Volume 33, No. 1, 1983

the telecommunication journal of Australia

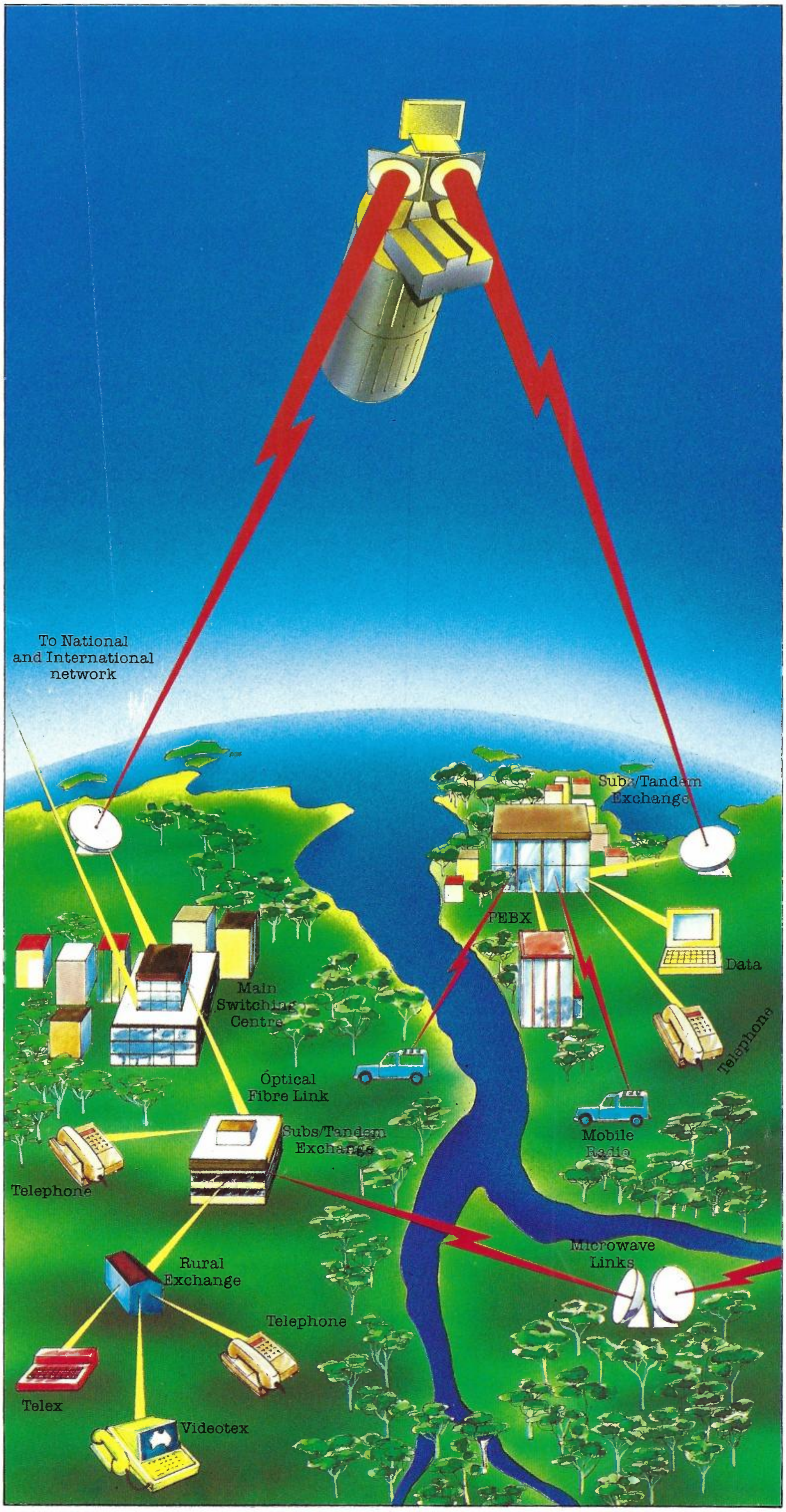
WORLD COMMUNICATIONS YEAR 1983

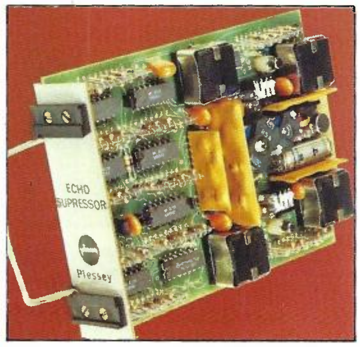
33/1

FEATURED IN THIS ISSUE:

- COMMUNICATIONS IN THE NAVY
- CCR IN NEW GUINEA
- AXE MAINTENANCE
- SATELLITES FOR THE OUTBACK
- ECONOMIC ANALYSIS

Plessey: now you're talking.





Top: IXT.
New generation fully electronic telephone.

Lower: Echo Supressor.
Advanced hybrid technology in transmission equipment.

Our involvement in communication goes back more than half a century to bring you the future, sooner.

The result of our efforts is seen in the hundreds of products which daily touch the lives of a very large number of people not only across Australia but throughout the world.

Products that include:

- Computer controlled digital exchanges.
- PEBX.
- Satellite terminals.
- Microwave links.
- Subscriber telephones.
- UHF/VHF mobile radios.
- Optical fibre links.
- Videotex terminals.
- Line transmission equipment.

And more.

Plessey Australia Pty Limited
Telecommunications Division
Faraday Park, Railway Road
Meadowbank NSW 2114
Telex: AA21471
Telephone: (02) 807 0400

PLESSEY

PT134

The Society Reporter

Volume 33 No. 1 supplement

This supplement to the Telecommunication Journal of Australia will bring you news of topical and programmed society events in all States and of the people involved in running your Society.

The Reporter is supplied in this form so that you can conveniently separate it from the Journal for your ready reference while its contents are current, or possibly to pass it on to a potential new member to kindle an interest in the Society's affairs.

TJA Publishing Program

The Board of Editors of the TJA has received promises of 72 papers for publication in 1983. These papers are covering a wide spectrum of new developments in the Telecommunication industry within Australia and are to be drawn from areas which will ensure all interests are covered. Some of the subjects to be published are:

AXE MAINTENANCE

NEW TELEPHONE INSTRUMENTS

NETWORK PLANNING COMPUTER SYSTEMS

ISDN

TELECOMMUNICATIONS IN THE ARMED SERVICES

SIGNALLING TO PCM

MOISTURE-BARRIER CABLES

UHF TELEVISION

SATELLITE SYSTEMS

FINANCING TELECOM PROJECTS

Consolidated Index

All members should have received their free copy of the 1971-1980 Consolidated Index of papers published in the TJA (If not, contact your agent or State Secretary).

The indexing arrangements have now been established on a computer system which will allow a more rapid compilation of the data from individual volume indexes.

Consideration is being given to issue the index more frequently — perhaps every 5 years, if the demand exists.

Membership

The Council of Control is taking the question of the growth of the Society very seriously.

At a recent meeting, the Council passed a resolution which demonstrates its commitment to growth and appointed the Vice-chairman, Dr Clem Pratt, to head a standing committee on membership. Dr Pratt commented that the major task of the committee is to co-ordinate and assist the State Divisions to expand their membership and the early priority will be towards getting an information kit together which explains the objectives and activities of the Society.

The Council will keep membership figures constantly under review and will take whatever steps are necessary to ensure growth.

Dr Clem Pratt

State Division News

Tasmanian Division Activities

Following the AGM in April 1982, the Tasmanian Division activities were centred around a variety of very interesting lectures, culminating in the Christmas get-together after the December Meeting.

Lectures are normally held each two months in Hobart and wherever possible the same presentation is made at Launceston and Burnie.

Presentations in 1982 were:-

9 JUNE.
DR. TODD from the University of Tasmania gave a very interesting lecture on Domestic Heating, covering advantages and disadvantages of various types, including fuel-costs and methods of efficiency improvement. This presentation was to Hobart members only.

22, 23, 24 JUNE.
A busy month for Hobart, together with Launceston and Burnie, each being briefed by MR. JIM MITCHELL, Telephone Marketing Section, Commercial Services Department, HQ, on the CT4 coin telephone.

11 AUGUST.
MR. PETER MARSHALL of Directory Section, Marketing Department, Hobart gave a talk and conducted a tour for members on the DAS/C system and its facilities in Hobart.

12, 13, 14 OCT.
MR. MIKE COLES from Installation Section, Engineering Department, Hobart introduced the subject of ISD CCR to members in all three locations.

8 DECEMBER.
Hobart members visited the Fisheries Development Authority at Old Wharf and were shown both the operation of the organisation and the refurbished building which they now occupy. This visit was followed by supper and light refreshment, enjoyed by all.

The lecture programme for 1983 is still being developed. Members will be advised of presentations by a personal copy of the notice in addition to the copies displayed at work centres. All members are reminded of the general interest in all lectures and are requested to bring non-members if possible.

Membership needs to be promoted. If you can introduce a new member, from any area, they will certainly get value for their subscription.

The Secretary, MIKE TOPFER, in Network Service Section, 3rd Floor, City Mutual Building, 47 Liverpool Street, Hobart, Telephone (002) 208463 is available to answer any queries and, in particular, to enrol new members.

Annual General Meeting 1983 is planned for March/April and all members will be advised directly on the date.

The Chairman and Committee of Tasmanian Division wish to all members, Australia-wide, a prosperous and happy 1983 and look forward to another interesting year of activities.

Victorian Country Lecture Makes TV News

A lecture by Carl Dillon on the subject of 'outback TV' — one of the Society's country lecture series in Victoria — was featured on the local television news service at Sale.

The other lecture in this country series was presented by John McIntyre, on the subject of 'SULTAN'.

These lectures, each presented in six different country centres, have been very well-received and the assistance and co-operation extended by the District Telecom Managers in the host Districts has contributed to their success.

The metropolitan lecture program for 1982 concluded in October with a well-attended lecture on the Computerised Directory-Assistance System by Alistair Fraser and Charles Dougall.

Victorian membership Drive

As a first step to a membership promotion drive in Victoria, Hugh McCall, who retired recently from Telecom and from Chairmanship of the Society in Victoria, has, with the assistance of Andrew Robertson and Mun Chin, updated the membership and agency records.

From a sample survey of about half of these records he has reported a Telecom membership age profile in Victoria as follows:

Under 25 1.4%	25-29 10.3%	30-34 18.3%
35-39 20.1%	40-44 14.5%	45-49 11.0%
50-54 9.1%	55-60 12%	Over 60 3.2%

The survey did not include retired officers who are still subscribing to the Society and private industry members. Half of our members who are in Telecom Australia are aged under 40.

The profile does show a need to recruit especially in the under-30 age-group because they are the people who will be involved in controlling the technology explosion.

Agents are being asked to publicise the Society to all Telecom staff regardless of their occupation because of the need for all staff to appreciate the approaching era of operations activities in which issues other than technology are assuming greater importance. Many of the articles in T.J.A. are broadly based to cater for a wide spectrum of interest: not only the technically trained.

A 25 Year Connection

An Ericsson type ARF 51 crossbar telephone exchange which was installed in a 'temporary' structure at Templestowe, notched up a quarter century of service last month.

The commissioning of the exchange in 1957 was the start of Ericsson's close association with Australia's national telecommunications network.

The exchange equipment was originally delivered to the P.M.G. Department's workshop in Port Melbourne where it was installed in a transportable steel clad building before being connected into the public network at Templestowe. It remained in operation at this new outer suburb of Melbourne until 1970 when it was replaced by a new Ericsson crossbar system located in a more 'permanent' building.

The old ARF 51 was later moved to Epping in Victoria where it was used until the new exchange was built. Five years afterward, the ARF 51 was again put into service in a new developing area, this time in Mill Park where it was to remain until late last year.

To mark 25 years of Ericsson telecommunications in Australia, several members of the team who played an important role in the original ARF 51 installation visited the Broadmeadows plant of L. M. Ericsson in November. They were greeted by Managing Director, Lars Estberger, who was the engineer assigned from Sweden in 1957 to carry out installation tests and P.M.G. training for the original equipment.

A second ARF 51 type exchange was put into service at Sefton NSW shortly after the Templestowe project.

The ARF 51 system was originally designed for the Irish Post Office which then had a network of British Post Office step by step equipment similar to that used through Australia.

The P.M.G. Department, after completing in-service testing of this equipment and that of several other manufacturers, recommended standardising upon the Ericsson crossbar system for the Australian public network. Government policy required that suppliers have manufacturing facilities in Australia and it was this condition which led to the establishment of production plants at Broadmeadows and Morwell, Victoria.

The photograph shows Len Haig, of Telecom Headquarters, and Bruce Bence, ex-Telecom and CFA, trying their hands at programming a newer generation Ericsson switching system as Lars Estberger (Ericsson Managing Director), Norm Holah (Ericsson Public Exchange Division), Colin Boyce and Jock Mather (Telecom) look on. All were involved in 1957 in placing the first Ericsson crossbar exchange in Australia in service.

Letter to the Editor.

Editor-in-Chief,
Telecommunication Journal
of Australia.

Dear Sir,

I am working at the Research Institute of the Hungarian Post Office, where I am dealing with radio and system technical research on VHF/UHF land-mobile-services, as well as rural systems. I am a regular reader of "The Telecommunication Journal of Australia". In publication Vol. 31, No. 3, 1981 I read your interesting series on "Telecom's Mobile Telephone Service". As in Hungary our efforts are similar, it would be very useful to know in my research work your design principles in greater detail. If possible please send me out of the literature listed on page 177, ref. 5 and ref. 6 written by Sergeant V. et al ... 'System Specifications Design Guide No. 3. Part 1-2.

I hope you can fulfil my request. Waiting to hear from you and thanking you in advance for your kindness.

Yours Faithfully,

Mrs Magda Okros.

Got something to say?

Why not drop a line to:

The Editor in Chief,
Telecommunication Journal of Australia,
P.O. Box 4050
GPO Melbourne,
Vic. 3000.

PIN UP

FORTHCOMING EVENTS

Queensland Lecture Program 1983

FEBRUARY 22 — Tuesday, 12.30 pm. Telecom Theatrette. Annual General Meeting. "OPTICAL FIBRE LAYING AND JOINTING" — J. ALCORN.

MARCH 22 — Tuesday, 12.30 pm. Telecom Theatrette. "AUTOMATIC CALL DISTRIBUTORS" — A LOWEIN & G. CROSS.

APRIL 13 — Wednesday, 6.15 pm. 8th Flr, Railway Centre, 305 Edward St, Brisbane. "CENTRALISED TRAFFIC CONTROL AS APPLIED TO QLD GOVT. RAILWAYS" — D. G. WHISSON & T. J. ELLIS. (Joint meeting with I.E. Aust. & IREE hosted by I. E. Aust.)

MAY 24 — Tuesday, 12.30 pm. Telecom Theatrette. "WHITHER TELECOM" — V. McCAHON.

JUNE 21 — Tuesday, 12.30 pm. Telecom Theatrette. "FORECASTING CUSTOMER DEMAND" — P. FOSTER.

JULY 13 — Wednesday, 6.15 pm. Hawken Auditorium, I. E. Aust. Bldg, 447 Upper Edward St, Brisbane. "MITEC — A PROJECT TO DEVELOP AUSTRALIAN CAPABILITY IN MICROWAVE TECHNIQUES." — DR J. NESS. (Joint meeting with I. E. Aust. and IREE hosted by IREE.)

AUGUST 23 — Tuesday, 12.30 pm. Telecom Theatrette. "TRAILER BRAKING" — R. VIDLER.

OCTOBER 12 — Wednesday, 6.15 pm. Telecom Theatrette. (Light refreshments 5.30 pm). "DIGITAL RADIO CONCENTRATOR SYSTEM" — A. DUNSTAN AND T. THOMPSON. (Joint meeting with IE Aust. and IREE hosted by TSA.)

NOVEMBER 22 — Tuesday, 12.30 p.m. Telecom Theatrette. "SULTAN" — S. RUSSELL.

KEEP UP

WITH THE LATEST

JOIN

THE TELECOMMUNICATION SOCIETY OF AUSTRALIA

ADDRESSES OF STATE SECRETARIES ARE:

The State Secretary, Telecommunication Society of Australia,

Box 6026, G.P.O., Sydney, N.S.W. 2001.
Box 18020.Q, G.P.O., Melbourne, Vic. 3001.
Box 1489, G.P.O., Brisbane, Qld. 4001.
Box 1183, G.P.O., Adelaide, S.A. 5001.
Box T1804, G.P.O., Perth, W.A. 6001.
Box 10,000T, G.P.O., Hobart, Tas., 7001.

Victorian Country Lectures

	DIGITAL RADIO Dr. R. Coutts Research	DIRECTORY ASSISTANCE SERVICES A. Frazer Commercial Services
March 29th	Swan Hill	Ballarat
May 3rd	—	Benalla
May 17th	Horsham	Bendigo
June 21st	Dandenong	—
July 19th	Geelong	Warragul
August 16th	—	Mildura
Sept. 20th	Sale	—
Oct. 18th	Shepparton	Hamilton

Further details of these lectures will be circulated in the local areas.

Melbourne Lectures

February 14th
*TELECOMMUNICATIONS AFTER DAVIDSON
E. R. Banks, Business Development Directorate

April 11th
NETWORK MANAGEMENT
L. Smith, Engineering Dept.

June 20th
THE TELECOM MILLIONS
P. Minihan, Finance & Accounting

August 8th
*AUSSAT
G. Gosewinckel, Aussat Ltd.

October 10th
*PLANNING FOR A DIGITAL TRANSMISSION NETWORK
G.Nowotny, Engineering Dept.

With the exception of the first, all lectures are tentatively booked in the H.C. Sleigh Theatre 1st Floor, Queen and Bourke Streets Melbourne commencing 12.30 p.m. The first lecture is in the AMP Theatrette 535 Bourke Street Melbourne at 12.30 p.m.

*Jointly sponsored by the Institute of Electrical & Electronics Engineers (IEEE).

THE TELECOMMUNICATION JOURNAL OF AUSTRALIA

ISN 0040 2486

Volume 33 No. 1, 1983

Cover:
Guided Missile Frigate HMAS CANBERRA showing communication superstructure.

CONTENTS

- COMMAND-AND-CONTROL COMMUNICATIONS IN THE RAN ... 3
  R. Arundel
- AUSTRALIAN DEFENCE COMMUNICATIONS — A COMPLEX DISCIPLINE ... 8
  H. J. P. Adams
- THE DISCON PROJECT ... 9
  I.H. Maggs
- OPERATIONS AND MAINTENANCE FACILITIES PROVIDED BY AXE ... 19
  R. L. Orton, D. P. Kitchen
- PROBLEMS IN RADIO COMMUNICATIONS — SOLUTIONS AND ADVANCES ... 27
  J. E. Lamprey
- CALL CHARGE RECORDING IN THE PAPUA NEW GUINEA TELECOMMUNICATIONS NETWORK ... 31
  J. P. Steendam
- NETWORK PLANNING FOR THE UPGRADING OF TELECOM'S DIRECTORY ASSISTANCE SERVICE ... 37
  C. J. Dougall
- DAS/C AND NACD PROJECT MANAGEMENT ... 41
  R. Backman, J. A. Fraser
- BEYOND THE BLACK STUMP — SATELLITE COMMUNICATIONS IN OUTBACK AUSTRALIA ... 45
  F. A. Coates
- SPC PABXs — REGULATORY DEVELOPMENTS AND SYSTEM CHARACTERISTICS ... 49
  I. Pasco
- ECONOMIC ANALYSIS — PRINCIPLES & PROBLEMS ... 55
  C. W. A. Jessop, B. M. Yeoh, C. W. Parry
- CURRENT STATUS OF THE ISO/CCITT REFERENCE MODEL OF OPEN SYSTEMS INTERCONNECTION AND ITS ASSOCIATED PROTOCOLS AND SERVICES ... 59
  P. H. Gerrand
- THOUGHTS ON A NEW TELEPHONE NETWORK STRUCTURE FOR AUSTRALIA ... 67
  C. W. A. Jessop, N. W. McLeod
- AUSSAT-SPACE SEGMENT OVERVIEW ... 73

OTHER ITEMS

Editorial ... 2
Book Review — The Analytical Engine ... 26
Update on Papua New Guinea ... 36
Refresher Topics — Optical Communications Pt 1 ... 40
Telecom & OTC To Host CCITT Meetings ... 66
ANZCAN ... 71
Book Review — Telecommunication For Health Care ... 72
Advertising ... 77
New Products ... 78
Abstracts ... 79
Policy ... 80

Editorial

Welcome to World Communications Year (WCY), 1983: Development of Communications Infrastructures.

In proclaiming the Year on 19 November 1981, the United Nations General Assembly designated the International Telecommunication Union (ITU) as lead agency for WCY with responsibility for preparing an international programme of action, mobilising the necessary funds for the Year on the basis of voluntary contributions and for co-ordinating the inter-organisational aspects of the activities of the specialised agencies of the United Nations system.

In adopting the UN General Assembly Resolution, the governments of all member states recognised "the fundamental importance of communication infrastructures as an essential element in the economic and social development of all countries". The UN General Assembly expressed the conviction that WCY would provide the opportunity for all countries to "undertake an in-depth review and analysis of their policies on communications development, and stimulate the accelerated development of communication infrastructures".

Thus, all the UN member states have recognised, that the creation of adequate communication infrastructures, in particular in rural areas, is essential for the establishment of the New International Economic Order and of the New World Information and Communication Order.

In fact, since the marriage of communication and computer technologies in recent years, the tempo of telecommunication technology development has accelerated very considerably and continues to gain momentum. Actual technology is making old policies obsolete and new ones feasible, once probable trends unlikely and surprising ones possible, which obliges us to think about societies and peoples in different ways because it challenges customary definitions and laughs at national boundaries.

More than ever before, every facet of human endeavour depends on the availability and trouble-free working of telecommunication services and facilities, whether we are talking about maritime, aeronautical, space or postal services or health, agriculture, transport, science, education, trade, broadcasting, or whatever we choose to add.

Yet, this telecommunication revolution is taking place when the vast majority of mankind does not have an ordinary telephone or even access to one. On 31 December 1982 there were some 560 million telephones in the world, some 620 million television receivers, 1.4 million telex terminals, thousands of data networks and other special-purpose transmission systems. However, 90% of the installations are confined to some 15% of nations.

But it is unlikely that adequate funding for telecommunications infrastructure development will be obtained until we achieve better comprehension of what we are doing. A major challenge is to increase the awareness of policy makers, economic planners and all providers and users of communication services of the importance of communications in the development process so that all may grasp the value and meaning of the new tools at the disposal of their authorities and communities.

Among a series of decisions in favour of accelerated communication infrastructures development, the Nairobi ITU Plenipotentiary Conference (1982) decided to set up during WCY 83, an "Independent International Commission for World-Wide Telecommunications Development". Whilst other independent commissions were concerned with world economic strategies and with problems of communication software, the Independent International Commission for World-Wide Telecommunications Development will be hardware and telecommunication service oriented. It will be composed of representatives of the highest decision-making authorities of the government and private sector, telecommunication leaders and financiers of industrialised and developing countries and from all regions. They will examine all existing and possible future relationships between countries in the field of telecommunications involving technical co-operation and a transfer of resources in order to identify the most successful methods of such transfer, and recommend a range of methods, both tried and untried, for stimulating telecommunication development in the developing world.

Our efforts must lead to the progressive achievement of self-reliance in the developing world and to contributing towards narrowing the telecommunication gap between the developing and developed countries and finally support the ITU in its efforts to achieve a more balanced expansion of telecommunication networks.

Today I invite readers of the Telecommunication Journal of Australia and all my Australian compatriots to support the world-wide movement for the promotion of the realisation of more rapid communications development through the World Communications Year Secretariat, ITU Headquarters, Geneva, Switzerland, by voluntary contribution in cash, kind and services.

GUEST EDITOR

RICHARD BUTLER

SECRETARY GENERAL
INTERNATIONAL TELECOMMUNICATION UNION

Command-and-control Communications in the RAN

Captain Richard Arundel, RAN

The use of telecommunications for command and control purposes in the Royal Australian Navy, is described.

INTRODUCTION

During the past 50 years, developments in communication technology have led to dramatic changes in the methods, systems and equipment used by the RAN. These changes have taken place across almost the entire radio frequency spectrum — from very low frequency (VLF) to satellite communications in the ultra high frequency (UHF) range. They have been indispensable in assisting the RAN to meet its command-and-control (C^2) support requirements for contemporary naval operations.

The range of activities undertaken by the RAN today — such as major fleet unit operations in the Indian Ocean, transport of high-priority cargo to the Australian contingent in the Sinai, various submarine tasks, participation in large allied exercises, and continuous coastal surveillance — dictates the need for rapid, reliable, flexible and secure communications. Communication networks must serve all the navy's shore establishments, all fleet units, our submarines and our fixed and rotary-wing aircraft — a not insignificant task.

The magnitude of the task is made more complex by the area which these networks are required to cover — from the east coast of Africa to the west coast of the United States and from the north Pacific to the Antarctic.

In brief, C^2 communications for the RAN need to be able to support long-range fleet operations, short-range tactical operations, and coastal operations **(see Fig. 1).**

HISTORY AND DEVELOPMENT

The story of modern RAN communications begins in 1938/39 with the establishment of the first major Australian shore-based radio facilities at HMAS Harman, ACT, and HMAS Coonawarra near Darwin. Initial equipments provided at these two facilities were to support RAN and allied fleet operations in Asian areas and the Pacific.

These two facilities, which are being updated continuously, continue to provide communication services to units at sea. At the same time they are nodal points for fixed networks connecting the two stations with North-West Cape, and the navy's coastal communication stations at Cairns, Brisbane, Sydney, Nowra, Westernport, Melbourne, Hobart, Adelaide and Garden Island in WA. They also interface with army and air force networks through defence fixed network communication links called the DEFCOMMNET.

During World War II, RAN procedures and doctrine closely followed Royal Navy practice. In the late stages of this period, significant integration with USN networks also occurred. Since 1945 the RN communications infrastructure has gradually diminished while at the same time there has been a growth in the USN presence in our region. In support of this increasing USN presence, the Australian government agreed, in 1963, to the establishment of a naval communication station (NAVCOMMSTA) at North-West Cape, W.A. This base has been operated on a joint basis by the USN and RAN since 1974. Its purpose is to provide communications to USN, RAN and allied naval units operating in the Indian/Pacific areas and includes the important VLF broadcast so essential for C^2 of submarine forces. One of the great benefits of North-West Cape to the RAN is the allocation of an independent VLF channel for RAN submarines.

MODERN REQUIREMENTS

The requirements of naval operations today have necessitated enormous improvements in communications for C^2 purposes, both in peace and war. The slow speed morse signals of World War II period have given way to radio automatic teletype (RATT), together with high-speed data exchange links between onboard tactical data systems. Data links between long-range maritime patrol (LRMP) aircraft, fleet units and, in the future, shore HQ, are also necessary for co-ordinated maritime operations. Major reactive communications developments have been in improved HF systems as well as very high frequency (VHF) and ultra high (UHF) tactical line-of-sight (LOS) horizon-to-horizon links.

Recent advances made in satellite communications (SATCOM) have tended to obscure the fact that 'traditional' means of transmitting and receiving messages by HF systems are still of central importance to the RAN's operations. Moreover, HF will remain the primary means of communications for most RAN requirements throughout the 1980s and into the 1990s. The advent of satellite links for long haul and short haul communications, complements rather than replaces, existing HF systems.

