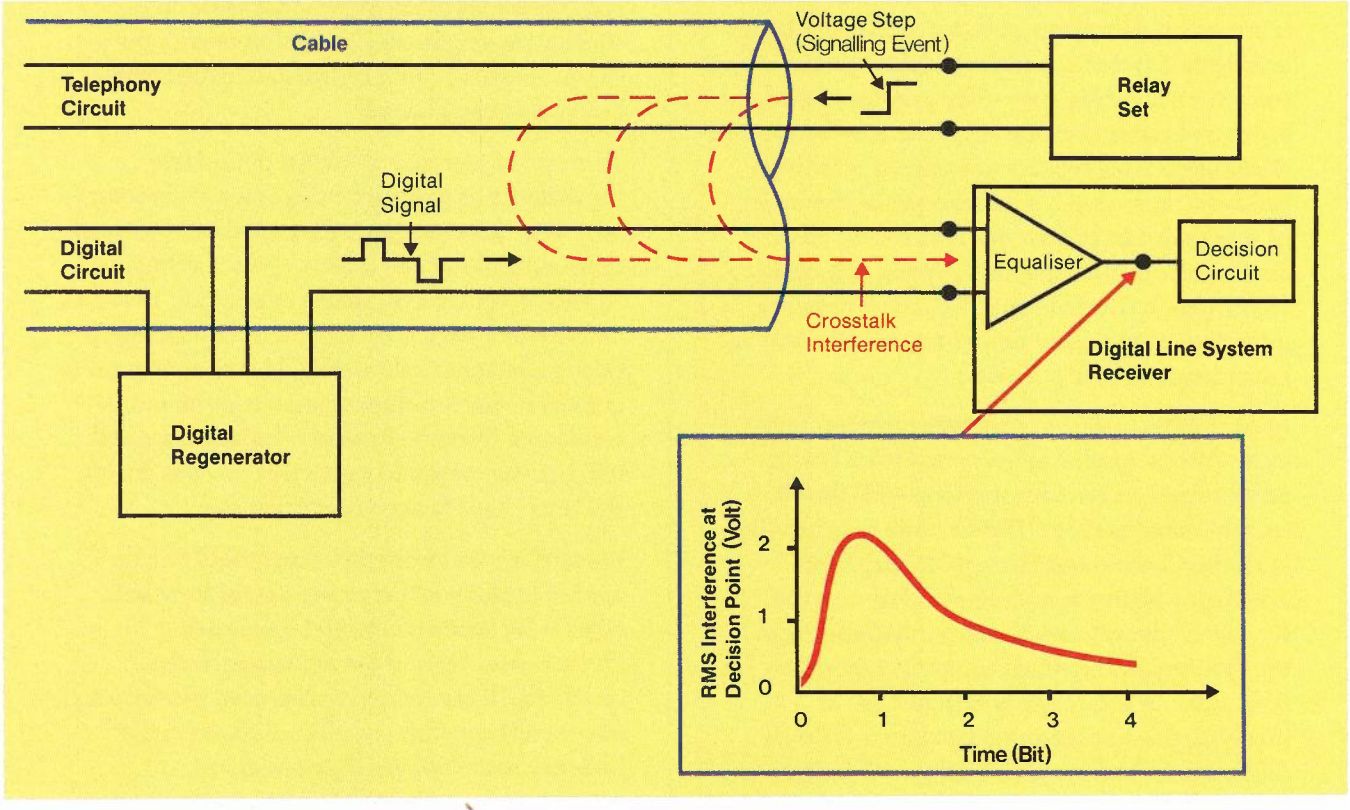
With the increasing rate of installation of digital transmission systems on multi-pair cable in the Telecom Australia network, compatibility with other types of transmission systems is an important design criterion. For example, 2048 kbit/s digital line systems on inter-exchange junction cables must be able to tolerate interference from nearby telephony circuits which employ loop disconnection and/or reversal of line voltage polarity for signalling. These signalling techniques involve stepped changes in voltage level which result in strong electromagnetic coupling (crosstalk) into other circuits in the same cable. The interference signal thus produced is impulsive in nature and can affect systems operating within a wide range of frequencies. Because circuits employing these types of signalling techniques are expected to be present in the Australian network for several more decades, all new digital systems need to be able to tolerate this impulsive interference.

The Research Laboratories have undertaken a theoretical study of this interference process, in order to reduce the number of measurements required to characterise the noise environment in the cable, to determine those receiver characteristics which improve the immunity of the system, and to enable the prediction of the effects of this interference on other systems with different line codes and transmission rates.

The crosstalk coupling is mainly due to irregularities in the twisted structure of the pairs of wires and can only be represented by its statistics over all combinations of circuits within the cable. Combination of the statistical crosstalk gain and the measured response of the receiver's equaliser enables the statistics of the interference at the decision point of the receiver to be computed. Comparison of this interference with the digital signal, at the instant at which the receiver identifies a received bit, results in an estimate of the probability of an error in identifying that bit. When this probability is averaged over all types of bits received and all possible temporal relationships between the digital signal and the interference, an estimate of the expected error rate is obtained.

The Laboratories have developed a theoretical model embodying the abovementioned features to study the interference process. The model has been confirmed experimentally for dialling pulse interference from step-by-step relay sets into a 2048 kbit/s digital line system on a small size cable. Along with estimates of the telephony traffic on all disturbing circuits, the model enables the prediction of error rate as a function of the section loss in the digital line system. The lengths of sections adjacent to exchanges in digital line systems may then be selected to achieve the desired error-free performance.

Interference into a digital line system from a dc signalling reversal



The Relationship between Errors in Digital Transmission and the Multiplexing Factor

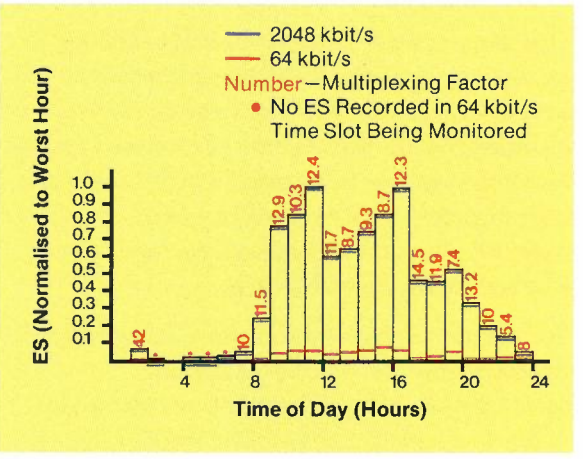
Digital transmission systems carry information as a series of zeros (0) and ones (1), called "bits". If for any reason a 0 is incorrectly received as a 1 or vice versa, an error is said to have occurred. There are a number of ways in which the allowable number of such errors on a system can be specified. One of these is in terms of error-free-seconds (EFS); another is related to error-seconds (ES). An EFS is a second in which no errors are received, while an ES contains one or more errors. Most error specifications are written for system performance at the widely used digital rate of 64 kbit/s. For reasons of efficiency, groups of 64 kbit/s streams are transmitted at a higher bit rate (e.g. 2048 kbit/s), and it is advantageous to be able to specify the performance of this higher order bearer to ensure the 64 kbit/s specifications can be met.

The relationship between ES performance at the two bit rates is called the Multiplexing Factor (MF). MF is difficult to determine analytically because errors occur not only in isolation but also as bursts of varying lengths. These bursts contain a mixture of errors and correctly transmitted bits. Each transmission system will have a distribution of error bursts in terms of length, frequency of occurrence and composition. Each of these three factors affects MF. For this reason, the Research Laboratories are currently undertaking an experimental programme to measure MF directly.

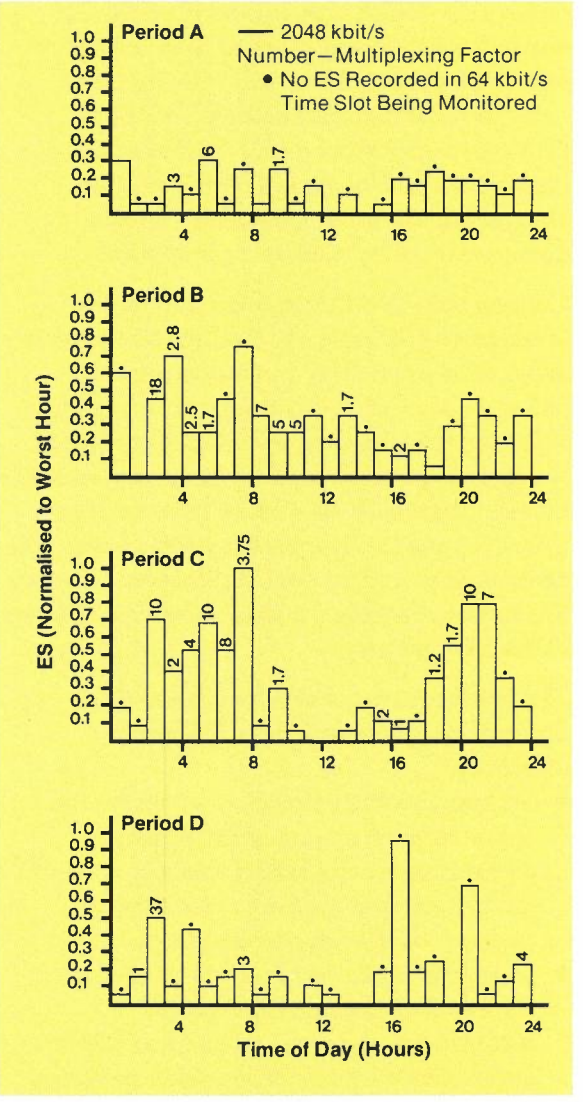
A data test set developed by the Laboratories has been used to make simultaneous ES measurements at 2048 kbit/s and 64 kbit/s. Using this equipment, measurements have been made of the performance of 2048 kbit/s digital line systems and Data-Above-Voice (DAV) radio systems.

The results from these tests have shown that for 2048 kbit/s line systems, the MF has considerable short term variation but rather less long term variation. No single MF can be used to characterise digital line systems, although a lower limit may be put on MF, associated with the error performance of an in-service bearer. A lower limit for MF of 10 has been indicated by the test results showing that 10 ES in the 2048 kbit/s stream results, on average, in one ES in the 64 kbit/s stream in digital line systems.

DAV systems exhibit quite different MF behaviour from that found on line systems, since the MF is strongly influenced by radio propagation fading. For this reason, a MF much closer to 1 is needed to ensure an adequate margin.



Average error-second performance of a digital line system



Average error-second performance of a data-above-voice radio system

Eye Closure Analysis for Digital Radio Systems during Fading

Digital microwave radio systems are finding increasing application in telecommunications networks around the world. Telecom Australia is planning for the introduction of medium capacity 34 Mbit/s systems in metropolitan networks and high capacity 140 Mbit/s systems in the trunk network. The first of these systems will be put into service by the mid-1980s.

Techniques to predict the performance of digital radio systems are a subject of current consideration. Field experiments performed by various administrations around the world have demonstrated that outages due to an error rate greater than 1 in 1000 bits occur almost exclusively during periods of multipath propagation which causes in-band amplitude dispersion (commonly referred to as frequency-selective fading) and produces inter-symbol interference bit errors. Further, it has been demonstrated that for digital radio systems of high bit rate and long hop length, the errors arising from the inter-symbol interference dominate those induced by thermal noise.

Consequently, the Laboratories have been investigating the inter-symbol interference that arises during periods of frequency-selective fading. In addition to other approaches, a mean-square eye closure analysis has been performed for digital signals subjected to frequency-selective fading. Progressive eye closure from the ideal open eye state finally leads to system outage. The analysis employed the well documented two path (i.e. single echo) fade model used by most workers in this field of study.

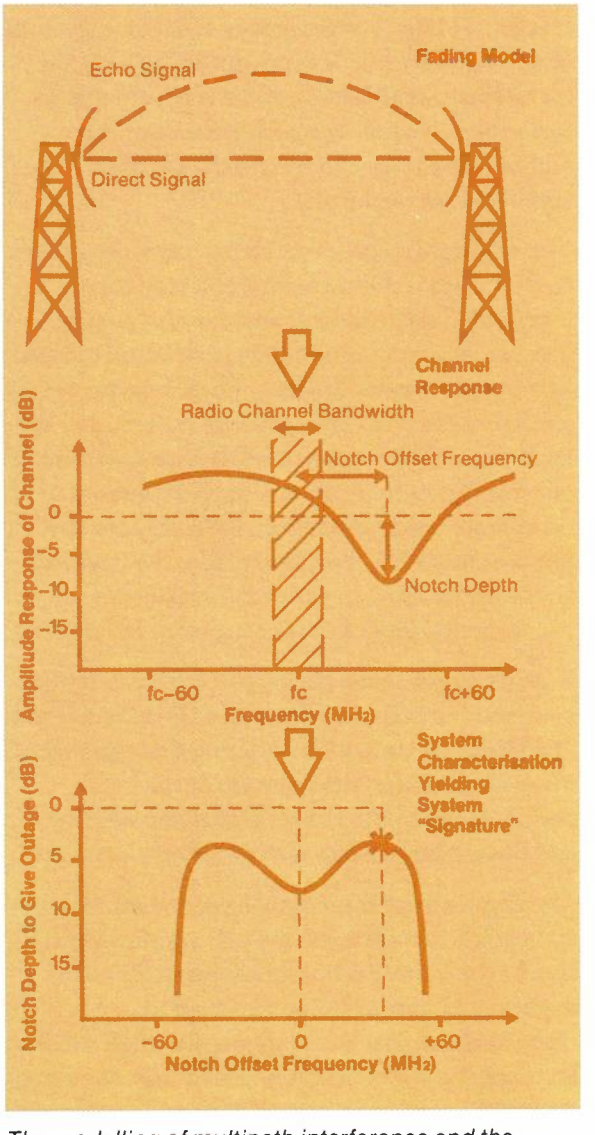
The mean-square eye closure analysis was undertaken to accomplish the following objectives:

- to obtain mathematical expressions for the optimum carrier phase offset, optimum receiver gain and optimum timing point, which can then be employed in a more complex analysis which evaluates error probabilities
- to provide a mathematical tool which can be employed to compare the expected performance of various modulation schemes during periods of frequency-selective fading.

To ascertain whether the mean-square eye closure analysis technique can be employed with a degree of confidence, a number of comparisons were also made between the experimentally observed phenomenon and that predicted by the mean-square eye closure criterion. These comparisons included:

- characteristics of "system signatures", including the effects of signature scaling
- comparison of the performance of different modulation schemes during periods of selective fading; in particular, 4 PSK, 8 PSK, 16 QAM, 32 QAM and 64 QAM were compared
- examination of the observed property of amplitude dispersion (often referred to simply as "in-band dispersion").

In all comparisons, agreement was obtained, thus providing a justification for the mean-square error approach. The mean-square error criterion is also seen to be useful in the study of adjacent channel interference.



The modelling of multipath interference and the generation of digital radio system "signatures"

Determination of the Channel Parameters Affecting Digital Radio Transmission Performance

Most of Australia's trunk telephone traffic is carried by microwave radio links. Among the many factors considered when designing such a link is the effect of the atmosphere on the quality of telephony and other types of traffic carried by the radio system. Adverse atmospheric conditions can cause the received radio signal to virtually disappear or be seriously distorted. An adequate understanding of the varied effects of weather on the propagation of microwave radio signals is therefore crucial in the design of these systems. For many years, the Research Laboratories have measured the radio propagation performance of paths of planned trunk routes throughout Australia. These tests have been conducted on paths where difficulty in meeting the design objective performance was expected. The tests conducted allowed path performance statistics to be compiled for systems using analogue modulation.

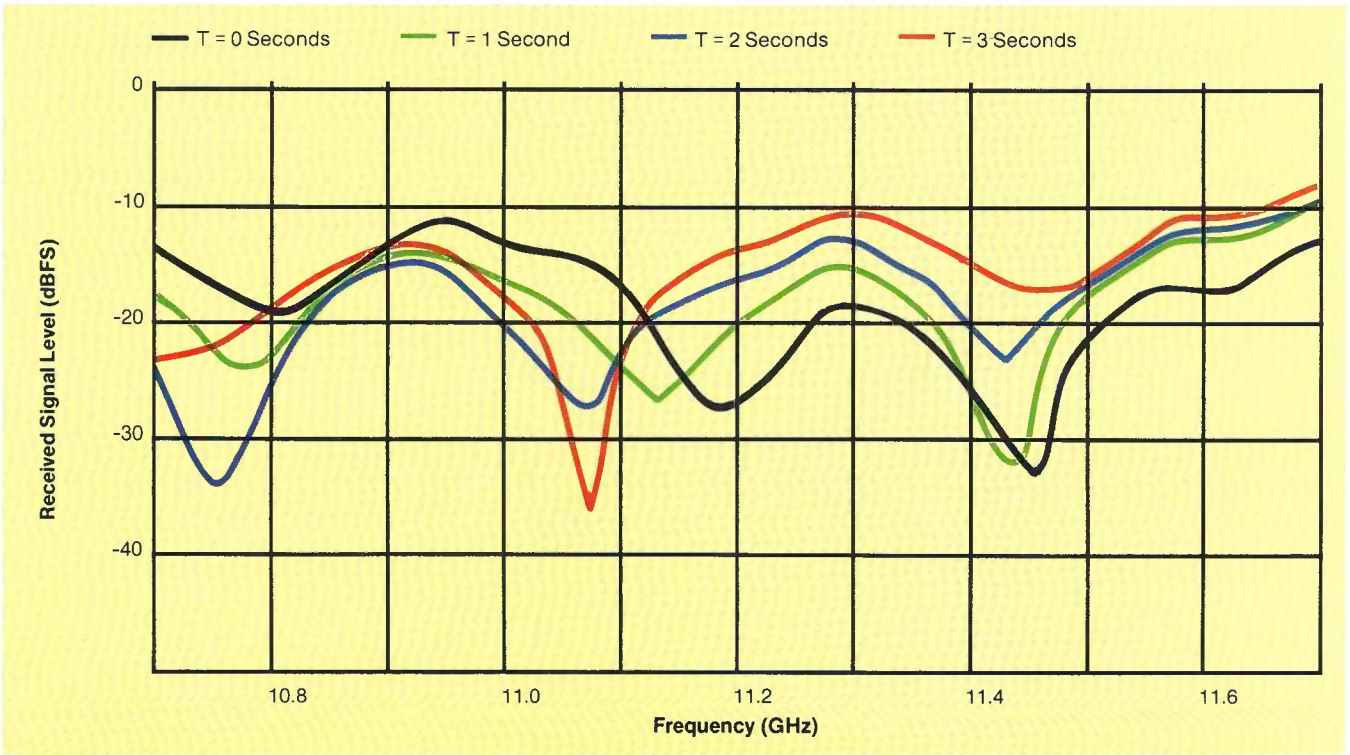
Telecom is now planning the rapid deployment of digital radio systems throughout the trunk network. These high capacity systems are particularly sensitive to distortion of the radio signal and additional statistical distributions of the broadband parameters of radio paths are now required. Until recently, the Laboratories have been collecting such data using radio propagation equipment operating at 11 GHz on a 36 km path in Gippsland, Victoria. The propagation experiment was set up some years ago over this path, mainly with the objective of investigating and gaining an understanding of the propagation mechanisms which might affect the quality of digital radio transmissions.

Distortion of the radio signal is caused by specific combinations of atmospheric conditions. When the wind velocity is low and the sky is clear, the earth re-radiates at night the heat which it gained during the day. The air temperature therefore increases with height above the ground until a stable layer of maximum temperature is formed. When the height corresponding to maximum air temperature coincides with that of any radio antennas, the radio wave is de-focussed and the received signal suffers enhanced interference from any ground-reflected component which may be present. The consequent strong variations of amplitude across the radio band result in inter-symbol interference of a digital radio signal and increase the probability of errors in the digital transmission process.

From the statistical distributions of amplitude and amplitude-slope, the system designer can predict the performance of the radio system.
By determining the distribution of the de-focussed ray, the overall distribution can be computed for different values of ground reflection coefficient and frequency.

Early in 1982, the broadband radio propagation

Measurements of broadband amplitude response of a radio system on a 36 km path in Gippsland



measuring equipment used by the Laboratories in the collection of statistical data of relevance to high capacity digital radio transmission system design was moved to the Mount Gray to Gun Gun path on the Sydney to Melbourne trunk route. The current test programme is directed at providing specific design information for the future development of this route.