In this regard, the cardinal principles of military communications are that these must provide survivability, flexibility, security and national control of the primary system. No naval planner would be so

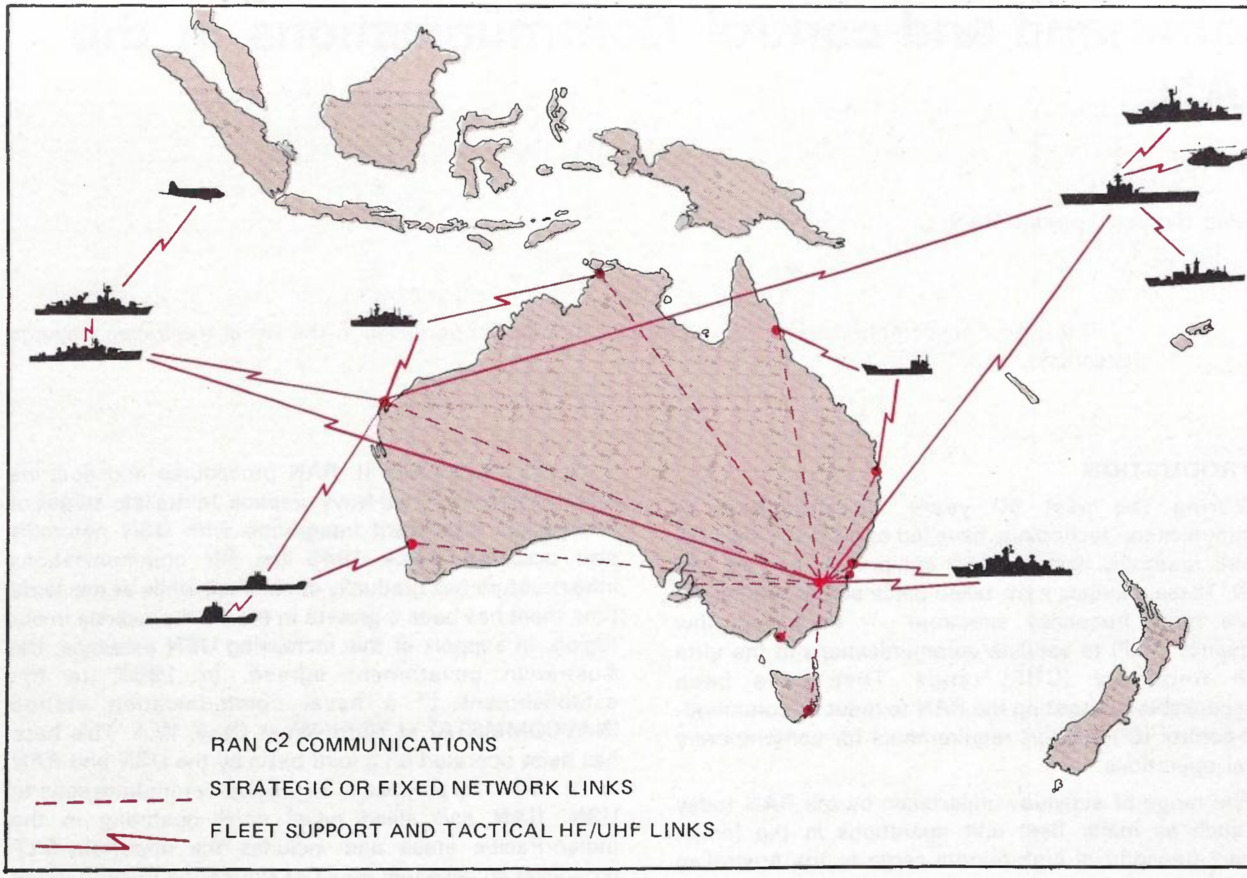


Fig. 1 — RAN Command and Control Communications

unwise as to rely on another country for the primary means of strategic and tactical C² communications, and neither would the need for back-up communications facilities and capabilities, to be available at all times, be overlooked.

These principles are relevant to public discussion that has taken place recently about new replacement UHF radio transceivers — designated AN/WSC-3 (RAN V1) (Fig. 2) — that are being fitted widely in RAN ships and to some shore installations. These radios, like the obsolescent post World War II equipment they are replacing, will operate in that portion of the UHF band that is reserved for military use under International Telecommunications Union agreement.

Australian fleet units deployed in tactical maritime operations use the UHF military band almost exclusively for short-range LOS tactical communications as do all other allied naval forces. Communications using the AN/WSC-3 transceivers are totally under Australian control in this mode. Each major fleet unit has a number of these equipments for multi-role uses, e.g., cryptographically secure voice and teletype communications and tactical data exchange between ships and aircraft.

Limited quantities of the AN/WSC-3 transceivers are intended eventually to be reconfigured with appropriate modules and ancillaries to give the units so fitted the

Captain Richard Arundel joined the RAN in 1947. He has been a specialist communications officer in a number of fleet and shore staff billets in the RAN and RN since qualifying in 1958. He was a member of the interdepartmental working group which reported to government in 1979 on the impact of a national communications satellite. He is presently the Director of Naval Communications in Canberra.

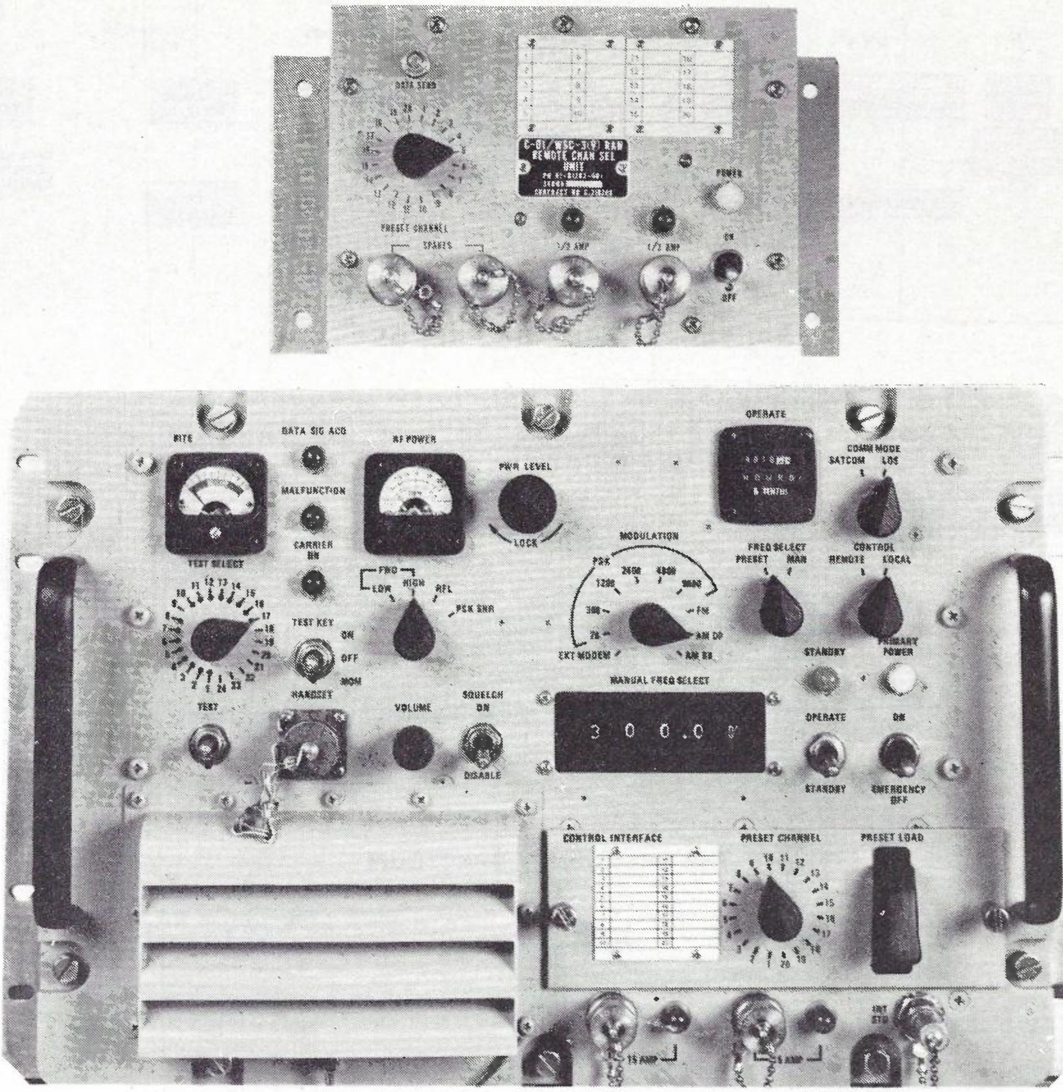


Fig. 2 — UHF Radio Transceiver AN/WSC-3 (Note the top right hand control switch of the main unit for independent horizon to horizon line of sight or SATCOM operation).

capability to communicate via satellite (FLTSATCOM) with other RAN and allied ships similarly fitted. But, even with this enhanced capability, alternative systems — such as HF — will always be retained, since they do not suffer the drawbacks associated with satellite systems. Thus limitations inherent in one radio path may be supplemented as is the case today, by the use of another communications mode or another frequency band. This flexibility is essential in modern warfare to ensure survivable operations for C^2.

However, HF also has some limitations, mainly due to over-crowding in its very limited portion of the frequency spectrum. It is also susceptible to electronic counter measures (ECM) and has a limited capability for error-free operation. On the other hand, UHF and SHF frequencies are capable of being utilized for high-quality data transfer in both LOS or SATCOM modes.

MODERN INSTALLATIONS

Uses made by the RAN of the various segments of the frequency spectrum are shown in **Table 1.** The process of frequency management of very scarce resources requires much skill by users. Given that ECM is a real and fast developing weapon, there is a clear need for a sensible balance between the differing characteristics and capabilities throughout the communications spectrum to sustain adequate and continuous communication paths.

C^2 between deployed units and maritime aircraft is ensured using tactical communication networks. The allied UHF military band (225-400mHz) is used almost exclusively. A typical ship installation is illustrated in the Guided Missile Frigate (FFG) schematic diagram **Fig 3**. This indicates that all major fleet units are provided with a highly capable and flexible range of communication options and this is enhanced, inter alia, by the inclusion of send/receive satellite communications. It is a formidable engineering feat which provides the user with so much capacity crammed into a small sea vehicle and which is juggled not to interfere with fighting and steaming systems and their external antennae. This can be seen in the cover photograph which gives an external glimpse of today's efficient communications systems in warships.

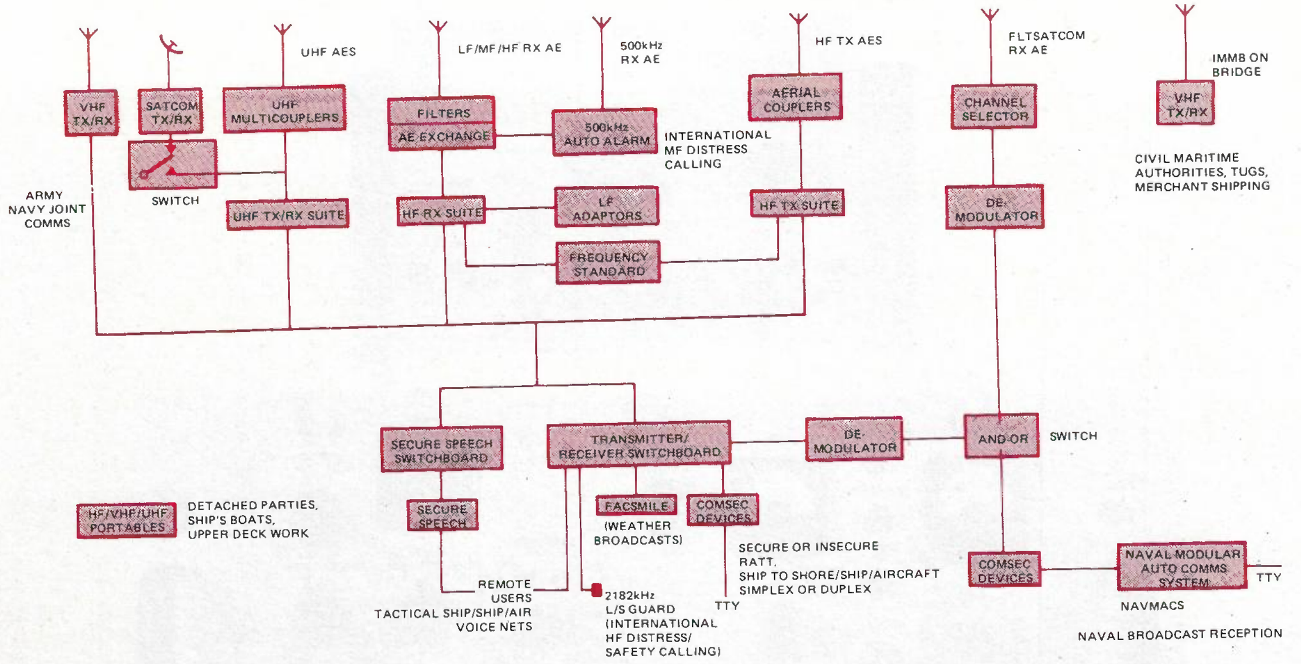


Fig. 3 — Guided Missile Frigate (FFG) Communication Systems

THE FREQUENCY SPECTRUM

Name	Frequency	Illustrative RAN communications uses
Extra low frequency (ELF)	0.3-3kHz	Nil
Very low frequency (VLF)	3-30kHz	Shore to submarines
Low frequency (LF)	30-300kHz	Shore to ships/submarines
Medium frequency (MF)	300kHz-3mHz	Safety and SAR circuits
High frequency (HF)	3-30mHz	Shore to all units. All units to store. Tactical use all units.
Very high frequency (VHF)	30-300mHz	Tactical use all units LOS. Tactical use SATCOM all major units.
Ultra high frequency (UHF)	300mHz-3gHz	FLTSATCOM to major units.
Super high frequency (SHF)	3-30gHz	Aircraft carrier?
Extra high frequency (EHF)	30-300gHz	Nil

Table 1 — Frequency Spectrum Usage by RAN.

THE USE OF SATELLITES

There are no current RAN plans to develop an SHF SATCOM capability although this is used by the RN and, increasingly, by the USN. The only military SHF ground station in Australia used for naval communications is at North West Cape.

This is the obsolescent AN/TSC-54 analogue defence satellite communication system (DSCS) terminal, which is now planned to be replaced at some time in 1983 by a DSCS dedicated AN/GSC-39V(1) digital terminal.

It might be noted that the AN/GSC39V(1) operates with an antenna beam width of 0.2^0. Since the FLTSATCOM satellites are separated by 3^0 and 97^0 of arc from the antenna's normal orientation, this terminal will not be able to access DSCS and FLTSATCOM satellites simultaneously. Thus, if it were to be 'patched' to the FLTSATCOM, which would be a complicated technical process at best, the North-West Cape station would have, no longer, the ability to receive important messages via DSCS for retransmission on VLF. Such a loss of capability would be operationally unacceptable because the station's prime communications mission could not be satisfactorily achieved.

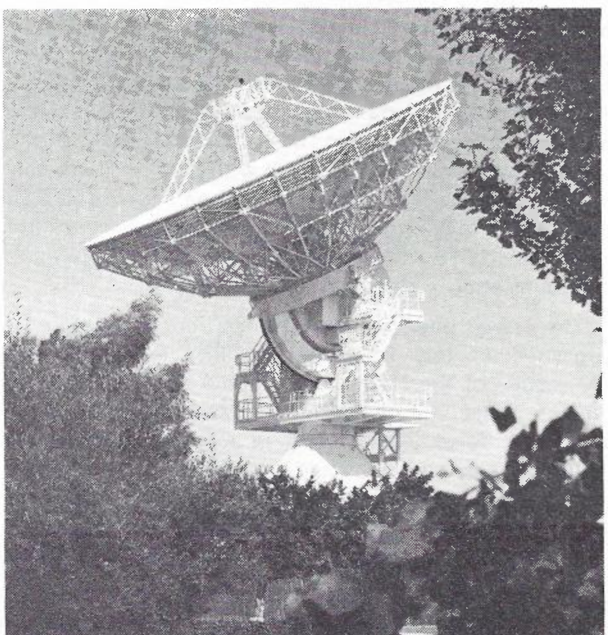


Fig. 4 — AN/FSC-79 Series DSCS SHF SATCOM Transmitter Terminal.

FLTSATCOM broadcasts naval messages on UHF. It receives its traffic on SHF uplinks from an AN/FSC-79 SHF transmitter terminal **(Fig. 4)** backed up by UHF uplinks from an AN/WSC-5(V) UHF terminal. Neither is fitted at North-West Cape, but at the various FLTSATCOM control stations. For the Indian Ocean and Western Pacific satellites this is effected from Naples and Guam NAVCOMMSTAs respectively. A UHF AN/SSR-1 receive-only equipment is fitted at North-West Cape to monitor the quality of FLTSATCOM fleet broadcast channels and to relay these from the station, via HF rebroadcast, to fleet units if required. This is a normal communications configuration in major USN HF-equipped NAVCOMMSTAs. The RAN is not normally involved with either of these satellite facilities at North-West Cape, since RAN ships do not operate on USN national channels. However, some RAN ships are fitted with the AN/SSR-1 receiver which enables them to read both allied and Australian national broadcast channels transmitted on FLTSATCOM or GAPFILLER satellites. This facility enhances long-range communications support to the fleet and improves inter-operability.

Ultimately, it would seem, given the pace of advance of modern communications, that an Australian defence force (ADF) SATCOM capability must be realised. These requirements in relation to the national communications satellite system (AUSSAT) were mentioned in both the task force and working group reports to government of July, 1978 and August, 1979, respectively. In particular, the latter underlined the need for decisions concerning ADF SATCOM development in the national communications infrastructure.

CONCLUSION

In summary, the RAN relies for primary C^2 support to all fleet units on its long established and continuously operating national HF military systems linked with allied networks worldwide. There is much work to be done to update and improve these national facilities for dynamic and reactive command needs. In terms of capability they are as flexible and effective as the best of any modern navy. Tactical fleet communications will utilise vastly improved and overdue UHF, LOS and HF replacement equipments. As planning proceeds some major 'blue water' units will have an additional UHF FLTSATCOM send/receiver facility for improved capability and added inter-operability.

The process of communications planning to enhance the command-and-control capacity of the RAN is an evolutionary process and, as this article explains, is conditioned by the need to increase our capability, ensure survivability and promote inter-operability with the Army, the RAAF and our allies.

Australian Defence Communications — A Complex Discipline

Australian defence communications comprise a wide range of activities in the communications-electronics field, while at the same time involving many agencies within the Navy, Army, Air Force and within the Department of Defence itself. This is to be expected when one considers the wide range of operations and activities undertaken by the Australian Defence Force and the Department. Furthermore, the communication capabilities developed to support these activities are unique to the defence community, with emphasis being placed, understandably, on special needs such as security, reliability, survivability, maintainability and interoperability. Defence communications must also be flexible and capable of rapid expansion and have the capacity to survive in a hostile electronic environment. At the same time, there are limited resources which can be made available to develop and maintain defence communication systems. In planning future systems one has always to be mindful of the defence force structure as a whole as well as strategic perceptions as they relate to our national defence interests.

For convenience, defence communications can be divided into two categories — the ***tactical*** links which are those required in the field for the tactical control of ships, aircraft and ground forces extending up from individual units, through formations to major headquarters — and the ***strategic*** services providing long haul links between major headquarters both within Australia and overseas. However, the advent of the microprocessor, and the minimisation of manual systems has tended to blur these categories and indivisibility between the fixed strategic and the tactical arena is becoming more and more evident as new systems are introduced.

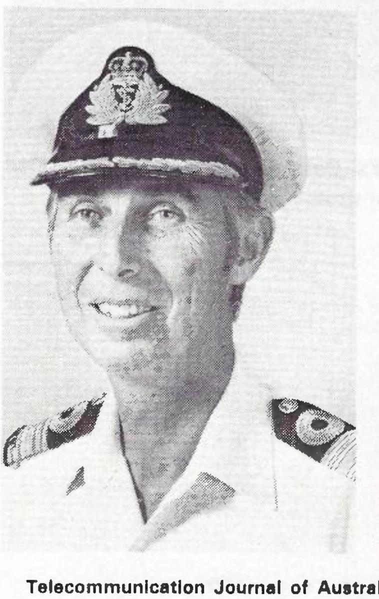
In broad terms, it is the responsibility of each of the single Services to plan and develop their own tactical systems. In their planning they must take account of strategic guidance, interoperability requirements between the Australian Services and with our more important Allies, as well as their own force structure. The Services also become involved in plans for strategic links since all the major defence communication nodes are Service manned and operated. Plans for new strategic fixed services are, however, a Defence Department, central staff responsibility with the Defence Communications System Division having responsibility for the operation and management of the fixed telegraph network and the planning and management of the replacement system — DISCON. The Computing Services Division has unique responsibilities for communications support services for defence computing systems while the Industrial Division has responsibility for the progressive development of the Defence National Automatic Telephone System, now serving most of Eastern Australia. Other agencies are involved with communications security, while research and development into communication-electronics systems are conducted at the Defence Research Centre Salisbury, now operated by the Department of Defence Support.

In terms of technology, defence communications embrace a wide range of techniques such as satellite communication systems, in which all three Services are now involved, fibre optics, radio services from LF through to SHF, high speed and medium speed data as well as flashing light and flags, still indispensable in certain tactical situations.

In terms of people there is a great depth of communication-electronics skill available within the Defence community, with almost all the specialist and technical training being conducted by the Services in their own specialist schools or in the various tertiary institutions in Australia. In the provision of any communication service, the importance of people has never been greater than it is today, and while there may be shortages in the highly skilled technical and graduate levels, Servicemen and women involved today in Defence Force communications are well trained, well motivated, and a credit to the nation. In all some 4,500 serve their country as operators or technicians in the field of military/defence communications.

In the future, one can expect a quantum jump in terms of capacity and capability in the new systems planned for introduction in the next decade. In the next 5 years alone it is planned to spend in excess of $500 M. on defence command, control and communications systems, with major upgrades planned for the fixed strategic system — Project DISCON being budgeted at $185m. — and the Services' tactical systems. These new projects, with the new technology which will come with them, will not only provide enhanced communications for effective command and control and for efficient management, but will provide a challenge to all in the defence communication - electronics community.

The two papers on defence communications, published in this issue of the TJA are only brief summaries of the Navy requirements and the DISCON Project. These will be followed by papers on the Army and the Airforce requirements in subsequent issues. In reading these papers would you keep in mind three things. Firstly, that the papers are only representative of the wide scope of our activities; secondly that the overall coverage of the papers is for a co-ordinated and integrated system; and, thirdly that the total system is uniquely Australian.



COMMODORE H. J. P. ADAMS, RAN
Director General Joint Communications-Electronics

The "DISCON" Project

I. H. MAGGS, B.E., F.I.E.(Aust), M.I.E.E.

Defence fixed or strategic communications are described from a background of requirements leading to an outline of the new concept of a digital network which has been approved by the Australian Government. The project to introduce this network has been titled DISCON and the paper concludes with an indication of the present status of that project.

BACKGROUND

The Australian Government in 1977 announced that it had approved in principle a new multi-purpose defence strategic communications network. This new network, DISCON, which means the Defence Integrated Secure Communications Network, is to be an all digital system and is to gradually replace the existing defence strategic communications network. The current objective is to implement DISCON nation-wide during the 1980's.

DISCON, in common with other military networks, and in conjunction with the three Services' tactical networks, is required to provide, as its first priority, secure, reliable, and survivable communications essential for rapid and effective command and control of the Australian Defence Force.

The network is designed to cater for the flow of commands or other classified information, either by telephone, message, facsimile or data, from the higher defence authorities down through the Services' command structure, and also for the return flow of key information which will facilitate the decision and command making process at senior military operational and defence management levels.

INTRODUCTION

The principal functions of defence fixed or strategic communications are to provide secure, reliable and survivable communications that link major defence bases and inter-connect the senior military commanders of the defence force. Security, in this context, is provided by the use of cryptographic techniques and by operation of the system within guarded perimeters. Modern electronic, duplicated and redundant systems and sub-systems, including the computer in various forms with various functions, provide higher equipment reliability and thus allow high overall system availability to be achieved. Network survivability is a more difficult problem. However, efforts to plan and provide for hardened and protected military sites, diversity of transmission media, utilisation of different trunking routes, dispersion of facilities and complex signalling interconnection arrangements are continuing at all levels. These key factors, when combined, contribute to as high a degree of overall network survivability as is considered to be reasonably, economically and technically feasible.

It is of interest to Australia to observe that the US Department of Defence is also concerned with new secure communications and is proceeding towards the development of new defence communications programmes during the 1980's. The following statement, which could also apply to Australia was made at a seminar reviewing trends in US DOD military communications by Mr George L. Salton who is Director, Communications Systems, Office of the Assistant Secretary of Defence for Command, Control, Communications and Intelligence. (Salton, 1979).

> 'Strategic and tactical communication satellite systems, digital communications networks, automatic message exchanges, new and efficient modulation and the use of much higher frequencies combined with many improvements and innovations to give us greater, faster and better communications capability. At the same time, automation of command and control, the need for rapid reaction in the face of faster and more powerful weapons, consolidation and automation of logistic and personnel systems, the availability of and demand for additional intelligence data plus many other demands are quickly consuming the additional communications capacity and making the (defence) communications systems much more crucial for effective defence and military operations'.

The new DISCON concept needs to provide those special features and facilities required to support the efficient and effective command and control of the defence force. Provision is to be made for new secure voice, facsimile and data communication services, as well as for further automation of the existing secure message telegraph system. Recent user surveys of defence communication requirements for a modern defence force have confirmed the user requirements for the new types of communication services. In particular, there is a strong trend for "user-oriented" communication services for handling classified traffic. For example, the extension of secure (cryptographically protected) facsimile and telegraph facilities closer to the user's actual location, rather than placing reliance on specially trained operators at central locations, is a constant and firm user requirement of the 1980s and the 1990s. Therefore, more extensive use is planned for simplified message formats and automatic computer controlled assistance for the operators as well as for the local storage of message information in DISCON user terminal systems.

Throughout the world there are many Departments of Defence programmes which are aimed at providing new or updated secure defence communications networks to match the continuously changing and growing threats.

Defence departments are seeing the need to do more work in this area in the future, than has been done in the past, to protect and secure both tactical and strategic communications from outside exploitation and interference.

DISCON is Australia's answer to the growing threat of interception of classified information and is being developed in much the same timescale as other allied military secure networks. Furthermore, it is quite significant to the DISCON project that the new military networks of the 1980s will be all digital to provide effective encryption. They will also be exploiting microelectronics, micro-processors, and stored programme control (SPC) switching systems inter-connected by a mix of space and terrestrial digital transmission systems. In addition, all the terminal devices which interface the user, including the telephone, facsimile, data and message preparation systems will utilise the latest digital micro-circuit technology.

DEFENCE STRATEGIC COMMUNICATIONS

Overall military communications can be seen to exist in perhaps three distinct areas. Firstly, there are the forward or tactical communication systems which consist of extremely mobile and flexible communications at all field (land, sea and air) operational levels. Tactical equipment is designed to specialised military specifications. In particular, the equipment has a requirement to continue to operate in very special and often adverse environments.

The second area of defence communications is the trunk system which provides for communications behind the combat zone and through the communications zone. It provides the link between the forward tactical communications back to the individual or joint force commanders at their headquarters and the rear link back to the Australian support areas. This system, in effect provides the bridge between the forward tactical communications and the strategic or fixed defence communications.

The third area of defence communications is the defence fixed or strategic communications which interconnect fixed military bases, support locations and defence HQ throughout Australia. These fixed Defence locations include command headquarters, logistic depots, repair centres, dockyards, air fields, army barracks, etc.

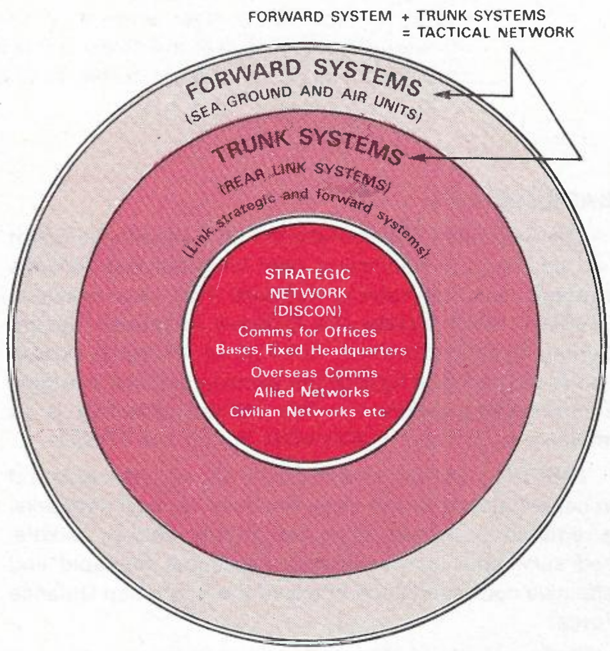


Fig. 1 — Defence Communications — Overall Concept

Fig. 1 — Defence Communications — Overall Concept, shows the interaction and arrangement for

Mr I. H. Maggs graduated from the University of New South Wales in 1957 with an Honours Degree in Electrical Engineering (Communications).

In 1958 he joined the APO as an Engineer. From 1958 to 1965, he was the project manager responsible for installation of automatic telephone switching, broadband radio and coaxial cable transmission systems.