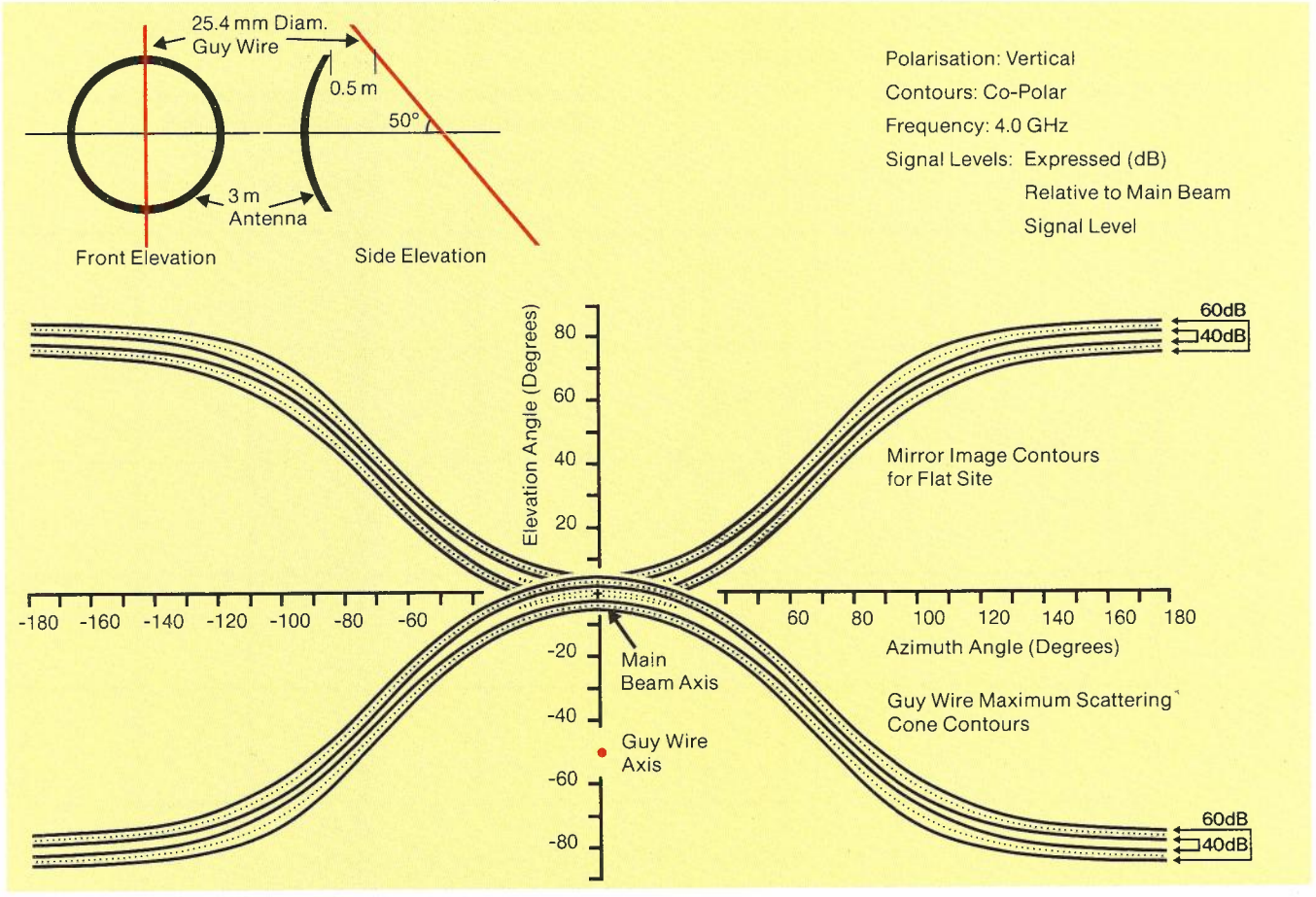
Effects of Guy Wires near Microwave Radio System Antennas

Although many microwave radio systems employ self supporting antenna towers, significant advantages are often afforded by guyed masts. The benefits derive from substantially reduced structure costs for mast heights above approximately 45 metres. The savings are gained either directly or by means of the flexibility which tall guyed masts permit in choosing alternatives to difficult or relatively inaccessible high sites. These advantages have resulted in increased use by Telecom Australia of guyed masts on its expanding microwave radio routes, and have made it necessary to ascertain the effect of nearby guy wires on the technical performance of some antennas at particular sites.

The problem has been investigated by the Laboratories using both experimental and theoretical techniques. In the experimental approach, antenna radiation patterns were measured on a far-field range, both with and without a simulated section of guy wire present. For specific guy wire orientations, the typical pattern degradation which can occur in the azimuthal plane of the antenna showed that the worst deterioration of the pattern side lobes occurs within a few well-defined regions. It was considered that, in non-critical applications and where the likely interference paths of interest lie close to the horizontal plane, it should be possible to operate antennas in such a mode.

However, the investigations suggested that more careful design is needed when the antenna operates in frequency bands shared with communications satellites. The guy wire generates a cone of maximum scattering, which affects a significantly greater region of space than is suggested by the azimuthal patterns alone. The scattering map prepared from computed wire scattered fields demonstrates that portions of the scattering cone reflected from the ground produce "mirror image" contours which would be likely to create interference problems with satellite systems.

Computed guy wire scattered field contours, including flat ground reflections



Instrumental Measurement of the Loudness Ratings of Telephones

Loudness Rating (LR) is expected to be recommended soon by the CCITT as a new technique for rating the transmission performance of telephone sets and connections. A major aim of the LR technique is to make feasible instrumental measurements which accurately reflect the subjective performance. The Research Laboratories have been studying this technique and are now applying it in relation to Telecom's reference standards for telephone transmission performance.

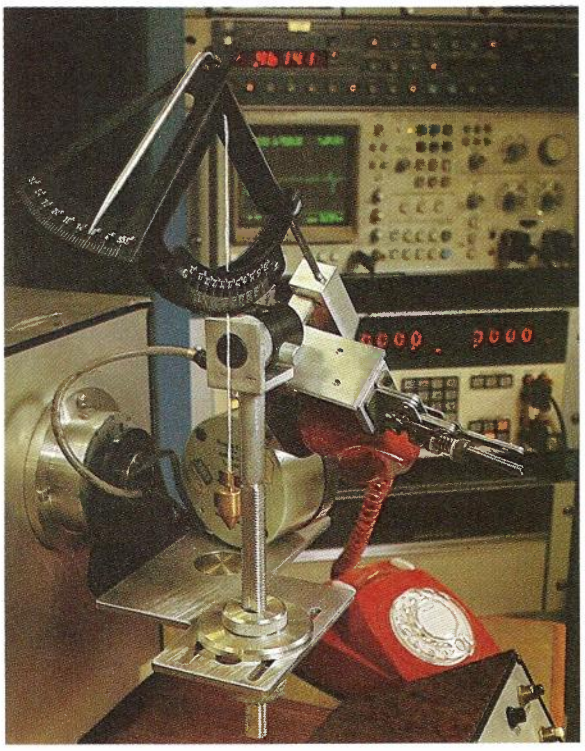
Instrumental measurements may take two forms. In the first form, the measurement set-up includes an artificial line and feed bridge with the telephone set, and the LRs are produced directly. If LRs are required for a variety of line conditions, each of these must be set up and individual measurements carried out. In the second form, a constant current power supply replaces the line and feed, and fundamental sensitivity and impedance measurements as a function of frequency and feed current are carried out. The parameter values are then inserted into an off-line computer and LRs may be computed for many different and quite complicated circuits using network modelling and analysis techniques.

The critical components required for the instrumental measurement of LRs include the artificial voice, the artificial ear and the loudness computation algorithm. If carbon microphones are involved, the artificial voice signal should be speech-like in both spectral and temporal properties, and the microphone should be pre-conditioned by careful rotation prior to measurements. Speech-weighted random noise has proved to be a satisfactory test signal in most cases, with the measurements being made using a fast Fourier transform spectrum analyser. A motorised conditioner has been constructed to perform the conditioning function. For non-carbon microphones, more accurate results are obtained using a frequency response analyser which uses sine wave test signals at discrete frequencies and a phase-sensitive detector.

The sound pressure leakage between a real ear and a telephone ear-cap is difficult to simulate consistently and accurately using artificial ears. Until a better solution is found, this leakage is accounted for by including a correction factor in the measured sensitivity data. The CCITT has standardised a loudness computation algorithm which is satisfactory for most send and receive LRs where the frequency response characteristics are reasonably typical. Alternative algorithms are being tested in the Laboratories for the less satisfactory cases.

A programmable artificial telephone line has been constructed which has plug-in units for each wire gauge of interest (0.32 mm to 1.27 mm equivalent copper cable). Up to three gauges may be used in cascade at any one time. A programmable switching unit and a system controller (desk top computer) complete the system. A programmable R-C network is also used for accurate determination of the effective sidetone balance impedance, although this can be determined with reduced accuracy from the measured telephone line terminal impedance and measurements of the sidetone sensitivity (gain and phase) with the telephone line terminals open circuit and short circuit.

The above system which has been developed in the Laboratories gives reliable data with minimum operator intervention. It will eventually obviate the need for most subjective measurements of loudness ratings. The fundamental data, once measured, allows network planners and others to perform quite complex studies of the loss distributions in telephone networks using computer models alone.



Motorised pre-conditioning of telephone microphones prior to instrumental performance measurements

A Sampling Voltmeter for Speech and Programme Signal Level Measurements

Telecom Australia has a continuing interest in assessing the levels of speech and other signals generated and transmitted in its telephone network. In the past, such signal level measurements have been made manually using simple analogue meters such as VU meters. Because such measurements are laborious and can be subject to operator bias, it has been difficult to achieve an adequate knowledge of signal levels in the network.

Using standard measurement principles as recommended by the CCITT, the Research Laboratories have been undertaking studies since about 1970 to automate the measurement of various speech signal parameters.

A prototype sampling voltmeter developed around 1972 punched out data on paper tape for subsequent computer processing. Following a limited period of field measurements, the instrument was found to have an inadequate dynamic range and poor accuracy, and the requirement for subsequent processing made measurements tedious and expensive. Another failing of the system was its inability to produce reliable estimates of activity factor in the presence of even moderate levels of circuit background noise.

Further laboratory studies, involving measurements relative to many different thresholds, indicated that the effect of noise could be minimised by extrapolating data obtained using thresholds above the noise level.

With rapidly developing microprocessor technology and the availability of compact printers, it was considered feasible in the late 1970s to design an instrument which would sample the signal at high speeds, process data in real time, and print out results almost immediately after the conclusion of the measurement period. A technical specification for such an instrument was prepared in the Laboratories and a research and development contract was subsequently let to Plessey Australia Pty. Ltd. for the development of the instrument.

As specified, the instrument has a sampling rate of 250 per second and a dynamic range of 60 dB. For speech signals within the bandwidth from 300 to 3400 Hz, it provides simultaneous processing of activity factor for 16 separate fixed thresholds. At the conclusion of each measurement, it both displays and prints out on an inbuilt printer such data as overall mean power level, activity factor and mean power level while active. It can also provide optional print-outs of distributions of activity factor versus threshold level, distributions of sampled amplitudes over 30 level ranges, and both 1% and 10% exceedance levels.

For sound programme signal measurements, the signal bandwidth capability is increased to 40-15 000 Hz and the instrument produces one minute mean power levels together with a statistical distribution of levels, and 1% and 10% exceedance levels.

In both modes of measurement, the output is available in digital form for recording on an external magnetic cartridge recorder.

Cost Effective Custom Logic Circuit Design

New generations of telecommunications equipment perform increasingly complex logic functions. Standard logic circuit components can be used to realise these functions, but this approach often results in a system with a large number of devices, which in turn involves many printed circuit cards, high power dissipations and reduced reliability. An alternative approach is to use special "customised" logic circuit components to realise the same functions with fewer, custom-designed devices, less circuit card area, lower power dissipations, improved performance, higher reliability and cost effectiveness at high volumes. Such customised devices include:

- field programmable devices (e.g. Programmable Array Logic devices and Programmable Read Only Memory devices), which are customer programmable using relatively simple programming equipment
- semi-custom devices, in which the device manufacturer provides standard logic building blocks with which a wide range of circuits may be designed and specific circuits fabricated to particular designs specified by the customer using these standard building blocks
- fully custom devices, which are uniquely designed and fabricated by device manufacturers to satisfy the particular circuit requirements of individual customers.

The application of all three types of customised logic circuits is already apparent in telecommunications equipment. The next

generation of switching equipment, in particular, involves a significant complement of fully customised logic circuitry.

In the Research Laboratories, investigations of the applications of these approaches have been directed towards evaluation of the performance features, limitations and cost effectiveness of the various alternatives, particularly in relation to typical telecommunications switching system applications and environments.

Studies of the use of field-programmable logic devices have shown that at least a five-fold decrease in package count is achievable in typical high speed logic systems.

In particular, the usefulness of Programmable Array Logic devices in laboratory prototyping and system development work has been identified. Simplified, computer-aided design tools have been developed for this application.

Collaborative study programmes involving the Australian microelectronics industry and tertiary academic institutions are being undertaken to ascertain the cost effectiveness and suitability of the semi-custom design approach in typical telecommunications applications. To date, this work has involved designs for advanced signalling terminal processors and digital line transmission test equipment.

The Laboratories' studies of the application of the fully custom logic design approach are directed towards assessing the suitability of silicon foundry technology for the realisation of various switching system functions, including digital time switches and high speed error rate monitoring circuits. This research activity, which is being conducted in co-operation with the Division of Computing Research of the CSIRO, involves computer-aided design of high complexity MOS logic circuits.

Automated Acquisition and Analysis of Field Data

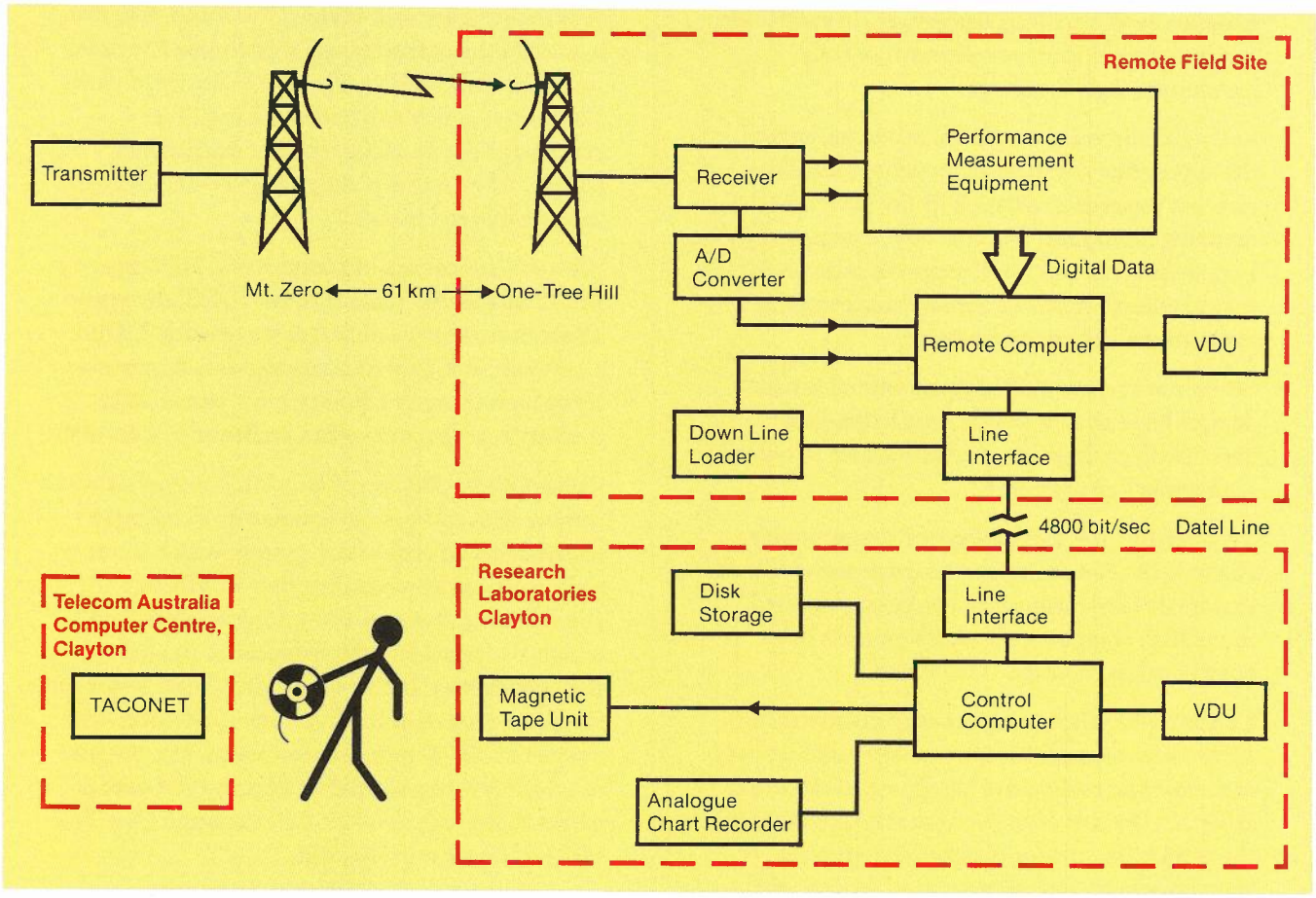
To design radio routes with predictable system performance, many field measurements were made in past decades to determine the effects of propagation changes due to meteorological variations on system performance. In the majority of cases, the measurements of equipment parameters were recorded on paper charts and required subsequent laborious analysis. This wealth of information, gathered over many years, has enabled the route designer to predict the performance of analogue FM radio systems with confidence on the majority of paths. The design of difficult paths still requires knowledge derived from further on-site field testing. Alternatively, they are over-engineered to ensure performance.

With the impending introduction of high capacity 140 Mbit/s digital radio systems (DRS) to expand Telecom Australia's digital data network (DDN), a new series of field measurements is required as these high capacity DRS are more sensitive to multipath propagation than analogue FM systems.

Continuous collection of large amounts of data at remote sites can best be handled by a computer-controlled data acquisition system which is not only designed for recording data in a form suitable for subsequent computer analysis, but which also provides a high degree of flexibility in the operations it is able to perform. Such a system has been devised in the Research Laboratories for a series of digital radio field experiments, the first of which is being conducted during 1982 over a 61 km radio path between Mt. Zero and One Tree Hill, near Ararat in Victoria.

The data acquisition system provides for radio propagation data to be collected at a remote receiver site and subsequently transferred over a Datel line from the remote computer at the site to the control computer located in the Laboratories in the Melbourne suburb of Clayton. When data is received, it is sorted and stored on disk in blocks corresponding to 15 minutes of operation. If, during a 15-minute period, atmospheric conditions have given rise to fading of the radio signal, the relevant block of data is recorded on magnetic tape; in the absence of fading, the block of data is discarded. Thus, the system stores only data which is of interest for further detailed analysis using programs on Telecom's computer network, TACONET. The data acquisition system is also capable of giving immediate read-outs on the performance of the radio system.

By means of two-way communications between the control and remote computers, the system also provides a facility for remote control of the data acquisition equipment. This permits periodic calibration of the radio receiver equipment, as well as remote diagnosis of the operation of the measurement system in the event of failures in the data collection process. As the remote computer has no permanent storage capacity, a down-line load facility is provided to enable programs to be loaded into the computer at the remote field site from the control computer via



Schematic outline of data acquisition system

the Datel line. This feature allows the system to be employed for field tests at any site which can be connected to a Datel line, with the operation of the test programme remotely controlled from the Laboratories. As a number of experiments of a similar nature are planned for a variety of field sites, further line interfaces may be added to the control computer to allow for expansion of the system.

Microprocessor Development Systems in Instrumentation

For many years, instrumentation development required the design and testing of discrete logic circuits mounted on numerous printed circuit boards. Faults in such systems were difficult to locate. It was even more difficult to modify or extend these instrumentation systems. Over the last few years, instrumentation systems have been increasingly designed around various microprocessors, using minimal hardware which in most cases is standard. Using this approach, the instrument function can be modified by simply changing the program software which the microprocessor executes.

However, this new type of instrument design has required the use of new fault diagnosis (debug) facilities. In some instances, large computer systems are used to assemble the code and to software emulate the design. Down-line load facilities are then used to enable the object code to be executed on a single-board micro-computer containing a debug/monitor program stored in read-only memory (ROM). This type of fault finding is slow and not always at real-time speed.

A more useful method of software/hardware checking can be obtained by using microprocessor development systems (MDS). These are stand alone systems, enabling the writing of source programs either in assembly language or in a high level language like PASCAL and thence, the assembling and/or compiling of these into machine-executable object code. Once loaded into memory, the code can be executed on an in-circuit emulator, where program execution can be controlled and viewed.

At the beginning of a design, the emulation mode uses only MDS memory for debugging the software modules. As hardware is designed and manufactured, the emulation mode is changed so that external memory is included. This emulation takes place by replacing the hardware prototype processor with a cable from the MDS, which connects to a processor in the MDS. Eventually, at design completion, all the memory will be

mapped to the prototype hardware. In this last stage, the MDS is used to semi-permanently "burn" into hardware memory the information required to carry the microprocessor instructions for the final system.

The major advantage of this approach to instrument design is that modifications can be made simply by changing the erasable programmable memory (EPROM) components to change instrument functions.

Over the past few years, the Laboratories have assembled a number of user-initiated MDSs, most of which are limited when compared with commercial systems. The Laboratories have also evaluated a number of commercial units and have purchased five such systems. These systems enable the complete operation and emulation of a range of microprocessor makes and types (e.g. 6800,6809,Z80), and they contain EPROM programming facilities which can store data in the most popular types of EPROMs. They are also able to communicate with Telecom Australia's computer network, TACONET, for down-loading standard microprocessor library packages.

These commercial systems can be upgraded to work with other processors in the future and will enable the use of high level programming languages, symbolic debugging and other facilities to reduce the design and development time for an instrumentation system.

In the design of the Laboratories' Automated Battery Testing Facility, the use of the MDS has greatly decreased the time taken to design and then modify the software to accomplish a final workable system. With such a design, the MDS enables the easy partitioning of software into specific task modules. This again facilitates future modification.

Sputter-Etching of Microstrip

Sputter-etching of gold coated alumina substrates is a technique used in the Research Laboratories in the manufacture of microstrip components for experimental applications. The technique is clean and dry and offers more straightforward process steps than more conventional methods. Geometries with dimensions of the order of a micrometre can be resolved with good edge definition and near vertical walls, making sputter-etching an ideal method in the manufacture of fine-line geometry microwave devices, including inter-digitated couplers.

The sputter-etching operation can be graphically described as sandblasting on an atomic scale. Gas ions from the plasma are accelerated towards the target to which the substrate to be etched is attached, striking the surface of the target and substrate, and causing atoms to be ejected from the target by momentum transfer. In order to produce a desired conductor pattern, the pattern is first formed in a film of photo-resist using photo-lithographic techniques. The resulting photo-resist film acts as a mask to protect the conductor material from the ion bombardment.

A planar diode sputtering system is used for the operation and the essential features are shown in the adjoining schematic diagram. Two plates, one water cooled and connected to a RF potential, called the target, and the other, the ground electrode, are housed within an evacuated chamber. A gas, typically argon, is bled into the system to provide the medium for the glow discharge. The glow discharge is initiated by means of the RF potential, which is connected to the target via an impedance matching network. A frequency of 13.56 Mhz is employed. During the sputter-etching operation, the complete substrate including the photo-resist mask is enshrouded by the plasma and subjected to ion bombardment. The efficiency of the sputter operation is relatively low and RF power levels in excess of 0.01 W/mm^2 may be used, resulting in significant temperature rises of the target or substrate. Since photo-resist polymers are sensitive to high temperatures, effective water cooling of the target and good heat conduction between the substrate and target is essential.

To evaluate the sputter-etching technique for use in microstrip manufacture, a 14.5 GHz linear resonator test circuit was designed. Circuits were processed by more conventional means and a comparison of unloaded circuit Q made with the sputter-etched version. As no practical difference could be measured, it was concluded that the sputter-etching technique may safely be used for prototype applications.

Optical Fibre Tap Coupler

The coupling and reticulation of light signals in optical fibres will become increasingly important as the use of optical fibre systems for communications expands. Consequently, considerable effort has recently been directed to this area of research and development to realise efficient and economic devices to perform these functions.

Passive couplers for optical fibres can be considered as devices with three or more fibres or ports that enable optical radiation to be extracted from, or to be directed into, the fibre in some fixed way. One particular device of interest, the tap coupler, extracts a small fraction of the power propagating in the optical fibre with minimum interference (or insertion loss) to this fibre. Such couplers have two main areas of application.

One area of application of tap couplers is in optical fibre data loop distribution systems, where a small percentage of the optical signal is required to be accessed for each subscriber. The most important parameter in such a system is the tap coupler insertion loss (the ratio of output to input power, expressed in decibels) for the desired tap ratio (the ratio of tap to input power, in decibels). As tap couplers are cascaded in a distribution network, their accumulated insertion losses essentially determine the number of subscribers' terminals that can be accommodated on the optical fibre loop.

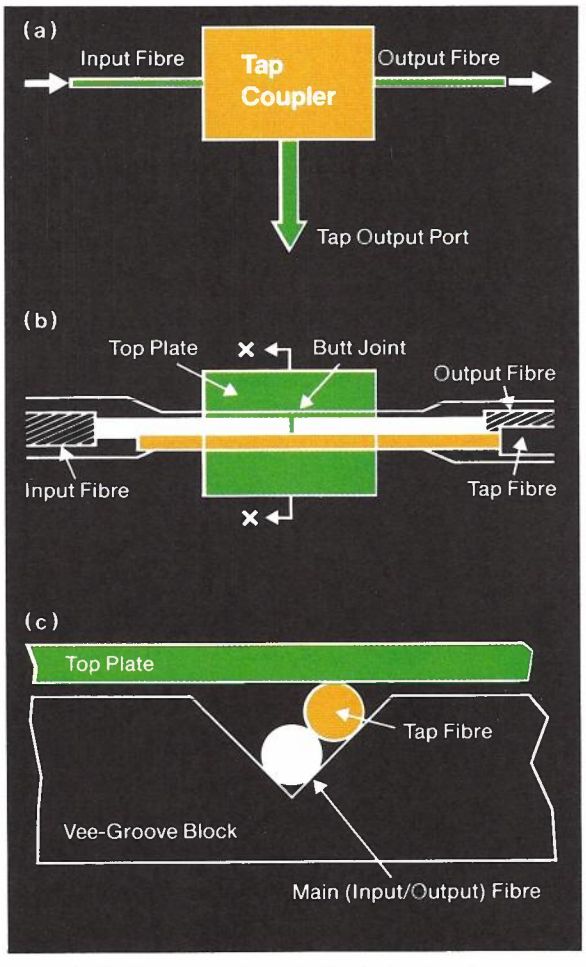
A second area of application is for monitoring the optical signal power in the fibre, particularly near the source. The tapped signal can be used to stabilise the power coupled from the source to the fibre or to linearise the source using optical feedback techniques. This technique taps a small fraction of the signal from the fibre, converting it to an electrical signal and adjusting the source current drive to achieve the desired effect. For this type of application, apart from a low insertion loss and usable tapped power, it is essential that the tapped power faithfully tracks the coupled power under various input conditions. These include source ageing and temperature dependence, changes in source drive and small relative displacements between source and fibre.

There is a wide range of types of tap coupler which use many different operating principles, so that for each particular application, there is a trade-off between the various performance parameters and cost.

A novel type of tap coupler has been developed within the Research Laboratories, in respect of which patent applications have been filed. The coupler features:

- low insertion loss (<1 dB)
- adjustable tap ratio (-15 to -25 dB)
- suitable tracking characteristics
- compactness, reliability and economical realisation.

The coupler is fabricated by forming a butt joint in the main fibre in a precision vee-groove such that the tap fibre can be secured adjacent to the butt joint. Some of the signal that is normally lost at the butt joint is collected by the tap fibre. Careful choice of the tap fibre type, index match at the butt joint, and the separation of the input and output fibres at the joint gives control over the tap ratio. A device with a small insertion loss can be fabricated in this way using many different fibre types. Tap couplers embodying these principles have been fabricated in the Laboratories for 50 μm core graded-index and stepped-index multi-mode fibres and for single mode fibres with a core diameter of 6 μm. Tests on these couplers have verified the performance features noted above.



The tap coupler developed in the Laboratories
(a) functional schematic
(b) side elevation of coupler configuration
(c) cross section view of the coupler at XX

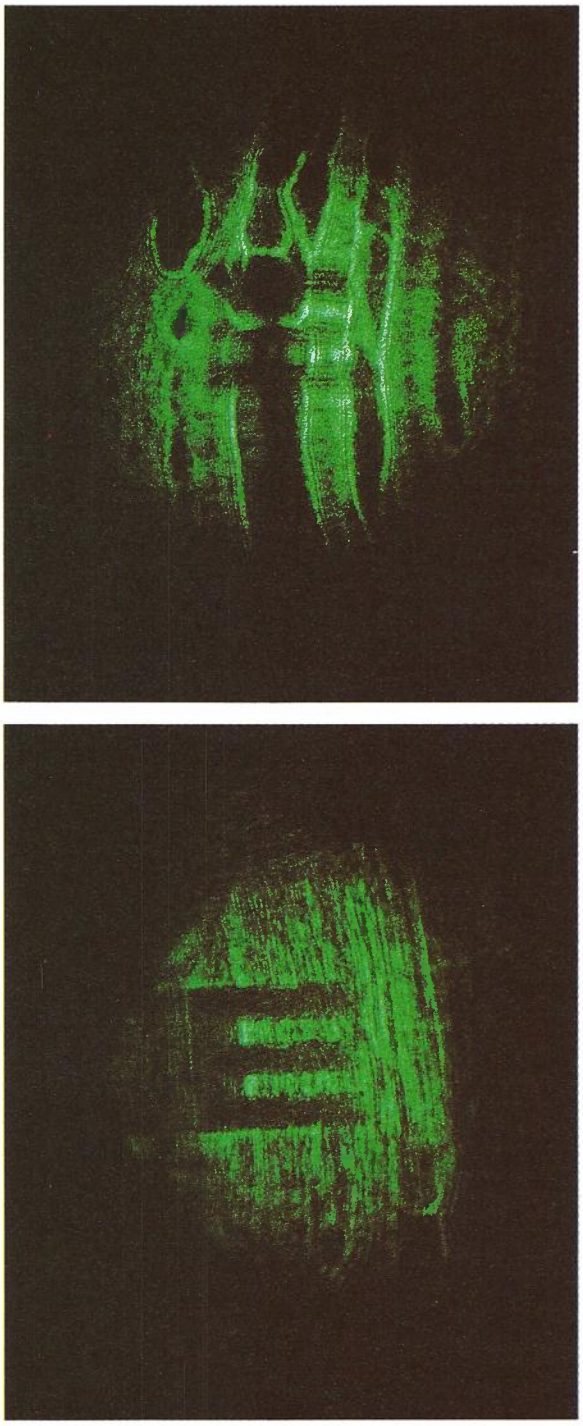
Generation of Phase-conjugate Waves in Non-linear Optical Materials

One main feature of research performed in the newly-emerged field of phase-conjugate optics concerns the generation of a reverse travelling wave with a phase distribution which is, at each point in space, the exact opposite of that of an incoming wave of arbitrary form. For instance, the reverse wave will converge if the incoming wave diverged, and vice versa. The reverse wave will therefore retrace the path taken by the incoming wave, even through an aberrating medium.

There are a great number of non-linear optical materials which can be used to generate a phase-conjugate wave. These include bismuth silicate ($Bi_{12}SiO_{20}$), bismuth germanium oxide ($Bi_{12}GeO_{20}$), lithium niobate ($LiNbO_3$), barium titanate ($BaTiO_3$) optical fibres, carbon disulphide (CS_2) liquid, sodium (Na) and sulphur hexafluoride (SF_6) gas. The photo-refractive crystals of bismuth silicate or bismuth germanium oxide are among the most promising materials because of their good optical quality, availability, high sensitivity and ease of handling. The refractive index of these photo-refractive crystals can be changed by sufficiently intense incident light and they can be used to store and retrieve optical information, in a manner similar to conventional holograms.

In the Laboratories, phase-conjugate waves have been generated via four-wave mixing in a reflection geometry in a bismuth germanium oxide crystal with an argon-ion laser source. In a four-wave mixing configuration, the signal wave and a reference wave are caused to impinge on the crystal from the opposite sides. Analogous to holography, these two waves interfere with each other through the non-linear medium and a phase hologram is created. The third wave is usually obtained using a reflective mirror placed behind the crystal, and it travels in an opposite direction to that of the reference wave and is diffracted by this hologram. The fourth wave, which is the phase-conjugate of the signal wave, is thereby generated and travels backward along the direction of the signal wave.

The phase distortion of an image when travelling through a distorting medium such as uneven glass can be corrected by taking advantage of this process. The general technique is extremely versatile and has potential application to the correction of aberrations caused by distorting media. It also has potential application in communications channels such as optical fibres and other optical waveguides, optical signal beam amplification, real-time optical data processing and real-time holography, including holographic interferometry. The real-time aspect means that optical information can be recorded, retrieved or operated on, without the need to remove and process the recording material.



Correction of optical image distortion by phase-conjugate wave generation
(a) distorted image of letter "E"
(b) corrected image

Growth of High Quality Semiconductors by Molecular Beam Epitaxy

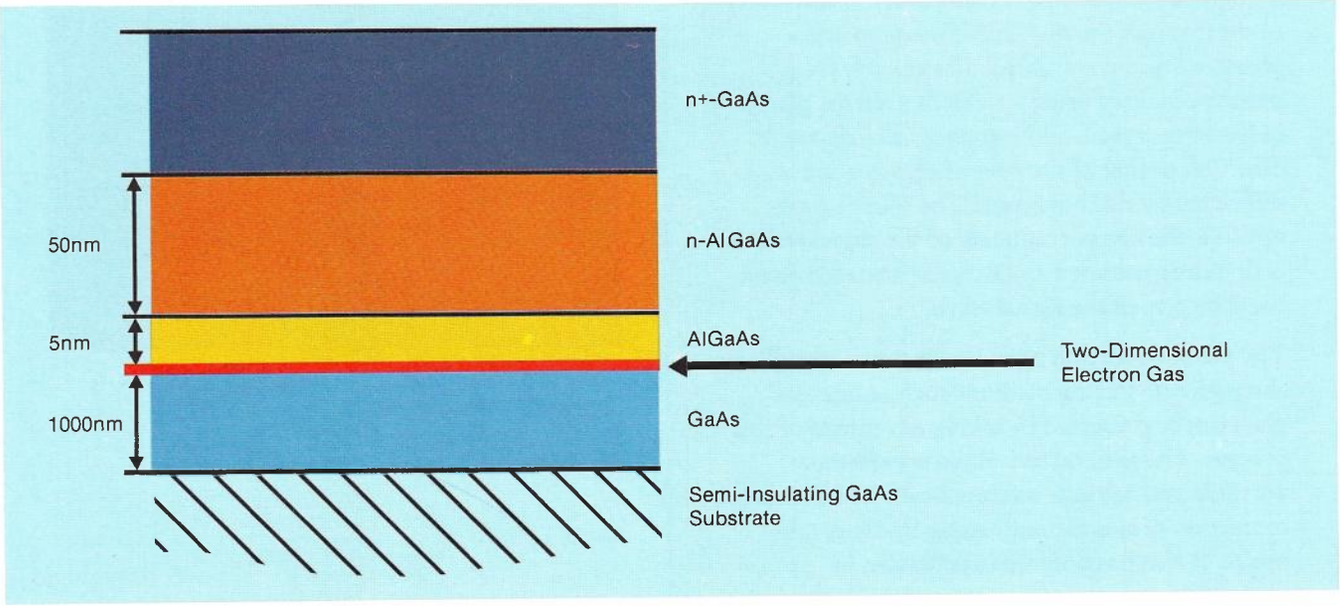
Semiconductor devices of telecommunications interest can be divided into two broad classes. One class comprises the familiar silicon and germanium based devices, while the second comprises those based on the higher technology semiconductor alloys made from such elements as gallium, arsenic, phosphorous, indium and aluminium. The materials in this second class are superior in many respects to the more common silicon. Their fundamental properties of high electron mobilities and direct band gaps enable the manufacture of the solid state lasers and high frequency devices of special interest to telecommunications. Typical examples are devices operating in the Terahertz region and lasers which can be tuned to match the wavelengths of maximum data throughput or minimum attenuation of silica optical fibres.

There is also a large commercial difference between the two classes of semiconductor devices. Silicon devices are inexpensive and widely available; but apart from the most simple devices, the higher technology lasers, transistors and diodes are mostly unprocurable. This is a result of a relatively small world market, considerable difficulty of manufacture, and the fact that most major telecommunications organisations and systems manufacturers have established their own production facilities.

At the beginning of 1981, the Laboratories commissioned a molecular beam epitaxy (MBE) machine to make these higher technology semiconductors for research investigation. MBE is the most recently developed crystal growth technique. The required semiconducting alloy is grown by evaporating the constituent elements from separate ovens. The molecules emitted from these ovens are collimated to form beams which impinge on a single crystal substrate. They then react together to form a very pure semiconductor whose atomic structure mimics that of the substrate — a process known as epitaxy. The growth is slow, about one atomic layer per second, and with the use of shutters, complex layer structures can be grown to atomic precision.

An example of such a material structure which has been grown in the Laboratories' machine and which is currently being characterised is an n-type large band gap aluminium gallium arsenide material (AlGaAs) which has been grown in contact with an undoped smaller band gap gallium arsenide material (GaAs). The excess electrons in the AlGaAs move to a lower potential in the interface between the AlGaAs and the GaAs and form a concentrated two-dimensional electron gas. Unhindered by donor impurities and constrained by the inherent potential difference between the two materials, these electrons have extremely high mobility and this structure can be used to make transistors which are more than thirty times faster than the best silicon devices.

A high electron mobility structure



Manufacture of an Ultra-high Vacuum Flange

Complex machining and welding processes were involved in the in-house manufacture of an ultra-high vacuum flange for use in conjunction with the Research Laboratories' molecular beam epitaxy (MBE) machine. The flange provides attaching points for a multiplicity of electron evaporators, heating ovens, rotary manipulators and shutters.

The assembly consists of a 200 mm diameter stainless steel connecting flat (conflat) into which 13 holes are bored. The centre hole, bored perpendicular to the conflat, contains a single tube and conflat assembly. Equally spaced around a 47.5 mm pitch circle diameter and at 17° to the conflat axis are six similar tube flange assemblies and six smaller one-piece mini-flanges. Each conflat consists of a stainless steel disc with a knife edge machined in a recess on the outer face. The conflats are mated with a copper gasket, which when penetrated by the two knife edges, forms a reliable seal from the atmosphere outside the vacuum chamber.

At the required vacuums below 10^{-9} Torr, leakage can occur through the material itself. Thus, the grain structure of the material in the completed flange was a major consideration, with the grade of stainless steel to be used and the production method being important factors.

As 304 low carbon grade stainless steel, the grade most commonly used in ultra-high vacuum work, was not readily available, the alternative 321 grade was chosen. Although it has similar welding characteristics to 304 grade, 321 grade is a far more intractable material to machine and special grades of cemented carbide tools had to be employed to remove material efficiently. However, the knife edges, which form the seal with the copper gasket, were plunge cut with more conventional high speed steel cutting tools, using slow speeds, slow tool feed rates and coolant to minimise tool wear and chatter.

Leakage along the grain direction in stainless steel is of concern for vacuums below 10^{-9} Torr since molecules can migrate through the material. Any such molecules entering the vacuum chamber by such leakage would contaminate it. Hence, flanges were cut from plate and then machined, so that the grain direction lay perpendicular to the atmosphere-vacuum interface. Producing the bored holes in the 200 mm diameter conflat was accomplished by using a spigot in the turned centre hole for locating purposes and then clamping the conflat to an indexable rotary table on a milling machine. The milling machine's table was tilted to provide the required angle of 17°.

A special press tool was necessary to insert each of the finished tubes into the 200 mm diameter flange. Without the press tool, the leading edge on the 17° angle of each tube tended to cause misalignment, resulting in damage to the edge of the tube. This edge was very important as it was used to optically align the assembly for final welding operations.

Welding preparation became a very important factor to ensure high quality welds. Each mating part was cleaned with spirit to prevent any impurities becoming entrapped in the weld.

Welding the flanges and tubes into their various positions required two different welding techniques. The small flanges were welded onto their mating tubes using the micro-plasma arc welding technique available as an in-house facility, which is a low power unit. It produces constant high quality non-porous welds provided the metal surrounding the area to be fused is kept to a minimum. Removing the material from the weld area minimises the heat affected zone and decreases the power input required to create a weld. The larger flanges required a higher welding current than was available from the in-house facilities and they were completed for Telecom by the Department of Industry and Commerce, utilising their electron beam welding facilities.

Ultra-high vacuum flange

Solderless Wire Wrapped Connections

Wire wrapped connections have become a cost effective replacement for soldered joints in the termination of single wire conductors. A wire wrap is a helix of wire wound on a square or rectangular metal post. The post is generally manufactured from a copper-based alloy and electro-plated with gold, tin or solder alloy. Wires are normally tin-coated copper. The degree of sharpness of the post corners is important in locking the wire helix to the post, maintaining low resistance joint continuity and providing long term reliability.

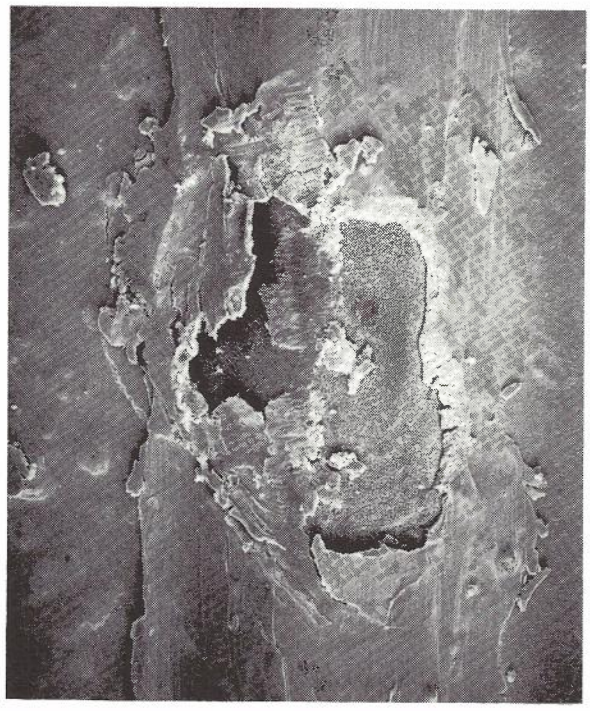
Since Telecom has experienced difficulty in obtaining supplies of 1.2 mm square wire wrap posts with the specified corner radii of 0.075 mm, alternatives were considered worthy of laboratory investigation. To determine their relative reliability, the behaviour of wire wraps using posts with dimensionally relaxed corner radii of 0.12 and 0.18 mm was compared with that of wraps on posts of the specified radii. In addition to the influence of corner radii on wire wrap reliability, the suitability of plain copper wire as a replacement for tinned copper wire when used for wire wrapping was also considered.

In the laboratory investigation, 30 samples of each post corner with both tinned and bare copper wires were exposed to environmental and mechanical tests. The tests covered aspects such as industrial atmosphere, damp heat, dry heat, thermal shock, mechanical vibration and stripping force. The behaviour of the wire wraps under various environmental conditions was evaluated by measuring the change in electrical resistance as a consequence of environmental exposure. The mechanical properties were compared from the results of a range of mechanical tests.

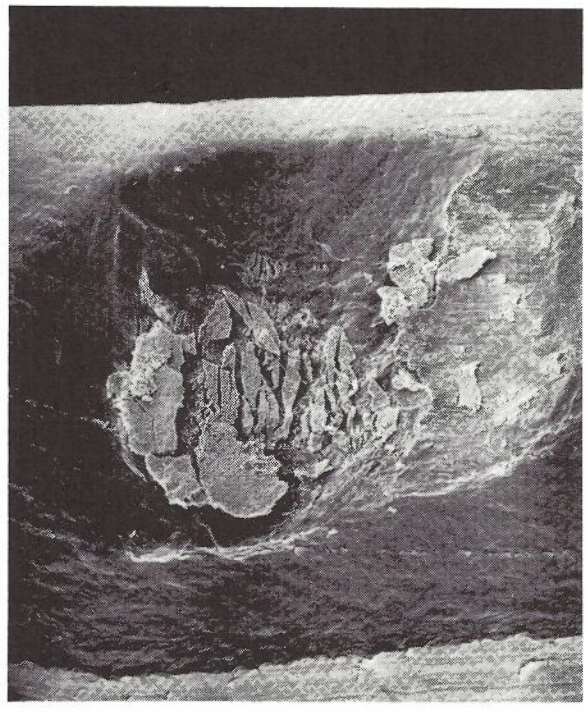
Interfaces of carefully unwrapped connections were also examined using scanning electron microscopy. This revealed that cold welding had occurred between the wrapping wire and the post corner as mechanical separation occurred within the electro-plated post deposit.

From the experimental work, it was concluded that, provided the corner radii of 1.2 mm square posts were maintained within the range examined, the reliability of the wire wraps could be maintained. Furthermore, the use of tin-coated copper wire appeared to be unnecessary since the tests concluded that plain copper wire could be substituted with equal confidence regarding reliability and with significant financial saving.