From 1965 to 1975, Mr Maggs was with the APO HQ staff in Melbourne, as a network and switching system planning engineer. He contributed to the forward plans for the development of metropolitan and country telecommunications networks and planning for the national STD system and for the introduction of International Subscriber Dialling (ISD) into Australia. He was also associated with the introduction of computer controlled switching systems into the local and trunk telephone networks throughout Australia.

At the request of the Chinese Government, Mr Maggs presented a communications seminar in Pekin in late 1974 on national telephone network planning and systems planning.

His final position with the APO HQ in 1975 was an Assistant Director General in charge of the Telephone Switching and Facilities Planning Branch.

Mr Maggs was appointed General Manager, Defence Communications System (DCS) Division in the Department of Defence in mid 1974. Since then, he has been associated with the network and system planning and technical specification of the new Defence Integrated Secure Communications Network (DISCON).

In 1978 Mr Maggs was nominated as a member of the Commonwealth Government Task Force on the National Communications Satellite System.

these three key areas of defence communications activities.

The interconnection concept between strategic communications and the army rear link or field trunk system and their tactical or field communications is presented in **Fig. 2.** In Fig. 2 it is clearly shown how the strategic network, either the communication system of today or the DISCON of tomorrow, is required to operate throughout Australia at fixed locations and be capable of providing ready interconnection with the Services' tactical systems.

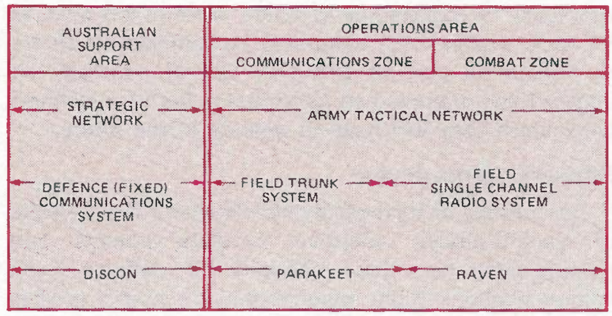


Fig. 3 — Deployment Concept

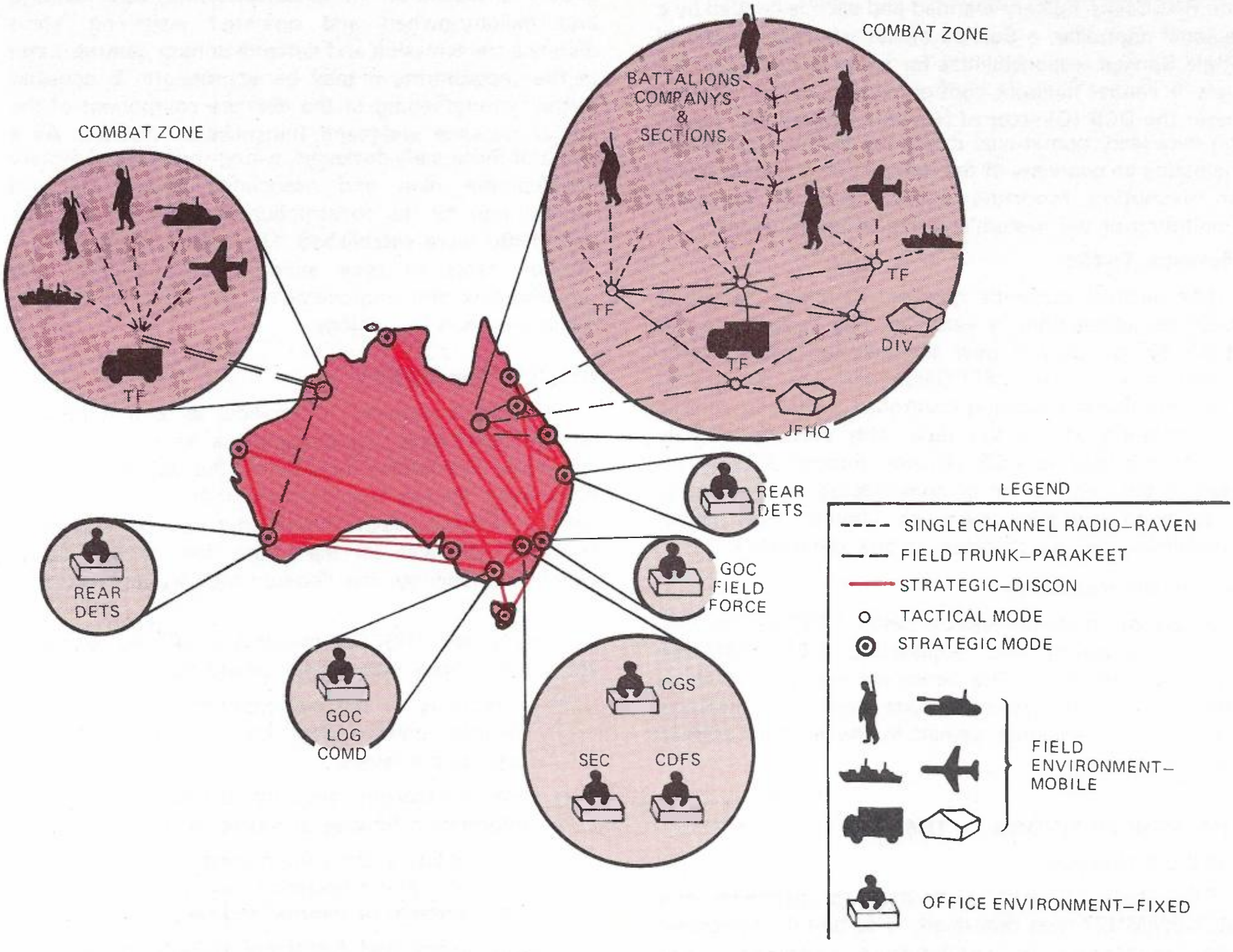


Fig. 2 — Interconnection Concept, Strategic Communications/Army Tactical Communications

In **Fig. 3**, projects relating to the three areas of defence communications have been given particular code names. The army Raven Project concerns itself with mobile tactical radio communications; the army Parakeet System has the objective of providing a field trunk system and a rear link communications capability. DISCON is shown as providing the defence fixed communications network throughout the Australian support area.

THE EXISTING NETWORK — DEFCOMMNET

The present Defence Communications Network (DEFCOMMNET) was developed from the integration of the fixed network elements of the three Services in the mid 1970's.

Network Capabilities

DEFCOMMNET is primarily a low speed telegraph network, using leased Telecom bearers and military owned and operated HF and microwave radio systems. Message switching is provided by a mix of computer controlled store-and-forward switches, including two UNIVAC 418-III systems, a CDC 1700 message switch, a STRAD hard wired logic system and a number of manual torn-tape relays. Additionally, significant use of secure telex, with cryptographic protection, enhances the overall capability of the network. A small facsimile capability is provided, but this is low speed and without cryptographic protection. No common user voice capability is available within the existing network.

Some of the present DEFCOMMNET facilities will eventually be replaced by DISCON, while others such as HF radio systems and teleprinter equipments which are to remain as part of DISCON, will of necessity be updated and improved so as to match the new facilities with which they will have to operate in the future.

Network Management

For reasons of survivability and flexibility, the principle of decentralised, adaptive network control and management has been adopted for defence fixed communications. Eight regional network control centres (RNCCs) throughout Australia exercise real-time operational control of the network within their regions. The RNCCs are military-manned and each is headed by a regional controller, a Service officer who has additional single Service responsibilities for communications in his area. A central network control centre (CNCC), working under the DCS (Director of Network Operations), issues the necessary operational directions to the regions ano maintains an overview of the network on a system basis. An exception reporting system permits real-time monitoring of the system's technical performance.

Message Traffic

The network currently handles 30 million telegraph message transactions a year and has been averaging about 8% pa growth over the last ten years. Traffic statistics for the DEFCOMMNET are generated automatically at computer controlled switching centres and manually at the torn-tape relay stations. Weekly returns provided to DCS Division through RNCCs are used in the compilation of consolidated traffic reports. Engineering statistics such as channel and circuit availability, are also reported on the same basis.

Manpower Resources

At present there are approximately 1200 Service personnel operating and supporting DEFCOMMNET throughout Australia. The personnel are from all three Services and include operations staff and technical maintenance personnel trained in the existing military training schools.

THE NEW NETWORK — DISCON

DISCON Concept

The new digital network to replace the DEFCOMMNET, just described; is to be fully integrated and developed in accordance with the user recommendations arising from previous defence studies. It will be integrated in that it will provide both the communication needs of all three Services, (all types of communications) and communication security (COMSEC) for the information transmitted through the network; hence the name, "Defence Integrated Secure COmmunications Network", or its short title, "DISCON".

DISCON will ultimately provide defence users with secure communications in the voice, telegraph, facsimile and data modes. DISCON is planned as a single, fully digital, integrated network concept which will gradually replace the single Service networks that were established during the 1960s and 1970s. New technology to be introduced includes medium and high speed digital radio and landline channels, digital electronic computer switching systems under stored programme control (SPC) and a range of digital terminal instruments.

Some early key decisions were taken concerning the essential need for a long term plan for DISCON up to the year 2000. It was recognised that an approach which involved a steady and properly planned build-up of DISCON facilities in the early to late 1980s would be financially and technically appropriate. Such a long term plan would also maximise the use of available manpower and financial resources and enable Australian industry to progressively develop its capability to both meet and support the DISCON digital communication equipment requirements.

It was also decided in the initial concept that emphasis should be placed on the establishment of user facilities and military-owned and operated switching, short distance transmission and network control centres. Later in the programme, it may be appropriate to consider further strengthening of the defence component of the longer distance wideband transmission systems. As a result of these early decisions, a long-term overall system development plan and associated annual financial programmes for the construction of DISCON up to the year 1990 were established. This plan is updated on a regular basis to take account of changing user requirements and improvements and advancements in communication technology.

DISCON Capabilities

DISCON is required to provide, as a first priority, reliable and rapid communications essential for the command and control function of the defence force. It must cater for the flow of commands from the higher defence authority down through the services' command structure, and also for the return flow of information which will facilitate the decision-making process at all levels.

In summary, DISCON should provide the following important military operational capabilities:

- responsive to the communication needs of the defence commanders and authorities at the appropriate levels;
- communication security (COMSEC) for the information flowing or stored in the system;
- survivability under certain conditions of electronic warfare, natural disasters, and physical damage from external or internal threats;
- economical and functional viability in the early 1980s and through to the year 2000 and beyond;
- interoperability now and in the future with the individual Service tactical and allied military strategic networks.

In parallel with the development of the DISCON programme, planning within defence has commenced for the provision of new and enhanced tactical communications capability for the defence force. It is proposed that, during the 1980s and 1990s, significant new tactical communication systems such as RAVEN and PARAKEET for the army, will be introduced to meet the Services, future field or mobile requirements. Australia will then have complementing strategic and tactical communication capabilities, enabling rapid and reliable real-time secure voice and data communications between the strategically located defence organisations and the senior operational commanders.

DISCON Configuration

Major concentrations of military bases and establishments occur in the east and south-eastern parts of Australia with important, but a lesser number of, military bases in the west, northwest and the north. This tends to imply the development of a partly meshed, hierarchical network with its centre in the south-eastern area; the west, north, north-east and north-west of the continent would be connected to this central area by the use of a variety of dual and alternate transmission links. **Fig. 4** illustrates this DISCON network structure and the "backbone" or main interconnection links planned for the new national network.

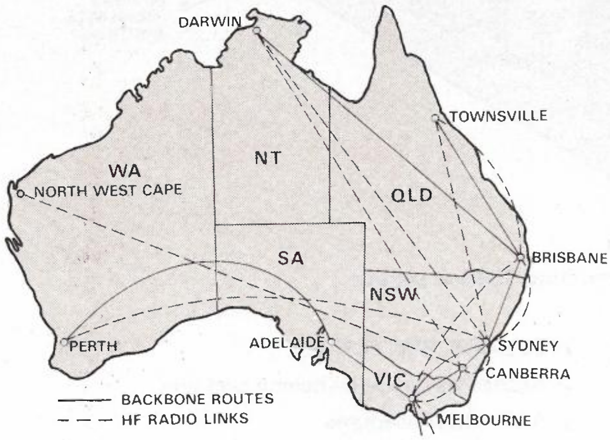


Fig. 4 — DISCON Network Structure

The continued emphasis in DISCON configuration planning is on the need for interlinking of Command, Control and Communications ("C³"). Also, in addition to providing a real-time, secure, digital switched network for voice, DISCON will be designed to offer secure data communications services to users as a common carrier. Data communications, bulk or interactive, are expected to represent up to 5% to 10% of total network digital traffic at about 1990. However, external electronic data processing (EDP) services or devices will not be included as part of the DISCON network configuration. This group of users will provide their own terminal/computer information systems, either centralised, dispersed, or both. The aim will be for the DISCON configuration to allow ready, reliable and rapid interconnection of the input/output devices to the central or dispersed host computer centres.

It is planned to achieve a high degree of operational management autonomy for defence strategic communications within major regions of Australia. These regions will approximately correspond with Australian State boundaries. Operation of the DISCON network will be similar to DEFCOMMNET and will be controlled by military regional controllers located at the regional centres. An automated network performance monitoring system will be configured to provide these regional controllers with the necessary network supervision control and management facilities.

Finally, network vulnerability and survivability studies are seen as continuing the vital network configuration planning activities. As the DISCON configuration changes and expands over the period up to year 2000, critical network elements such as key switching nodes and/or transmission links will be identified and the necessary steps will be taken to ensure that these elements remain intact in the face of a variety of threats. Also, as the number of modes and links increase, it becomes more difficult to evaluate network vulnerability but it usually also means an increase in overall network survivability, given appropriate routing patterns and network connectivity. (Frank, 1974).

SWITCHING AND SIGNALLING

Switching Hierarchy

Each DISCON region will have at least one trunk area or local switching centre. The network structure or switching hierarchy for DISCON, showing the interconnection of trunk, area and local level switches is illustrated in **Fig. 5**. The trunk switching centre will provide for storing telegraph message traffic and subsequent forwarding to addressees. The diagrammatic internal layout of a typical DISCON trunk switching centre is shown in **Fig. 6**.

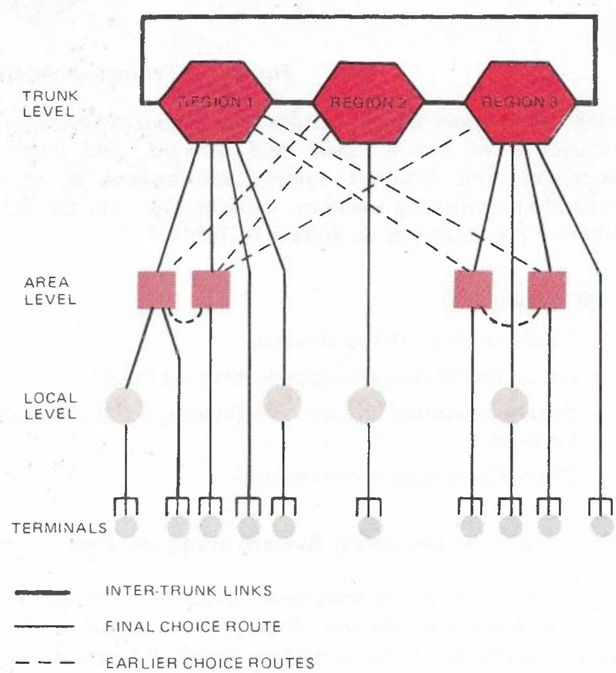


Fig. 5 — DISCON Switching Hierarchy

Digital Switching

DISCON will be planned to switch digital voice, data, facsimile and telegraph communications at 0.3, 0.6, 2.4, 9.6, 16 and 32 kbps. Some of the telegraph communications will require store and forward as well as circuit switch capability.

Switching technology has now evolved from the analogue, space division, large central computer, stored programme controlled (SPC), systems of the 1960s and early 1970s to the modern smaller, time division, distributed, digital, modular, microprocessor controlled systems. These new systems, based on distributed microprocessor functional control architectures, offer distinct advantages in cost, size, power, flexibility, modularity and ease of installation and maintenance. With this latest technology, a redundant system capability with a capacity for straight-forward modular expansion and modification is readily achieveable. These

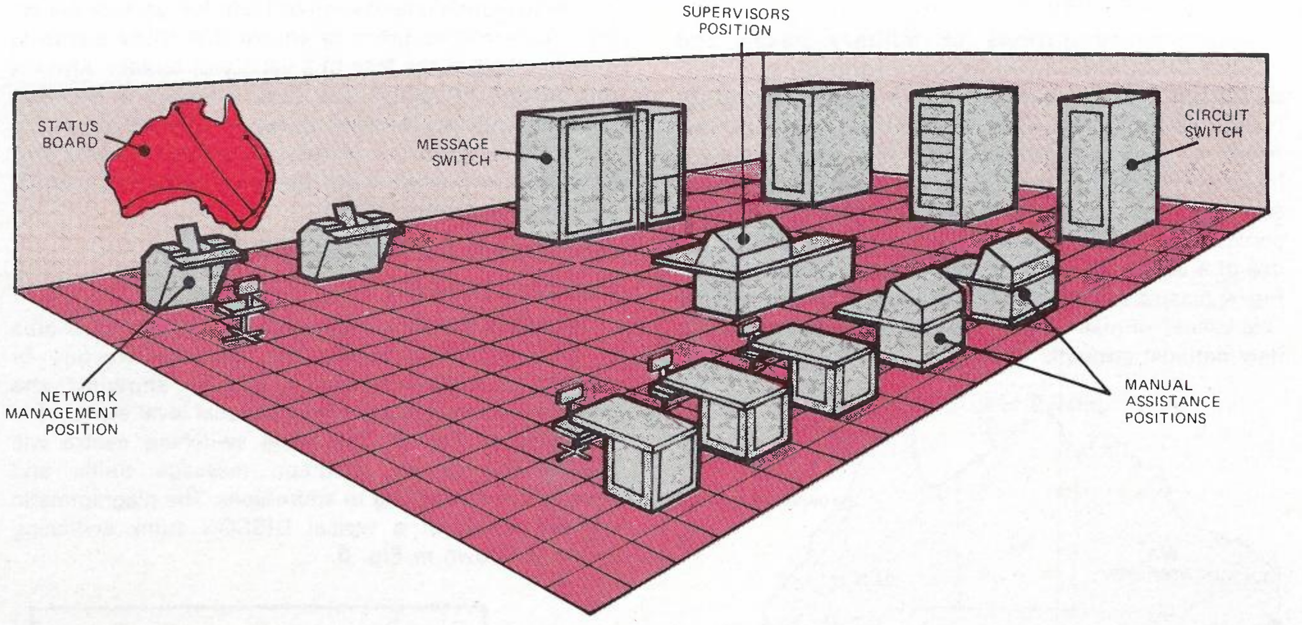


Fig. 6 — Typical DISCON Switching Centre Layout

advantages apply equally across the various switching techniques of circuit, store and forward, and data switching. The DISCON system will consist of an integrated switching system catering for all these different requirements as shown in **Table 1.**

INTEGRATED

- Single network serves all users
- Circuit and Message switching systems linked
- Single integrated system OR integration of discrete systems
- Single Comsec control interface.

Table 1 — Switching System Requirements

Circuit switching matrices have developed from space division electro-mechanical analogue to digital time division multiplex (TDM), providing large solid state non-blocking matrices. Such microprocessor-based digital circuit switches are both being installed and are planned in civilian and military telephone and data switched networks around the world. The main parameters of the proposed DISCON circuit switch and message switch are detailed in **Table 2 and 3** respectively.

CIRCUIT SWITCHING

- Voice and facsimile at 32 kpbs
- Telegraph and data up to 9.6 kbps
- Access to Message switching system
- Pre-emption
- Alternate routing
- Operator assistance
- Voice conference
- Other PABX facilities
- Interfaces

Table 2 — Parameters of Circuit Switch.

MESSAGE SWITCHING

- Access via circuit switching system
- ACP 128 procedures
- DSMF
- AS 1776
- Service assistance
- DEFCOMMNET interface
- Other interfaces

Table 3 — Parameters of Message Switch.

Digital Signalling

To meet the requirements for the digital signalling of DISCON, to operate in a noisy environment, which might result in a bit error rate of 10^{-3}, microprocessors will be used to implement sophisticated algorithms to detect and correct errors. In the DISCON, redundant cyclically permutable digital code words will be used for loop signalling. Trunk signalling will use modern link control procedures and error check systems on the common channel signalling systems planned to be employed. A summary of DISCON signalling requirements is presented in **Table 4.**

TRANSMISSION

System Capability

The transmission system capabilities for DISCON are to be chosen to provide as wide a range of diversity as possible and to take into account the effects of various types and levels of threats. From the outset, a combination of military owned and operated radio links and leased channels provided by Telecom Australia will be used. The diversity of the DISCON trunk network is shown in Fig. 4. Military owned HF trunk radio systems and microwave radio systems linking key defence locations at the local level are already used in the existing defence secure telegraph communications network,

SIGNALLING

- Digital
- Loop
  - — in band
  - — X20/21
  - — Tritac
  - — Eurocom
- Trunk
  - — Common channel
  - — CCITT No. 7
  - — Tritac
- Security
- Error Environment

Table 4 — Summary of Signalling Requirements

DEFCOMMNET. The provision of DISCON transmission facilities will enhance and expand these capabilities. As the project proceeds, benefit is seen in the possible introduction of digital tropospheric scatter radio systems, and leased or owned satellite systems when available, to provide increased defence trunk capacity up to 2048 kbps, and to bridge gaps which cannot be successfully covered by HF radio links.

Baseband Signal Processing

One of the more important parameters which has guided the development of the DISCON transmission standards is the standardisation of the 32 kbps rate for the basic voice signals.

Continuously variable slope delta (CVSD) modulation is to be used because an adequate level of performance and clarity can be achieved, it is compatible with international standards for military systems, and is extremely robust in a noisy environment. Cost forecasts for CVSD modulation chips integrated into an LSI package and which contain other control and terminal functions are in the order of $100 in the 1980s. However, telephones required to operate in a secure environment and carrying classified traffic would cost considerably more. A 16/32 kbps standard has been adopted for the design of future tactical systems and DISCON will therefore be able to interoperate directly with such systems. Within the generally noisier tactical environment, 16 kbps is the most appropriate choice which allows for use of about one bit per Hertz signalling rate in the 25 kHz channel spacings used for tactical radio systems. The 32 kbps rate is likely to find favour in tactical and strategic applications with the availability of SHF satellite links. Also, there will be many instances where tactical communications are limited to 2.4 kbps and when interfacing or transiting through DISCON the 32 kbps sampling rate should not further degrade the information content.

A further key factor in the choice of 32 kbps as the basic subscriber loop transmission rate was to allow for the high speed transmission of an A4 sized black and white page of text by digital facsimile in about 10 to 15 seconds. The 32 kbps rate will also satisfactorily cater for high speed data circuits required between any users connected to the integrated switched network.

Recent applications of microprocessor techniques to voice signal processing have led to the development of operational linear predictive coding (LPC) units. Although expensive, it is possible to use these devices for voice signal transmission at 2.4 kbps over military narrowband HF trunk radio networks. The LPC device scores well in diagnostic rhyme tests for intelligibility, but speaker recognition is low and the voice quality is not considered satisfactory for long term applications.

Work on the application of the LPC technique has now been going on for some ten years and appears to have reached a plateau, with little further dramatic improvement expected in the near future. The cost of the LPC units is some ten times higher than the cost of the CVSD based telephone and may not change significantly in the near future. Therefore LPC units will continue to find application in the narrowband HF situation. On the other hand, advances are still being made in the application of new digital technologies to cable, radio and satellite transmission systems, resulting in considerable improvements in capabilities with little increase in costs. Hence, in the long term, the choice of 32 kbps channels for basic DISCON subscriber voice services will be a most satisfactory balance between total cost (capital and leasing charges) and overall operational capability and quality, while only requiring half a standard (64 kbps) Telecom digital telephone loop circuit.

Transmission Rates

DISCON is required to cater for the transmission of low speed telegraph signals in the range from 0.3 to 2.4 kbps and, during the DEFCOMMNET/DISCON transition phase, telegraph signals at rates below 100 bps. To provide for transmission of voice and facsimile signals above this rate is becoming the standard for military applications of HF radio systems worldwide, and a number of modulation and jamming resistent schemes have been developed to protect such channels.

To provide satisfactory performance and quality for voice services provided over broadband channels under normal circumstances, a 32 kbps transmission rate has been chosen. This rate is half the international civilian standard of 64 kbps. However, DISCON will use a delta modulation system rather than a PCM system to improve its tolerance to higher noise environments.

In summary, the prime digital transmission rates currently planned for DISCON are 2.4, 32, 72, and 512 kbps, although other rates will also be included in the total DISCON system.

Trunk Links

Long distance trunk links will be provided in the main by upgrading existing DEFCOMMNET HF radio systems where required for narrowband traffic to operate at 2.4 kbps and by the use of cable and radio broadband channels leased from Telecom Australia. Initially, in the absence of a national digital data network, leased datel circuits will provide 32 and 72 kbps channels using a single FDM Group, which is a recognised CCITT standard. The 512 kbps rate will be provided by use of Defence provided digital modems in association with a single FDM supergroup, that is at approximately 2 bits/Hertz.

Because of the numbers of different types of existing

FDM microwave radio systems and the long distance involved in the links to be provided by the Telecom network, there are particular transmission problems at the 512 kbps rate. Defence is currently sponsoring studies towards the development of a new supergroup digital modem to meet this requirement.

The most suitable method of obtaining possible future digital transmission at 2048 kbps using channels in the Telecom FDM network, is being investigated. Three contiguous supergroups have been used for this purpose elsewhere, but the difficulties of selecting mid-band supergroups in the mastergroup is likely to preclude this approach in Australia. The alternative of using combinations of independent FDM supergroups at the 512 kbps rate may resolve this issue. However, the future introduction of a digital trunk network currently being planned by Telecom for the mid 1980s is expected to overcome these initial problems.

Future Transmission Systems

Studies have been initiated into the application of fibre optics for local distribution in typical defence complexes and for short haul intersite links. The chief advantage of the optic fibre is the wide band-width available and the high data rates that can be obtained. The cable does not produce electromagnetic emanations and therefore has potential to minimize local wiring requirements. However, it still needs to be physically protected against interference. For this reason, studies have shown that the installation costs with fibre optics are not likely to be markedly different to that for other local distribution cable systems.

In the event that a national satellite system becomes available, it would be a requirement that digital channels leased by Defence be provided from both the satellite system and terrestrial systems. At a later stage, it may be appropriate to consider the inclusion of a military component in a satellite system. Such a component could provide advantages to Defence in that it could provide an anti-jam capability and be configured to provide for a range of field transportable terminals for tactical use as well as directly linking military bases.

HF radio will always provide an important trunk communication capability which can be established without reliance on external assistance and provides a minimum level of transmission capability under most conditions. Communication links available from the civilian networks will be used to increase the range of systems available and, hence overall survivability. Broadband, military operated, terrestrial communications will be provided as appropriate to enhance the capacity and capability of the trunk network in the interests of providing increased diversity, or in response to particular threat situations.

It is unlikely that a particular transmission medium will predominate in the future development of the fixed communications network. To maximise network survivability reliance will always be placed on a judicial mix of media including owned and leased microwave radio, HF radio, troposcatter radio, co-axial cable, fibre optic cable and satellite systems.

TERMINALS

The function of the DISCON terminals will be to provide for all types of defence fixed communications where the user has a requirement for secure information transfer. Broadly, the DISCON customer terminals are divided into:

- telephone;
- telegraph;
- facsimile; and
- data.

The methods of providing these customer terminals are illustrated, in secure and non-secure areas; on the left of **Fig. 7**, and are discussed in detail in the following paragraphs.

Digital Telephone

The proposed DISCON desk-top telephone terminal will operate in the digital mode at a transmission rate of 32 kbps. The telephone will use a continuously variable delta modulation (CVSD) scheme to translate the analogue voice into its digital form for transmission. In addition, the telephone will provide a number of features which will simplify and improve the user's use of the DISCON network. These features include abbreviated dialling, automatic recall features and storage of the dialled number so that it can be automatically redialled if the call number is busy on the first attempt.

The telephone should also provide an in-built answering service which would allow calls to be redirected if the user is absent. The CVSD codec and the signalling and control interfaces to the switch and telephone peripheral devices will be provided by LSI micro-circuits operating under the control of a microprocessor.