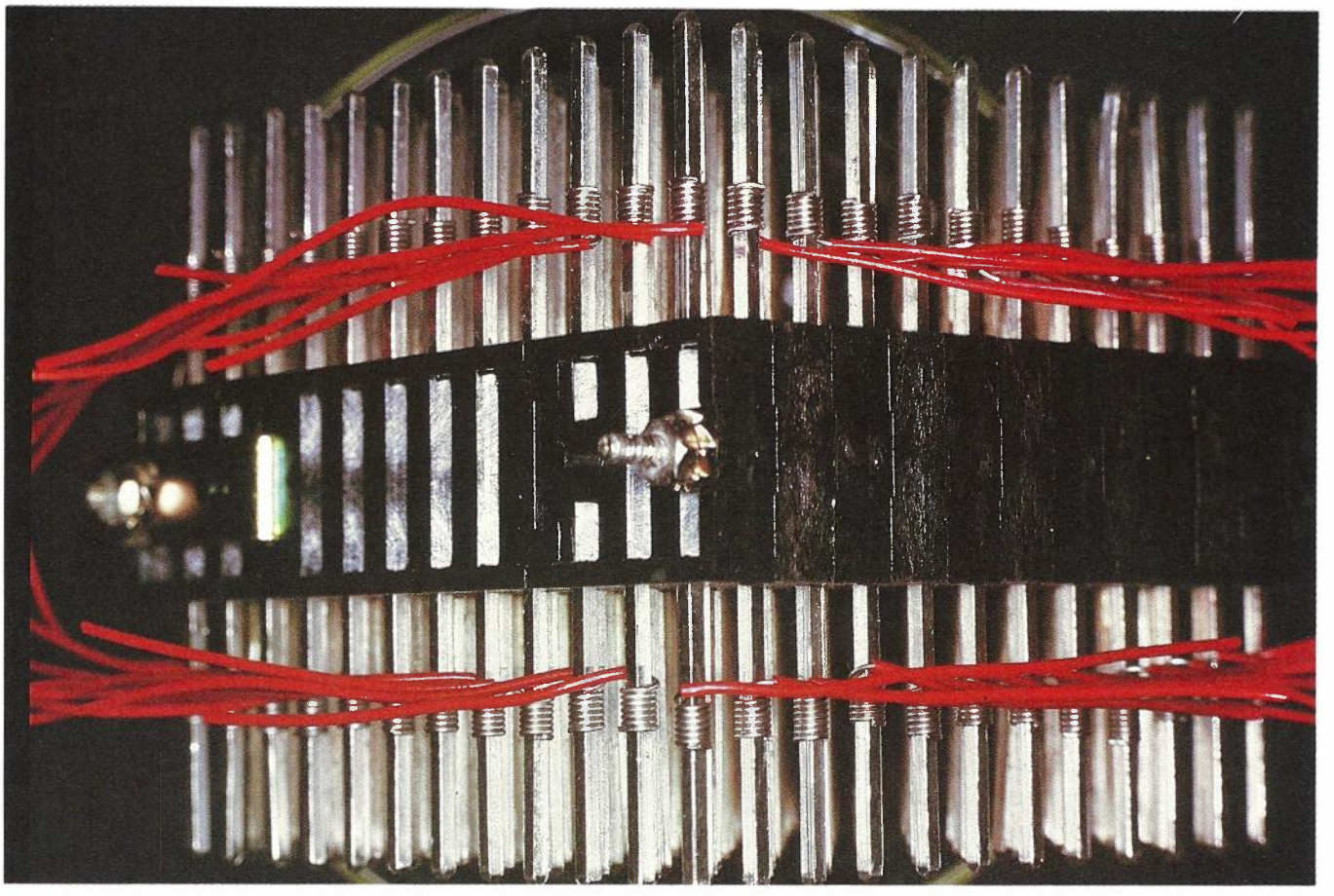
(a)



(b)



SEM photos of unwrapped connection shows that cold welding had occurred
(photo (a) shows corner of post with plating layer removed with wrapping wire
photo (b) shows plating layer removed from post adhering to wrapping wire)



Examples of wire wrapped connections

Component Evaluation Activities

The continuing evolution of telecommunications technologies requires an ongoing programme of appraisal of electronic components. By virtue of their expertise and facilities, the Laboratories are regularly called upon to investigate in some detail those components which are novel or which are significant to the network.

The majority of components used by Telecom Australia are "professional grade", that is, they are manufactured to comply with specifications prescribing their behaviour under a variety of electrical and climatic conditions. Component specifications are becoming standardised worldwide through the activities of such organisations as the International Electrotechnical Commission (IEC) and they cover in particular those components which are in widespread use throughout the telecommunications industry. National standards also exist and their preparation is the responsibility of the Standards Association of Australia (SAA), which also provides Australia's interface with the IEC and to whose activities Telecom is a significant contributor.

In most cases, components used in equipment purchased by Telecom are found to meet the specifications set by the component manufacturers and the role of Telecom can be reduced to one of surveillance testing. However,there are occasions when detailed specifications are either not available or not sufficiently comprehensive for Telecom's purposes. Occasionally, inherent functional weaknesses are missed by manufacturers and these must be documented by Telecom so that they can be brought to the attention of the manufacturers.

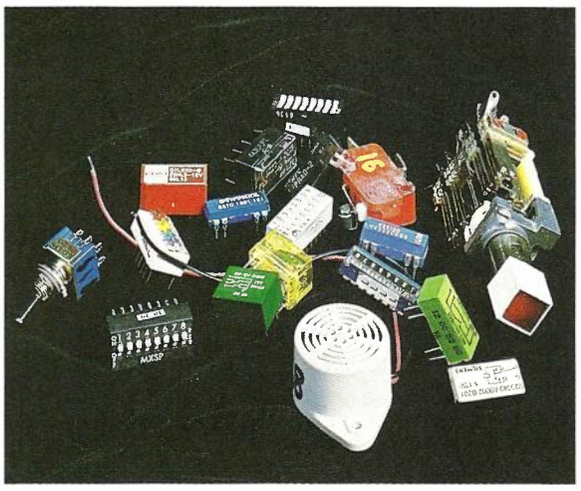
Often, a thorough testing programme by Telecom's Laboratories highlights unexpected shortcomings. Some recent examples included:

- dual-in-line switches assembled with a water sensitive adhesive which resulted in component failure in a moist environment
- dual-in-line relays whose connecting legs were of such a design that they broke when used with dual-in-line sockets
- integrated circuit sockets which allowed the connecting legs of mating integrated circuit packages to be inserted on the wrong side of the contact surfaces, to an extent where no electrical contact was made
- the presence of silver (which readily tarnishes) in gold plated connector contacts.

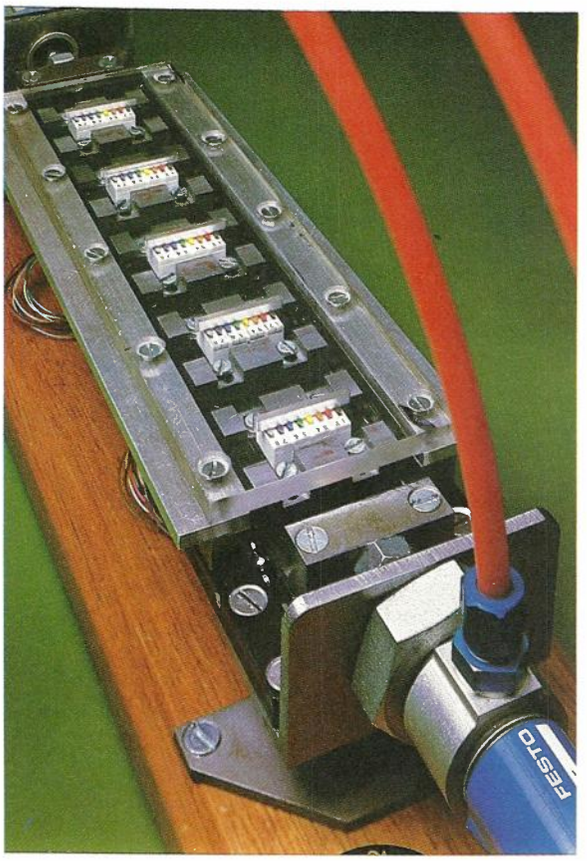
In addition to these examples of unexpected weaknesses, rigorous testing by the Laboratories has also indicated other occasions where components have failed to meet their specifications as a result of poor quality or process controls applied by the manufacturer, and subsequent remedial action has been the result of mutual discussion.

Investigative testing is usually performed under normal operating conditions, often supplemented by other tests devised to impose more severe electrical and environmental stresses to promote defects prematurely but without introducing new failure mechanisms. Electrical and mechanical functions of a component are monitored before and during tests to characterise performance, behaviour and to assess reliability. Various physical and chemical analysis techniques are also applied to provide information on the suitability of the materials used in the construction of a component.

By means of this work, the Laboratories are able to provide in-house advice on component selection and application within Telecom. The accumulated data and analytical expertise also enables effective diagnoses and remedies to be offered regarding component failure in operating plant. As opportunity presents, the knowledge gained from this work is also passed by Telecom to manufacturers and standards organisations, assisting in the specification of appropriate national (and international) product standards for telecommunications components.



A typical array of components evaluated recently by the Laboratories

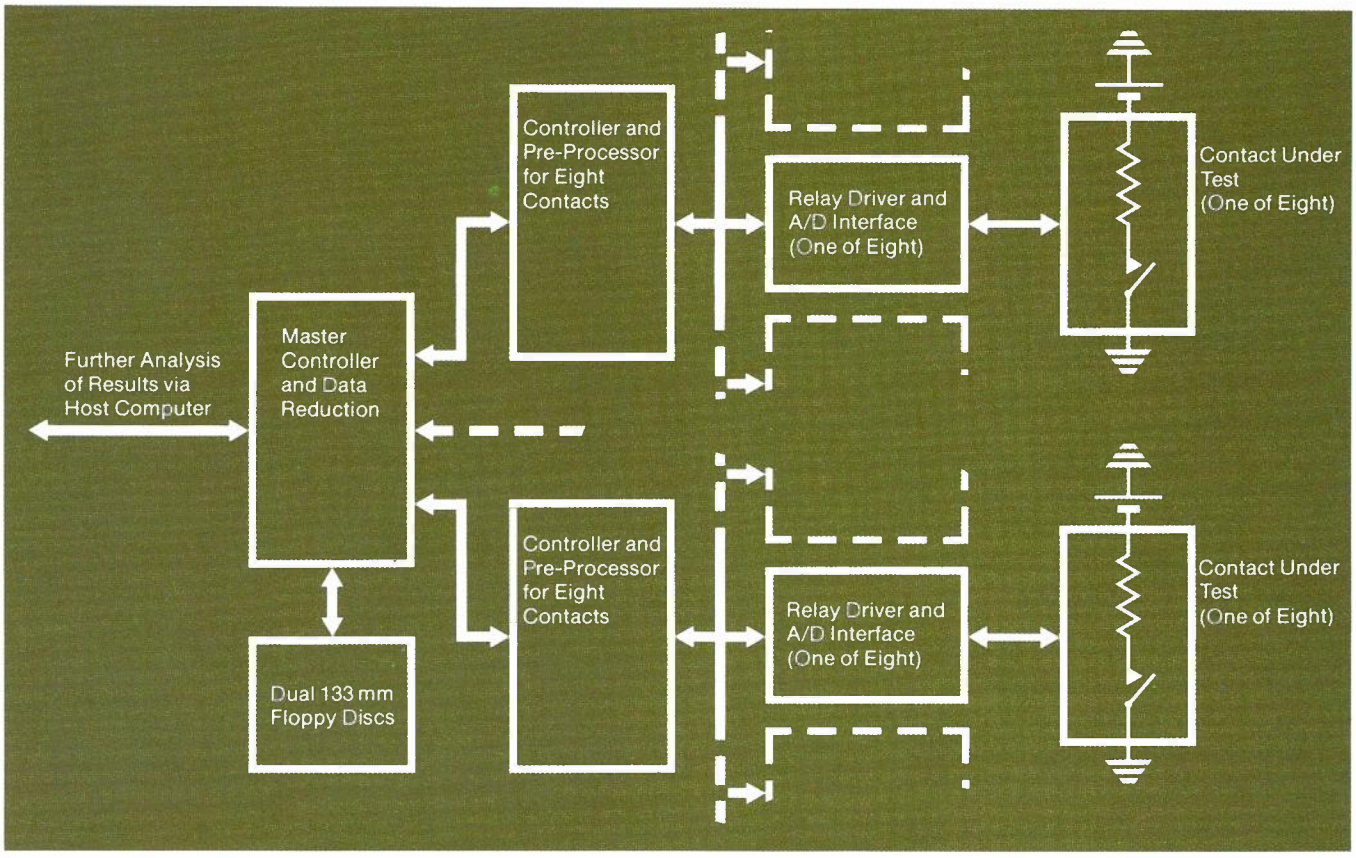


Dual-in-line switches undergoing operational life tests on a laboratory test rig

An Automated Contact Testing System

Despite an increase in the use of semiconductor switches in recent years, many applications remain where they cannot effectively compete with traditional electromechanically operated contacts on the grounds of performance or cost. Electromechanical relays and switches have remained competitive because they have some inherent advantages over solid state devices, such as low "on" resistance, high power handling capability, and high insulation and isolation properties. In addition, new, smaller designs have evolved in which the manufacturers endeavour to provide reliable performance at minimum expense. New materials, mechanical designs and manufacturing techniques are also being employed. The result is a diversity of switches and relays from which equipment designers can choose.

In practice however, a significant number of switch contacts fail prematurely. Often their short service life is due to a contact design which does not recognise all the factors which could affect performance. Two common



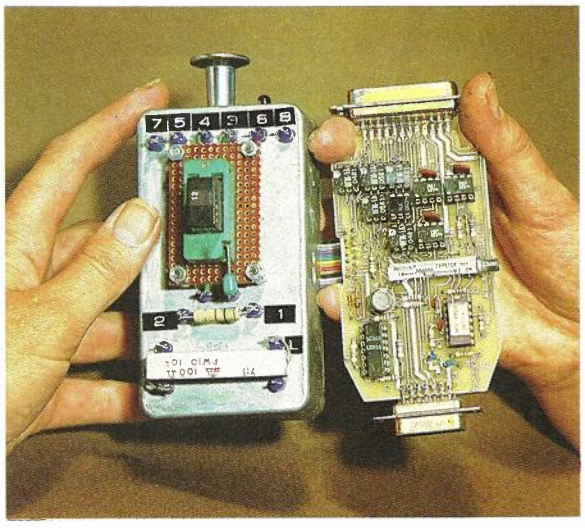
Schematic outline of the Laboratories' contact tester

misconceptions are that any contact that has a voltage and current rating greater than operating conditions will be suitable, and that it is always necessary to apply a large over-design "safety factor" to the maker's specifications to ensure trouble-free performance.

For most contacts, there is an optimum combination of current and voltage which will give the longest life. For example, if the contact switches voltages or currents that are much lower than the maker's rating, the contact may fail because there is not sufficient energy to break through the insulating tarnish films which form on contact surfaces. Alternatively, if used to switch much larger currents or voltages than optimum, the contacts may be degraded by sparking or arcing.

An automated contact testing system has been designed and constructed in the Laboratories to improve the facilities for and efficiency of reliability assessment of switching contacts. The system provides a detailed picture of the characteristics and performance of a wide range of contact types. Contacts under test may be operated by the equipment either electrically (for relay contacts) or pneumatically (for other types of contact). Contacts are grouped in multiples of eight for monitoring by the control computer. For each contact under test and for every operation, measurements are made of:

- operate time
- release time
- bounce time
- number of bounces
- contact resistance.



Measurement head and interface for contact under test

During a typical simulated life test, there will be some five thousand million measurements performed. These are summarised during the course of testing and the condensed results are stored at regular intervals for later examination and analysis.

An additional feature is the ability of the test equipment to store all data for the 256 operations immediately prior to interruption. This facility can provide a detailed history for each contact over the critical period just before failure.

Impact Testers for Telephone Cases and Safety Helmets

For many years, the Laboratories have conducted impact tests on samples of the plastics from which moulded products are made for Telecom Australia. The tests comprise part of a programme which seeks to ensure that the plastics comply with Telecom's specifications.

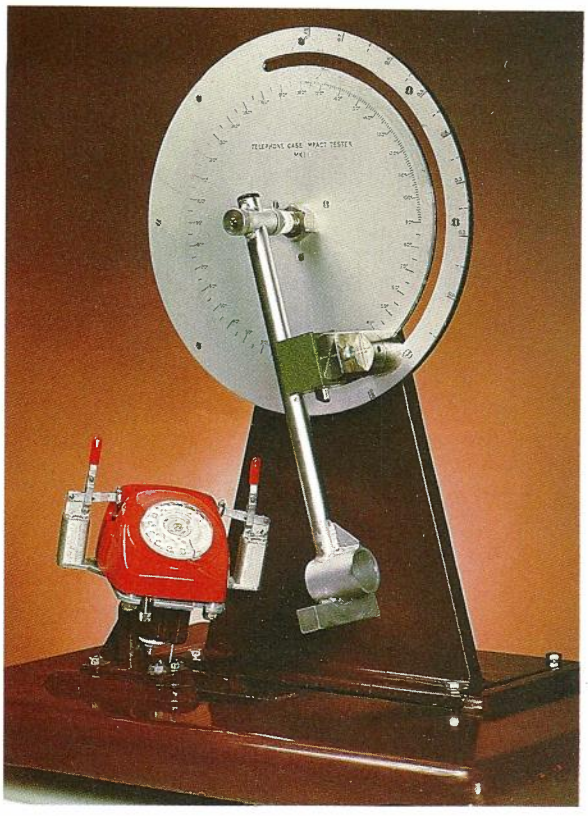
Recently, the programme was extended to include more rigorous impact testing of two types of finished product, namely, the case of Telecom's standard telephone instrument and the industrial safety helmet used by Telecom staff. Several special testing machines have been designed in the Laboratories for the purpose of quickly showing ageing effects or the presence of residual stresses after moulding in actual samples of the two products.

- **Impact Tester for Telephone Cases**

The most recently developed tester for telephone cases operates in a mode which is different from other known testers. The latter generally operate in a mode where the telephone is dropped from a fixed height onto a hard surface. In the former, the telephone, without a handset, is clamped to a rigid support and is struck by a guided mass. This ensures that the mass can be directed at specific target areas and that the test parameters are thereby more closely controlled.

In this latest machine, the mass is guided by a pendulum, in a manner similar to that used in Izod and Charpy impact testers. In earlier machines developed in the Laboratories, a crossarm sliding on guiding rails was used but the energy loss due to friction gave inconsistent results.

The pendulum is configured so that the velocity of the striking face and the kinetic energy at impact are equivalent to those of a 1.18 kg mass falling free from a height of 0.75 m. In addition, the centre of percussion of the pendulum has been designed to coincide with the centre of the impact face to ensure negligible horizontal reaction at its support bearings.



Telephone case impact tester

Additional features of the design are that:

- the energy lost in the downswing is less than 0.25% of that available at release of the pendulum
- the machine is self calibrating
- about 99% of the energy available at impact is transferred to the telephone case under test.

The machine was successfully commissioned during the year and is being used to measure the degree of strength reduction which occurs when telephone cases moulded from different plastics are exposed to sunlight under glass for periods up to two years.

- **Impact Tester for Safety Helmets**

A parallel test programme is being conducted in the Laboratories to determine more accurately the safe working life of safety helmets worn by Telecom staff. As the helmets are often worn outdoors, they are exposed to ultra-violet light and variable weather conditions.

To simulate the ageing of helmets under such conditions, over 2000 helmets are being exposed on an outdoor test frame, in a test programme to cover up to five-year exposure periods. Every six months, sample helmets are taken from the frame, further conditioned in laboratory test chambers at selected temperatures in the range from - 5°C to 50°C, and then impact-tested to obtain statistical data on the effects of exposure and environment on their impact resistance.

An impact tester was custom-designed and built in the Laboratories for this programme. Its facilities enable tests to be performed as specified in Australian Standard AS1801-1975, which requires the helmets to be subjected to both shock absorption and penetration tests. The shock absorption test specifies that helmets should withstand the impact of a 3.5 kg steel ball of 96 mm diameter when it is accurately dropped from a height of 1.46 m onto the top of a helmet held on a rigid aluminium headform. The impact energy transferred from the helmet to the headform is subsequently calculated by a technique which relates the indentation in the headform to that made by a second smaller steel ball impacting on an aluminium bar of specified hardness. The smaller ball, which is fixed to the bottom of the hinged headform carrier of the impact tester, is arranged to touch the fixed aluminium bar before the test is initiated and it is subsequently driven into the bar during the impact test.

The penetration test requires that a 2 kg pointed impacter be dropped on a helmet from a height of 1.46 m. If the impacter's point punctures the shell of the helmet under test and touches the aluminium headform, the helmet is considered to have failed the test. In the tester, such a failure is detected and indicated by means of a panel light. The tester features a lever-operated, magnetic hold and release mechanism for the impacter. For operator safety, a swinging basket catches the falling impacter if it is released inadvertently and a cage surrounds the test bed to ensure that the impacter is constrained within the cage after it bounces off the helmet under test.

Mechanical and Electrical Facilities for Battery Testing

The stationary lead-acid batteries which are the basis of the emergency power supplies of Australia's telephone exchanges must combine long service lifetimes with reliability. The Research Laboratories have therefore undertaken test programmes for some years to monitor the quality of these batteries, which are of six types ranging in capacity from 25 Ah to 3200 Ah. The test programmes, conducted in accordance with Australian Standard AS1981, provide for cyclic charge/discharge tests to determine battery capacity. The tests are performed at ten, three and one-hour discharge rates.

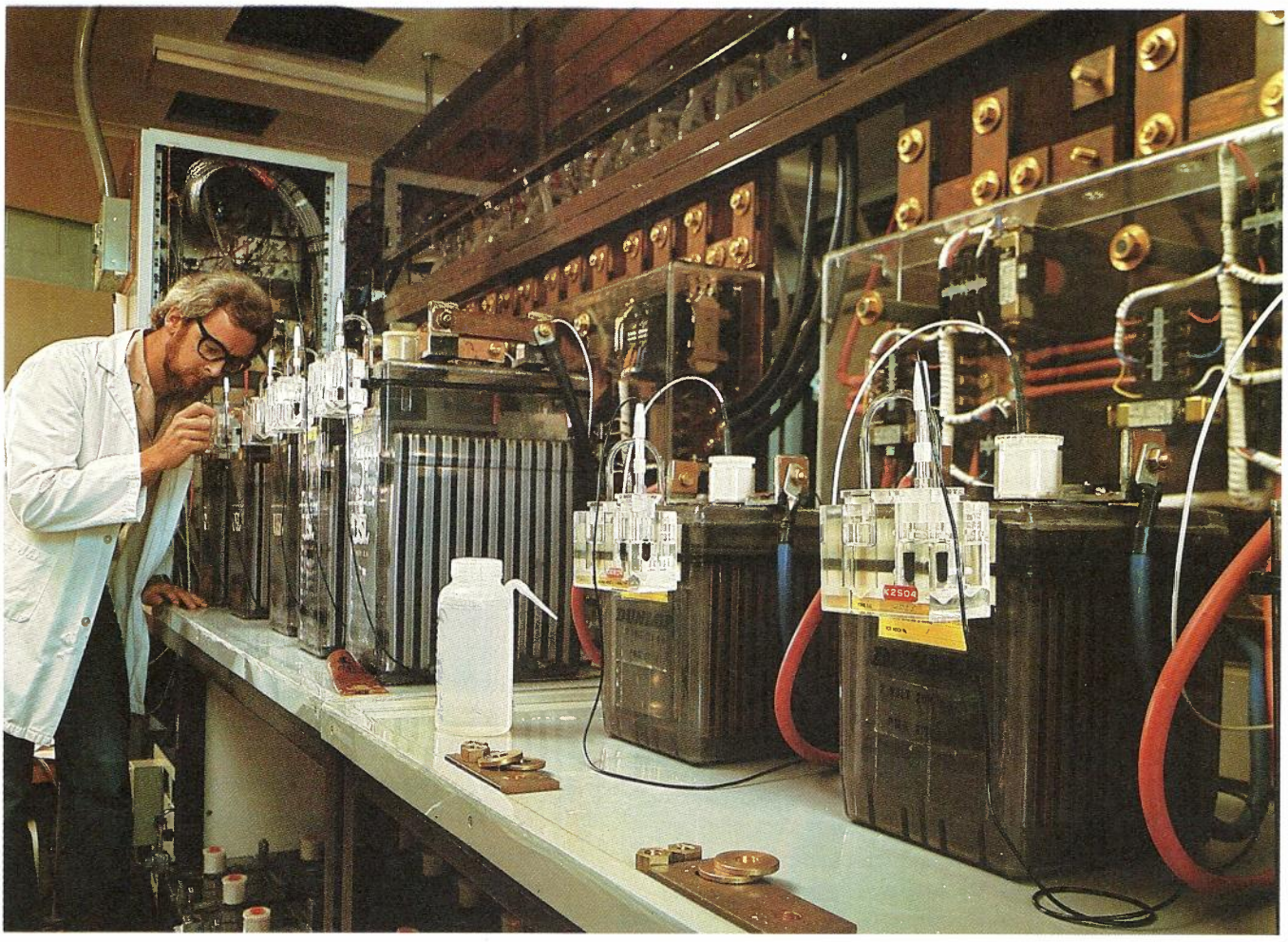
To improve the efficiency of the testing process, a battery test facility has been designed and constructed in the Laboratories. The facility provides six distinct test bays, one for each type of exchange battery, arranged so that each type can be tested readily at its relevant ten, three and one-hour discharge rates. Once sample batteries have been connected in the appropriate test bay, the test programme and logging of test data are performed under computer control.

The test bay dedicated to each type and size of battery comprises an acid-resistant bench located beneath a sturdy modular frame which supports the dc power conductors and the signal leads for control and instrumentation.

Each battery under test is provided with its own set of resistive loads which are terminated on an insulating panel above the battery. Charging and discharging are achieved by the controlled operation of a contactor mounted on the opposite face of the panel. The changeover contacts of the contactor interconnect the battery with the load or charger by means of heavy cables or busbars, depending on the required current level.

Control software and hardware is essentially identical for all bays. Control instrumentation for each bay comprises a sub-controller, scanner and digital panel meter and is centrally located in equipment racks. The racks also house the fan-cooled dc power supplies for battery charging, with the exception of the larger, free-standing power supplies for the 500 Ah and heavier duty battery bays.

Electrical mains power supply to the battery chargers totals over 50 kVA. If simultaneous discharge tests are conducted on all bays at the one-hour rate, the power dissipated in the load



A view of the battery test facility, showing 200 Ah battery test bay (front) and 500 Ah bay (behind), with centralised equipment rack (rear)

resistors exceeds 26 kW. Hence, most loads are water cooled, with an externally located cooling water chilling plant sized to handle 22 kW. The smaller load resistors are air cooled. For personnel and plant safety, flow rate indicators are incorporated in the cooling water lines and these activate switches to isolate the batteries should the flow rate drop below the safe working limit. For similar reasons, fusible links are attached to all loads to shut down any test where the load temperature exceeds the safe upper limit. All dc power conductors are sized and jointed to achieve minimum resistance and temperature rise and to avoid hot spots.

For ease of maintenance, the battery test facility has been built from commercially available components, whether they are structural, mechanical, electrical or electronic, with a minimum of custom-designed components. All materials and construction methods were chosen to give the system an expected working life of 10 years or more, in the corrosive environment of a battery test room.

The battery test facility has been designed so that it can be adapted to future needs for battery testing. A modular design approach was adopted to enable extensions of the system to be made as future needs arise for testing other types of re-chargeable batteries for exchange and other applications.

The automation of battery testing in the Laboratories is expected to permit data on the service behaviour of re-chargeable batteries to be collected and analysed more systematically, to assist in the development of more efficient operating practices and hopefully, of better battery design techniques.

Chemical Analysis Aids Telecom's Occupational Safety and Health Programme

To illustrate one aspect of Telecom's research which is often overlooked, the following two items describe how the scientific expertise and facilities of the Laboratories have been employed to assist Telecom's Occupational Safety and Health Programme. These investigations are recent but not isolated. Other activities of the Laboratories, particularly those of the Applied Science Branch, regularly involve considerations relating to safe working practices and the protection of people and plant from hazard.

- **Isocyanate Concentrations in Air**

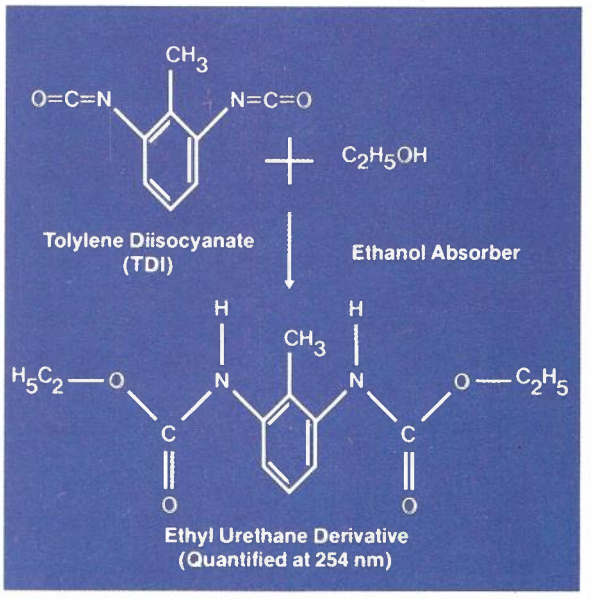
Polyurethane (PUR) materials are used in some overseas telecommunication organisations for encapsulation of larger size cable joints which may be re-entered after curing. Another application receiving developmental attention within Telecom Australia is that of sealing off the space within cable ducts which are already occupied by cables, since such sealing prevents unwanted vapours and liquids migrating between sections of underground plant. There are also other foam-in-place and surface coating applications of PUR which offer engineering advantages, particularly in external plant situations.

This increasing potential for the use of PUR plastics in telecommunications applications has required the development of special methods for field sampling and laboratory analysis of workplace atmospheres for safety assessments. One possible hazard stems from the necessary presence of chemical compounds called diisocyanates which may be liberated into the atmosphere in the reaction stage of PUR curing.

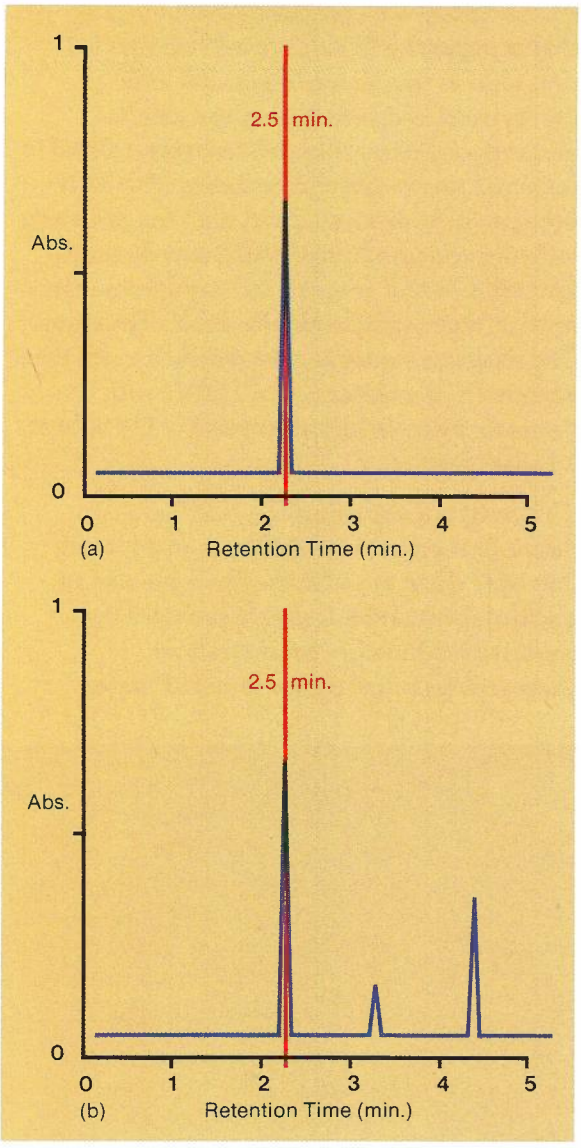
Vapours of diisocyanates have a documented history of producing toxic respiratory effects in sensitised persons at very low exposure levels. Safe working standards are set by industrial health regulatory bodies at not more than two parts of diisocyanate vapour per thousand million parts of atmospheric air, if the toxic agency is toluene diisocyanate (TDI).

Quantitative methods of analysis based on colour development with spectro-photometric detection have been found lacking in sensitivity for monitoring the pilot studies on PUR applications. The Laboratories have therefore adapted the latest methodology described in the scientific literature, refined the sampling system and improved the analytical sensitivity by using reverse phase, high pressure liquid chromatography (HPLC). In outline, the procedure is that air, contaminated with diisocyanate, is drawn through an all-glass absorption system which has been pre-treated to minimise surface absorption losses. This air is brought into intimate contact with the absorbing and complexing solution, which may be simple alcohol or "nitro" reagent, and any diisocyanates present then form chemically stable derivatives. The solutions containing the derivatives are then analysed in the laboratory by HPLC, with detection by molecular absorption of UV light at 254 nanometres.

This analytical procedure has enabled discrimination between different diisocyanate derivates when mixed in the contaminated air, and the quantitation stage has provided the sensitivity to measure concentrations of diisocyanates below the parts per 10^9 range.



Diagrammatic representation of the derivatisation reaction for the determination of isocyanate concentrations in air



Typical chromatograms obtained using ethanol as absorber solution for:
(a) laboratory-prepared ethyl urethane standard
(b) atmospheric sample from commercial material

- **Identification of Polychlorinated Biphenyl Compounds**

Polychlorinated biphenyls (PCB) constitute an eco-toxicological hazard which could, in certain circumstances, be liberated from some types of telecommunications equipment. These fluids are encountered as heat transfer media in transformers or capacitors which are normally totally enclosed at the time of manufacture. Since leaks can occur in such items of equipment in service, a rapid analytical procedure for identifying any suspected spillage of PCBs was found necessary to guide staff taking remedial action. A laboratory method was therefore developed which depends on the analytical technique of capillary column separation, followed by gas chromatography coupled with mass spectrometry (GC-MS). The capillary columns used for this work were narrow bore (less than 0.3 mm diameter) vitreous silica tubes in 25 metre lengths. The inner wall of the tubing was coated with a methyl silicone compound to enable the separation of the chlorinated biphenyl mixture into its chemical components.

A range of commercial PCB compounds, has been analysed using the capillary column/GC-MS method and the resulting mass spectra have been stored on computer disc. This stored data has enabled the collection of a comprehensive reference library of the mass spectra of PCB compounds. Mass spectra obtained from the GC-MS analysis of an unknown sample can be quickly compared with the reference spectra using a computer matching program to give unambiguous identification of the specific types of PCB in the sample.

A Coolant Water Controller for Scientific Apparatus

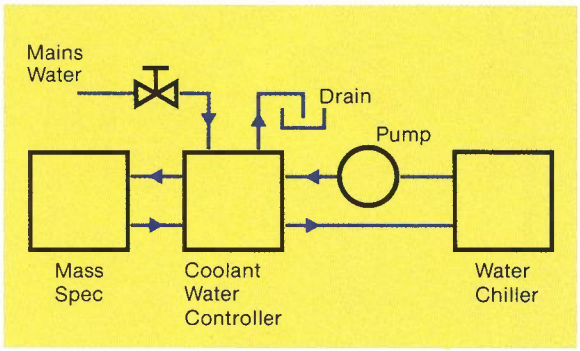
Many scientific instruments must use a recirculated coolant water supply rather than a total loss mains water supply, primarily to avoid excessive use of mains water.

The mass spectrometer in the Chemistry Section of the Research Laboratories uses a refrigerated, recirculated, coolant water supply to cool its associated high vacuum (HV) oil diffusion pump. The pump must run continuously to maintain a high vacuum (1×10^{-7}Torr) in the chamber and must also operate unattended overnight and at weekends. If the coolant water supply should fail at any time, the electron multiplier would be destroyed, necessitating an expensive repair and a delay of twelve hours to attain the operating vacuum after the multiplier is replaced. A Coolant Water Controller was therefore designed in the Laboratories to provide a mains water back-up system and ensure that the mass spectrometer is protected in the event of failure of the recirculated refrigerated coolant water system.

The Coolant Water Controller was engineered to fulfil the following design parameters:

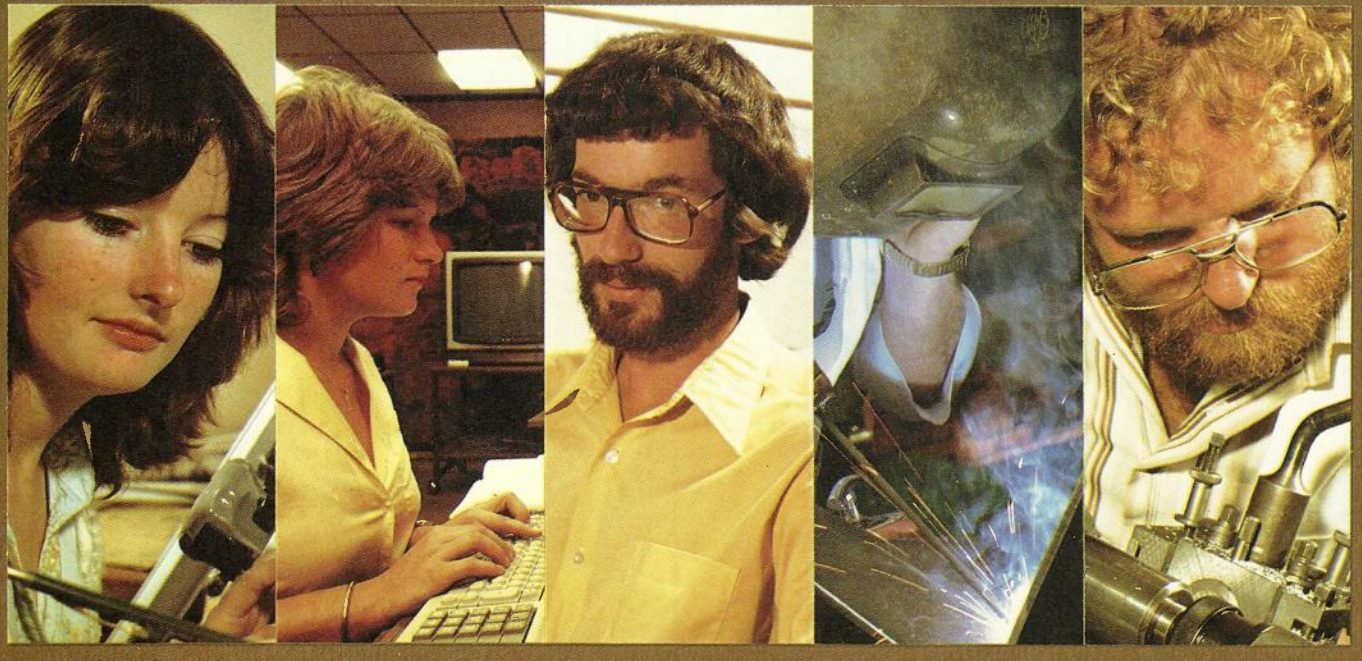
- in the event of power failure, to switch the mass spectrometer to mains water cooling and to ensure that the HV pump stays off when the power is reconnected
- if the refrigerated, recirculated coolant flow drops below 0.5 litres per minute, to switch to mains water cooling

- if the flow from the mains water supply drops below 0.5 litres per minute, to switch off the mass spectrometer HV pump
- if the temperature of the coolant water from the refrigerated, recirculated supply exceeds 15°C, to switch to mains water cooling
- if the temperature of the coolant water leaving the mass spectrometer exceeds 24°C, to switch off the mass spectrometer HV pump
- if any failure of sensors occurs within the Coolant Water Controller, the supply of coolant water to the mass spectrometer not to be affected.



Schematic of coolant water controller system

The Coolant Water Controller uses temperature sensors with current proportional outputs to measure the incoming and outgoing temperatures of the coolant water as it passes through the mass spectrometer. A flow switch incorporating an infra-red transmitter and detector was purpose-designed in the Laboratories to provide a logic high when the flow rate is below a predetermined level and a logic low when the level is exceeded. The outputs from the temperature sensors and the flow switch are fed into CMOS logic circuitry which uses three-way solenoid valves to switch to an alternate water supply when required. The temperature sensors can be set over the range 0° - 50°C and the design of the flow switch allows it to be manufactured with its switching point set to a variety of predetermined flow rates. Hence, the Coolant Water Controller can be adapted to suit other scientific instruments with different operating requirements.



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 the 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.

In addition to performing larger project-scale research investigations in an on-going work programme, the staff of the Laboratories are often 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 assistance provided by the Laboratories during the past year. They range from advice on the design and specification of equipment; to assessments 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 contribution 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.

Digital Radio Systems Seminars

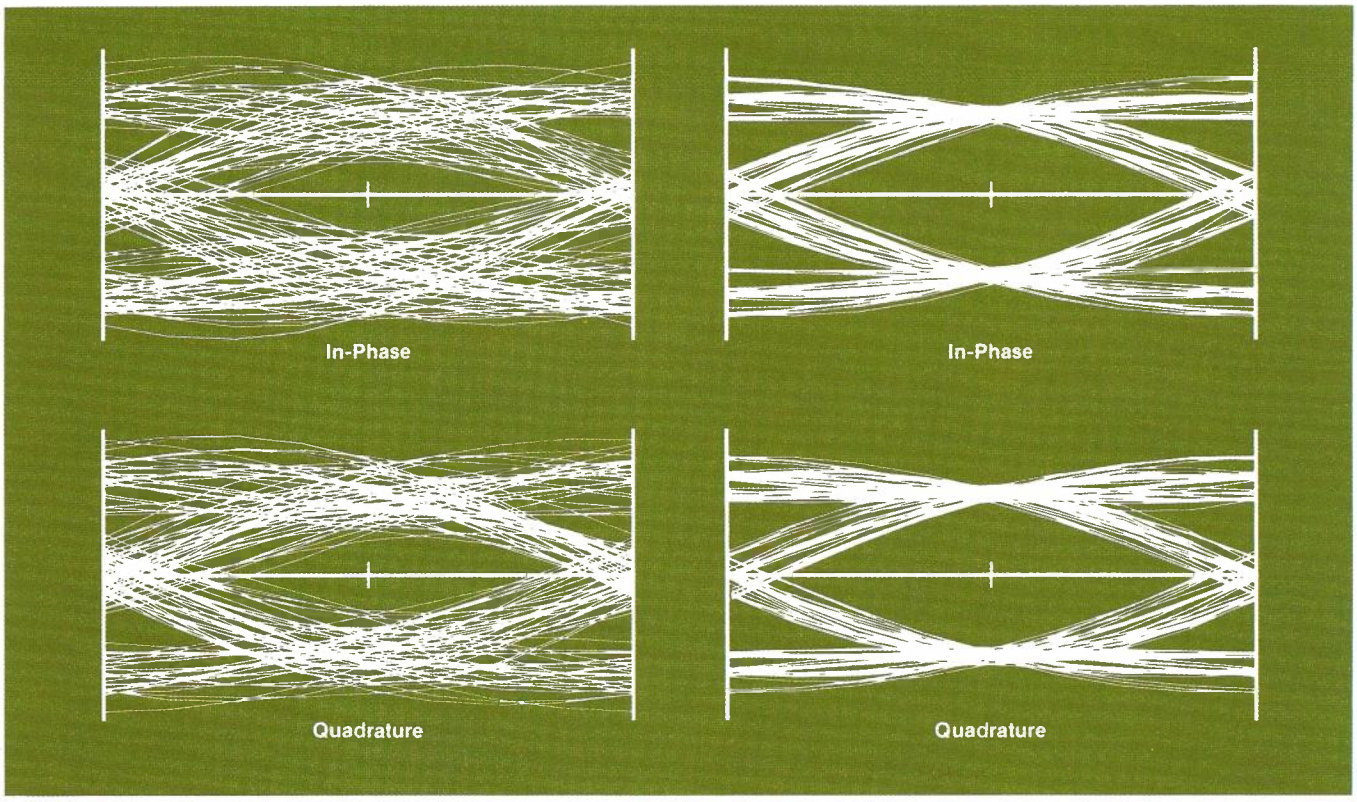
Telecom Australia's recent decision to install digital radio systems of 140 Mbit/s capacity on its inter-capital trunk routes implies that many Telecom engineers will need to become familiar with the principles of digital radio transmission and their application in systems and networks. Since it is planned to install such systems on the Melbourne-Sydney route from 1983/84 and to extend their application to routes from Perth to Brisbane from 1985/86, the need to familiarise more engineering staff with this new technology was considered immediate.