Telegraph

A DISCON family of telegraph message transmitting and receiving terminals will be provided based on a microcomputer message tributary system. The telegraph family will allow for the configuration of Defence message communication centres consisting of up to four visual display unit (VDU) based message transmitting terminals, four page printers and mass storage (double sided, double density diskettes), as well as the provision of single keyboard/page printers. The maximum data storage capability of a single station will be of the order of five megabytes (3600 messages).

Digital Facsimile

Detailed studies and analysis have indicated that the most cost-effective way in which the switched high-speed digital facsimile service can be provided is to operate it in conjunction with a digital telephone service. The signalling and supervision elements of the telephone unit can then be a useful adjunct for better exploitation of the facsimile service. Recently completed user surveys, when compared to the surveys carried out in the early 1970s, show a continuing user trend towards facsimile. Fast digital facsimile, incorporating data compression, provides a rapid and economical communication service in particular instances. It is ideally suited for the rapid transmission of charts, text, maps, graphics, drawings and photographs. It is obviously well suited for the transmission of information prepared in particular formats which would be difficult, expensive and time-consuming to translate into a telegraph message format.

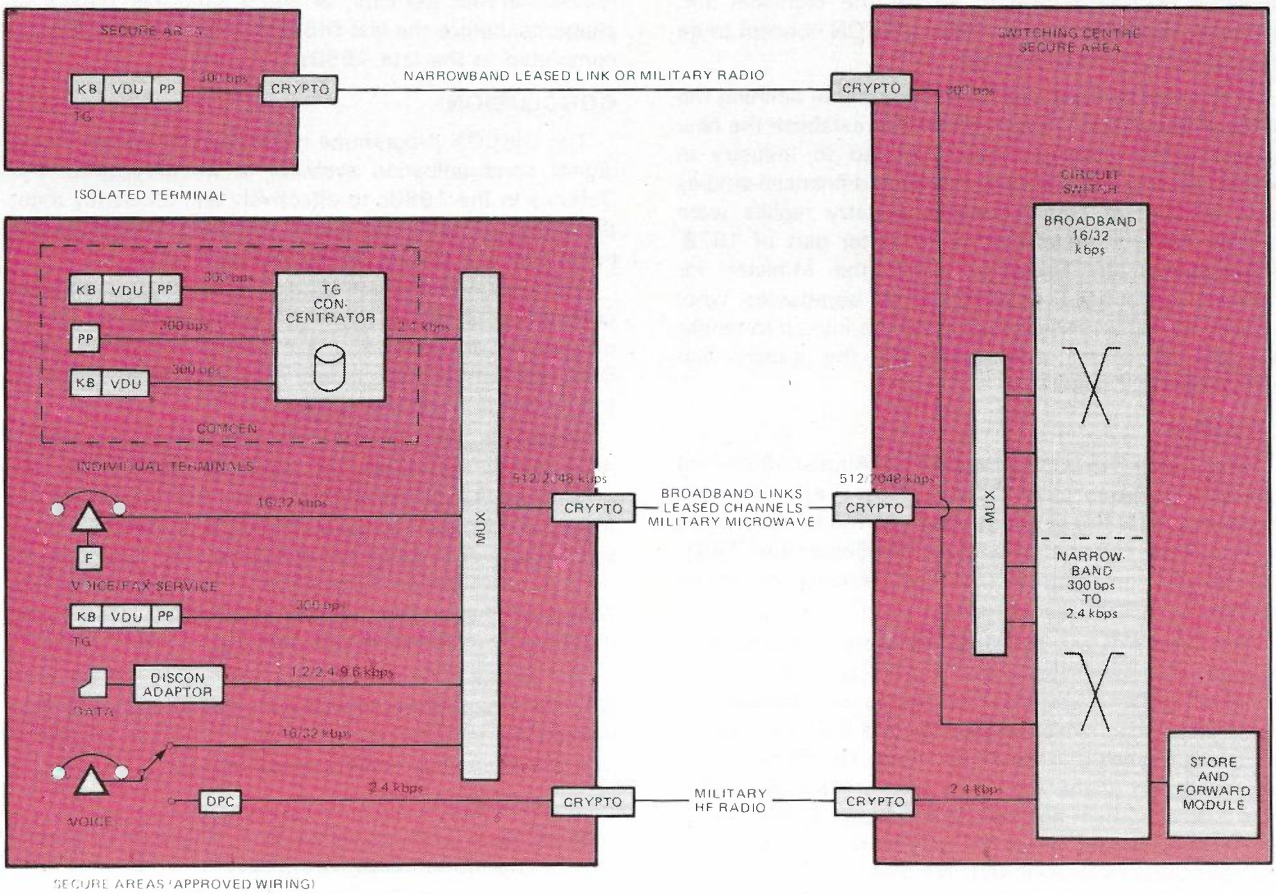


Fig. 7 — Typical System Configuration

It is also seen as the beginning of a national defence secure electronic mail service.

The digital facsimile that will meet DISCON requirements will probably be a microprocessor based terminal that may utilise flat bed, He-Ne laser scanning techniques and an electro-photographic recording process. It would provide for black and white initially and probably grey scale transmission in the future at speeds from 2.4 kbps up to 32 kbps. Also, modern two-dimensional source encoding algorithms enable a typical A4 size business letter to be transmitted in about 10 to 15 seconds in high bit-error-rate environments (10^{-2} BER). Special features of the specified facsimile unit include fully automatic, unattended received operation, broadcast, fault detector and indicator and automatic multiple copy transmission.

Data

Data services might range from the provision of very high speed (512 kbps) dedicated channels, through the switched data services of 4.8 kbps or 9.6 kbps, to "virtually" dedicated data links at low speeds such as 1.2 or 2.4 kbps. The "virtually" dedicated link connecting a number of remote visual display units (VDUs) to their related central processors may be achieved by use of a "hotline" switched facility which will be activated on receipt of a suitable pre-programmed signal from the data terminal.

It is not intended that the users data terminals will be provided as part of DISCON. They are to be provided by the user as part of the user information system. Suitable signalling and control interfacing arrangements will be specified to ensure their correct connection to DISCON. It is expected that microprocessor technology will have significant application in the provision of the interface arrangements.

Security

A special feature of all DISCON terminals is the requirement for secure operation. This security comprises two major aspects:

- protection against compromising emanations from a terminal or piece of equipment in order to deny unauthorised persons information of value which might be derived from intercept and analysis of those emanations; and
- cryptographic security by the provision of special encrypting equipment provided at the originating and terminating terminals which encyphers any type of digital bit stream as it leaves a terminal and decyphers it at the receiving terminal.

DISCON — PROJECT STATUS

Background

The concept of the new strategic defence communications network was initially indicated to Australian and overseas industry in mid 1976. A request for information (RFI) was circulated in the rapidly developing area of advanced digital, micro-processor-based, communications technology. Responses from major companies in Europe, USA and Australia to the RFI provided important data to enable the technical and economic feasibility of the 1980s DISCON concept to be evaluated and further defined.

A Request for Proposal (RFP) to assist in defining the state-of-the-art technology required to establish the new secure digital network was circulated to industry in November 1977. Detailed technical and financial studies of a number of comprehensive industry replies were carried out within Defence in the latter part of 1978. Subsequently, in February 1979, the Minister for Defence announced a short list of companies who, subject to further discussions, would be invited to tender as potential prime contractors for the supply and installation of DISCON.

Timetable

Tenders for DISCON were called in August 1979, and closed in November 1979. However, contract negotiations for Phase 1 with the preferred tenderer were subsequently terminated and, on 10 September 1981, the Minister announced that new tenders would be invited for the DISCON project.

The new tenders for DISCON were announced in August 1982. The closing date for the tenders will be in January 1983. A revised implementation strategy has been introduced which allows for the first contract to cover the regions of New South Wales, Queensland, Victoria and part of the ACT. This contract will be divided into a Development and Test (D&T) Stage A followed by an Implementation Stage B. Installation of DISCON in the remaining regions of ACT, NT, WA and SA would be by a second follow-on contract.

Australian Industry Participation (AIP)

The potential prime contractor companies have extensive experience in the design, development and provision of military communication systems. A mandatory requirement for the successful prime contractor will be to ensure that a progressively increasing level of communications, digital and microprocessor technology is transferred to Australia. Areas of activity designated for a high Australian content are digital user terminal systems, maintenance of switching system software, transmission systems design, installation and equipment and system maintenance.

The plan to achieve 50% AIP over the project is so designed as to build up Australian industry knowledge of the communication systems to the point where the network can be modified and maintained without significant "off-shore" support. This objective should be realised except perhaps for some small percentage of elements, before the last DISCON regional installation is completed in the late 1980s.

CONCLUSION

The DISCON programme is the first of a series of new digital communication systems to be introduced into Defence in the 1980s to effectively and efficiently meet the strategic communications demands related to the command and control of the Defence Force.

The new network will be one of the first of the new generation of allied strategic defence, digital, multipurpose secure networks making use of electronic digital SPC switching and terminal systems and digital transmission communications.

Electronic and digital communications technology in Australia is expected to advance significantly by maximising Australian involvement in the provision of the new, all-digital, secure DISCON network. New technology and technical problems will undoubtedly emerge, and will need to be solved; in the integration of a variety of digital communication services into the one nation-wide defence secure network.

The introduction of this digital technology is expected to have a significant impact on parts of the Australian electronics industry and will place it in a far better position to meet emerging requirements.

REFERENCES

FRANK, H. (1974), Survivability Analysis of Command and Control Communications Network — Parts 1 and 2, IEEE Transactions on Communications, Volume COM-22, Number 5.

FRANCIS, Colonel J. A. D. (1978), The NATO Integrated Communications System, Journal of the Royal Signals Institution, Volume 13, Number 5, pages 17-23.

MAGGS, I. H. (1978), The Australian Defence Integrated Secure Communications Network for the 1980's — DISCON, Signal, February 1978, Pages 21-25.

SALTON, G. L. (1979), DOD Protected Communications Programs, Signal, August 1979, Pages 86-87.

MAGGS, I. H. (1979), Developments in Australia's Strategic Defence Communications — Part 1: Capabilities and Concepts Triad, Summer 1979, Pages 20-22.

MAGGS, I. H. (1980), Developments in Australia's Strategic Defence Communications — Part 2: Application of Digital Technology, Triad, Autumn 1980, Pages 20-23.

Operations and Maintenance Facilities Provided by AXE

R. L. ORTON, Grad. I.E. Aust., D. P. KITCHEN, Grad. I.E. Aust.

The introduction of AXE switching equipment into the Australian telephone network will provide sophisticated facilities for improved network operation and exchange maintenance. AXE is the next generation of SPC telephone exchanges following on from the ARE-11 system which is now prevalent throughout the Australian network. This article reviews the operation and maintenance facilities provided by AXE and examines the affect on the role of the various Network Operation Centres.

INTRODUCTION

The introduction of AXE into the Australian telephone network heralds a new era in telephone switching technology in this country. The AXE exchange is a stored program controlled (SPC) system which, except for the initial installation at Endeavour Hills in Victoria, will employ integrated digital switching and transmission techniques for the first time in the Australian network.

Being a modern system, AXE offers many sophisticated facilities both for the customers and for Telecom. The structure and the general facilities provided by AXE have previously been described in Reference 1 and 2. The purpose of this article is to expand the information on the operations and maintenance facilities provided by AXE and to relate these facilities to the role of the various work centres affected by the introduction of AXE.

SPC exchanges, by their nature, provide for the establishment of specialist centres that are responsible for specific functions e.g. traffic measurement, network performance monitoring etc. The centres are called Network Operation Centres (NOC) and have been in limited operation for some time. The introduction of ARE-11 in the late 1970's enhanced the role of these NOC's by providing improved facilities and the introduction of AXE in the 1980's will further enhance that role.

SYSTEM STRUCTURE

The AXE exchange is made up of two major systems:

- the data processing system, designated APZ, which includes the central and regional processors; and
- the switching system designated APT which includes the switching stages and associated devices.

Both systems comprise several sub-systems which are made up of hardware and/or software. The systems contain their own operation, maintenance and supervisory facilities. All contact with the AXE exchange is via input/output terminals. Terminals are located on site and remotely at the network operation centres. The remote terminals are connected to the exchanges via data links connected to the AOM message switching system.

This article does not attempt to describe in any detail the operation of these systems; this has been covered in the earlier articles mentioned above. However, a brief overview of the relevant supervisory facilities is included.

SUPERVISION OF APZ

The APZ system is supervised by the maintenance subsystem (MAS). MAS comprises eighteen discreet function blocks providing standard system facilities. Of all these function blocks only one, the maintenance unit (MAU), contains hardware. The MAU is situated between the two central processor sides as shown in **Fig. 1.** MAU records the operating state of the processors and passes test signals to the processors. The MAU is controlled by the APZ software via a regional processor (RP) and a processor test unit.

The supervisory facilities associated with APZ ensure the exchange processors are operating correctly to report on any fault conditions and reconfigure as necessary. No statistical data is provided by MAS and therefore, the APZ supervisory facilities are only of use to exchange maintenance staff.

The functions performed by MAS are:

Supervision of Central Processors:

The central processor (CP) consists of two identical sides operating in synchronism, i.e. both performing the same function at the same time. The operation of the CP sides (CPA and CPB) is continuously compared at the micro instruction level, parity checks are performed on data transfers and timing checks are applied to program execution. If an error is detected, diagnostic routines are activated to identify and isolate the failed CP side. The diagnostics then printout a list of probable faulty PBA's in priority order with a weighting factor assigned to each PBA.

Irrespective of whether or not a hardware fault is detected, a small restart is initiated. A small restart cancels calls in the process of being established and clears the call data from memory. If no hardware fault is identified and a further error is detected within 30 seconds then a system reload is initiated which reloads all programs and data. System reload results in all established calls being lost.

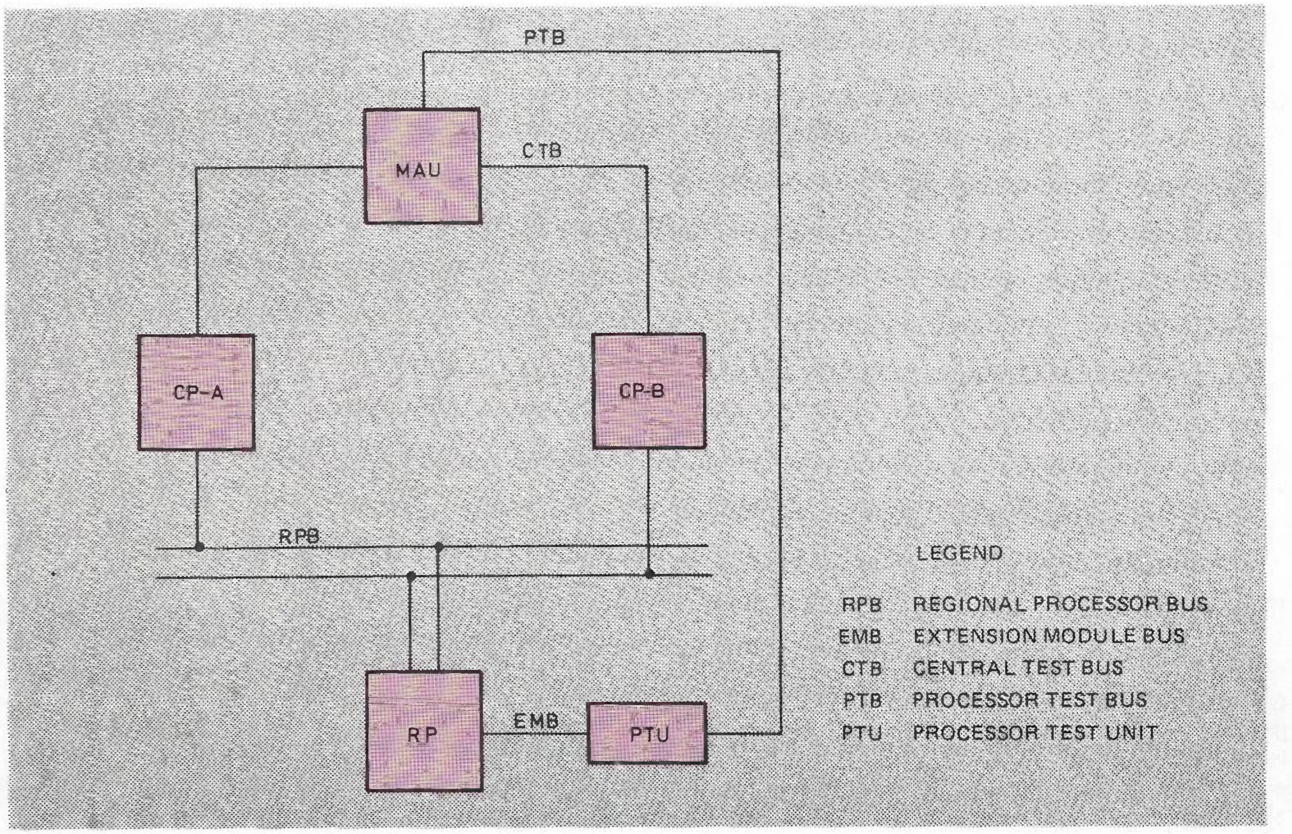


Fig. 1 — Hardware Monitoring and Testing of the CPU.

Supervision of Regional Processors:

Regional processors (RPs) have their own test programs which routinely check their operation and pass the results to MAS. If faults are suspected MAS can order more detailed testing of the RP, which will list any PBAs which may be faulty. A typical printout is shown in Fig. 2.

Program Testing

Software testing facilities are provided by a test sub-system, which enables exchange maintenance staff to trace information and control signal transfers passing between function blocks. This system also provides the ability to read data directly from the data store associated with a particular function block.

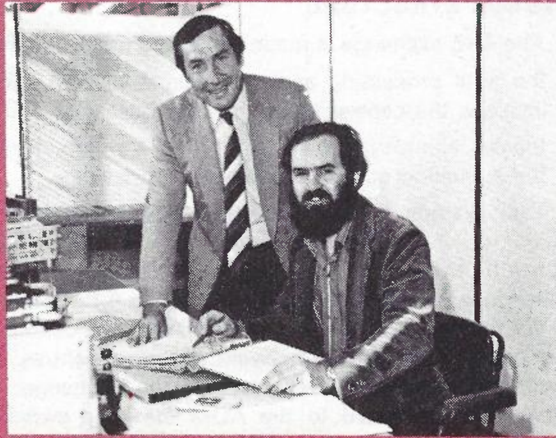
In addition to the supervision and fault location of CP and RP, MAS also controls other functions such as system start up, function changing and system restarts.

SUPERVISION OF APT

The switching system (APT) is supervised and controlled by the operation and maintenance sub-system (OMS). OMS is the interface between the exchange and the staff. Unlike the MAS, the OMS contains facilities that are affected by the specific requirements of the telephone administration. The AXE exchanges

Bob Orton (standing) commenced with the APO as a technician in training in 1958. In 1969 he qualified as an Engineer and spent 5 years on exchange installation in Victoria before joining Telecom HQ in 1975. Following 3 years in Switching Design Branch evaluating ARE-11 Bob moved to Network Operations Branch in 1978. He is currently Manager of the Exchange Switching Service Section.

David Kitchen (seated) commenced as a cadet engineer with the APO in Sydney in 1972 qualifying in 1975. David worked at the Chatswood Field Engineering District until 1978 when he joined Exchange Switching Service Section, Telecom HQ, where he is currently a senior engineer involved in specification and evaluation of AXE operations and maintenance facilities and procedures.



```
ALARM 820401 1001 A2/APZ

RP FAULT

RP    FCODE   INF1     INF2     INF3
 64   H'13    H'1      H'0      H'0


MAG          CARD          WEIGHT
P-RP- 64                    10
RP- 64       EMBU            2
RP- 64       OBU             6
RP- 64       IBU            11
RP- 64       ALU             5
RP- 64       PRU            13
RP- 64       PSH            17
RP- 64       DSH             6
RP- 64       MIG            30
RP- 64       MPSU            8
RP- 64       PS-0A   1       1
RP- 64       PS-2A   3       1

END
```

Fig. 2 — Typical Printout for APZ Fault

installed in the Australian network will have about 60% of the OMS function blocks modified specifically for Australian requirements.

The functions performed by OMS can be grouped under the following headings:

- Supervision of switching equipment;
- Test and Fault Localisation;
- Administration;
- Statistics (traffic engineering and charging statistics).

Supervision

OMS supervises the operation of the individual APT equipment devices by monitoring live traffic. Supervision is performed by calculating the ratio of successful calls to total seizures in devices and comparing it to the average for the device route or by counting the number of failures in a fixed time interval. If a threshold is exceeded an alarm is given and the device may be blocked from service automatically.

The individual supervisory functions include:

- ***Disturbance Supervision.*** Individual devices and routes are supervised. Suspected faulty devices are fault marked. The device is blocked when a fault is confirmed. This function cannot cause the blocking of more than a preset number of devices.
- ***Blocking Supervision.*** A check is kept of the number of devices in a route that are blocked. If more than the prescribed number of circuits are blocked an alarm is given.
- ***Seizure Quality Supervision.*** This facility detects device faults which result from short holding times that are at variance with the average route holding time.
- ***Seizure Supervision.*** This function is initiated by command and can be used to check that at least one call of a minimum length has been made from a subscribers line (e.g. public telephone) in a certain period.
- ***Subscribers Line Supervision.*** Each subscribers line is periodically checked for line lock out or a fault condition. An alarm is issued if a line has been blocked for more than a predetermined time. This function also checks the subscribers line for insulation resistance on both incoming and outgoing calls. If the line is faulty it is automatically blocked.
- ***Switching Network Supervision.*** Digital switch blocks are permanently supervised by parity and clock checking at numerous points through the switch block. The switch block is fully duplicated and if a fault occurs in one side, the other side is selected automatically without any disturbance to the subscriber's conversation.

The analogue switch blocks are supervised by fault counters associated with each link and matrix in the switch block. Faulty crosspoints or links are indicated by high values in the fault counters. When the counters exceed a threshold, the link or matrix is blocked.

Diagnostic routines are automatically activated to identify faulty units. Alarm and diagnostic results are sent to the maintenance centre.

Test and Fault localisation

Test functions are provided for the test of all the equipment in APT, including the subscribers plant. Some of these tests are performed automatically while others are manually initiated to locate or confirm faults. The major test and fault localisation facilities are:

- a traffic route tester function (TMRT) is provided so that local and junction test calls can be initiated. TMRT is operated by man/machine command;
- connection to external test equipment via an access selector (ACCS) of a subscriber line module. ACCS is used to connect Service Assistance (1100), test desks and service assessment operators;
- subscribers line testing (SULT) is performed by command to measure insulation resistance, line resistance, capacitance, foreign potential etc.;
- a trace facility is available to record the state of test and operate points and the current state of a specified telephony device.

Administration

OMS provides the interface between the exchange and all operations activities. These activities include changes to analysis tables (digit analysis, route analysis etc.), subscribers data (connection, classification, and facility disconnection) and exchange extensions. Program changes are loaded from a cartridge tape drive under the control of MAS.

A command logging function is provided to record all commands which change the exchange data. This function provides a record of recent changes made subsequent to the creation of the latest reload tape to allow updating of the exchange data if a reload occurs.

Statistics

The final functional grouping of OMS is for the statistics functions. This group of function blocks produce:

- ***Traffic engineering data.*** Including traffic dispersion and circuit occupancy.
- ***Automatic Service Assessment.*** This feature provides an automatic version of the manual service assessment but without a check on voice transmission quality. ASA provides statistics on call failures due to switching loss and congestion.
- ***Charging statistics.*** This randomly samples live traffic, records A & B party numbers, the number of meter pulses returned and the call time. This information can be used to check the accuracy of the charging equipment. A further feature can also provide a detailed call record for an individual telephone service (i.e. CCR).
- ***A timetable function*** for the delayed or repeated execution of statistics functions. This enables functions to be preset in system software to be executed at a specific time or repeated periodically.

In summary, OMS supervises the operation of all the telephone hardware and can produce traffic and service performance statistics. OMS also contains the test facilities to diagnose faulty PBAs in APT. Overall the emphasis is on monitoring the success or failure of 'live' traffic to assess the exchange performance.

The subscribers switching stage (SS), AJs (A subscriber transmission bridge) and BJs (B subscriber transmission bridge) can be remote from the group selector and central processor. This SS, AJ and BJ forms a remote switching stage (RSS) which is connected to the group stage and central processors by digital links. The RSSs which can be located anywhere, and their parent node are treated as a single exchange for operations and maintenance activities.

INPUT OUTPUT COMMUNICATION

The input-output subsystem (IOS) which is a part of the APZ system, provides communication facilities between the exchange and staff. Normally, these facilities are provided and operated in conjunction with the AOM message switching system, as described in Reference 2. **Fig. 3** shows the typical arrangements for interconnection of AXE, AOM and the NOC's.

The man/machine communications facilities are grouped into the following areas:

- ***Alphanumeric devices*** — These devices (e.g. cartridge tape drive CTD, VDU and TTY) are used for entering commands and receipt of printouts. Features available include command authorisation checking, automatic routing of printouts to nominated terminals and rerouting of printouts to a standby unit when required.
- ***File oriented devices*** — These devices (e.g. CTD) are used to store data for system reload and for message logging (if required). File devices may be categorised as read only devices to protect contents. Automatic overflow to another unit is available when a file device is full.
- ***Data channel interface*** — Data flow between the AXE exchange and the AOM takes place via a high level data link using a protocol based on CCITT X.25.
- ***Alarms*** — Alarms are classified as A1, A2 etc. similar to existing exchange systems. The alarm printout indicates whether the alarm is from the APT or APZ systems. The alarms can be routed depending on the source of the alarm, e.g. subscriber line faults are sent direct to the fault despatch centre and equipment alarms are sent to the maintenance centre.

Each exchange is equipped with two terminals, a back up link to the maintenance centre, five or six cartridge tape drives and an X.25 link to the AOM. The back-up link provides a direct connection between the exchange and the maintenance centre for use if the AOM or X.25 link is out of service. Two terminals (a VDU and a TTY) are provided on sight for cold start-up of the CPU and for printing of alarm conditions which occur at that site.

Normally the NOC terminals are connected to the

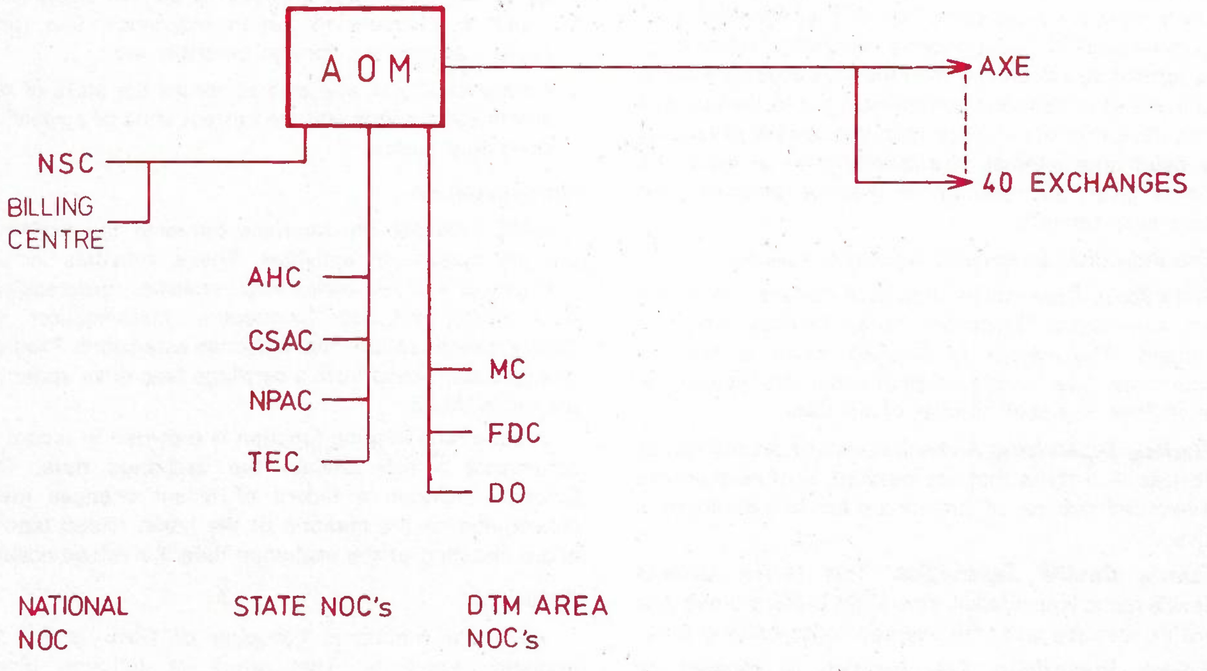


Fig. 3 — AXE/NOC Interconnection Arrangement

AOM through which access is gained to the exchange. Command authorisation (AOM or AXE) limits the NOC terminals to the functions prescribed for them.