To meet this need, staff of the Transmission Branch of the Laboratories joined forces with staff of the Radiocommunications Construction Branch and the Training Group of the Headquarters Engineering Department to present three one-day seminars for Telecom engineers during 1981/82. The seminar approach was selected since it provides for quick and cost-effective technology transfer.

The topics covered by the seminar included:

- fundamentals of digital radio transmission
- typical applications of digital radio systems
- performance measurement
- problems encountered in route design
- guidelines for route and system design.

Speakers from the Transmission and Radiocommunications Construction Branches delivered six short talks, which were followed by lively discussion. Engineers from Headquarters and all States were invited. About one hundred and twenty people attended the three seminars. One seminar was video-taped to assist greater numbers of engineers in all States to become involved in later local follow-up training discussions.



Eye patterns of 2 Mbit/s QAM system prior to equalisation

Eye patterns of 2 Mbit/s QAM system following equalisation

Equalisers for the Digital Data Network

In the provision of digital radio links for the digital data network via existing analogue equipment, transmission impairments can arise due to the presence of pilot-stop filters. The Research Laboratories undertook a study of this compatibility problem to determine the degree of transmission impairment and to recommend a suitable equaliser to improve transmission performance.

As a result of these studies, a simple compromise equaliser was proposed which corrects amplitude slope and parabolic and linear-slope group delay distortion. The adjoining figure shows the theoretically predicted improvement obtainable with the equaliser acting as a channel conditioner. Whilst the compromise equaliser does not completely remove the transmission impairments, it has the potential to give a significant improvement. A simple compromise equaliser also has the advantage of ease of construction and suitability for local manufacture.

Field trials of a prototype constructed by the Research Laboratories are to be conducted during 1982 by the Radiocommunications Construction Branch of the Headquarters Engineering Department.

Assessment of Telephones for Papua-New Guinea

In its considerations concerning the introduction of a new telephone for general use, the Department of Posts and Telegraphs of Papua-New Guinea sought the assistance of Telecom Australia to measure the telephone's reference equivalents. This information was required in the technical assessment of the performance of manufactured samples of the telephone under consideration.

Fortunately, as Papua-New Guinea uses telecommunications cables of the same design as those used in Australia, the Research Laboratories were able to assist, using established facilities.

Fifty samples of the telephone were measured objectively to allow selection of a few samples with average characteristics for more detailed assessment. These were then measured subjectively using the Laboratories' NOSFER system, which derives its name and functions from the new CCITT Fundamental System for the Determination of Reference Equivalents. It was concluded that the telephones lacked receive

sensitivity, which was further accentuated by an inappropriate feed current regulation characteristic. These results were reported to Papua-New Guinea.

After consultation with the manufacturer, Papua-New Guinea later sent a batch of higher sensitivity receivers to Australia, together with suggested modifications to the regulator circuit. These were then assessed and a report sent to Papua-New Guinea.

Evaluation of Premium Telephones

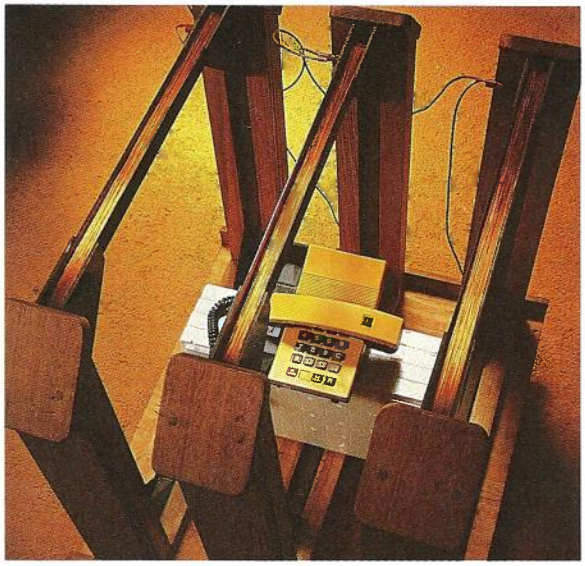
During 1981, Telecom Australia extended its existing range of telephones by introducing a range of premium telephones, offering customers a wider range of facilities and styling. Many sample telephones, of both Australian and overseas design, were examined to assess their suitability for connection to the Australian public switched telephone network.

The Research Laboratories assisted in the evaluation of these telephones by examining their transmission performance. Factors assessed included the following:

- sending, receiving and sidetone loudness levels
- frequency distortion
- parallel operation with existing standard 800 Series telephones
- operation with hearing aids
- susceptibility to magnetic fields and radio frequency transmissions
- loudspeaking (hands-free) operation, if applicable.

The results of the measurements assisted Telecom to select the most suitable models. In some instances where a particular type of telephone did not quite meet requirements, the results were used as a basis of discussion with the manufacturer regarding performance improvements.

The first category of telephones examined were the compact "Trimphones", intended mainly for domestic use and offering keypad dialling facilities and a last number re-dial facility. More elaborate types with extra features such as repertory dialling, loudspeaking operation, built-in calculator and abbreviated dialling are currently being examined.



Measuring the effect of an audio frequency magnetic field on a telephone (the three large coils produce an alternating magnetic field at the centre of the coils which is nearly uniform throughout a spherical space of 300 mm diameter)

Reliability of New Telephones

In recent times, Telecom Australia has sought to extend the range of telephones which it makes available to business and domestic customers. To assist the Commercial Services Department to select the most appropriate types of telephones to include in this range, the Laboratories recently conducted a number of technical evaluations and tests related to the technical performance, electrical safety, mechanical reliability and environmental performance of a variety of types of telephones offered by manufacturers for consideration by Telecom.

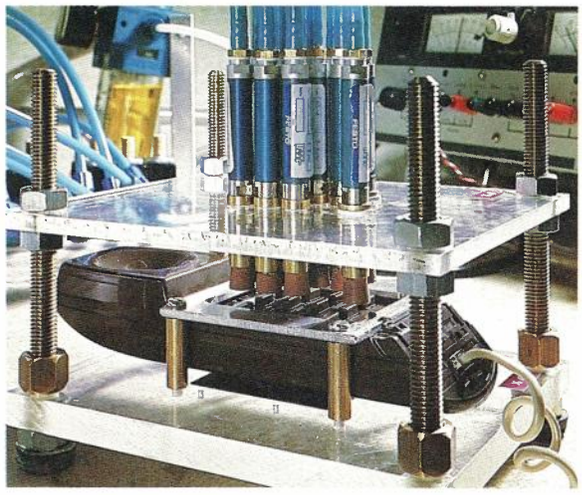
Electrical safety was assessed by simulating conditions which may occur if a telephone, when in use, is subjected to a high voltage impulse. Such impulses may be generated in the telephone network by a lightning strike or by a power surge emanating from a fault in electrical power distribution systems.

Test equipment was also designed and constructed in the Laboratories to determine the mechanical service life of a telephone by automatically and repeatedly operating the equipment and monitoring its output. Typically, a button on a dialling keypad must withstand a minimum of 200 000 operations before failure.

Sample telephones were tested in a wide range of laboratory-simulated environments under cyclically controlled conditions of temperature, humidity and corrosive atmospheres. These

accelerated tests are designed to identify any design weaknesses and desirable modifications necessary to enable the telephones to perform reliably in the wide range of actual environments encountered in service in Australia. The tests are designed to ensure that the equipment not only withstands the environmental stresses but maintains its performance standard within technical specification throughout the range of environments.

The collated results from these laboratory tests were used both in the initial selection of equipment and to provide data for modification or refinement of the selected equipment to suit Australian conditions. Recent evaluations have covered telephones for the Trimphone and Featurephone ranges, small business systems and push button dial replacement kits.

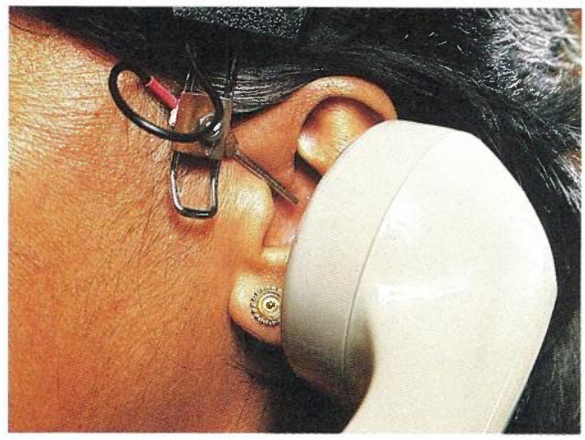


Equipment developed in the Laboratories to test reliability of dialling keypads

A Probe Microphone for Noise Dose Measurement

Telecom Australia's Hearing Conservation Programme requires an extensive series of measurements to be made to identify work areas where staff are exposed over a working day to noise levels equivalent to a continuous noise level in excess of 85 dB(A). Such "noise dose" assessments are made over a working day using a noise dose meter with its microphone mounted near the worker's ear, particularly in situations where noise levels vary with time of day. Occasionally, special circumstances concerning the measurement necessitate the use of special facilities.

The Victorian Administration of Telecom Australia recently sought the assistance of the Research Laboratories in assessing noise doses for staff exposed both to high levels of ambient noise and to loud signals from a telephone receiver. To meet this requirement, the Laboratories developed a small electret probe microphone to operate with a standard noise meter in order to monitor noise levels at the entrance to the ear canal. The microphone has been successfully used on several occasions to measure noise doses in circumstances where staff are employed on the maintenance of trunk radio transmission systems.



Electret probe microphone developed for noise dose measurements

Microwave Propagation Assessments in North Western Australia

The availability of solar-powered, low-consumption microwave equipment has greatly enhanced the economic feasibility of radio systems on telecommunications routes through the remote and sparsely populated areas of Australia. Typical routes are from Port Hedland through Broome to Derby on the north west coast, from Derby to Kununurra through Halls Creek in the Kimberleys, and from Karatha to Paraburdoo in the Hammersley Ranges of Western Australia.

As the meteorology of north western Australia differs considerably from that of eastern and southern Australia and as Telecom has no operational experience with microwave radio systems in this region, the Laboratories were requested to assist in the examination and specification of the radio propagation aspects of the designs of systems for these routes. Based on map studies, route inspections, available but meagre meteorological data, computer modelling and ongoing propagation studies, a number of less common fading mechanisms were identified.

These included:

- trapping and propagation of the radio wave by multiple transmission paths due to the sea breeze duct, which were estimated with the assistance of a computer model developed by the West Australian Institute of Technology, ray tracing techniques and knowledge gained from earlier Laboratories test results on a Port Hedland path
- de-focussing of the direct ray for antennas set at the height of a moist temperature inversion due to nocturnal radiation of heat from the earth, in consequence of which temperature inversion heights were estimated
- risks of sub-refraction (i.e. abnormal upward curvature of the radio wave), which were estimated from overnight increases in surface dewpoint where the latter data was available.

Because of the lack of inland meteorological data and the high cost of retrofit should the system performance be unacceptable, it was necessary to employ specific design techniques, which involve some increase in system cost. However, their adoption will enable the design objectives to be met under extreme meteorological conditions.

Computational Support

The Laboratories are a major user of Telecom Australia's computer network (TACONET), particularly for the purposes of numerical analysis and to support the design of microprocessor-based systems used in laboratory investigations. Many of the computer programs initially developed for in-house use by Laboratories staff have later been used more widely within Telecom Australia. Some recent examples of such use involve a range of microprocessor cross-assemblers installed on TACONET and a collection of data analysis programs being used for the digital data network (DDN) studies.

The Laboratories have also been responsible for the purchase, installation on TACONET and subsequent maintenance of a variety of other software products. Computer programs acquired in this manner over the past year include the Tektronix IGL plotting library, the IEEE programs for digital signal processing and the Motorola 6809 simulator. Information on new software products is placed into a "newsletter" file which is widely accessed throughout Telecom Australia. This ensures that all interested parties can benefit from the Laboratories' investment in software resources.

Portable Power Point Tester

Over recent decades, a variety of test equipment has been used to check the safety of general purpose, 240 volt, alternating current power points (fixed outlets) installed in Telecom Australia's numerous buildings. The need for a portable, comprehensive, standard tester was recognised in the early 1970s, and in 1974, the Research Laboratories designed such a unit which was later manufactured in quantity by a local company for field use by Telecom staff.

This tester was used widely in Telecom, with success. It incorporated in one unit facilities to test outlets for correct wiring polarity, earth potential and impedance of the active-earth loop. However, the unit was not as small as desired and required a degree of technical skill in its user to both operate it and interpret the meter readings obtained.

More recently, the relevant Australian Standard was amended to require that any direct current applied for testing purposes to the earth conductor of an outlet should be minimised and should not exceed 200 mA. This condition was not met by the active-earth loop test technique of the existing tester, and hence a need arose to re-design the tester. At the same time, opportunities were seen to use modern technology to make it smaller and simpler to operate, since a new requirement was seen for the tester as a tool to enable linemen to test power outlets in a wide variety of customers' premises.

A new instrument incorporating these changed features was designed in the Laboratories. Recently completed tests of the prototypes have demonstrated that the new tester fulfils the specified requirements. More extensive trials of the tester by field staff are expected to prove its suitability as a replacement for the earlier model.

Portable power point tester

Cleanliness of Printed Circuit Board Assemblies

Reliable operation of printed circuit board assemblies is required over the wide range of service conditions which arise in the Australian national network. These conditions can range from those found in air-conditioned telephone exchanges to public telephone cabinets located in any of the harsh climatic environments found in the geographical extremities of Australia. To an increasing degree, modern circuit design is based on the use of solid state devices which operate at very low potentials and currents and where the components are distributed at high density on printed wiring boards. Consequently, any contamination which degrades the effective insulation resistance of the surface of a board can adversely affect the performance of the individual components on the printed board assembly, particularly in highly variable or non-ideal environmental situations.

Contamination of a board surface may occur either during the various stages of manufacture or subsequently, due to poor handling, storage, installation and maintenance procedures. Typical contaminants are residues of inorganic chemicals remaining after the printed wiring board manufacturing process, damaging solder flux residues or hygroscopic deposits produced by fingerprints. These may remain undetected for a considerable time due to their latent chemical activity.

In order to fully understand one phase of the manufacturing process, a selection of fluxes used for machine soldering by Telecom's contractors has been categorised chemically and electrically. Specially designed printed wiring boards have been passed through various manufacturers machine soldering installations using their respective fluxes, and the boards are now being exposed in a humid environment, in which their long term current leakage is being monitored.

Lightning Performance of Jelly Filled Cable

Preliminary results of an investigation aimed at evaluating the performance of jelly filled cables with cellular conductor insulation under electrical stress similar to that caused by lightning strikes indicate that the performance of the filled cables is comparable, and in some cases, superior to the performance of the several types of cable which the filled cables are intended to replace.

Laboratory tests have shown that the breakdown potential of the jackets in the filled cables which incorporate an aluminium screen is significantly higher than that of jackets in cables without screens. Consequently the initial soil to core breakdown potential of the filled cables should be higher than that of screenless unfilled cables with solid plastic conductor insulation and similar jacket size.

The tests have also shown that when the energy is sufficiently high to produce holes in the aluminium screen, a breakdown from screen to core need not necessarily occur. In tests with energies which could cause screen to conductor breakdown, the resulting damage to the filled cables was generally found to be less extensive than that caused to unfilled cable types with solid conductor insulation.

Degradation of Plastics in Crossbar Exchange Equipment

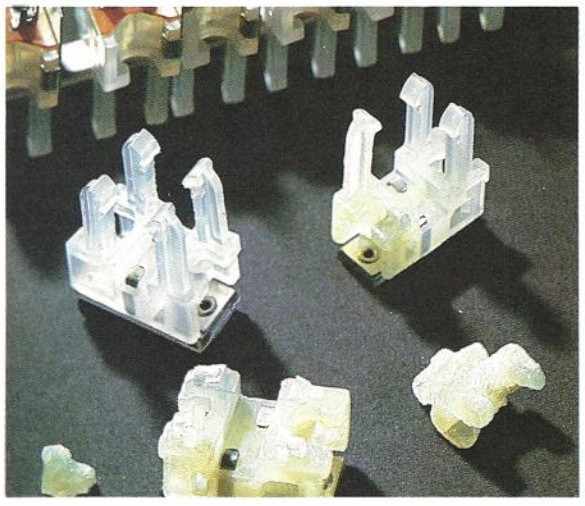
Deterioration in the form of crazing, discolouration and embrittlement of the polypropylene component of terminating elements used on group distribution frames has been reported from several exchange locations in Melbourne after approximately 8 years of service. Problems arose during routine operations on the distribution frame when the support arms on the affected elements fractured and allowed the elements to fall on to other terminating elements below, thereby creating the possibility of short circuits across terminations, with serious effects on the services concerned.

When exposed in the laboratory to conditions which accelerate thermal oxidation, the obviously degraded elements showed negligible resistance to further oxidative degradation. This instability could be readily demonstrated by the very short oxidation induction times (OIT) being measured on the affected plastics. Even unused replacement spares gave an OIT of approximately one half the value obtained for another grade of commercially available polypropylene.

The finding of marked thermal oxidative instability in the polymer was supported by thin layer chromatographic analysis, which showed an almost complete absence of any stabilising additive in the degraded elements and only trace levels of stabiliser present in unused elements.

As a result of these investigations, the premature degradation of the plastics used in the terminating elements was attributed to the use of inadequately stabilised polypropylene. This degradation was no doubt accelerated by the presence of metals, either as metallic parts in intimate contact with the plastics components of the element, or in the form of catalyst residues held within the polypropylene itself.

To eliminate the problem, it was recommended that the plastics component of the terminating elements be a stress-free moulding of effectively stabilised polypropylene free of manufacturing catalyst residues. High molecular mass, high density polyethylene was suggested as a superior material for this application. A physical service lifetime of 20 years in the temperature-controlled environment of a telephone exchange was predicted as a reasonable expectation for terminating elements constructed from either of the recommended materials.



Examples of failed terminating elements of an exchange distribution frame

Cracks in Exchange Battery Cases

Potentially serious defects have been observed in lead-acid batteries of large capacity installed in telephone exchanges over the last three years. The batteries are of the stationary duty type and the case enclosing the battery plates is injection moulded from styrene-acrylonitrile.

The defect shows up as cracks which appear on the internal face of the vertical cell wall and originate where the plate supporting ridges meet the cell wall. Possible propagation of a crack through a cell wall would lead to leakage of the sulphuric acid electrolyte, a matter for major concern.

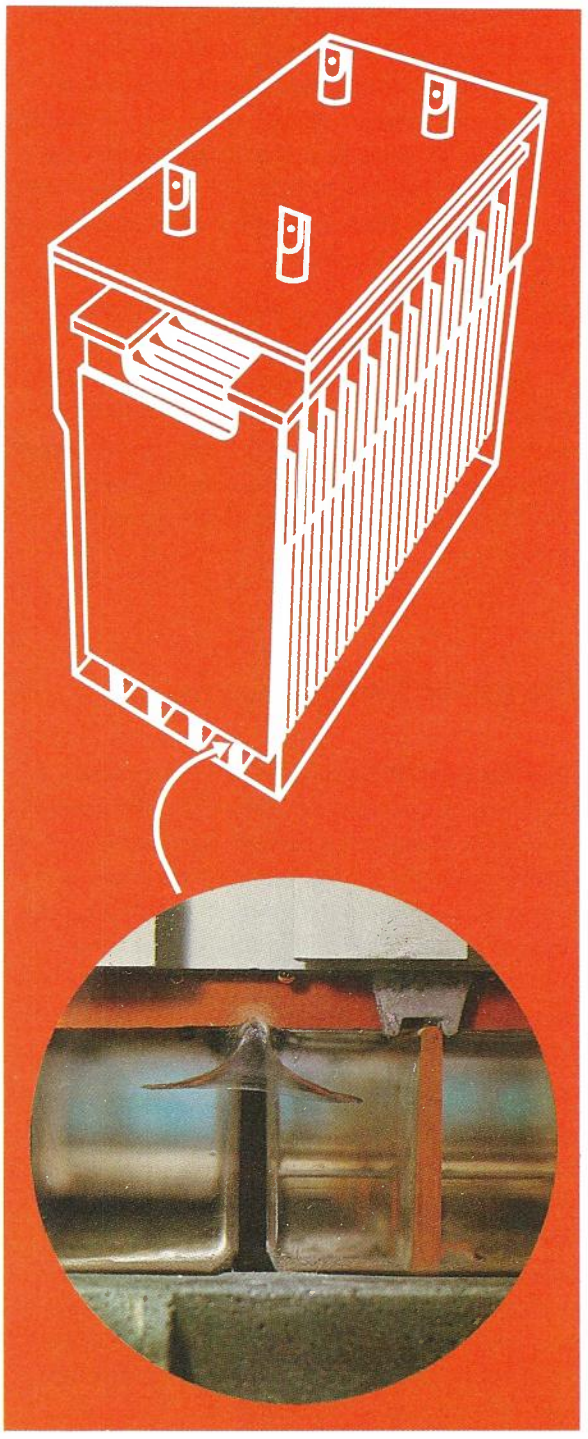


Diagram showing location of cracks in battery case (side view of bottom of case showing crack)

An extensive inspection of this type of battery in two States concluded that more than 20% of the battery cases are already showing internal cracks and that the incidence of the phenomenon is increasing. However, no cracks found have yet extended completely through the battery casing wall and consequently no acid electrolyte leakage has occurred.

From supply and installation data, the occurrence of case cracking did not appear to be time dependent.

To aid investigations of the possible causes of the cracks, a series of short term and long term mechanical tests were commenced to simulate static service stresses. So far, the modes of failure induced in the tests do not replicate the service failures and the values of the forces involved tend to indicate that the design of the cases is adequate for static service stresses.

As a material, styrene-acrylonitrile appears to have the necessary physical and chemical properties required for the manufacture of large capacity battery cases. However, the tests have suggested that changes in the design geometry of the casing are necessary to eliminate sites for the initiation and propagation of stress-promoted cracking.

Diagnostic Event Indicator

Telecom Australia's building plant maintenance staff have the problem of identifying the primary cause of a fault when a system, such as an air conditioning plant, automatically closes down when the fault occurs. Previously tried methods to identify the cause of shutdown have been found inadequate, and the Laboratories were asked to assist in the development of a diagnostic event indicator.

The original concept was for the indicator to be connected directly to the plant control circuitry to record the first of a number of series contacts opening. A prototype based on this concept was designed, constructed and installed in an air conditioning plant, where its performance was shown to be satisfactory over a trial period of several months. In this form, the indicator was designed to show the sequence of operation of four out of a total of 16 contacts.

However, an additional need became apparent for a light-weight portable indicator which could be readily taken to fault-prone plants by field staff for short term diagnostic checks. As a result, a second prototype was designed and constructed. In this second form, the indicator is small, easily installed and battery-operated, and it identifies the first contact to operate out of a number in series.

The second indicator is currently undergoing field tests and early indications are that it is working satisfactorily and will fulfil the specified need, with further potential as a useful monitor in the general control circuitry field.

Failure Analysis of RF Power Transistors

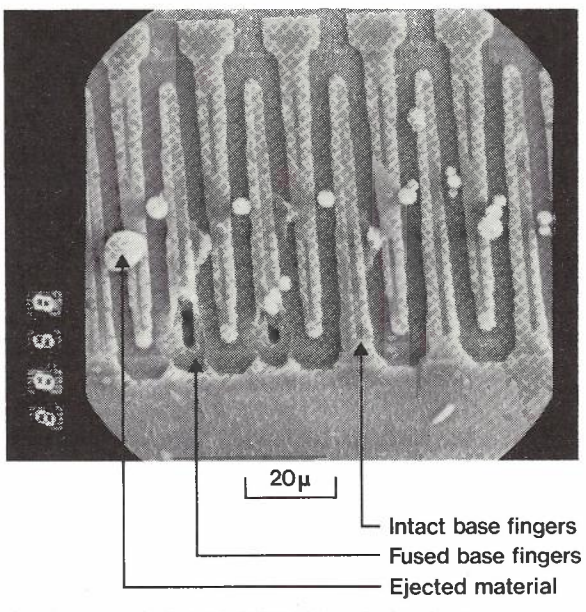
When the output transistors failed in a number of 100 watt remote area television translaters, the complex nature of the internal construction of the transistors prevented on-the-spot diagnosis of the failure mechanism involved. Each package contained several devices in parallel, connected through a base matching network. These factors made it impossible to diagnose the failure mechanism from external examinations.

To overcome this problem, internal examination of the transistors was carried out using the Laboratories' Scanning Electron Microprobe facility, which is ideally suited to this task. The highly magnified images of the transistors and their associated compositional maps made the identification of the failure mechanism possible.

It was found that some base fingers and leads between the base and matching network had fused. This observation is consistent with failures related to excessive base current transients and excessive drive to the final stage.

The microprobe analysis also showed the metallisation to be aluminium, which is not suited to high current density and high temperature operation because of its susceptibility to metal migration. Therefore, a recommendation was made to change to a transistor type using a metallisation based on gold, which has a higher fusing current and is less prone to metal migration.

It was also suggested that, if practical, steps be taken to limit the drive to the final stage.



A micrograph of a partially damaged output transistor

Failure Assessment of a Diesel Engine Fuel Line

During the year, a high pressure fuel line on a diesel engine coupled to a 150 kVA generator ruptured and caused a fire at a telephone exchange. Diesel fuel had leaked from the rupture onto the hot exhaust manifold, where it ignited. The site of the failure was in the fuel line to one injector, at a point adjacent to a cold-formed nipple which forms part of the connection of the line to the injector. The fuel line break was not initially evident, as the line had remained in position and the fracture was hidden by the securing nut.

Metallurgical examination of the fracture revealed that it was a fatigue failure and that the fracture had initiated at a score mark on the surface of the line. The cause of this scoring could not be positively determined but it was thought to be the result of hand filing to remove ridges which had been made on the surface of the line when clamping during the nipple forming operation. Other roughened fuel lines were found to be present on the engine, contrasting with the smoother finished line supplied as a replacement.

Vibration measurements made on the installation showed that the likelihood of future failures could be further reduced by fitting extra supporting brackets between the fuel lines and the engine block. This modification was recommended.

Magnified view of fractured fuel line and adjacent scored surface

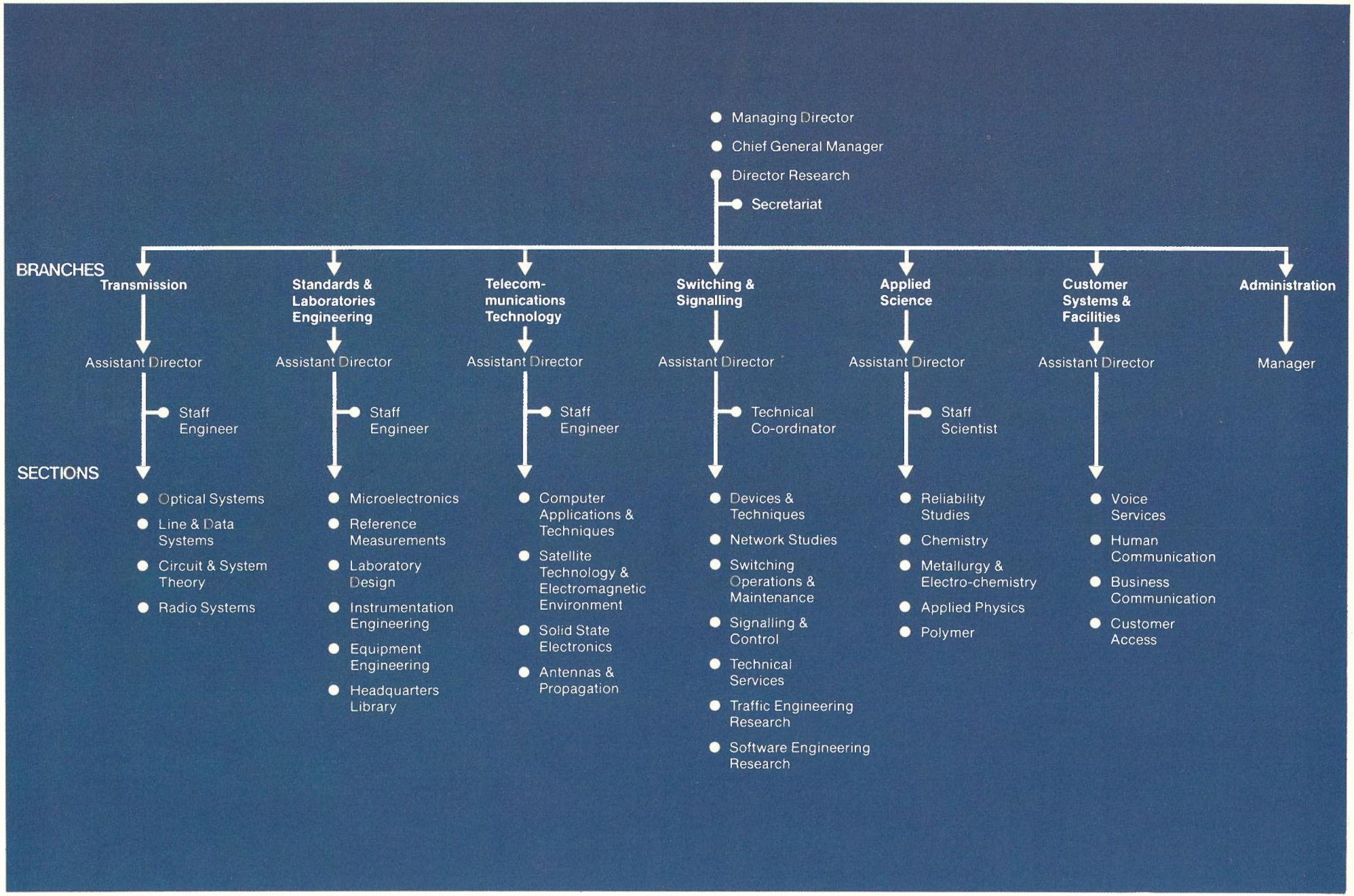
Laboratories' Assistance with the AUSTPAC Project

Telecom Australia is working to introduce its new packet switched data service, AUSTPAC, into operation by the end of 1982. The new network supporting the AUSTPAC service will allow nation-wide switched interconnection of different types of computer equipment via switching nodes initially located in Sydney and Melbourne. The network will support the attachment of computers or terminals with interfaces described by CCITT Recommendations X.25 for packet mode operations and X.3, X.28 and X.29 for asynchronous operation.

The development of networks such as AUSTPAC has progressed rapidly following the development of international standards by the CCITT in regard to aspects such as interface and facility specifications.

Amongst other considerations, the commercial success of AUSTPAC depends upon the timely availability of adequate customer-network interface specifications. During 1981/82, staff of the Laboratories were able to draw on related research experience to assist the Commercial Services Department with the preparation of such interface specifications for both packet mode terminals and the character mode interface for unintelligent, asynchronous mode terminals. On occasions during the period between October 1981 and February 1982, three staff members of the Laboratories were outposted to join the Commercial Services Department team working on the AUSTPAC project and they were backed up with support from other Laboratories' staff.

Recently, the Commercial Services Department established the AUSTPAC Users Group to provide a forum for discussion of various issues arising in the use of the AUSTPAC service. The Group comprises representatives of Telecom Australia, potential users of the AUSTPAC service and the Australian telecommunications industry and it has several subsidiary Working Parties to consider specific issues. Mr. G. Dickson of the Switching and Signalling Branch of the Laboratories is the current Chairman of the Working Party concerned with technical issues.



The Research Laboratories' Organisation

The Laboratories – Summary Information

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.

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 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.

PROFESSIONAL AND SENIOR STAFF

The names given below are those of the actual occupants of the positions (appointed or acting) at 30 April 1982.

Director: E.F. Sandbach, AM, BA, BSc, FTS.

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, BEE, MEngSc.

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

Engineer: O.J. Malone, BEE.

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, BE(Hons), ME, MIEE, SMIREE.

Staff Engineer: R. Horton, BSc(Hons), PhD, AMIEE, FIREE.

Branch Administrative Officer: M.J. Holmes

Optical Systems 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 optical media such as optical fibre cables.
- Evaluate the potential applications and utilisation of such systems using such media for the transmission of telecommunications services in the local, junction and trunk networks.
- Investigate the inter-working of such systems with other parts of the transmission and switching network.
- Develop and advise on new techniques for the measurement of transmission properties and characterisation of optical systems.
- Maintain an awareness of and evaluate and advise on emerging techniques relating to optical systems transmission.

Section Head: A.J. Gibbs, BE(Elec Hons), ME, PhD, SMIEEE, SMIREE.

Principal Engineer: R.W.A. Ayre, BE(Elec Hons),BSc(Hons), MEngSc.

Senior Engineers:
E. Johansen, BE(Hons), PhD, SMIREE.
G. Nicholson, BE(Hons), MEngSc, MIEEE.

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

Scientist: J.L. Adams, BSc(Hons), PhD.

Senior Technical Officers:
J.B. Carroll
J.H. Gillies

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 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 metallic bearer and system testing methods.
- Conduct exploratory development of appropriate systems and testing apparatus which are not otherwise available.

Section Head: B.M. Smith, BE(Hons), PhD, MIEEE.

Principal Engineers: A.Y.C. Quan, BE(Hons), ME, AMIEE.
G.J. Semple, BE(Hons), MEngSc.

Senior Engineers:
N. Demytko, BE (Elec Hons), BSc, M Admin.
L.J. Millott, BE(Hons), MEngSc, MIEEE.
P.G. Potter, BE(Hons), PhD.

Engineer: P.R. Hicks, BE(Elec), BSc(App Maths).

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

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, BE(Hons), MEngSc, PhD.

Senior Engineers:
F.G. Bullock, BE(Hons), Grad IE Aust.
A.J. Jennings, BE(Elec Hons), PhD, MIEEE.

Engineer: D.B. Albert, BE(Hons), PhD.

Senior Technical Officer:
R. Owers, MITE

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, BEE, MIE Aust, MIEE.

Principal Engineers:
R.P. Coutts, BSc, BE(Hons), PhD, MIEEE.
W.S. Davies, BE, MEngSc(Hons), PhD.

Senior Engineers:
I.C. Lawson, BEE.
A.L. Martin, BE, Grad IE Aust, SMIREE.

Engineers:
J.C. Campbell, BE, MEngSc, MIEEE.
B.J. McGlade, BE(Hons).

Research Officer: S. Choy, BSc.

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

Standards and Laboratories Engineering Branch

Branch Objectives
To ensure a sound scientific basis for all measurements made by and within the Australian Telecommunictions 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, BSc.

Staff Engineer: G. M. Willis, FRMIT, MIE Aust, MIREE.

Branch Administrative Officer:
T.H. Brown

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, BSc, MIEE.

Principal Engineer: R.L. Trainor, BSc.

Senior Engineers:
R.W. Harris, BSc(Hons), BE (Elec Hons), BComm.
E. Pinczower, Dip Elec Eng, MIE Aust.

Engineers:
J.P. Colvin, BE(Elec), Dip Elec Eng.
D.A. Latin, BE(Elec).
R.W. Pyke, Dip Elec Eng, BE(Elec Hons), MIE 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

Microelectronics Section

Section Functions

- Conduct research studies into the design and physical realisation of electronic circuitry, in particular that involving miniature and microminiature 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, MIE Aust.

Senior Engineers:
G.K. Reeves, BSc(Hons), PhD, MIE Aust.
H.S. Tjio, BE(Mech), Assoc Dip Electron Eng.

Engineers:
A. Brunelli, Dip Electron Eng, BE(Comm).
J.L. Chester, BE(Mat Hons).
G. Heinze, Dip Electron Eng, BE(Elec).
D.R. Richards, BE(Elec), MIEEE.

Scientist:
Z. Slavik, Dip Eng, ARACI.

Senior Technical Officers:
G. Brinson
M. Crarey
F. Gigliotti

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, BSc.

Senior Engineers:
A.J. Stevens, BE(Elec), MIEE, MIEEE.
F.R. Wylie, BE, MIEEE.

Engineers:
I. Dresser, BE(Elec).
N.A. Leister, BE(Elec), Grad IREE.
P. Standaert, BE.

Senior Technical Officers:
S.P. Curlis
P.J. Dalliston
D.R. Daws
P.S. Dawson
D.C. Diamond
B.K. Eley
D.G. Marshall
K.L. Rogers

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, MIEE, MIE Aust.

Engineer: R.J. Day, Dip Elec Eng, Dip Mech Eng, MIE 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 electromechanical engineering design of the hardware aspects of telecommunications models; arrange for production of these designs within Telecom Australia or industry or, when necessary, within the Section; establish specification criteria for performance and quality, and the necessary measuring equipment, and employ these to ensure adequate performance of the items produced.
- Oversight 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, CEng, MIMech E.

Senior Engineer: P.F.J. Meggs, Assoc Dip Mech Eng, MIE Aust.

Engineers:
A.R. Gilchrist, Assoc Dip Mech Eng, BE(Mech Hons), Grad IE Aust.
W.F. Hancock, Dip Elec Eng, MIE Aust.
K. Ho-Le, BSc, BE(Mech Hons), Grad IE Aust.
R. Proudlock, BE(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, BA, Dip Lib.

Senior Librarian: D.J. Richards, BA, Dip Lib.

Librarians:
G. Chua, BAP(Lib Stud WAIT), ALAA.
M. Frewin, BSocSci(Lib).
M. McAllister, BSc(Hon), Dip Lib, ALAA.
P. Millist, Dip Lib, ALAA.
E.M. Spicer, BA, 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, BSc(Hons), MIEE.

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

Branch Administrative Officer: C.J. Chippindall

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, BE(Hons), BSc, MIEEE.

Senior Engineer: K.F. Barrell, BE(Elec Hons), PhD.

Engineers:
L.A.R. Denger, ENSEMN, MIEEE, M Soc Fr de Elec, Grad IE Aust.
S. Iskta, BE(Hons).

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 coexistence 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, BSc, SMIREE.

Principal Engineers:
R.K. Flavin, BSc, MSc.
I.P. Macfarlane, BE(Elec), ARMTC, MIEEE.

Senior Engineers:
A.J. Bundrock, BE(Elec Hons).
D.J. Kuhn, BE(Elec), MEngSc.

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

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, BE(Elec Hons), PhD.

Principal Engineers:
G.E. Rosman, BEE, ME.
P.V.H. Sabine, BSc, BE(Elec Hons), PhD.

Senior Engineers:
Y.H. Ja, BE, PhD.
J. Hubregtse, Fell Dip Comm Eng, MIREE.

Engineer: A.M. Duncan, BSc, BE(Elec Hons).

Principal Scientist: G.L. Price, BSc(Hons), D Phil, MAIP, MAPS, MIEEE.

Senior Scientist: P.C. Kemeny, BSc(Hons), PhD, Grad APS.

Scientist: B.J. Linard, BSc(Hons), PhD, Grad AIP.

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, BEE, MIE Aust.

Principal Engineers:
J.V. Murphy, BE(Elec Hons), BA.
S. Sastradipradja, BE(Elec).

Senior Engineers:
R.A. Harvey, Dip Rad Eng, BSc, AMIREE.
E. Vinnal, BE(Hons).

Engineer: W. Lobert, BE(Hons), MEngSc.

Scientist: P. Turner, BSc(Hons), PhD.

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

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;
- traffic engineering.

Assistant Director: F.J.W. Symons, BE(Hons), DIC, PhD, MIE Aust, AIEE.

Technical Co-Ordinator: B.T. Dingle, Dip Elec Eng, BE(Hons).

Branch Administrative Officer: S.J. Chalk.

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: R.A. Court, BE(Hons), BSc, MEngSc, MIEE.

Senior Engineer: E. Tirtaatmadja, BEng(Elec).

Engineers:
D.M. Harsant, BE(Hons).
P.L. Nicholson, BE, MIEE.

Scientist: C.J. Scott, BAppSc, Grad AIP.

Software Engineering Research Section

Section Functions

- Conduct research and investigations and develop new techniques in fundamental areas of the application of computer systems to telephony and data switching and signalling.
- Study the characteristics and potential of new approaches in the field of SPC programming and software technology.
- Participate in the design and assessment of laboratory and field trials of new switching and signalling systems using novel software engineering and programming techniques.
- Provide an SPC system programming and software specification, analysis, 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 programming and software technology into the network.

Section Head: R.H. Haylock

Senior Computer Systems Officer:
E.M. Swenson, MSc. Grad Dip Data Processing, MAIP, AACS.

Programmers:
J.S. Drake
G.P. Rochlin, BSc, MACS.

Engineer: N.W. Bergmann, BSc, BE(Hons).

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, BEE.

Principal Engineer: G.J. Champion, BE.

Senior Engineers:
J. Billington, BE (Hons), MEngSc, MIEEE.
K.S. English, BE(Hons), MEngSc, MIEEE.

Research Officer: G.R. Wheeler, BSc(Hons), MSc.

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, BEng(Hons), MEngSc, MIE Aust.

Principal Engineers:
M.A. Hunter, BE(Hons), MIE Aust.
M. Subocz, BE(Elec), MIE Aust.

Senior Engineers:
P.A. Kirton, BE(Hons), PhD, MIEEE.
G.K. Millsteed, Dip Elec Eng, BE(Hons).

Engineers:
H.K. Cheong, BE(Hons).
S.M. Jong, BE(Elec).
C.J. O'Neill, BE(Hons).
M.C. Wilbur-Ham, BE(Hons).

Research Officer: I.P.W. Chin, BSc(Hons), AIEE.

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, ARMTC, MIE Aust.

Senior Engineer: R.E. Warfield, BE(Hons), PhD.

Scientist: R.J. Harris, BSc(Hons), PhD.

Engineer: G.A. Foers, BE(Hons).

Research Officer: M. Rossiter, BSc(Hons).

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

Senior Engineers:
G.J. Dickson, BE(Hons), MEngSc, MIEEE.
J.C.N. Ellershaw, BSc, BE(Hons), PhD, MIEEE.
J.L. Snare, BE(Hons), MEngSc.

Engineer:
P.I. Mikelaitis, BE(Elec), MEngSc, MIEEE.

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, AAIM.

Senior Technical Officers:
R.L. Backway
P. Ellis
H.G. Fegent
L.P. Lucas
P.C. Murrell
A. Romagnano
B.J. Wilson

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, FIM, MAIMF.

Staff Scientist: G. Flatau, FRMIT (App Sc).

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

Principal Engineer: A. Fowler, MIE Aust.

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

Solar Module Evaluation Group

Group Leader: D. McKelvie, BSc(Hons).

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

Branch Administrative Officer: M.A. Chirgwin

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, BSc(Hons), MSc.

Senior Engineer: I.K. Stevenson, BAppSc, Dip Eng(Electronic Eng), ARMIT, Grad AIP, Grad IE Aust.

Senior Physical Scientist: S.J. Charles, BAppSc.

Senior Technical Officers:
R.A. Galey
J.F. Pidoto
R. Wilkinson, Eng Ass IREE, MTETI (Aust)

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, BSc, MSc.

Senior Physical Scientists:
E.J. Bondarenko, Dip App Phys, BAppSc, LAIP, SMIREE, FRAS.
G.W.G. Goode, BSc.