CHARGING

A twenty four bit software counter is used as a subscribers call charge accumulator. The counters can be read out at any time by command. The print out of the accumulators value is presented as an 8 digit decimal number. Unit fee and STD multimetering pulses are recorded on the call charge accumulators in the same manner as meter pulses in existing exchanges are stored on electromechanical meters. Currently the accumulator records are printed out and then manually entered into the billing systems however, a data link is being developed which will enable the meter readings to be extracted automatically to be sent direct to the billing system computer.

DIGITAL LINKS (Fig. 4)

The digital group selector can directly terminate digital inter-exchange links. This is in contrast to the existing switching and analogue transmission systems where the analogue frequency division multiplex (FDM) system must be demodulated to individual voice channels. The interface between the exchange and the digital link is provided by the exchange terminal (ET) equipment. Line terminal equipment (LTE) provides power feed for regenerators and line code conversion.

The ET continuously monitors the performance of the digital link. High bit-error rates, loss of synchronisation and alarm bits are detected and alarms sent to the maintenance centre. This enables the line section in which a failure has occured to be identified quickly and usually without the need for special test equipment. Location of the failed repeater or cable damage is then carried out using standard transmission test equipment and fault location techniques.

NETWORK OPERATION CENTRE ACTIVITIES

Operation and maintenance activities in an SPC environment extend beyond the confines of a single exchange and relate to an entire network. A problem faced by network operation centres in an electromechanical network is the difficulty in extracting data from an exchange and making it available at the appropriate centre at the appropriate time. AXE supports the use of NOCs for the remote operation, maintenance and monitoring for exchanges **(Fig. 5)**.

As SPC spreads throughout the network there are increasing opportunities for the NOC's to extract data direct from exchanges. The terminal and command authorisation procedures built into the AXE system make it possible for the capability of individual terminals to be accurately specified. Currently, the terminal classification and command authorisation is performed by the AOM message switching system. Command authorisation can also be provided by the AXE exchange, a feature which may be used when AXE is introduced to provincial centres.

Each NOC is supplied with a manual which details the procedures to be followed by that NOC in the performance of its role in relation to AXE exchanges.

The following is a brief summary of how AXE facilities will be used by NOC's:

Maintenance Centre (MC)

Maintenance activities for AXE exchanges are controlled from a staffed location, which for the purpose of this article is called the maintenance centre. The switching equipment requires minimal regular maintenance therefore most maintenance activity is in response to an alarm from the exchange or performance query from another NOC (eg NPAC).

The only spontaneous outputs from exchanges are alarm messages and these are transmitted direct to the maintenance centre where they will appear on a video monitor. The maintenance centre then verifies and locates the fault using test and fault localisation facilities. Standard fault trace and repair instructions are included in a manual supplied to maintenance staff. Having located the fault, the failed unit is replaced and the test procedures are again used to verify that the fault has been fixed. It is anticipated that 80-90% of hardware faults will be located in this manner.

The maintenance centre is also responsible for updating the analysis tables of the exchange as they are required. These tables provide the digit and route analysis. These changes are done by commands.

Subscribers category data which specifies type of service and facilities available is also set by command. This work is performed by the maintenance staff, but could also be performed from a terminal in the local Telecom business office.

Fault Despatch Centre (FDC)

AXE offers improved supervision of subscribers lines

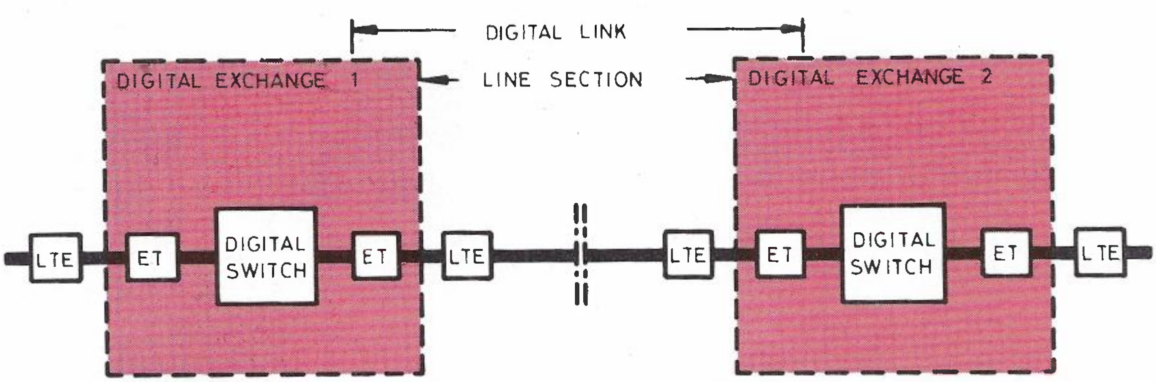


Fig. 4 — Digital Exchange Link.

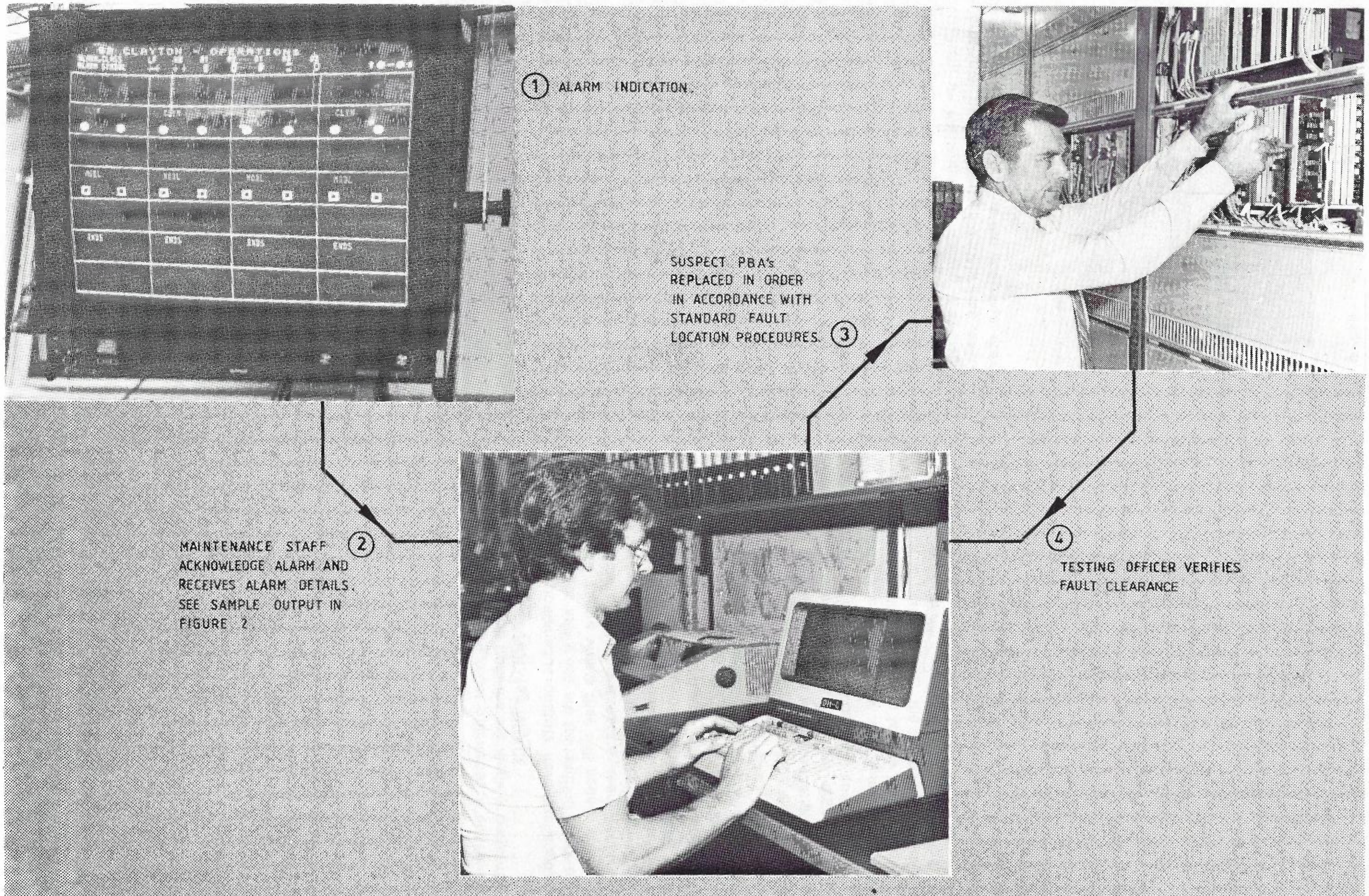


Fig. 5 — Standard AXE Alarm Handling and Fault Correction Procedure.

and testing facilities. The major change in the FDC is that the testing officer will operate from a terminal (VDU) rather than a traditional test desk. The major facilities available to the FDC are:

- Test of subscribers line.
- Blocking/deblocking of subscribers lines.
- Check state of subscribers line (eg busy, idle, or blocked).
- Check subscriber classification, eg access, PBX, etc.
- Test line circuit in exchange.
- Subscriber line supervision.
- Subscriber seizure supervision.
- Print external alarm lists (eg PABX, gas pressure alarms).
- Reset external alarms.

Development is proceeding to enable AXE to interwork with the Telecom designed SULTAN network and test robot.

Network Performance Analysis Centre (NPAC)

AXE can automatically collect performance statistics and call failure information which are sent direct to NPAC. The statistics are gathered according to preset programs which NPAC can change as required by command. The information available includes call failure information similar to the ARF RKR as well as new facilities including automatic service assessment.

The key facilities available for NPAC are:

- Generation of test calls.
- Service quality statistics automatic service assessment.
- Network call failure supervision.

The network call failure supervision data is sent direct to the NPAC minicomputer for analysis. This is described in Reference 3.

Traffic Engineering Centre (TEC)

The traffic engineering statistics are collected according to programs set by the TEC. The data is sent to the TEC where it is directly entered into a computer data base used for traffic forecasting.

Centralised Service Assessment Centre (CSAC)

Facilities are provided to enable the CSAC operator to monitor calls in the usual manner for switching loss, congestion, etc. Additional facilities are also available to perform sample checks of metering accuracy.

Service Restoration and Traffic Control Centre (SRTCC)

The AXE system includes facilities which could provide traffic control, ie the ability to reroute or block certain traffic in the case of a failure within the telephone network.

After Hours Centre (AHC)

All urgent alarms are directed to a nominated after hours centre during preset times. The AHC is supplied with a terminal and has limited powers of interrogation to perform initial investigation of the alarm cause so that appropriate staff may be recalled.

District Office (DO)

The district office collects individual call record data and call and revenue statistics. The individual call record data provides the same information as call record printers.

CONCLUSION

Maintenance activity associated with AXE is significantly reduced compared to earlier switching systems. This is due to the inherent reliability, powerful internal supervision and diagnostic capabilities of AXE. Similarly, the sophisticated facilities provided for normal exchange and network operation will result in a more efficient and reliable operation of the AXE component of the telephone network. Supervision of existing exchanges will also be improved as a result of the improved route and circuit supervision of AXE. Thus the service to all customers will be improved.

The introduction of integrated digital transmission and switching means that the traditional interface between exchange switching equipment and transmission equipment no longer exists. Hence maintenance of the digital network will necessarily be based on a total system approach (i.e. exchange and digital link) rather than separate transmission and switching segments.

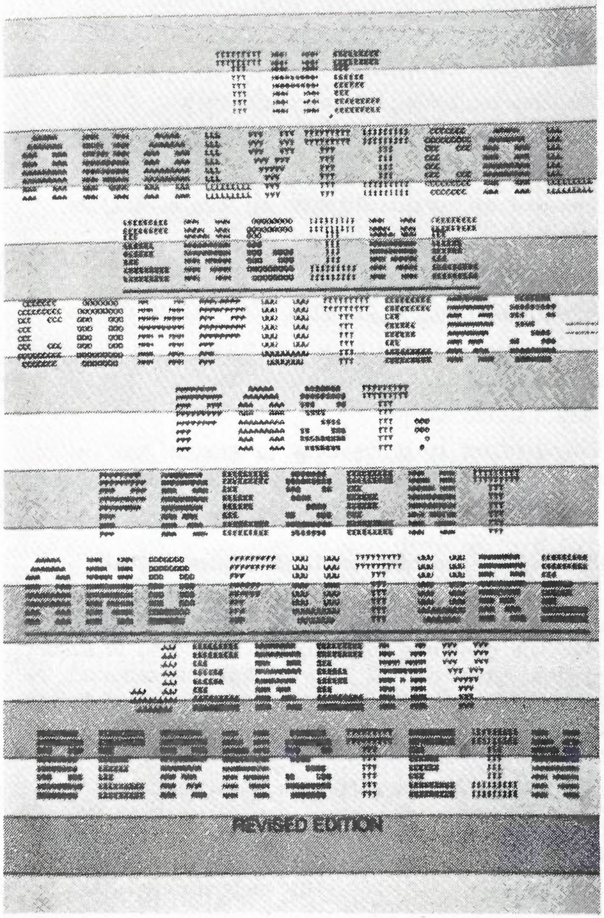
In addition to the more sophisticated facilities available for use in the traditional operations and maintenance areas, AXE provides avenues for the introduction of advanced network management philosophies such as control of traffic routing during abnormal situations. The future development of the Australian network with AXE digital exchanges will provide a challenge to Telecom Australia to extract the full benefits of modern technology as applied to telephony networks.

REFERENCES:

1. Ward, M. K. and Craig, W. R.: 'AXE/AOM. Some Design Aspects': TJA Vol. 28 No. 3.
2. Bate, W. K.; 'Operation and Maintenance of AXE in the Australian Telephone Network'; TJA Vol. 28 No. 3.
3. Bradbury, R.; 'Call Failure Supervision in a Telecommunication Network'; TJA Vol. 30 No. 3.

THE ANALYTICAL ENGINE. Computers Past, Present and Future

Jeremy Bernstein, William Morrow and Coy. Inc. New York.



If you have an interest in how things work and how they have developed, and the actual mechanism of the computer has so far escaped you, then this book will provide an interesting and easily consumed text to satisfy your needs. It is not a book for the computer expert although, to revisit some of the history and early activities in the computational field, could prove entertaining.

I found that I could relate well to the book, as, along with many engineers who were practicing the profession in the 1950's, I took the same path described by the author, in getting to know more about the emerging wonder of that period — the computer. For the author, he undertook a simple course in FORTRAN; in my case, it was a course in Elliot Autocode run by Monash University, Melbourne.

The first chapter describes the basic steps in programming and places this in perspective with how the earlier machines operated.

The second chapter deals with the development of computers and notes that within our history there have been individual humans who could, in fact, perform extremely difficult calculations without the use of mechanical aids — not even pencil and paper.

The book points out that the present world chess champion is a human even though the machines have been matched against the top players. The prediction is made however, that this situation will not remain for long as the technology moves towards more closely matching the memory capacity and interlinking ability, of the human brain.

The chapter goes on to describe some of the work of the early mathematicians and inventors and covers some of the interesting and more human aspects of Charles Babbage's most significant part in the development of modern computers.

Chapter three goes a little deeper into the two broad parts of a computer, the hardware and the logical design; that is, how the hardware elements work together. Again the author follows the approach of starting with a historical survey leading to modern developments in both hardware and software.

At this point the reader may have become a little frustrated with the format as the author has failed to provide a clear thread which links the chapters for the benefit of the serious reader.

The final two chapters concern the analogy of the computer, or more correctly, the computer network, with the human brain and, as such, is quite intriguing. Most who have contemplated the future of computers will have wondered how far the technology can go and whether the machines will eventually control man. The book does not, of course, answer the question but gives some basis for thought and offers some explanations about how the machines have evolved in the regenerative cycle.

The book also offers a selected bibliography for those who wish to explore the author's line of thinking further.

In summary, I found reading the book to be a brief but enjoyable activity and I would recommend the experience to others who wish to know more about the generalities of computers without having to also digest a large amount of detailed technical material.

Reviewed by:
Ron Keighley
Editor in Chief
Telecommunication Journal of Australia.

IN THE NEXT ISSUE

TJA

- TELECOMMUNICATIONS IN THE ARMY
- TELEPHONE TRAFFIC RECORDING
- REMOTE AREA TV
- KALGOORLIE MICROWAVE LINK
- INVESTMENT ANALYSIS
- CODING OF TRANSMISSION PATHS
- LOOP SIGNALLING TO PCM

Problems in Radio Communications — Solutions and Advances

J. E. LAMPREY

This paper outlines some general characteristics of the unguided electromagnetic medium with particular reference to new radio communication frontiers in the extra high frequency part of the spectrum. Associated equipment developments and new signal processing techniques directed towards exploitation of these frequencies are also reviewed.

INTRODUCTION

In 1873 James Clerk Maxwell published a definitive theory on the "electromagnetic field" that was to have a profound effect on the future development of communications, both "wired" and "wireless". Some 23 years later in 1896, theory became practice, with the invention of radio by Guglielmo Marconi and independently by Alexander Stepanovich Popov. The developments stemming from this invention have probably been unequalled in the history of mankind and have posed many problems of great complexity.

The elegant solutions to these problems, which have emerged over the last 80 years or so, and which led to the present state of the art, might suggest that further advances in the field of radio communication and its associated technology are unlikely. Nothing could be further from reality. Even more dramatic progress is being made as new electronic techniques emerge, uncovering in the process, complex problems which will require the application of great skill on the part of radio engineers in the future.

There can be little argument that radio engineers have contributed much to the advancement of this technology in the past; but what of the future? There is some evidence to suggest that other specialists working in the fields of physics, chemistry, materials science and mathematics are now pioneering discoveries which have the potential to significantly affect future developments in radio communications. It is important that we take full account of the work of these other specialists when seeking solutions to new problems as it is likely to lead to fundamental changes in methodology of design and future system configurations.

CHARACTERISTICS OF THE ELECTROMAGNETIC SPECTRUM

The unguided medium (the so-called ether) pervaded by electromagnetic waves is fundamental to radio communications and still demands much research and understanding, particularly at the higher frequencies.

Some of its characteristics in terms of isotropic path attenuation at different frequencies are illustrated in **Fig. 1**. Interpretation of the attenuation versus frequency curves is necessary to take into account whether the particular radio path is from point to point on the earth's surface; point to point in free space above the earth's ionosphere; or from earth to space, traversing both the atmosphere and the ionosphere.

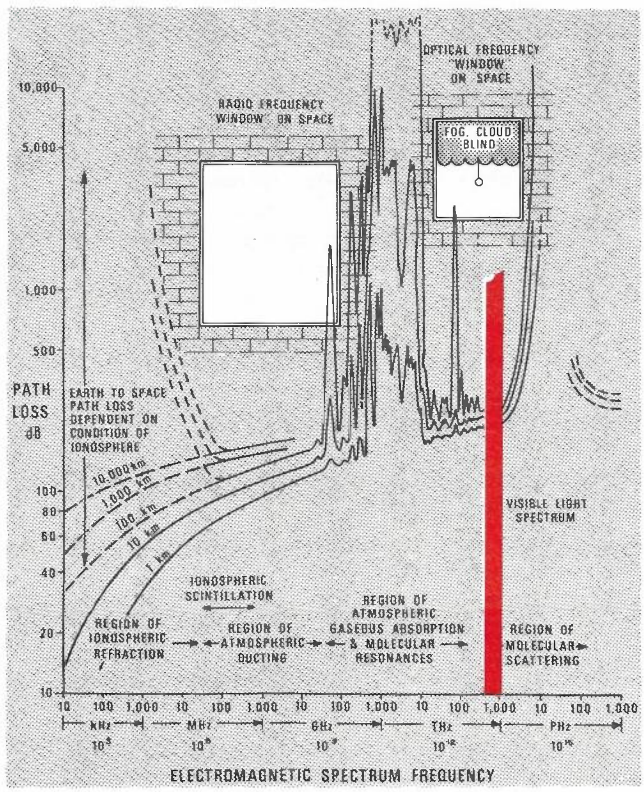


Fig. 1 — Isotropic Path Attenuation At Different Frequencies.

The underlying family of attenuation curves for the typical radio path lengths indicated are basically attributable to free space, line of sight between isotropic antennas, unperturbed by ionospheric or atmospheric effects. Overlayed on these at the extra high frequency end of the spectrum is the additional attenuation resulting from an atmospheric effect.

At the lower end of the spectrum, the refracting effects of the ionosphere and sporadic ducting effects of the atmosphere, result in transmission of the

Reprinted from Journal of Electrical and Electronics Engineering, Australia Vol. 2, No. 1.

electromagnetic waves around the curvature of the earth with much the same attentuation as in free space paths of equivalent length. Considerable variation to these attenuation figures, particularly at the lower end of the spectrum results from difference in surface conductivity, permitivity and refractivity indicated by the broken curves on the diagrams. Ionospheric density variations, topographic and climatic factors, antenna height and polarisation also play a significant part in the resultant radio path attenuation. It follows, that when the radio signals at the lower frequencies are confined to the earth's surface, the path attenuation from earth to space is extremely high; the ionosphere imposing an almost impenetrable barrier to radio transmission.

On the other hand at the very high frequencies and above, radio signals can be propagated from earth to space, suffering relatively little attenuation in passing through the atmosphere and ionosphere. Some sporadic interaction of the electromagnetic waves with the ionosphere occurs at these frequencies, particularly in the equatorial and polar regions, resulting in severe phase and amplitude perturbations to the received signal. This is the region of scintillation fading which still poses many problems and is the subject of ongoing research into UHF satellite communications.

Above about 25 GHz the absorption and scattering effects of the gases and water vapour of the earth's atmosphere begin to have a profound effect on the attenuation. However, that part of the spectrum from about 100 MHz to 25 GHz, represents a unique electromagnetic window on space. This is of considerable importance to designers of satellite communications systems and of course to radio astronomers who have a strong and competitive interest in its use.

One interesting outcome of the World Administrative Radio Conference (WARC) in Geneva in 1979 was the reservation of suitable frequencies within this "space window" to cater for chance extra-terrestrial communications with alien civilisations. A challenging problem indeed for the future!

The much higher frequency, "optical window", encompassing as it does the visible spectrum, can very easily have a "blind" drawn over it by smoke, haze, cloud, fog and rain. These attenuating influences affect the greater part of the spectrum from optical frequencies down to about 20 GHz and can result in much greater attenuation than that indicated in Fig. 1 for the clear atmosphere. The additional attenuation resulting from such obscuration is dependent on the length of the path to be traversed as well as the specific nature of the obscuring agent. Below 20 GHz these obscuring factors have a minor effect on path attenuation in comparison with that at frequencies above 20 GHz.

The inordinately high attenuation to which radio signals are subjected in the atmospheric absorption region above 20 GHz might mislead one into thinking that such frequencies are useless for radio communications. On the contrary, they may well be ideal for satellite space communications links, where the high attenuation of the atmosphere to these frequencies provides a natural and useful shield against unwanted interference from earth transmissions. Terrestrial communication applications are also possible at these frequencies where short distance, highly directive transmission is required and propagation of the signal beyond the short operating range can be minimised.

In view of the ever increasing demands for information bandwidth there can be little doubt that the 10 GHz to 100 GHz band represents an important frontier for future research and application.

EQUIPMENT DEVELOPMENT

Development of techniques and equipment to operate at higher frequencies is fundamental to future advances in radio communications. It is fortuitous that the ever-increasing demands for communication bandwidth in the electromagnetic spectrum have been matched so far by significant technological advances in radio frequency power generation, modulation and detection.

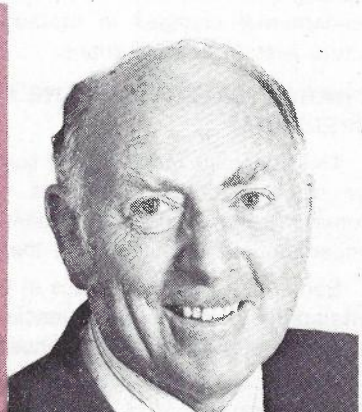
Recent reports from many research laboratories highlight improved Gunn oscillators operating to 100 GHz [1]; klystrons operating to 200 GHz [2]; solid state IMPATT diodes and oscillators operating to 300 GHz [3]; and improved versions of the backward wave oscillator (Carcinotrons) operating to 1000 GHz [4]. These devices are mainly used for low power applications.

In the medium power region the magnetron has been improved in reliability and frequency range and is presently available for applications up to 95 GHz [2]. Also an extended range interaction oscillator has been operated up to 260 GHz [5]. A breakthrough in extremely high power rf generation has been obtained with the gyratron which can achieve megawatts of peak power

John Lamprey is the Superintendent of the Communications and Electronic Engineering Division of the Advanced Engineering Laboratory, Defence Science and Technology Organisation, and is currently acting as Chief Superintendent of that Laboratory.

He started his career in the Commonwealth Public Service in 1939 with the Postmaster-General's Department and was associated mainly with design and development projects for the National Broadcasting Service. In 1955 he joined the Weapons Research Establishment (now Defence Research Centre Salisbury) where he was engaged on the development and project management of a wide range of military electronic and communications engineering systems.

Mr Lamprey completed his tertiary education at the University of Adelaide majoring in physics and in communications engineering through Commonwealth Public Service examination, and is a Member of the Institution of Engineers, Australia.



output and hundreds of kilowatts of CW output at efficiencies approaching 50% [6].

Optically pumped lasers can also be used to produce significantly large power output at specific frequencies in the terahertz and petahertz bands, but efficiencies and pulse repetition rates are relatively low [7]. Nevertheless there is considerable scope for improvement in this area, with the development of greater varieties of solid state, gas and metal vapour lasers and organic dye, tunable lasers and amplifiers. Despite the sophisticated laser systems now available or under development, we are only at the threshold of this technology. Our present stage of development in this field could be likened to our position 60 years ago when spark transmitters were being developed to operate in the lower frequency regions of the spectrum.

After a decade or so of effort, these rf power generation advances are now matched in the solid state low noise mixer area, with mixer noise temperatures lowered significantly, thus opening the way for the design of improved receivers capable of operating at these extremely high frequencies. Modern requirements in the field of radio astronomy have motivated some advanced research work in this field. Many of these developments are being adopted by radio engineers to communications problems and they should be further extended and improved as other applications become apparent. Delegates to the WARC have foreshadowed such applications in their most recent legislation which now provides for member nations to allocate regions of the electro-magnetic spectrum up to 400 GHz — previously this was only legislated to 40 GHz.

Against this background of legislation and advances in millimetre and sub-millimetre wave device technology, a new awareness of potential applications for radio communications in these bands must surely emerge. In this context it is perhaps worth recalling Arthur C. Clarke's second law, [8] relating to "Failure of Nerve and Imagination".

> ***"The only way of discovering the limits of the possible is to venture a little way past them into the impossible."***

We are now at that threshold and it behoves us all to improve our understanding of the new technology and the environmental factors influencing radio propagation at these higher frequencies and to venture a little way into the impossible.

SIGNAL PROCESSING DEVELOPMENTS

As fundamental to the process of radio communications, as the propagation and reception of electro-magnetic carrier waves, is the impression on them of information signals and their subsequent detection through processes of modulation, demodulation and recognition. Developments in this field have been just as dramatic as those associated with electromagnetic wave generation and reception.

At the risk of gross injustice to the many pioneers who have contributed to the art of communication engineering and who cannot be acknowledged in this brief overview, the name of Claude Elwood Shannon must be mentioned. He was one who laid a cornerstone to the subsequent development of communication signal processing, fundamental to the transmission and reception of intelligence.

Earlier workers have explicitly recognised that communications "channel time" and bandwidth, in the presence of noise, could be exchanged as long as their product was held constant. However, it was not until 1948 that a clear understanding of the communications process emerged. This came about when Shannon postulated, in his publication at that time, a complete mathematical model, describing in universally applicable terms, the essential elements of the communications process.

In essence these are:

- the message source, representing the statistical universe of all possible messages that can be offered for transmission by a communication channel, each with its own probability of occurrence; and
- the transmission channel, on which is impressed the input signals and at whose output, the approximate version of those signals can be extracted; perturbed, by whatever noise and other channel vagaries are introduced in the transmission process.

Shannon showed, that within the limits established by the channel capacity, the effect of noise can be reduced arbitrarily at the expense of increasing the complexity of the encoder and therefore at the expense of an inevitable delay in the encoding and decoding process. He later derived mathematical bounds relating the probability of error at the receiver to the delay in the optimum coding processor.

The clue to future developments in signal processing lies in Shannon's exposition that we can extract the error free, or error reduced signal, "at the expense of increasing the complexity of the encoder", accepting of course, the associated processing delay.

Until recently we have had neither the technology nor the motivation to exploit this feature fully or cost effectively.

Recent developments in microprocessor technology are resulting in fundamental rethinking of old communications concepts and methodology. However, with the advent of large scale integrated circuits and more importantly, the promise in 1986 of very high speed integrated circuits (VHSIC) capable of operating at clock speeds of at least 25 MHz and several billion operations per second, relatively cheap, reliable and compact processing power will be at our disposal. This will enable information to be processed in ways undreamed of in the past.

Even more dramatic developments are likely in the more distant future. One can already sense many areas where quantum leaps in technology will take place. For example, magnetic bubble lattice memories, gallium arsenide semi-conductors and Josephson junction superconducting materials, to name a few, could lead to new approaches in the design of communications processors.

Given these powerful tools of processing and analysis, one of the problems still to be solved, relates to finding better ways of handling large masses of high speed sequential data.

Although super computers or near real-time communications processors of the future will approach the same density of logic gates as the brain (typically, 10^{10} neuron gates) and have clock rates (about 25 MHz) surpassing the speed of the brain (about 10 Hz) by some millions of times, they lack the high order of "connectivity" between logic cells to enable the parallel processing of vast amounts of information. This is a unique feature of the brain, whose "connectivity" is some hundred thousand times superior to the most advanced computer presently available. Indeed, it is this feature which makes the brain so adept at "pattern recognition" in all its many forms, related to all of our senses, all of which are involved in the communications process.

Such a capability may be achieved eventually in computer architecture as it evolves; however, quite different developments in electronics may lead to the solution of this problem of parallel processing and related "pattern recognition". These developments are in the field of coherent optical signal processing. This technology aims at integrating in a single solid state structure, an injection laser, a surface wave laser modulator, a wave guide geodetic lens, a Bragg opto-acoustic interaction cell and a charged coupled detector array.

Such a device may also offer communications engineers the essential tool they need to carry out the high speed parallel processing of large amounts of data, necessarily involved in manipulating many of the cumbersome functions related to communications such as matrix multiplication, convolution, a signal correlation, fourier transformation, spectrum analysis, matched filtering, pulse compression and the like.

It was perhaps in a light hearted vein at a recent symposium on Advanced Signal processing at Peebles in the UK that the Chairman remarked that he was driven to conclude there were three lemmas of signal processing which summarised the art:

- everything is the same as everything else,
- the solution to any problem in signal processing is to integrate longer; and, given
- sufficient matched filtering, cross-correlation and coherent integration, there is no need for an input signal!

Perhaps herein lies the solution to the problem of decoding those elusive galactic signals in the 10 to 100 GHz band, expected to arrive from some alien community; process and integrate the frequency band with a few years time constant and the message will emerge crystal clear!

ADVANCED SYSTEMS ENGINEERING

The need for rethinking overall system approaches was alluded to briefly in the introduction. This is probably worth re-emphasising in the light of some of the new developments in closely related technology.

Already we see new approaches being made to embrace the antenna system within the overall signal processing chain. This enables systems to be designed which can adapt their receiving beam patterns to optimise the reception of any desired signals which have been suitably coded for recognition and thereby reject unwanted signals which may arrive from other directions.

Fibre optic developments should not be overlooked. A good deal has already been published on the use of optical fibres as sensitive detectors of mechanical vibrations and magnetic fields. They may also be worth considering for electromagnetic sensor or detector applications, as an alternative to the conventional receiving antenna and detector. If the electromagnetic radio signal could be made to modulate a coherent electromagnetic signal from a local laser oscillator in a suitably modified part of the optic fibre itself, the received signal could then be extracted at the distant end of the fibre optic cable from an appropriate detector.

Completely new approaches to the problem of spectrum utilisation and management should also be "brain-stormed". With the very high speed signal processing soon likely to be at our disposal, it may well be possible to directly digitise large segments of the electromagnetic spectrum and, by digital processing, extract the desired signals.

CONCLUSIONS

If the past is anything to go by, we have yet to see many more inventions and innovations in electronics and computing science which will have a profound influence on the future development of radio communications.

Any attempt to predict them in any detail would probably appear ludicrous and far-fetched now; perhaps even more so in a few years time, when in all probability, they would be surpassed. The situation was summed up by Clarke in his first law relating to "Failure of Nerve and Imagination" [8] in which he postulated:

"When a distinguished but elderly scientist states that something is possible, he is almost certainly right. When he states that something is impossible he is very probably wrong."

It is apparent that a vigorous, open-minded and far-sighted programme of planning for the future is needed in all the many facets of radio communications.

Undoubtedly, the problems will be many both in the technical and sociological fields. However there can be little doubt that with the application of as much determination as has been demonstrated in the past, these problems will be overcome.

REFERENCES

1. Kramer, N. B., "Millimeter-Wave Semiconductor Devices", Trans. IEEE, Vol. MTT-24, November 1976, pp. 685-93.
2. Kantorowicz, G., Palluel, P. and Pontvianne, J., "New Developments in Submillimeter-Wave BWOs", Microwave J., Vol. 22, No. 2, February 1979, pp. 57-9.
3. Midford, T. A. and Bernick, R. L., "Millimeter-Wave CW IMPATT Diodes and Oscillators", Trans. IEEE, Vol. MTT-27, May 1979, pp. 483-92.
4. Golant, M. B. et al, "Wide Range Oscillators for the Submillimeter Wavelengths", Pribory i Teknika Eksperimenta, from a translation journal — Instruments and Experimental Techniques, No. 3, May-June 1969, pp. 801.
5. "Introduction to Extended Interaction Oscillators", Data Sheet No. 3445 5M, November 1975, Varian Associates of Canada Ltd., Georgetown, Ontario, Canada.
6. Chu, K. R., Drobot, A. T., Granatstein, V. L. and Seftor, J. L., "Characteristics and Optimum Parameters of a Gyrotron Travelling Wave Amplifier", Trans. IEEE, Vol. MTT-27, February 1979, pp. 178-87.
7. Gallagher, J. J., Blue, M.D., Bean, B. and Perkowitz, S., "Tabulation of Optically Pumped Far Infrared Laser Lines and Applications to Atmospheric Transmission", Infrared Physics, Vol. 17, No. 1, January 1977, pp. 43-55.
8. Clarke, Arthur C., "Profiles of the Future", — published by Popular Library (unit of CBS Publications), New York.

Call Charge Recording in the Papua New Guinea Telecommunications Network

J. P. STEENDAM, ARMIT, MIE.

Call Charge Recording (CCR) is a facility which provides telecommunication authorities with details of all long distance telephone calls (STD/ISD) made by each of its customers. The information obtained can consist of the calling and called parties' numbers, date, answer time, call duration, charging units and the costs.

In Papua New Guinea, existing ARF-102 primary exchanges are being converted to ARE-11 type exchanges and incorporate an electronic charging system which provides for storage on electronic accumulators of all charging units and the generation of CCR.

The CCRs are passed in real time via dedicated data links, to a central computer system and are used to substantiate bulk billing and telephone account queries. In addition, the electronic meters can be directly unloaded into the computer system for billing and automatic price advices.

INTRODUCTION

The Department of Public Utilities, Postal and Telecommunications Services, required that for the introduction of international subscriber dialling (ISD), detailed call charge records (CCR) of all long distance calls should be made available in order to substantiate the bulk billing system in use in this country.

In consequence, planning and implementation studies were conducted to determine optimum cost/benefits of the alternatives which included:

- provision of calling line identification (CLI) at the present ARF exchanges and provision of toll ticketing at the gateway ARM international exchange;
- introduction of one of a number of "add on" CCR systems;
- conversion of all ARF-102 exchanges to ARE-11 incorporating the electronic charging system (ECS).

The latter alternative was selected as it provided not only improved maintenance and customer facilities but also CCR for ISD calls and additionally, for STD calls within Papua New Guinea together with electronic metering. Further, a large increase in available tariff rates and charging pulses was achieved.

Bulk meter readings of every customer's electronic accumulator in the exchange can be extracted and passed to a centralised computer for preparing monthly customer accounts or for immediate billing of a single customer who may wish to terminate a telephone service.

Modifications and design changes were required to the initial ECS to permit all customer's STD and ISD call details from ARE-11 exchanges, to be passed to the operations and maintenance processor and then to be sent to the centralised computer, for storage and subsequent retrieval. Primarily, these changes concerned the real time transfer of CCR data and the remote command initiated transfer of electronic metering to a centralised computer, instead of dumping onto tape within each exchange.

A contract was placed with L. M. Ericsson, Australia for the initial ARE-11 conversion, with Level 4, OMPOS 2 and the modified ECS for the Ela Beach terminal exchange in Port Moresby. This further included the provision of an input/output terminal (IOT) at the exchange and a communications processor (COMMPROC) at the computer centre enabling up to twelve ARE-11 exchanges to be connected, using a derivation of X25 data protocols via V24 data links.

Subsequently, world wide tenders were called for the provision of centralised computer hardware and software to permit:

- storage, retrieval, display and printout of all CCR information for each individual customer's STD and ISD telephone calls during each monthly billing period, as well as bulk meter readings and individual meter readings;
- provision of a telephone order, records and billing system.

On the basis of these tenders, a contract was placed with Honeywell for the provision of a Level 6/47 computer and associated peripheral equipment.

The software and application programme packages contract was awarded to Ward Information Systems of South Yarra, Victoria, Australia. This company could demonstrate a distinct advantage in the tender procedure by virtue of their proprietary software tools.

These software tools included:

- CRT 400, which is a suite of programs which simplifies the development of interactive Cobol programs.
- RPT 400, which is a report program generator and assists in coding of programs.
- TRE 400, which provides data base facilities using standard Honeywell file management software.

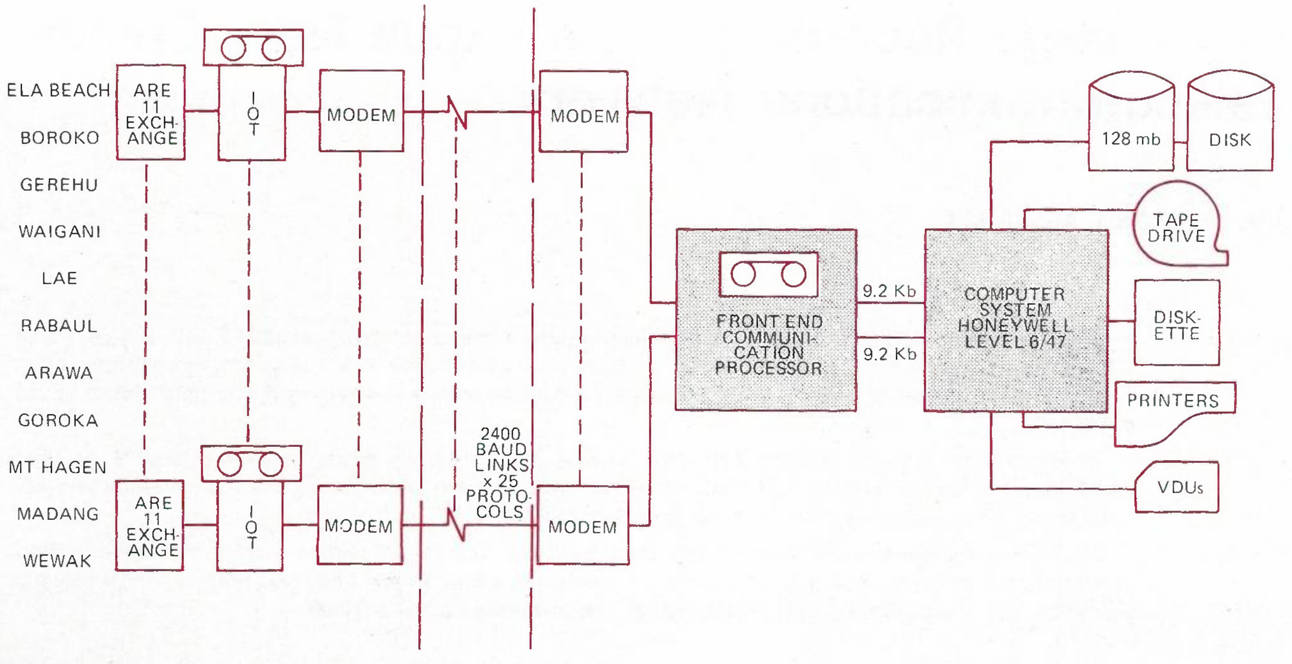


Fig. 1 — System Overview.

SYSTEM OVERVIEW

The basic configuration of the system is shown in **Fig. 1**. The CCR messages generated by each ARE-11 exchange are sent via the IOT and passed to COMMPROC via data links.

The COMMPROC comprises an APN 163 processor, synchronous line adaptors/modems, asynchronous line adaptors, maintenance terminal and a cartridge dual tape drive and interfaces, up to 12 ARE-11 exchanges. The physical links between IOT and COMMPROC are synchronous full duplex data links operating at 2400 baud. The link access procedure (LAP) is based on CCITT X25 together with the packet level interface (PLI) and message transfer protocol (MTP). The CCITT X25 protocol was required to ensure integrity of data transfer by means of headers and trailers for each block of CCR messages and the retransmission capability.

Between the COMMPROC and Honeywell Level 6/47 computer, the physical links are asynchronous, full duplex operating at 9.6k baud and conform to CCITT V.28.

The Honeywell commercial processor system comprises a Level 6/47 computer with an initial main memory unit of 750 kB, two 128MB mass storage units, a single 256kB diskette drive, a nine track tape unit for archival purposes and associated printers and visual display units.

This system initially handles the following broad functions:

- collects CCR data on-line as generated by ARE-11 exchanges;
- initiates monthly readings of all or individual electronic eight digit accumulators from each ARE-11 exchange;
- provides display and printout facilities of all STD and ISD calls per customer on a monthly billing basis;
- retrieval of CCR data stored on back-up cartridge tape as a result of failure or errors in the computer, COMMPROC or data links.

ELECTRONIC CHARGING SYSTEM

The ARE-11 ECS is used for the generation and storage of charging pulses on electronic accumulators,

JOHN STEENDAM is an Executive Manager with the Post and Telecommunication Corporation in Papua New Guinea and is responsible for the Planning and Design Department.

He is on secondment from Telecom Australia where he commenced in 1957 and worked in Country Installation until joining Headquarters in 1973 as a Senior Engineer in the Telephone Switching Planning Branch. In 1977, he went to Papua New Guinea and intially was responsible for the implementation of ARE-11 exchanges, the Electronic Charging System and the computer system which captures the Call Charge Recording data.

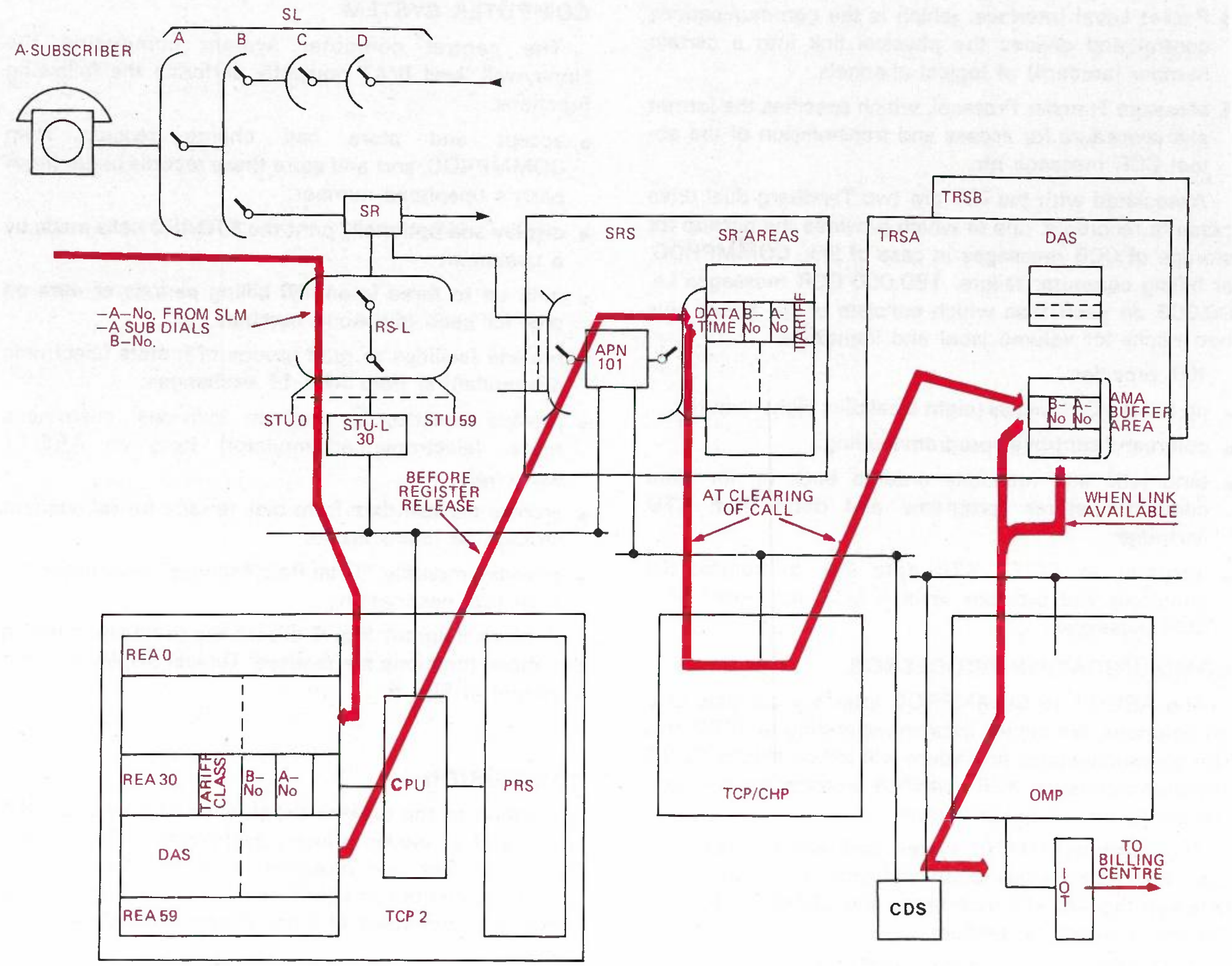


Fig. 2 — CCR Message Origin and Transmission.

charging statistics and presentation of detailed call charging records.

Basically, the ECS contains SR-scanners (SRS), duplicated charging data stores (CDS) and charging processor (CHP), together with storage facilities in the translation store (TRS), subscriber category store (SCS), the operations and maintenance processor (OMP) and the traffic control processor (TCP).

The main elements of a CCR message are stored in the ARE-11 exchange. The ECS merely has to take these elements from relevant data stores, add the other elements and pass these to the output stage for transmission to the central computer system.

The procedure of this transfer is shown sequentially in **Fig. 2** by the arrowed heavy lines.

The SRS scans the line conditions (A and B parties) of the SR, calculates the time interval required between multimetering pulses and stores each CCR message until unloaded. At the end-of-selection process, the TCP transfers the tariff class to SRS which then determine the pulse rate. The CDS stores the metering pulses in an electronic accumulator associated with each customer. The accumulator size is 24 bits and the counter provides capacity for 10 million charging pulses. The OMP can order the contents of each accumulator to be read out in decimal code for transfer to a printer or to the centralised computer centre.

Each CCR message is stored in the TRS which acts as a buffer and arranges for eight CCR messages to be transferred each time.

The transfer of CCR messages as well as the bulk and individual meter readings, are passed from the OMP to the IOT which provides the interface between the telephone exchange and the data links for interworking with the COMMPROC. CCR messages are spontaneous whilst bulk and individual meter readings are obtained on command from the centralised computer.

The IOT further contains the data link controller (DLC) for communication on a synchronous data link to COMMPROC. In the case of Papua New Guinea, a 2400 baud rate is used which means that each CCR message takes approximately 240ms to send. The central unit in IOT and DLC each consists of an APN165-03 microcomputer and have various connection units between each other and the OMP. The DLC communicates with the COMMPROC via a physical link and information is transferred on a number (maximum 8) logical channels in accordance with CCITT Recommendation X25. There are four levels of operation:

1. Physical Interface, in accordance to V24 for operation and handling of modems.
2. Link Access Protocol, for transmission and reception of frames.

3. Packet Level Interface, which is the communications control and divides the physical link into a certain number (amount) of logical channels.
4. Message Transfer Protocol, which specifies the format and procedure for access and transmission of the actual CCR message etc.

Associated with the IOT are two Tandberg dual drive cassette recorders, one of which provides the backup for storage of CCR messages in case of link, COMMPROC, or billing computer failure. 180,000 CCR messages i.e. 90,000 on each tape which consists of six tracks plus two tracks for volume label and identifiers.

IOT provides:

- up to 16 I/O devicess (eight local plus eight remote);
- command controlled program loading;
- automatic and manually ordered back up for semi conductor stores (programs and data) from CTU cartridge;
- adaption to CCITT X25 data link to commercial computer and provides level 4 MTP for blocks of 8 CCR messages.

COMMUNICATION PROCESSOR

The ARE-11 to COMMPROC interface consists of a synchronous, full duplex data link operating at 2400 bps. The communications procedure will follow that by CCITT in recommendation X25 specified protocol for link control and communication control.

The fourth level (MTP), system and user application, is used for control information and data (CCR messages) between the ARE-11 exchanges and COMMPROC with the link protocol as medium.

COMMPROC is a type APN163 miniprocessor connected to the commercial computer via full duplex V24 interfaces operating at 9.6 k baud. COMMPROC handles the input of CCR data which are sent on logical channels over X25 data links from each ARE-11 exchange onto the commercial computer which acknowledges, after secure storage. COMMPROC further handles commands transmitted to the ARE-11 exchanges to obtain individual or bulk meter readings of the electronic accumulators and unloading of the cassette tape recorders.

The principal components of the COMMPROC are indicated in **Fig. 3**.

COMPUTER SYSTEM

The central computer system comprising the Honeywell level 6/47 presently performs the following functions:

- accept and store call charge records from COMMPROC, sort and store these records under the A party's telephone number;
- display and optionally print the STD/ISD calls made by a customer;
- hold up to three (monthly) billing periods of data on disk for each telephone number;
- provide facilities to read groups of meters (electronic accumulators) from ARE-11 exchanges;
- provide facilities to read an individual customer's meter (electronic accumulator) from an ARE-11 exchange;
- archive old call data from disk to tape for subsequent storage on micro fische;
- provides monthly "Total Paid Minutes" summaries for each ISD destination.

A block diagram **Fig. 4** shows the principal in which the above functions are realised. Typical display printout is shown in **Fig. 5**.

CONCLUSION

In addition to the present programme of providing CCR facilities at all eleven primary exchanges in Papua New Guinea, studies and proposals exist to provide these facilities to customers connected to the existing 38 rural exchanges comprised of ARK-M and Meta Conta rural systems.

The CCR function is performed at the primary exchanges (parent end) and requires calling line identification at each of the rural exchanges. Furthermore, electronic metering is to be incorporated in the rural exchanges which will result in fully automated billing and account preparation by the central services computer for the entire Papua New Guinea telecommunications network.

It is of interest to note that after the first conversion of the Ela Beach exchange to ARE-11, the account queries rate has decreased from approximately ten percent of all customers to less than one percent.

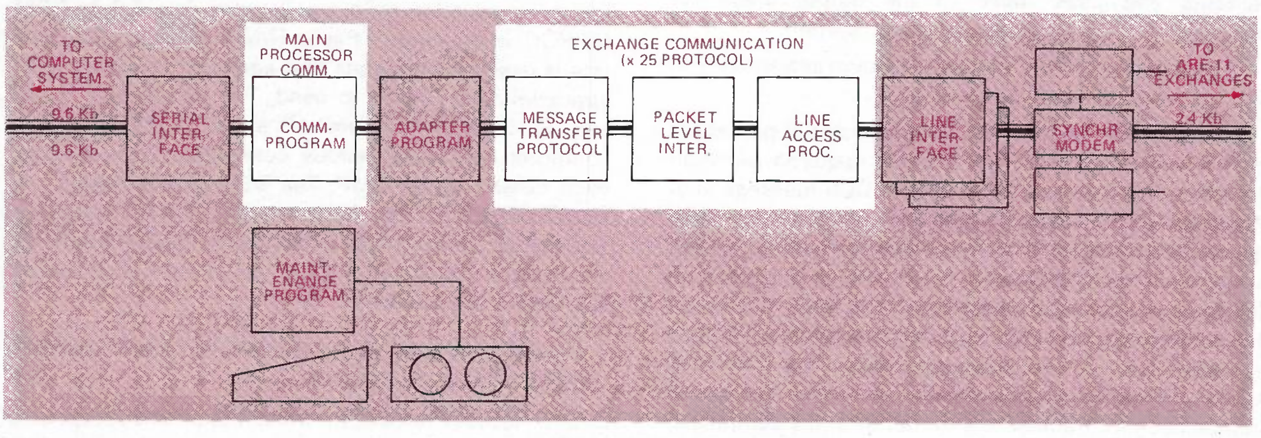


Fig. 3 — COMMPROC Configuration.

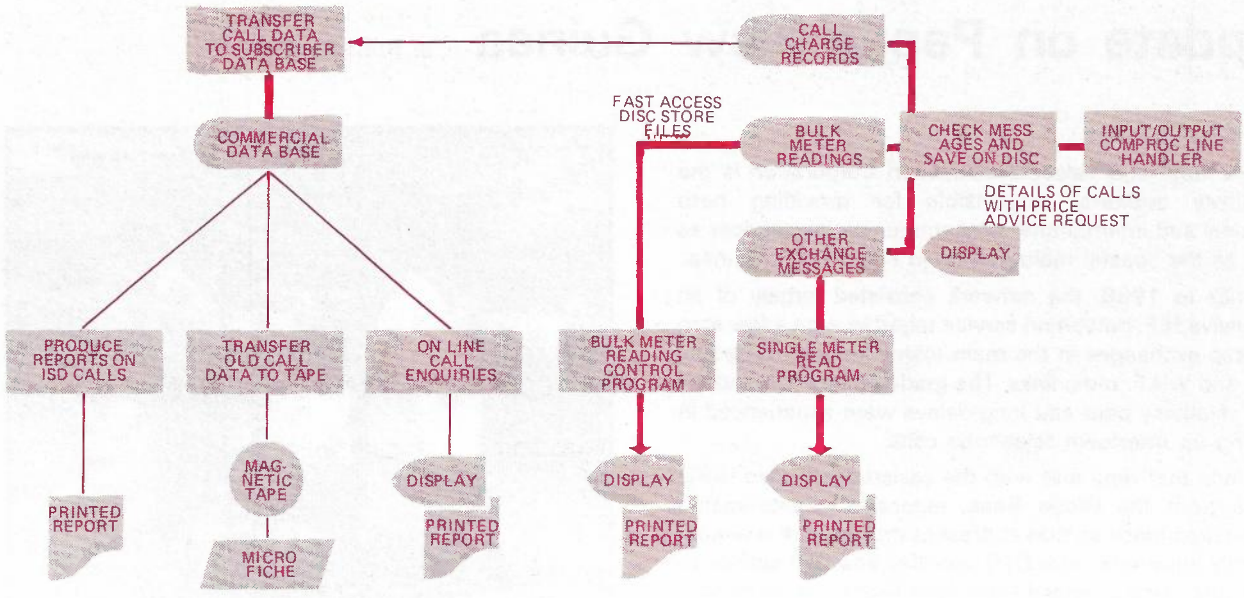


Fig. 4 — Application Programs.

POSTAL AND TELECOMMUNICATION SERVICES - PAPUA NEW GUINEA

TELEPHONE NUMBER 211905 PERIOD 4 01-JUN-82 TO 28-JUN-82 PAGE 1

DATE	CALLED NUMBER	ISD	DES	ANSWER	DURATN.	UNITS	COST (K)
3-JUN	308442387	*	AUS	1129:39	04:25	67	6.70
3-JUN	3026990044	*	AUS	1543:55	00:56	15	1.50
7-JUN	3033367797	*	AUS	2132:24	19:45	297	29.70
9-JUN	3033367797	*	AUS	1619:17	06:25	97	9.70
9-JUN	3033367797	*	AUS	2114:44	00:53	14	1.40
9-JUN	3033367797	*	AUS	2201:33	11:32	173	17.30
10-JUN	3033367797	*	AUS	1654:30	02:53	44	4.40
10-JUN	721015		GKA	1800:01	01:18	4	0.40
10-JUN	3033367797	*	AUS	1856:35	05:20	80	8.00
13-JUN	3144482655028	*	GBR	2221:07	05:03	101	10.10

TOTAL COST: STD CALLS = K 0.40 ISD CALLS = K 88.80

Fig. 5 — Typical Printout of CCR Data.