Engineer: P.W. Day, BE(Comm).

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

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 electrochemical 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, AMAIMM.

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, BSc, ARACI.

Physical Scientists:
P.J. Gwynn, Dip App Chem.
R.F. May, MSc, Dip Sec Met.

Engineer:
J.A.A. Lyimo, BEng(Hons).

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

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, ARACI, AAIST, C Chem, MRSC.

Senior Physical Scientist: R.N.M. Barrett, BSc(Hons), C Chem, MRSC.

Physical Scientists:
T.J. Elms, Dip App Sc, Grad RACI. Grad Dip Analyt Chem.
P.W. George, Dip App Sc(App Chem), Grad RACI.
S. Georgiou, BAppSc(App Chem). Grad Dip Analyt Chem.
F.M. Petchell, Dip App Chem, ARACI.

Senior Technical Officer: R.R. Pierson, MAIST

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, APIA, ARACI.

Senior Physical Scientists:
D.J. Adams, Dip App Chem, Grad RACI.
B.A. Chisholm, Dip App Chem, MSc, Grad RACI, Grad PRI.

Physical Scientists:
R.J. Boast, Dip App Chem, Grad RACI, Grad Dip Pol Sc.
P.R. Latoszynski, Dip App Sc, Grad RACI.
Grad Dip Analyt Chem.
D.T. Miles, C Chem, MRSC, MRSH.

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: R.J. Morgan, BSc(Eng Hons), PhD.

Branch Administrative Officer: B.F. Donovan

Customer Access Section

Section Functions

- Provide information, advice and consultancy as defined in the Branch objectives.
- Conduct studies of methods of providing customer access with particular reference to service and terminal requirements.
- Develop approaches towards the standardisation of customer access (electrical interfaces and logical procedures) which will enable maximum interworking of network terminals and services.
- Prepare recommendations regarding customer access standards.
- Assess the potential and limitations of proposed approaches towards customer access as they relate to terminal equipment and services.

Section Head: N.Q. Duc, BE(Hons), PhD, MIREE, MIEEE.

Senior Engineer: E.K. Chew, BE, MEngSc, PhD, Grad IE Aust.

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, BEE(Hons), MSc, MIE Aust.

Senior Engineers:
J.K. Craick, BE(Elec Hons), BSc.
D.Q. Phiet, BE(Elec Hons), PhD.

Engineer: P.H. Newland, BE(Elec).

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

Psychologists:
R.W. Hyland, BA(Hons).
L. Perry, BA(Hons), MAPS.

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

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: P.S. Jones, MEngSc.

Principal Engineers:
R.I. Davidson, BE(Elec).
G.K. Jenkins, BSc, BE(Hons), ME, MACS.

Senior Engineers:
A.R. Jenkins, ARMIT.
W.E. Metzenthen, FRMIT, ME, MIREE.
P.F. Frueh, BE(Elec), MEngSc.

Engineers:
P. Bernhard, BE(Elec).
D.M. Blackwell, BE(Elec).
R. Exner, BSc, BE(Hons), MAppSc, MIEEE.
G.R.G. Smart, Dip Eng(Radio), MIREE, ARMIT, JP.
J.S. Spicer, BE(Elec Hons).

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

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, BEE, Dip Mech & Elec Eng, MIE Aust, MAAS.

Principal Engineer: E.J. Koop, Fell Dip Elec Eng, BE(Elec), MAAS.

Senior Engineers:
P.F. Duke, Assoc Dip Maths, BTech.
R.A. Seidl, BE(Elec Hons), PhD.

Engineers:
G.M. Casley, BE(Elec), MEngSc, PhD, DIC, MIE Aust, AMIEE.
J.P. Goldman, Assoc Dip Rad Eng. Assoc Dip Comm Eng, Grad IE Aust.
N.H. Duong, BE(Elec).

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

TET/TAMS Task Force

Task Force Terms of Reference

- Rehabilitate the Telephone Efficiency Tester (TET) programme and maintain it until it can be replaced by the Telephone Apparatus Measuring System (TAMS) programme.
- Implement the TAMS-4 programme to complete its introductory phase.

Task Force Manager: R.W. Kett, Fell Dip Comm Eng, MIREE.

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

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

Administrative Services Section

Manager Administration: J.F. Reid

Senior Planning Officer: B.M. Douglas

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 12 months.

Papers

Adams, J.L.	"Wavelength Division Multiplexing for Optical Fibre Transmission Systems", 2nd Applied Physics Conference of the Australian Institute of Physics, Royal Melbourne Institute of Technology, December 1981.
Albertson, L.A.	"Reflections in a Crystal Ball : The Technologist as Prophet in a Turbulent Society", Australian Telecommunication Research, Vol. 15, No. 2, 1981.
Albertson, L.A. & Phiet, D.Q.	"Teleconferencing Research in Australia", The Telespan Newsletter, Vol. 1, No. 5, 1981.
Albertson, L.A. & Hyland, R.	"The Teleconference as a Micro-Network : A New Research Approach", 51st ANZAAS Congress, Brisbane, May 1981.
Ayre, R.W.A.	"Transmission Measurement Techniques for Optical Fibres", IREE Convention, Melbourne, August 1981.
Ayre, R.W.A.	"Optical Fibre Communications Research in Australia", 2nd Applied Physics Conference of the Australian Institute of Physics, Royal Melbourne Institute of Technology, December 1981.
Barker, G.J.	"Sputter-Etching in Microwave Planar Circuit Fabrication", IREE Convention, Melbourne, August 1981.
Billington, J. & Symons, F.J.W.	"Modelling and Analysis of Communication Protocols - Part I", IREE Convention, Melbourne, August 1981.
Billington, J., Dickson, G.J. & Symons, F.J.W.	"Modelling and Analysis of Communication Protocols - Part II", IREE Convention, Melbourne, August 1981.
Billington, J.	"Analysis of Multipath Fading: The Single Echo Model Revisited", Australian Telecommunication Research, Vol. 15, No. 1, 1981.
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Reports

Report No.	Author	Title
7310*	D.A. Latin	HP-IB Translator for Real-Word Interfacing
7319*	H.S. Tjio	Training Manual for Gerber Interactive Design System - 2 Axes Software Version PC 1.56
7321*	R.B. Coxhill & R.I. Webster	A Microprocessor Controlled Data Test Set: Hardware and Software Aspects
7322*	K.S. English	Analysis Programs for Digital Data Network Measurements
7326*	A.M. Duncan	Design of a TV Conference Studio
7354	O. Tenon	Global Matrix and its Transformation
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7367*	L.J. Millott & R.N. Swinton	A Control Unit for a Prototype Barrage Tester
7371*	L.A. Albertson	The Participation Model of Teleconferencing : Theory
7378*	D.M. Blackwell	Coding Techniques for Digital Document Facsimile
7382*	H.J. Ruddell	Overseas Visit Report, September-October 1979
7384	G.J. Semple & A.J. Gibbs	Assessment of Methods of Evaluating the Immunity of PCM Regenerators to Near End Crosstalk
7385*	P. Bernhard	A Method of Generating "Recorded" Announcements Under Microprocessor Control
7386	D. McMillan & P.F.J. Meggs	A Digital Display Dialler
7389*	F.G. Eastaughffe	IST/RSU Project - Software Testing Techniques and Experience
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7399*	G.C. Heinze	Report on Overseas Visit (April 1980) - Interactive Computer Techniques in Microelectronics
7400	W. F. Hancock	Precision Applications of Micro Plasma Arc Welding
7409	N.Q. Duc	ISDN Local Networks : An Overview of CCITT Studies and Related Topics
7411	J.J. Sekfy	Rainfall Recording Using a Digital Printer
7420*	H.S. Tjio	IDS-2 System Architecture and Programming Part 3 - Interactive Command Table (ICT) Language and an Insight into an ICT Program
7425	R.I. Webster	An Instrument to Control Phase Jitter Insertion on an FDM Carrier Supply
7426*	F.G. Eastaughffe & R. Haylock	IST/RSU Project - Principles and Comments on the Testing and Maintenance of Digital Exchange Systems
7428*	G.M. Codsi	User Guidelines for the Specification and Description Language - Australian Extended Version (SDL-A)
7430	R.L. Gray and R. Owers	Waveguide Bandpass Filter with Phase Compensation
7435	D.J. Thompson	Digital Test System - Code Word Insertion Extraction and Error Detection
7436*	E.M. Swenson	Visit to Overseas Organisations - 1979/80 Discussions on SPC Software
7439	R.A. Seidl	Synthetic Voice Response - A Review
7440*	B.T. Dingle & E.K. Chew	10C Data Line Interface Feasibility Study
7441	F.G. Bullock	The Measurement and Calculation of the Parameters of Switched Telephone Connections
7442	L. Perry	Developing a User Manual for Complex Telephones
7443	G. Nicholson	Output Jitter Measurement of a PCM Line System
7448	N.R. Smart	Manufacture of an Ultra High Vacuum Flange

7449*	H.S. Tjio	Interactive Design System, 2 Axes(IDS-2) - Operating Procedures for Printed Board Phototools
7450*	G.R. Wheeler	Algebraic Semantics of Programming Languages : The Vienna Development Method
7451	A. Gillett	Calculation of the Error Probabilities in a Radio System with Two Path Fading
7453*	I. Dresser	Fault Indicator - Air Conditioning Plant
7454*	G. Nicholson	A Jitter Transfer Function Mask for a PCM Regenerator
7455	G. Galanis	Network Analysis Using Sparse Matrices
7457*	J.L. Keedy (Monash University)	A Report on the Concurrent Processing Features of the CCITT Language CHILL
7458	R. Exner	Printing Technologies for the Future Office
7459*	G.W.G. Goode	Conductor Repairs for Copper and Aluminium Cables
7461	D.B. Albert & J.C.N. Ellershaw	Block Error Rate Calculations for Rayleigh Fading
7462*	R.P. Coutts	Data Transmission Over Broadband Radio-Relay Systems
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7464	M.C. Wilbur-Ham	A Redeployable Speed Conversion Device for Remote Word Processor Stations
7466	K.F. Barrell & N.Demytko	A Noise Averaging Data Acquisition Interface for Sampling Oscilloscopes
7467*	G.W.G. Goode	Plastic Re-openable Joint Enclosures
7469	G.J. Dickson	Overseas Visit Report - CCITT Study Group VII Meeting, Kyoto - April-May 1981
7470	K.F. Barrell	Optical Fibre Transmission Measurements II : Impulse Response
7474*	G. Nicholson	Modulation Techniques for Cable Television Distribution on Optical Fibres
7476*	P.I. Mikelaitis	An IEEE Std 488 Interface Module for Programmable Instrumentation
7477	K.F. Barrell	Software for the Recording and Analysis of Optical Fibre Impulse Response
7479*	R.A. Frizzo	Routines for Interfacing Between Data General Fortran IV and Data General X.25 Software
7484*	H.J. Ruddell	Group Distribution Frame Element - Plastics Degradation
7485*	R.J. Harris	End-to-End Grade of Service Investigation
7486*	R. Horton & M.J. Durrant	Digital Radio Tests at 13 GHz : Lonsdale Exchange to Mt. Gellibrand - Summary and Conclusions
7487*	J.C. Campbell	Transmission of Digital Signals Over Mobile Radio Channels
7488*	J.C. Campbell	Review of Cellular Structured High Capacity Mobile Radio Systems
7490*	R.A. Seidl	Overseas Visit, March-April 1981 Speech Processing
7492*	I.C. Meggs & R. Vesetas	A Batch Plotter Accessory for a Remote Batch Terminal
7494*	G.L. Price	Overseas Visit Molecular Beam Epitaxy - October 1980
7495	B.R. Ratcliff	Civil Time Receiver
7497*	E. Johansen	Optical Fibre Tap Couplers
7498*	G.J. Semple	Transmission Aspects of Subscriber Digital Line Access to an ISDN : Overseas Visit Report March-April 1981 Part 1
7500	R.N.M. Barrett	Estimation of Titanium Dioxide in Unplasticized Polyvinyl Chloride (UPVC)
7501*	E.M. Swenson	A Proposed Maintenance Aid - Exchange Service Index
7502*	G.J. Semple	Transmission Aspects of Subscriber Digital Line Access to an ISDN : Overseas Visit Report, March-April 1981 Part 2
7505	R.K. Flavin	Rain Attenuation Considerations for Satellite Paths
7507*	R. Exner	A Low Speed Data Channel for Confravision
7511	J.V. Murphy	Overseas Visit Report - URSI XXth General Assembly and CCIR Study Group 5 Final Meeting August-September 1981
7516	K.S. English & D.F. Hudson	Using the IEEE Programs for Digital Signal Processing on TACONET
7518*	G.E. Rosman	Overseas Visit Report - Non-Linear Optical Processes in Telecommunications September-October 1980
7520	F.J.W. Symons	The Application of Petri Nets and Numerical Petri Nets
7523	G.J. Dickson	Overseas Visit Report - CCITT Study Group VII, Special Rapporteurs Meetings, October-November 1981

Note: The reports marked * are classified as "Telecom Australia Use Only", in addition 12 "In Confidence" reports with 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)

Technical and Further Education Board, Victoria	
Science Laboratory Standing Committee	F.C. Baker
University of Melbourne	
External Member - Facility of Engineering	E.F. Sandbach
Monash University	
Research Associate - Department of Electrical Engineering	P.H. Gerrand
Footscray Institute of Technology	
Course Advisory Committee	H.S. Wragge G.F. Jenkinson
Swinburne Institute of Technology	
Electrical Engineering Departmental Advisory Committee	L.H. Murfett
Master of Engineering Ad Hoc Advisory Committee	L.H. Murfett
Chisholm Institute of Technology	
Course Advisory Committee	H.S. Wragge
Royal Melbourne Institute of Technology	
Course Advisory Committee	R.D. Slade
Communication and Electronic Engineering Course Advisory Committee	P.H. Gerrand
Industrial Fellow	P.H. Gerrand

National & State Professional Bodies

Australian National Committee for Radio Science	E.R. Craig
Radio Research Board	E.F. Sandbach
Australian Computer Research Board	E.F. Sandbach F.J.W. Symons
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
Telecommunications Society of Australia	
Council of Control	E.A. George G.F. Jenkinson H.S. Wragge
Board of Editors: "Australian Telecommunication Research"	H.S. Wragge J. Billington G.D.S.W. Clark G. Flatau P.H. Gerrand A.J. Gibbs G.F. Jenkinson P.S. Jones I.P. Macfarlane L.H. Murfett H.V. Rodd
Board of Editors: "Telecommunication Journal of Australia"	D.A. Gray
Institute of Electrical and Electronic Engineers	
Victorian Sub-Section Committee	R.A. Court R.P. Coutts A.J. Gibbs
University of Queensland	
Microwave Technology Development Centre	W.J. Williamson
Standards Association of Australia (SAA)	
Council of Executive and Staff Committee Telecommunications and Electronics	E.F. Sandbach
Standards Board and Executive Committee	G. Flatau E.F. Sandbach
Australian Electrotechnical Committee	E.F. Sandbach G. Flatau
• Reliability of Components and Equipment	G. Flatau
• IEC Quality Assurance Scheme for Electronic Components	G. Flatau E.F. Sandbach
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
Metals Standards Board	R.D. Slade
Technical Committees	
Acoustic Standards	
• Instrumentation and Techniques for Measurement of Sound	E.J. Koop
Australian Welding Research Association	
• Panel 12 - Welding of Plastics	H.J. Ruddell
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	
• Lightning Protection	E.J. Bondarenko
• 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	
• Hand Tools	P.F.J. 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
• Bi-metallic Corrosion	R. May
Plastics Industry Standards	
• Plastics for Telecommunication Cables	H.J. Ruddell D.J. Adams
• 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
• Electro-Acoustics and Recording	E.J. Koop
• Hazards of Non-Ionizing Radiation	S. Sastradipradja
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).
- International Organisation for Standardisation (ISO).
- 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
• IEC Joint Co-ordination Group Optical Fibres, Working Group 4	A.J. Gibbs
• 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 Quality Assessment System for Electronic Component Certification Management Committee	G. Flatau
• Special Rapporteur CCITT SG VII/39 (System Description Techniques)	G.J. Dickson
• Special Rapporteur CCITT SG XI/14 (Monitoring and maintenance of No. 7 Signalling Systems)	M. Subocz

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 No. (if granted)**	**Country**
Method and Apparatus for Testing Subscribers' Telephone Instruments in Situ under Service Conditions (J.F.M. Bryant & R.W. Kett)		233699	3261926	USA
Self Adaptive Filter and Control Circuit (L.K. Mackechnie)	65671/69	23649/70 P2063183.8 60513/70 33333A/70 70-45859 17270/70 98800	448805 2063183 1334250 913733 70-45859 362763 3732410	Australia Germany Britain Italy France Sweden USA
Tip Welding Means (E.J. Bondarenko)	49395/70	10361/70 4714/71	455004 3657512	Australia USA
Analogue Multiplier (H. Bruggemann)	43033/68	43033/68 855543	414207 3629567	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
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 3745418 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 367260	482860 564238 1419146 3874795	Australia Switzerland Britain 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 3882283 984068	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	519441	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 266321		Australia Germany Germany Japan USA
Noise Assessment of PCM Regenerators (A.J. Gibbs)	PD6790/78	52160/79 793025727 339841 148305/79 093228	 4300233	Australia Europe (designating: France Germany Britain Italy Holland Switzerland) Canada Japan USA
Tap Coupler for Optical Fibres (E.Johansen & E. Dodge)	PF0272/81			Australia
Hydrometer (F. Bodi)	PF1183/81			Australia

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 1982 are listed below:

Applied Science Conferences Attendees (RMIT)

Australian X-Ray Analytical AssociationVictorian Branch - Seventh Annual General Meeting

Ballarat Students from CAE

Mr. K. Bergstrom, East-West Centre Hawaii USA

Mr. R.W. Brack, Chairman of the Commission

Cable Television Enquiry Panel Members

Mr. D. Chennels, STO2, Adelaide Workshops

Associate Professor Sha Yu Chuan of the Radio Engineering Department of Nanking Institute of Technology, Peoples Republic of China

Dr. R. Clist, Head Electronics Group, Auckland Industrial Development Division, Department of Scientific and Industrial Research

Mr. Alec Curran, Assistant Deputy Minister, Space Programmes, Canada

Mr. Leon Stryker, Canadian Consul in Melbourne

Engineer Class 1 Induction Course

Mr. Entomoto, SE Asia Representative of NTTPC

Messrs. Farell and Simmons of Hewlett Packard

Dr. Peter Fisher, Metals Technology Centre, Technology Transfer Council, Sydney

Mr. Gerry Garwood, British Telecom Engineer

Messrs. Griffin, Martin, Ko and Davis, Electrical Engineering Department University of Adelaide, Dr. J. Ness, Microwave Technology Centre, University of Queensland

Mr. Dan Kay Hu, Student on Two Year Scholarship Shanghai Light Industry Research Institute, Peoples Republic of China

Mr. M. King, (A Member of the Telecom Inquiry Team)

Mr. M. Lett, Supervising Engineering, Materials Section, New South Wales

Mr. Mike Lin, Design Engineer with Watkins Johnson, USA

Lines Servicemen in Training from External Plant Training Centre, Doncaster

Norwegian Delegation from A/S.Elektrisk Bureau

Dr. Joe Patroni, Sugar Research Institute Mackay Queensland

Mr. B. Ramamurthy, Director (Telecom) Posts and Telegraphs Directorate, New Delhi

SAA Sub-Committee Members Visit

Mr. R. Sarraco, CSELT, ITALY

Mr. J. Scott, Course Controller of TAFE Applied Science Courses and Certificate of Applied Science Students from Swinburne

Professor S. Stachly University of Ottawa Electrical Engineering Department, Canada, Dr. M. Stachly, Bureau of Radiological Health, Ottawa, Canada

CCITT Study Group VII Delegates

Trainee Technical Officers 1982 intake

Dr. U.N. Tran and 3rd and 4th Year Students from Deakin University

TTCP Technical Panel JTP-10 (Lasers)

Professor J. Ward, Professor of Physics, James Cook University of North Queensland

Mr. J.S. Whyte, Deputy Managing Director, British Telecom

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:
G.J. Barker
J. Billington
E.R. Craig
G.J. Dickson
N.Q. Duc
P.F. Duke
R. Haylock
D. McKelvie
L.J. Millott
J.V. Murphy
G.K. Reeves
G.E. Rosman
H.J. Ruddell
S. Sastradipradja
R. Smith
M. Subocz

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 staff has been encouraged to engage in post graduate studies:

P.A. Kirton, Development Training. Information Science Institute - Programme Award - University of Southern California

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 Australian 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
- Refractive Index Profiling Techniques for Optical Fibre Preforms Distribution Network
- A Speech Level Measurement System
- Bird-proof Windows for Feeder Horns of Microwave Antennas
- A Colour Video Switching Unit for a Confravision System
- Double Pulse Q Switched Ruby Laser Development
- Test Instrumentation for PCM Systems
- A Precision Phase Locked Oscillator System
- Automated Plating Process for Printed Wiring Board Fabrication
- Correlation between Physical Properties of Plastics and their Resistance to Termite Attack
- Automated Generation of Chill Codes from Call State Transition Diagrams and Other Pictorial Data
- Adaptive Digital Hybrids for Subscriber Lines
- Fault Tolerant Microcomputer Systems for Telecommunications Applications
- Lidar Sounding of the Troposphere
- Transmission Performance of Single and Multimode Optical Fibres
- Optimal Dimensioning of Circuit Switched Digital Networks
- A Digital Transmission Error Performance Analysis System
- A Microprocessor Control System for Laboratory Environmental Test Chambers
- Systems Engineering for a Remote Data Acquisition/Analysis System
- Microwave Solid State Amplifiers for Satellite Communications
- Modelling and Analysis of Electric Field Strength and Noise Distributions in Mobile Radio Communications
- Techniques for Full Duplex Digital Communications on Subscriber Lines
- Electrical Parameters of Lightning Surges Induced in Telephone Lines
- Theoretical Studies of Interference Effects in Digital Radio Systems
- Modulation Characteristics of Laser Diodes

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

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