Update on Papua New Guinea

J. P. STEENDAM

INTRODUCTION

The Post and Telecommunication Corporation is the statutory authority responsible for providing both national and international telecommunication services as well as the coastal radio service in Papua New Guinea.

Prior to 1968, the network consisted largely of an extensive H.F. outstation service together with a few step by step exchanges in the main towns interconnected by H.F. and V.H.F. radio links. The grade of service provided was relatively poor and long delays were experienced in setting up intertown telephone calls.

Since that time and with the assistance of two IBRD loans from the World Bank, extensive improvements have taken place so that at present the network is almost entirely automatic with STD facilities and ISD service to Australia being provided from each telephone exchange.

PRESENT NETWORK

The telephone network presently consists mainly of L. M. Ericsson crossbar equipment incorporating ARE-11, ARF-102 (primary centres) and ARK-521/522 type exchanges. The primary centres at the main towns are interlinked by extensive backbone microwave systems with many of the repeaters powered by solar energy. Most of the smaller provincial and sub provincial centres contain ARK-521/522 rural exchanges and are parented on the primary centres via tropospheric, microwave or U.H.F. radio systems. Final choice routes are provided via a national ARM-201 exchange in Lae for the primary centres.

The network uses a six digit closed numbering scheme for the entire country and presently has approximately 37,000 equipped telephone lines.

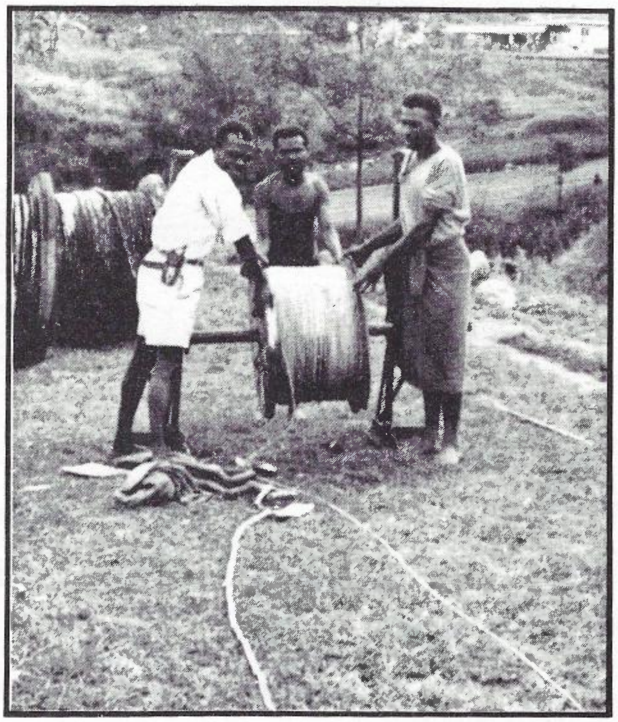
Stored program controlled telex exchanges at Lae and Port Moresby provide data and telex facilities to a rapidly increasing number of customers.

International service is provided by the Lae ARM-201 gateway exchange via the SEACOM and Australia-Papua New Guinea (A-PNG) submarine cables. An Intelsat 'B' earth station is programmed for installation in 1983 to cater for increased overseas traffic.

ARE-11 EXCHANGES

Recently, the first conversion of an ARF-102 exchange to ARE-11 stored program control was completed and incorporates an electronic charging system capable of storing metering pulses on electronic accumulators and the generation of call charge records of every STD/ISD call made by each customer. The call charge records are passed in real time to a centralised computer system and used to substantiate the present bulk billing system. In addition, the electronic accumulators can be unloaded by command from the centralised computer system and paves the way for fully automating the preparation of customer accounts.

The provision of call charge records was required, in line with a policy to provide these details, for extension of ISD to a number of other countries. Further conversions of primary centres to ARE-11 are being progressively introduced.



Measuring lengths of one pair cable for house lead-ins in north Goroka

RURAL DEVELOPMENT

Future expansion of the network is now being directed to the rural areas. There are nearly 10,000 villages in Papua New Guinea located in remote and difficult to access, locations in very rugged terrain with virtually no roads. Many of these remote villages are presently served by a H.F. outstation radio service but the introduction of full automatic telephone services is gradually being implemented.

Extensive use is being made of single V.H.F. radio links, small capacity radio bearers, electronic line concentrators for small villages (less than 100 lines) and the electronic Meta Conta rural exchange system.

Multiple access radio systems are also being introduced and have the advantages of covering a number of subscribers spread over a large area.

RADIO AND TV

Radio broadcasting in Papua New Guinea is provided by the National Broadcasting Commission who operate two separate radio services (one of which is stereo F.M.) throughout the country.

The Post and Telecommunication Corporation provides the necessary telecommunications and programme channels for radio broadcasting to various centres in the country and also the allocation of frequencies for all broadcasting transmitters.

Introduction of television is presently being studied by a number of committees constituted by the Government. Whilst a policy for provision of television has been approved in principle, further evaluations of the economic, social and technical ramifications are required before final approval can be determined.

Network Planning for the Upgrading of Telecom's Directory Assistance Service

Charles J. DOUGALL B. Com., A.R.M.I.T. M.I.E. (Aust.)

In the late 1970's the need was recognised for the upgrading of the procedures used for the look up of directory information in the Directory Assistance Service. A project team was established to plan this upgrade through the implementation of computer information storage and retrieval systems and Automatic Call Distribution Systems. This paper outlines the background to the upgrading plans and the main strategies leading to implementation throughout the Australian network.

INTRODUCTION

In Telecom Australia's Directory Assistance Service (DAS) operators employ paper records for the retrieval of directory information. In the mid to late 1970's it became clear that satisfactory levels of service to the customer could only be maintained at very high cost because of the highly labour intensive nature of the service. In addition there were growing delays (several weeks in many cases) in the update of directory information on paper records held at DAS centres.

Accordingly in early 1978 a project team was formally established in the Engineering Planning Division HQ to plan the introduction of a national computer system for the storage and retrieval of directory assistance information.

This paper outlines the background to the project and presents the main events leading to implementation, nationwide, of a computer directory assistance system and associated Network Automatic Call Distribution (NACD) Systems.

BACKGROUND

The service difficulties associated with the paper records DAS stemmed from a continuing growth in calls, effort wasting manual procedures, inadequate equipment and the high cost of operating a highly labour intensive service.

For these reasons the service level objective of answering 90% of calls within 10 seconds was not being achieved. Service levels varied between 60%-90% depending on the time elapsed following publication of the directory. Furthermore, a high proportion of calls generated by customers (estimated at about 20%) were not being answered at all.

Telecom Australia's "013" DAS centres (local numbers) were achieving average operator holding times per call in the range of 50-80 seconds, and longer average holding times applied on calls for interstate or intrastate numbers. Methods studies and other attempts to reduce operator holding times produced only limited improvements.

Administrations overseas which had faced similar problems with DAS had established computer systems to improve productivity of operators and, average holding times of less than 30 seconds were being widely achieved.

Between February and August 1979 a trial was successfully conducted in Sydney (Ref. 1) of a computer DAS system. The trial confirmed that significant productivity gains could be achieved with a computer DAS system.

In November 1979, Telecom management approved the replacement of paper records in all DAS centres in Australia by a computer system with a directory data base that operators would access via a visual display unit (VDU). In addition, approval was given to restructure the network for switching of calls to DAS operators through the implementation of new Network Automatic Call Distributor (NACD) Systems.

RELATIONSHIP OF DAS WITH MAC PLANNING

At the time the project team was established, a rationalisation of Manual Assistance Centres (MAC's) was under investigation and it was appropriate to link the study of the upgrade of DAS with overall MAC planning. This gave rise to the planning of NACD's not only for DAS but also for other manual services.

The planning of the DAS network (computer system and NACD's) particularly the location and dimensioning of MAC's was integrated with the overall review of Manual Services which was conducted concurrently with DAS planning. A major thrust of the review of Manual Services was the pooling and centralisation of Manual Services traffic and, the decentralisation of operator positions to achieve economies in position quantities and MAC locations.

It was planned to utilise the NACD for DAS in accordance with this objective and to queue calls on the NACD for other Manual Services in addition to DAS. The NACD will perform multi-service functions, initially serving the DAS, Service Assistance and Phonograms. A diagram showing this trunking principle is shown in **Fig. 1**.

PROJECT OBJECTIVES

Planning for the upgrade of the DAS proceeded in accordance with the following major objectives:

- Containment of the cost of operating the DAS

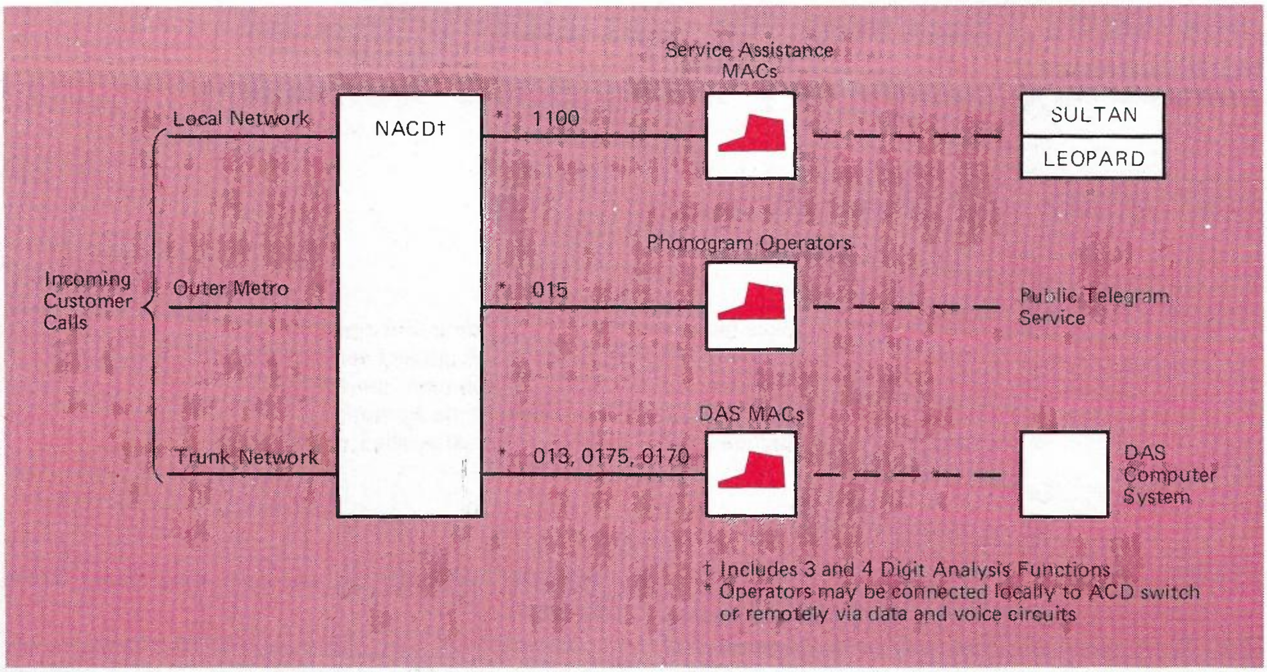


Fig. 1 — Network Automatic Call Distribution — Trunking Principles.

- Improvement of the service to customers through the following objectives:-
  - — 90% of calls to be answered within 10 seconds
  - — average operator holding time to be reduced to 35 seconds per call;
  - — provide new and altered numbers to DAS operators within 48 hours of reciept by Directories Branch.
- Improvement of operator working environment and job satisfaction.

It was planned to achieve these objectives through the following action:-

- Progressively replace, commencing in 1981/82, the system of manual search of paper directories; it was planned to provide each operator with a visual display terminal with access to a computer directory assistance data base.
- Provide NACD systems to serve as queue systems between the telephone network and DAS operators. It was planned that each State's DAS customer enquiry traffic would be concentrated through one or two NACD centres in each State with remote access to operators in MAC's in the State.

PROJECT STRATEGY

The project strategy to reach the stage of implementation nationally of the proposed systems was based on three broad phases:-

- Conduct of a trial in the Sydney 013 centre of a computer directory information retrieval system;
- In parallel with the trial, prepare plans for systems tc be implemented nationally;
- Subsequent to the trial, select for purchase, through the calling of world-wide tenders, an NACD system and a computer DAS system for implementation throughout Australia.

NETWORK SPECIFICATION

Customer Access Network

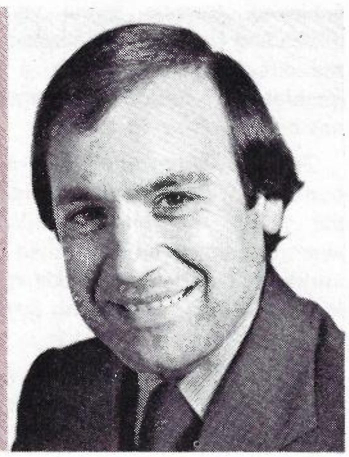
The present system for access by customers to a DAS operator is a "Near End Customer Dialling" arrangement where operators are located geographically close to the

Charles Dougall is presently a Principal Engineer in the Engineering Planning Division, Telecom Headquarters.

He joined the APO in 1968 as a Cadet Engineer and commenced work in telephone network planning and construction in the Victorian Administration.

In 1976, he joined the Planning Division, Headquarters, where he worked on telephone switching planning and was Project Manager for the DAS project from 1978 to 1981.

Following a 12 month period in Product Management in the Commercial Services Department he resumed with the Engineering Planning Division in late 1982.



customer and are able to supply information on all national numbers. An alternative arrangement ("Distant End Customer Dialling") was studied where customers would access via the telephone network operators located in the region applicable to the number enquiry.

The main technical difference between the two arrangements is the relative cost of telephone network versus data network access. Under the near end method telephone network links between customers and operators are short. Depending on the design of the computer information retrieval network, the operator may access a near or distant computer data base via data circuits. Under the "Distant End Customer Dialling" arrangement the costs of access to distant numbers are borne by the telephone network. Customers are required to identify, at least to State level, the location of the number sought and to dial via the STD network the appropriate interstate operator, if an interstate number is required.

A cost study of the two alternatives showed that a network configuration based on "Near End Customer Dialling" would be more cost effective than a network which required the use of interstate telephone network connections between customers and operators. Furthermore, a preference for retaining the existing customer dialling arrangement was enhanced by the high expenditure required to educate customers to contact distant end operators, and by the network complications and costs arising from trunk access barring and digit analysis capacity in terminal exchanges. Therefore, it was decided to retain the existing near end trunking and to configure the computer retrieval network in accordance with this.

The NACD was required to act as the interface between the customer and the DAS operator in accordance with Fig. 1 and to achieve economies in position dimensioning through the pooling of manual assistance traffic. The main functions of the NACD in achieving these network requirements were:

- call concentration and queuing for customers' calls generated within state networks;
- digit analysis to achieve economies of network trunking and route dimensioning;
- interface with the existing network's line and information signalling as well as the future requirement to interface with proposed line signalling based on the CCITT R2 (Digital) specification;
- remotely connect operators from the NACD switch over distances up to 800 kms.

Computer Network

When tenders were called for the computer retrieval network, tenderers were invited to offer a network configuration of their own design in accordance with the near end customer access network described above and other specifications of network dimensioning and performance.

The computer network was required to comprise:

- Visual Display Units
- Information retrieval systems and data bases
- Systems to generate update of the data bases

The design of these components was the responsibility of the computer network supplier provided that:

- any VDU located at any MAC could be used to retrieve any telephone number listing in all state directories;
- VDU's could be interconnected remotely or locally with information retrieval systems;
- the network was configured to meet specified traffic, data base size and response time requirements and specified quantities of MAC's and VDU's. These quantities were supplied for each State and they are summarised as national totals in **Table 1**.

ITEM	SPECIFICATION	
MAC's	46	Note 1
VDU's	738	Note 1
Response Time	2 seconds	Note 2
Customer Enquiry Transaction Rate	23 per second	
Data Base Size	400 mill. characters	

Note 1: The quantities of MAC's and VDU's were specified for tendering and planning purposes and were subject to change in implementation.

Note 2: Defined as the elapsed time between depression of the last key in the VDU keying sequence and appearance of the last character on the screen.

Table 1 — Computer Network Specifications

CONCLUSION

The project strategy objectives were achieved by late 1981 culminating in the selection of system suppliers.

IBM Australia Ltd. was selected to supply its DAS/C computer information storage and retrieval system (Ref. 2) and L. M. Ericsson Pty. Ltd. was selected to supply its ASDP 126 Automatic Call Distribution System.

Following system selection detailed implementation plans were prepared in conjunction with all States and two implementation project teams were formed. One team, responsible for the NACD, was established in Telephone Switching Construction H.Q. and the second team was formed in Directory Services H.Q. with responsibility for the computer system (Ref. 3). These two teams took the project into the implementation phase, extending the planning work conducted by the original project team.

REFERENCES

1. Dougall, C. J., "Trial of a Computer Directory Assistance System — Sydney," Telecommunication Journal of Australia, Vol. 31, No. 1, 1981.
2. Baxter, I. and Lyon, H. "The National Computerised Directory Assistance Service — DAS/C", Telecommunication Journal of Australia, Vol. 32, No. 2 1982.
3. Backman, R. and Fraser, J. A. "DAS/C and NACD Project Management" Telecommunication Journal of Australia, Vol. 33, No. 1, 1983.

INTRODUCTION: Refresher topics have been introduced into the range of TJA features on the suggestions from several readers. The papers produced under this heading will not be detailed but presented in a generally interesting format for the benefit of the broad spectrum of our readership. The first series of papers will deal with OPTICAL COMMUNICATIONS and these will be followed by a group on DIGITAL TRANSMISSION and DATA COMMUNICATION. In each case we are indebted to the Information and Publicity Office of Telecom for supplying the original material.

OPTICAL COMMUNICATIONS Pt. 1

The Speed and Nature of Light

The ancient Greek philosophers, around 300 BC, had thought that the speed of light was infinite. This view persisted for a very long time for, although light does have a definite, limited speed, it is so rapid that no means were available that could come close to measuring it until a few centuries ago.

Galileo, the great Italian scientist and astronomer, tried to measure the speed of light in the late 16th Century. He arranged for two men to take lanterns to the tops of hills separated from each other by a few kilometres. One man was to uncover his lantern at a particular time. The moment the second man saw the light, he was to uncover his own lantern. The first man would then note how long a time elapsed from when he uncovered his lantern to the time he saw the light from the second man.

However, when it was tried in practice, it was found that the delay in seeing the returning light was due entirely to the time it took the second man to react to seeing the light and to uncover his own lantern.

About a hundred years later, almost by accident, a good estimate was found for the speed of light by a Danish astronomer, Olaus Roemer. Roemer had been observing the moons of the planet Jupiter. The movement of the moons by then was known with a great deal of accuracy, but to his surprise, the moons seemed to be late in arriving where they were supposed to be. This was at a time when Jupiter was furthest away from the Earth. When Jupiter was at its closest, the moons were consistently early in their motions. After an extended series of observations, he realised that the effect was caused by light taking longer to reach the Earth from Jupiter when it was further away than when it was closer.

Roemer came up with a figure for the speed of light. In modern units, he calculated that light travelled at 227,000 kilometres per second!

The accepted modern figure for the speed of light is 299,792 kilometres per second.

Since before Roemer's time up until the beginning of this century, argument raged as to whether light was made up of waves or particles. One point of view said that light was a wave travelling through space like ripples travel through water; and there were a number of examples of ways in which light behaved like waves. On the other hand, there was the idea that light was like little hard balls zipping along and bouncing off objects; and again, there were ways in which light seemed to behave like this.

Light has been found to be a form of electromagnetic radiation, along with such things as radio waves, radiated heat, ultra-violet light and X-rays. They are called electromagnetic because they are made up of linked electrical and magnetic fields moving through space.

Any wave has two characteristics that distinguish it: the difference in height between the crests and the troughs (called the 'amplitude' of the wave); and the distance between the crests (called the 'wavelength'). It also travels at a certain speed depending on the medium it is travelling in.

There is one more characteristic of waves, but it is dependent entirely on the wavelength and speed of the waves. This is their 'frequency,' which is a measure of how many wave crests pass a stationary point in one second. If you think about it a little, you can see that, if the waves are travelling at a standard speed, then the frequency is entirely dependent on the wavelength. The longer the wavelength, the further apart the crests are, so, the fewer that pass a stationary point in one second, the lower is the frequency.

Light shares all of the characteristics of other waves. It comes in a variety of different wavelengths (and therefore frequencies). You can, in fact, tell very easily one kind of light at one wavelength from that at another wavelength, because our eyes interpret different wavelengths of light as being of different colours. Red light has a longer wavelength than green light, which in turn has a longer wavelength than blue light. A rainbow shows us the whole spread of different wavelengths of visible light. We call this spread the 'spectrum' (from the Latin word meaning 'something seen.').

But our eyes can only see a limited range of wavelengths. There are electromagnetic radiations of longer and shorter wavelengths than those of visible light. For example, the light of shortest wavelength we can see is violet. Radiation of somewhat shorter wavelength, or high frequency, is quite common. It is therefore called 'ultraviolet,' meaning 'above violet' (in frequency). Similarly, radiation of longer wavelength than red exists, though we can't see it. It has longer wavelength, therefore lower frequency, so it is called 'infrared' meaning 'below red.'

But this is still just a small part of the full electromagnetic spectrum. At wavelengths much longer than those of light, there are radio waves. At wavelengths much shorter than light, there are X-rays and gamma rays.

But it's interesting also to know just how long the wavelengths of visible light are. We are used to ripples on a pond having crests which are a few centimetres apart. But a ray of green light is made up of waves whose crests are only about 50 millionths of a centimetre apart!

(Part II, in the next issue will be about LASERS).

DAS/C and NACD PROJECT MANAGEMENT

R. BACKMAN, Dip. Com Eng., J. A. FRASER, Dip. Com. Eng.

The introduction of an automatic Directory Assistance Service (DAS/C) and associated Network Automatic Call Distributor (NACD) is a complex project with many interdependent activities involving Telecom, IBM and L. M. Ericsson. The paper describes the arrangements established for the management and control of this significant project.

INTRODUCTION

From the outset it was recognised that a strong project management structure was needed to control the various facets of the project.

Overall, the project involves the installation of:

- 700 VDUs and special work stations
- 240 data links
- 560 modems
- 120 medium capacity computers
- one large computer and associated peripherals
- nine NACD's and one model configuration

The work will affect some 2,000 operators, all of whom will be retrained. Forty-two Manual Assistance Centres (MAC's) will be refurbished and computer centres for the retrieval system will be established in the five mainland capital cities. Computer centres will also be established in the Directories Branch in each State. Two NACD's will be installed in NSW, VIC, QLD. and one NACD in SA, WA and TAS.

The introduction of the national DAS/C system is the responsibility of the Directory Services Division (HQ). Engineering Department (HQ) is responsible for specification of the NACD system and preparation of guidelines for the States who will install and operate the system.

The DAS/C system, selected for national implementation in Australia, is an IBM information data base and retrieval system used by operators to provide directory information to customers calling Directory Assistance (Ref. 1). Calls from the telephone switching network are directed to the operators via the NACD — an LME queueing system (Ref. 2).

The duration of the project is expected to extend over the four years from 1981 to 1985. Capital investment in computers, related equipment and buildings will exceed $30 million (1980 prices).

BROAD DESCRIPTION OF THE SYSTEM

The DAS/C is an IBM system currently operating, or being installed, in many telephone administrations throughout the world. A substantial software development was undertaken in Australia to:

- enable creation of the directory data base from existing directory listings; and
- update the data base on a daily basis via a data entry system located in each State Directory Branch.

The NACD is based on the LME queueing system ASDP 162 which is already in use in Australia by a number of organisations, such as QANTAS and the Victorian TAB, who have large volumes of telephone traffic to be answered by manual operators. Although a basic ASDP 162 system has been purchased, some enhancements have been introduced to provide new system facilities and to enable interworking with the Australian switching network. The system will be used to provide a number of services off the one NACD such as Directory Assistance, Service Assistance, Phonograms and Emergency. A number of MAC's can be served remotely by a single NACD.

A block diagram of the DAS/C and NACD system configuration is shown in **Fig. 1**. Calls to Directory Assistance are routed from the telephone switching network to the NACD which allocates the calls to the required group of operators. An available, or the next free operator answers the call and takes the enquiry from the caller. The operator interrogates the DAS/C retrieval data base via a keyboard and associated VDU to obtain the relevant directory information. When this information has been communicated to the caller the operator releases the information and the call by clearing the VDU screen.

The data base which stores the directory information is updated daily from a separate update system.

PROJECT MANAGEMENT

Major Issues

Following selection of IBM and LME systems from world wide tenders, timetables were established between Telecom and the contractors which allowed approximately 15 months for issue of contracts, adaptation, delivery, installation, acceptance, operation and support for these systems.

Some key aspects were:

- Establishment of project timetables and co-ordination between DAS/C and NACD management groups
- Issue of contracts —
  - — finalisation of technical specifications
  - — preparation of material lists
  - — arrangement of delivery schedules
  - — definition of commercial conditions
  - — software development to enable DAS/C to operate within existing Australian organisational arrangements

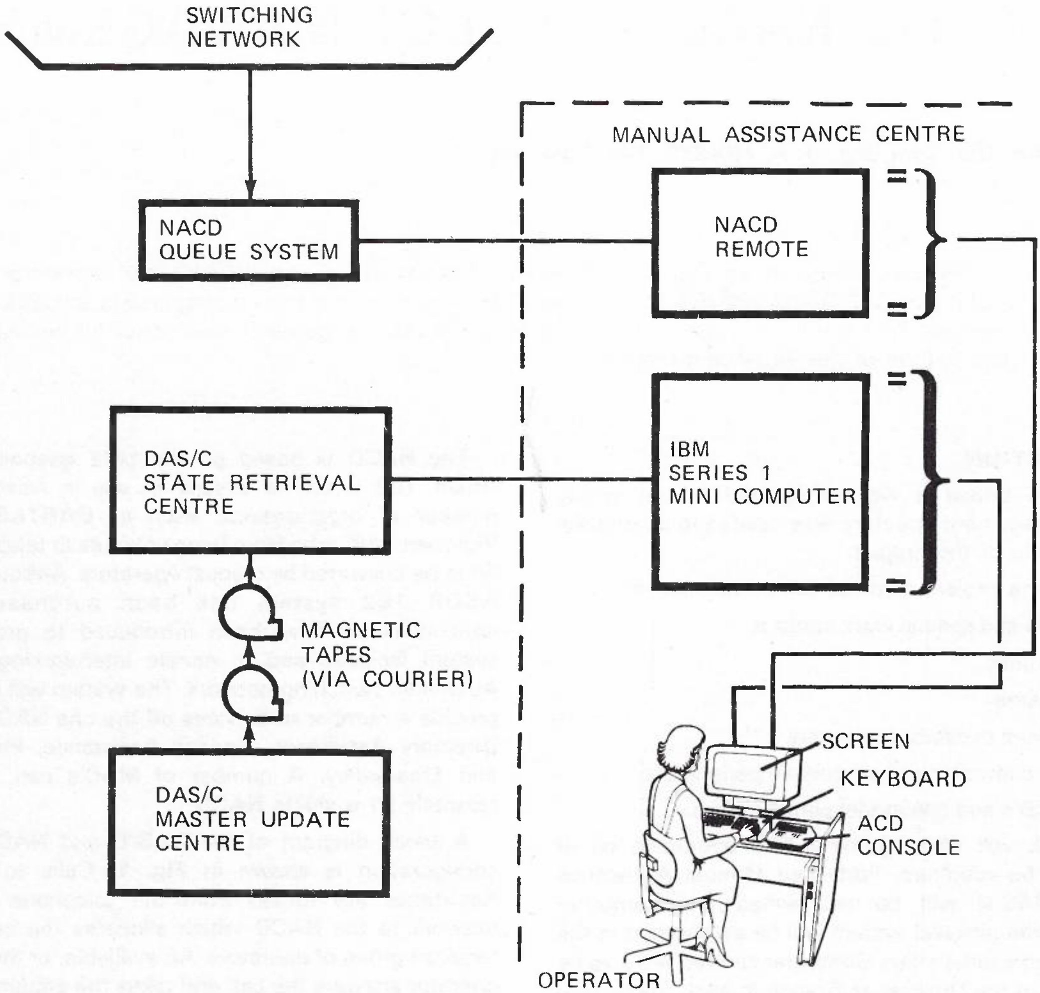
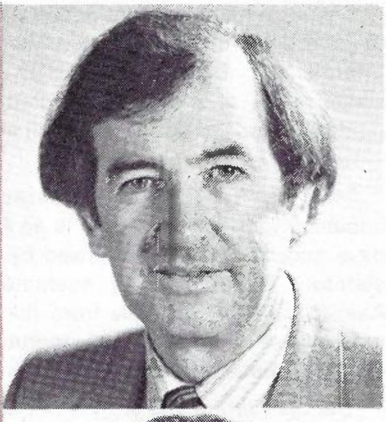


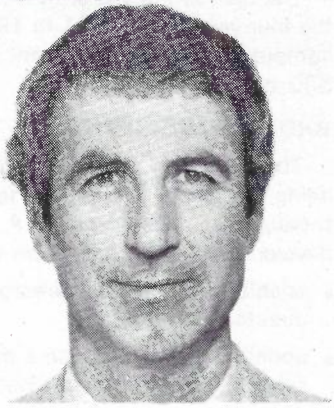
Fig. 1 — DAS/C and NACD System Configuration



ALISTAIR FRASER is the DAS/C Project Manager with Directory Services Division at Telecom Australia Headquarters.

He commenced with the Australia Post Office in 1953 as a Technician in Training and worked with Construction Branch, Victoria, mainly on Country Installation projects, before moving to Telephone Switching Equipment Section of the Engineering Works Division in 1968 where he was involved in the works programming aspects of the Trunk Switching Network.

After completing his Engineering qualifications at Royal Melbourne Institute of Technology in 1974 he worked with the Planning and Programming Branch, Victoria on the switching aspects of exchange and network planning prior to taking up his present position.



REG BACKMAN joined the Australian Post Office as a technician-in-training in 1950. He progressed through the technical area to a supervisory position. After completing a communications engineering diploma at RMIT in 1965, he worked in a number of planning and construction areas in the Victorian Administration. In 1973 he transferred to Telecom Headquarters where his major involvement has been with the introduction of SPC trunk and local exchanges. He is currently acting Engineer Class 5 in the Telephone Switching Construction Branch.

— enhancement and adaption of NACD to interwork in the Australian network.

- Implementation —
  - — prepare plans for manual assistance centres throughout the telephone network
  - — organise building alterations
  - — prepare staff impact statements
  - — arrange staff training
  - — prepare guidelines and procedures for State Administrations
  - — install systems
  - — test and accept systems
  - — operate and support systems.

Overall Management Structure

In order to complete the activities listed in a relatively short timescale and to ensure close co-operation between the contractors, Telecom Headquarters' Departments and State Administrations, the project management structure outlined in **Fig. 2** was established. Project Managers for DAS/C and NACD were appointed to control their respective projects.

The DAS/C and NACD Steering Committees are chaired by the Manager, Directory Services Division and Superintending Engineer, Telephone Switching Construction Branch respectively. These committees are responsible for formulating strategies and oversighting the complete project. Meetings are held together to ensure tight co-ordination between the two committees. All areas with a major input to the project are represented at Steering Committee level.

DAS/C Management

The DAS/C Implementation Committee is responsible for the formal co-ordination and control of the day to day implementation activity at a working level. It is convened by the DAS/C Project Manager and consists of the various implementation working group convenors together with representatives from Industrial Relations, Personnel and also the Victorian State Implementation Committee Chairman.

The overall HQ implementation task was broken into five working groups whose responsibilities are shown below. These groups include representatives from many diverse areas in Telecom.

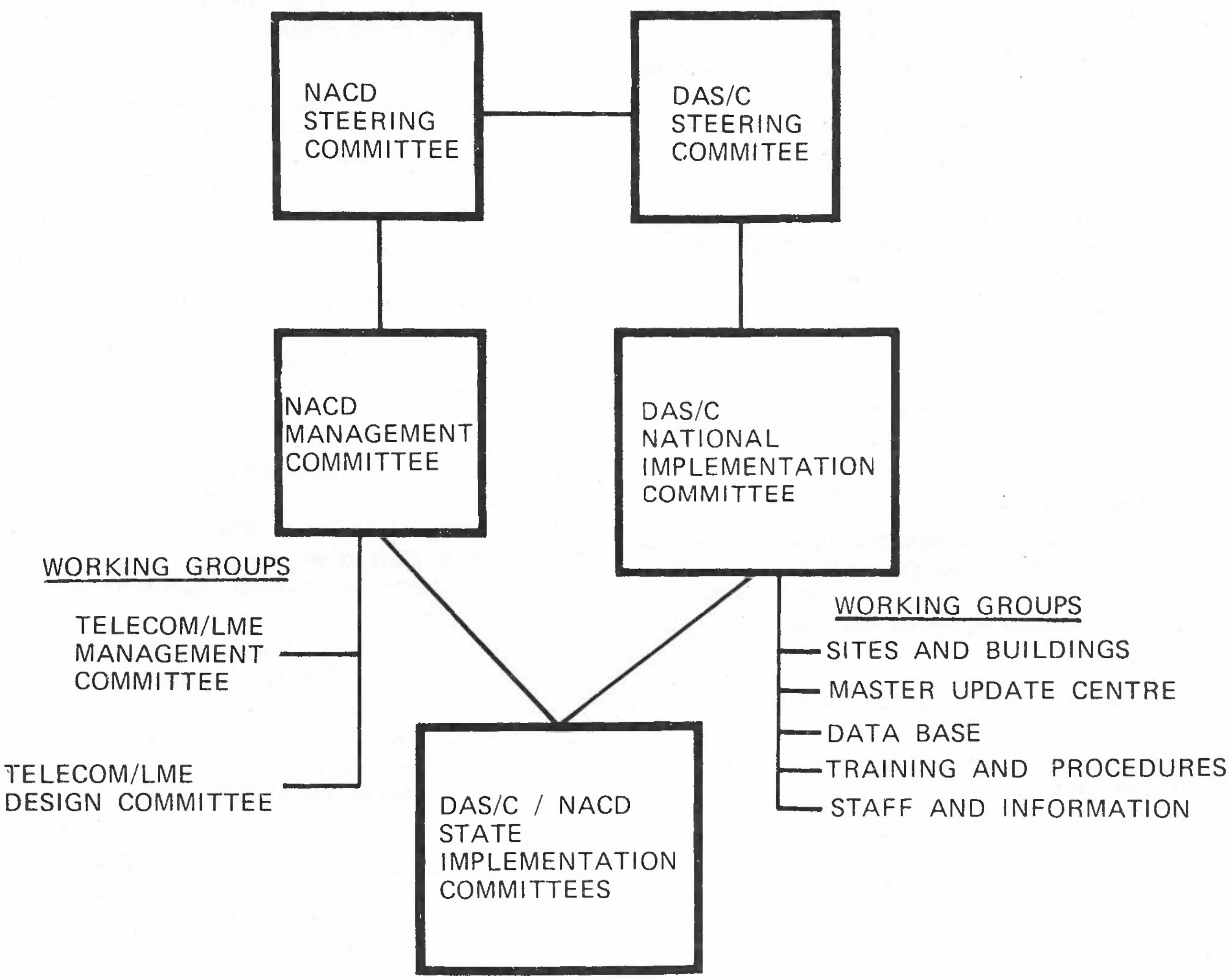


Fig. 2 — Project Management

(i) Site Preparation and Installation — responsible for the provision of accommodation and equipment at State Retrieval Centres, State Directories Branches and Manual Assistance Centres in accordance with the overall project schedule.

(ii) Application Systems, Data Base Development, System Testing — responsible for development of application software for the Data Send Centres, development of the National Data Base and daily updating procedures to ensure that a current data base is provided to Retrieval Centres.

(iii) Master Update Centre — responsible for provision and acceptance testing of the Master Update Centre at Clayton.

(iv) Methods, Procedures and Training — responsible for preparation of training and system management activities at Manual Assistance Centres.

(v) Staffing and Information — responsible for DAS/C staffing matters and dissemination of project information to management and staff.

NACD Management

Day to day co-ordination, for the introduction of NACD, is the responsibility of the NACD Management Committee. Representation on this committee covers design, purchase, installation, maintenance, operator service, training and staffing.

Two groups co-ordinated the work involving LME:

Telecom / LME Management Committee — Covers all management aspects of the project so that the equipment can be purchased, installed, operated and supported to a mutually agreed timetable.

Telecom / LME Design Committee — A technical sub-committee responsible for all system design aspects.

State Management

The DASC/NACD State Implementation Committee in each State is responsible for oversight of all relevant activities to be carried out in the State.

IMPLEMENTATION

The project will be implemented in three phases over the period 1981-85 — during which NACD's and DAS/C will be installed in each mainland capital city. NACD's will also be installed at Hobart and Townsville.

Phase 1

Establishment of the Update Network, Victorian Retrieval Centre and NACD:

— Main frame computer at Clayton Victoria, for Master Update Centre.

— Mini computers in each State Directories Branch and interstate data links.

— Initial development of the National DAS/C data base commencing with conversion of the Melbourne telephone directory, together with procedures for daily update of the data base.

— Installation of Retrieval Centre, NACD and operator training facilities at Windsor.

— Commissioning of the Manual Assistance Centre at Preston.

Phase 2

Completion of national data base development, installation of Retrieval Centres and NACD's in Sydney, Brisbane and Perth. Additional NACD'S will also be installed in Townsville and Melbourne (2nd). Manual Assistance Centres will be converted to DAS/C in metropolitan and country districts of New South Wales, Victoria, Queensland, Western Australia and the Northern Territory.

Phase 3

Installation of a Retrieval Centre in Adelaide and NACD's in Adelaide, Hobart and Sydney (2nd). Retrieval Centres will be expanded in New South Wales and Victoria. Additional Manual Assistance Centres will be converted to DAS/C in all States to complete the implementation of the project.

CONCLUSION

The introduction of the new Directory Assistance Service involves the development of two systems, DAS/C and NACD, and the participation of many functional groups within Telecom as well as the contractors IBM and LME.

Heavy emphasis has been placed on the establishment of a strong project management structure and thorough project planning. The benefits of this approach have been apparent and it is expected that there will be increasing exploitation of project management techniques for similar projects in future.

REFERENCES

1. Baxter, I., Lyon, H., 'The National Computerised Directory Assistance Service — DAS/C', Telecom. Journal of Australia, Vol 32 No 2, 1982.
2. Brown, P. A., Clark, D. W., 'Automatic Call Distribution System — ASDP 162', Telecom. Journal of Australia, Vol 29 No 3, 1979.
3. Dougall, C.J., 'Trial of a Computer Directory Assistance System — Sydney', Telecom. Journal of Australia, Vol 31 No 1, 1981.
4. Dougall, C.J., 'Network Planning for the Upgrading of Telecom's Directory Assistance Service', Telecom Journal of Australia, Vol 33 No 1, 1983.

Beyond the Black Stump — Satellite Communications in Outback Australia

F. A. COATES M.I.E. (Aust).

There are few engineering adventures that can capture the imagination like today's space technologies. Australia is about to join the sky-high club with the purchase of a domestic telecommunications satellite. Optimising the use of this national asset worth hundreds of millions of dollars, is essential. The provision of telecommunications to Australia's remote areas is one of the facilities now being evaluated. This article briefly describes the possibilities under consideration following launch in 1985.

INTRODUCTION

A number of recent reports in the technical and popular press have alluded to the telecommunication service provided by the proposed Australian domestic satellite.

This article briefly describes Telecom Australia's proposals for satellite telecommunications in the remote areas of Australia. A later article will provide more technical details but as tender evaluations were still in progress at the time of writing, the final system definition is as yet undecided.

Telecom's involvement together with the general milestones passed to-date in establishing Australia's domestic satellite, are shown in **Fig. 1**.

November 1976 —
Presentation and final report to Telecom Management on feasibility of a Telecom satellite.
September 1977 —
Government task force established to investigate national satellite applications.
October 1979 —
Government announces decision-in-principle to plan domestic satellite system.
April 1980 —
Briefing for industry to discuss concept of satellite service.
October 1980 —
Request for Tender issued.
May 1981 —
Tenders closed.
November 1981 —
Aussat Pty. Ltd. established to own and operate the space segment of the satellite system.
May 1982 —
Ministerial approval for Aussat to own and operate major city earth stations.
May 1982 —
Hughes Communications International named as successful contractor for space segment (3 satellites) and ground control stations at estimated cost of $166 million.

Fig. 1 — Satellite Milestones Passed to Date.

HISTORICAL BACKGROUND

The concept of extra-terrestrial radio relays became a popular scientific talking point in the 1940s following the development of rocket powered flight.

Writing in a 1945 edition of 'Wireless World', well-known science fiction author, Arthur C. Clarke, explained the principle:

"There are an infinite number of possible stable orbits, circular and elliptical, in which a rocket would remain if the initial conditions were correct . . . It will be observed that one orbit, with a radius of 42,000 km (an altitude of 36,000 km) has a period of exactly 24 hours. A body in such an orbit, if its plane coincided with that of the earth's equator, would revolve with the earth and would thus be stationary above the same spot on the planet . . . Let us now suppose that a station were built in this orbit. It could be provided with receiving and transmitting equipment and could act as a repeater to relay transmissions between any two points on the hemisphere beneath . . . Moreover, a transmission received from any point on the hemisphere could be broadcast to the whole of the visible face of the globe."

He then went on to enumerate some of the problems that he could foresee, not the least of which was placing the hardware in situ. The prevailing view amongst his contemporaries was that such a system was unlikely before the 21st century.

In fact, it was on 4 October 1957, just 12 years after Clarke's article, that the world watched a tiny speck of light, called Sputnik, move across the night sky.

But early communications satellites seldom exceeded an altitude of 10,000 km and only a few were active. Most simply bounced signals back to earth without regeneration during their journey between horizons. It required improved launch vehicles to achieve Clarke's geostationary orbit of 36,000 km, and in 1963 the first of the potentially commercial communication satellites, Syncom II, reached that altitude and maintained orbit.

Gradually more and more of these heavenly repeater stations were brought into service. Early Bird, or Intelsat I, was the first geostationary satellite launched by the International Telecommunications Satellite Consortium in 1965. It had an equivalent voice circuit capacity of 240 channels or one TV channel. The latest generation, Intelsat V, has 12,500 voice channels and 2 TV channels.

These international bearers were joined in the meantime by domestic satellites. Russia, Canada, USA, Germany, France, Indonesia, Italy and Japan were among the first to use satellites to carry domestic traffic in either an experimental or commercial role.

THE NEED FOR DOMESTIC SATELLITES

The real cost of satellite circuits has been decreasing over the years such that their application has widened to include domestic communications that would have normally used terrestrial solutions.

The satellite's ability to overcome geographical obstacles, like large bodies of water, has seen its application in the island nations of Japan and Indonesia. The harsh terrain and environment of countries like Canada and the USSR were important aspects in their choice of satellites for domestic traffic. Yet another use is in improving the diversity and security of terrestrial links such as in the case of Scandinavia and France.

Finally, there is the combination of low population density and long distances from larger centres of population that make satellite communications the most attractive option.

As can be seen from **Fig. 2**, this latter application is appropriate for outback Australia's telecommunication needs. Beyond the 'Black Stump' people are few indeed. So too are commercial power supplies, good roads and many other things vital for the provision and maintenance of modern telecommunications. Ironically, these same conditions that gave rise to problems in providing a service are also the strongest reasons to do so. In the outback, the necessities of life, and even life itself, sometimes rely upon telecommunications.

SERVICES PROVIDED BY THE SATELLITE

The potential users and uses of Australia's domestic satellite are many, including:

- ABC radio and TV relay to remote and regional transmitters;
- radio and TV programme interchange for ABC and commercial programmes;

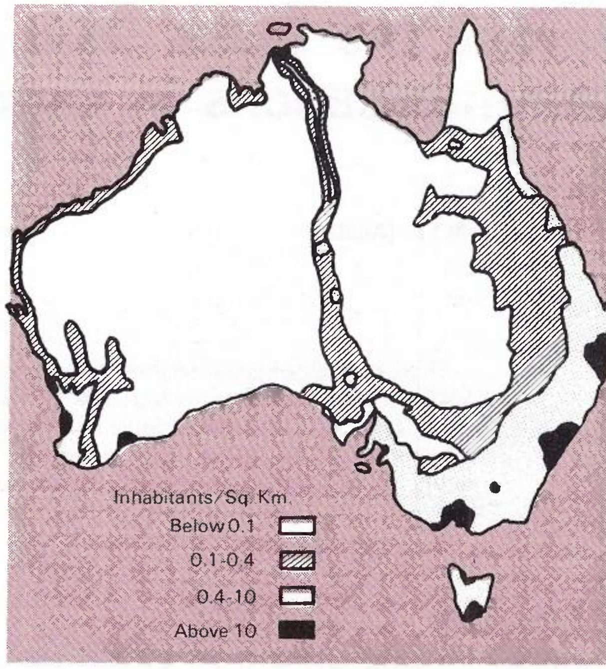


Fig. 2 — The Remote Areas of Australia are Characterised by Vast Distances and Low Population Densities.

- direct radio and TV broadcasting service to remote homesteads and communities;
- Department of Aviation, aeronautical, maritime and land communications.

Whilst a large share of the satellite capacity will be used for the above services, Telecom Australia will make use of one of the 15 transponders aboard the satellite to provide the Remote Telecommunications Satellite Service (RTSS) shown conceptually in **Fig. 3**. Actually, there will be two orbiting satellites just to the east of Australia, one operational and one standby, with a third on-the-ground spare.

TELECOM'S USE OF THE SATELLITE

Telecom's primary application is to extend the automatic telephone service to those regions which are beyond the practical reach of terrestrial

Frank Coates is presently the Satellite Implementation Section Manager in the Engineering Planning Division, Telecom HQ.

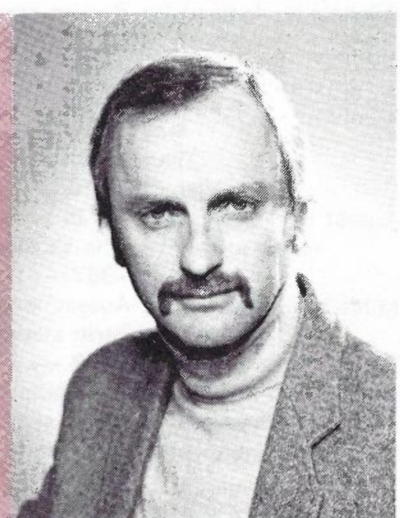
Since commencing with the PMG as a trainee technician in 1960, he has worked as technician, technical officer, instructor and finally Trainee Engineer before graduating in 1970.

His professional engineering career then commenced with network planning and traffic engineering positions in Planning Branch, Victoria.

From 1974 to 1978 he was seconded to the Papua New Guinea telecommunications authority, representing the country in a number of international planning forums.

He resumed with Traffic Engineering and was occupying the position of Supervising Engineer until his appointment as the ITU Senior Expert in Traffic Engineering to the Government of Malaysia in 1980.

In May 1981 he returned to Australia and joined the satellite project.



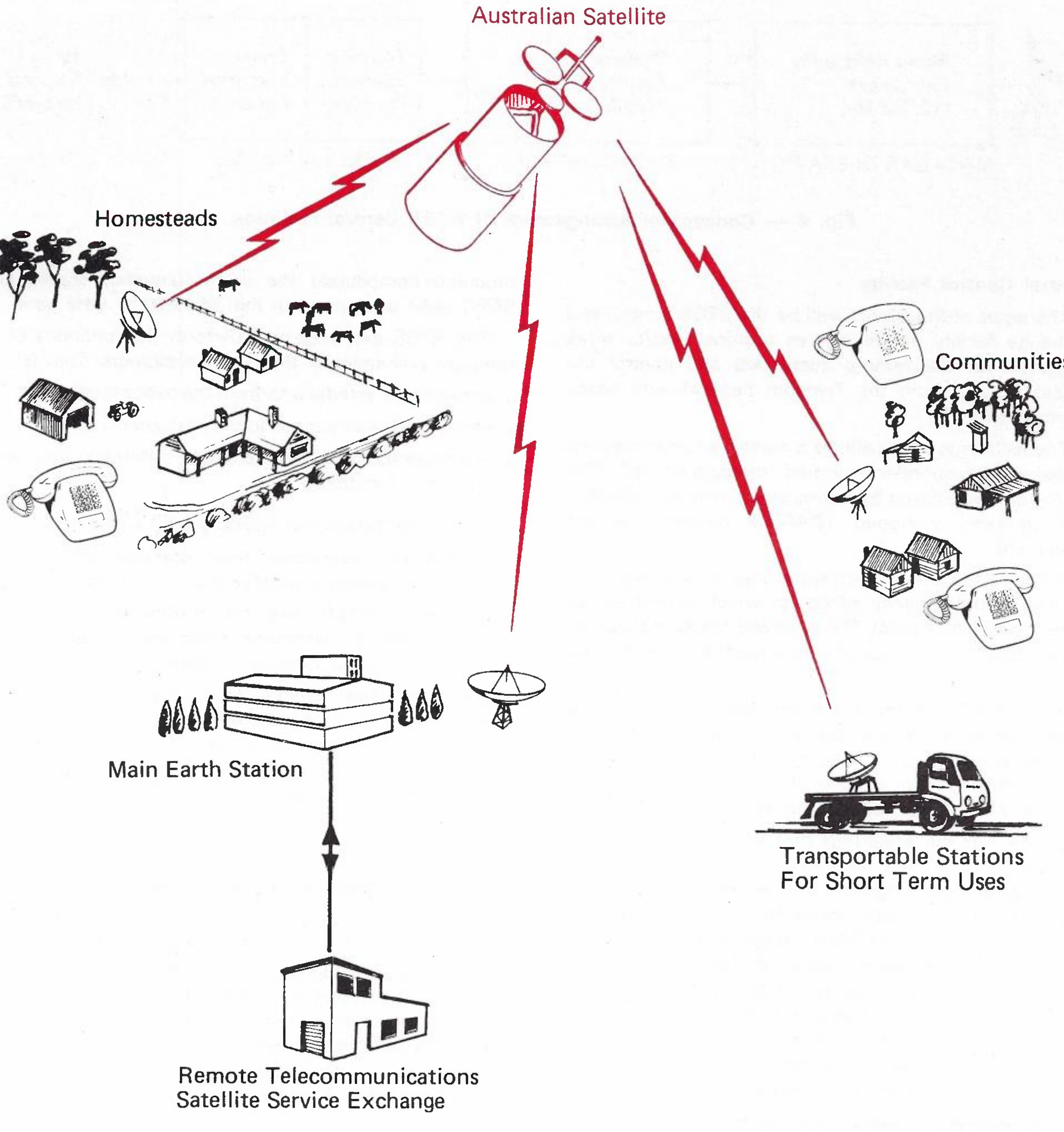


Fig. 3 — The Australian Satellite May Find a Number of Telecommunications Applications in the Outback.

telecommunications technology. It is this facility that will be the subject of the remainder of this article. However, optional TV and sound programme reception, community conference facilities, eg. school of the air, etc, may also be possible.

The remote customers will receive standard automatic telephone services including access to operator assistance, directory service and other information services, STD and ISD, public telegraph and Datel, and a comprehensive range of possible customer equipment attachments such as facsimile, automatic answering and recording machines, telewriters, etc.

Although there is a clear case in support of satellite telephony in Australia, the extent of its use is less certain. It has been established that about 60 earth stations, comprising homestead and community types (see below), will be provided initially. The system has the capability to serve some 2000 customers, but the satellite's ultimate application depends upon customer requirements, available funds and a number of other technical and economic considerations. To explore all of these is beyond the scope of this article, but briefly the technical trade-offs relate to the ongoing enhancements to terrestrial transmission techniques. Taking the global view, the satellite will be an integral part of Telecom's drive to extend services to the outback. Scarce resources must be carefully used in these areas so that the benefits available from modern telecommunications are shared amongst the widest group possible.

RTSS STATIONS

The Request for Tender called for the provision of three types of remote stations and a central control station.

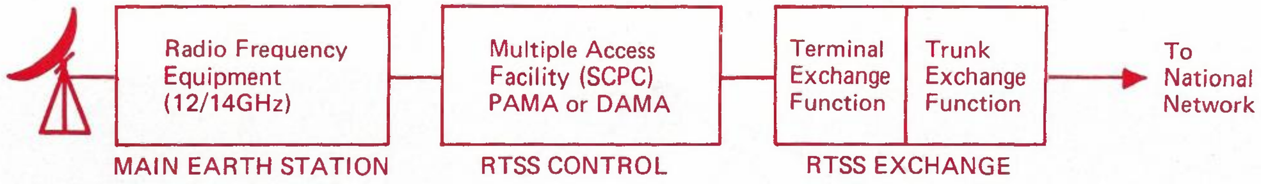


Fig. 4 — Conceptual Arrangement of RTSS Central Facilities.

Central Control Facility

The heart of the service will be the RTSS control and exchange facility. It will act as terminal and/or trunk exchange for the remote customers and control the access to and from the Telecom network and space segment **(Fig. 4)**.

The technique which allows a number of earth stations to use one transponder is termed "multiple access". This facility can be offered by permanently assigned (PAMA) and demand assigned (DAMA) multiple access equipment.

In the PAMA mode, each subscriber or trunk is given a unique radio frequency allocation which serves as the communication channel. The so-called single channel per carrier (SCPC) technique is also a feature of the DAMA mode.

If a DAMA system is chosen, the SCPC units are shared amongst all customers by means of a more sophisticated control (computer) facility. The DAMA control dynamically assigns RF channels to remote stations when a call request signal is received.

DAMA has the advantage that fewer SCPC units are needed. It may also overcome one of the PAMA difficulties when calling from one remote RTSS customer to another. This problem arises from the need to route the connection via the PAMA controller for the duration of the call. The resultant double satellite hop introduces significant delays in conversation (about 1 second) due to the propagation time between stations. With the DAMA mode, the central control can release after the call is set up, transferring the connection between customers directly via the satellite and thereby halving the delay.

The trade-off for these advantages is the cost of the extra computer equipment needed in the central DAMA control.

Homestead Telephone Earth Stations

The homestead telephone earth station (HTES) offers a single, standard voice grade circuit between the customer and the RTSS central facility.

The remote earth station equipment will modulate/demodulate the voice frequency signals on SCPC radio equipment in the 14 GHz/12 GHz band.

The RTSS exchange will perform the functions of a terminal exchange for the HTES customers. That is:

- provides the interface to/from the national network;
- sends supervisory tones to the customer;
- incorporates the call charge determination and recording functions.

Community Telephone Earth Stations

Community telephone earth stations (CTES) may provide two separate functions or a mixture of both.

Firstly, a CTES can be configured for up to approximately 12 telephone customers. In this way a CTES performs the function of several HTESs.

Secondly, the circuits from the CTES may be connected to junction-type relay sets and connect the remote earth station to a new or existing terminal exchange. Under this condition, the RTSS exchange would perform the functions of a parent trunk exchange (minor switching centre) for the remote terminal exchange.

Emergency Telephone Earth Stations

The flexibility offered by a satellite system lends itself to itinerant use. The emergency telephone earth station (ETES) was envisaged to be a transportable station capable of providing a number of circuits with various applications. They may include the emergency replacement of telecommunication facilities following damage to normal equipment, use by exploration ventures or other itinerant service requirements.

CONCLUSION

Although arguably the most exotic addition to Telecom's network, satellite technology is nevertheless subjected to the same basic decisions on technical compatibility and economic application as its terrestrial alternatives.

This is the work now facing Telecom in the lead up to the proposed 1985 launch.

SPC PABXs — Regulatory Developments and System Characteristics

Ivan PASCO, Dip. Electronic Eng.

In 1979 Telecom Australia introduced a new PABX policy which had a major impact on the PABX market. Additional suppliers were allowed into the market, approval procedures were radically changed, and a greater responsibility was placed on customers in choosing a system to suit their needs.

This article describes regulatory procedures for listing customer switching systems including PABXs. The new listing procedures coincided with the introduction of new generation SPC PABXs. The characteristics of these systems, and possible future trends are also discussed.

INTRODUCTION

With the introduction of the 1979 PABX policy there have been a number of significant changes to the PABX regulatory role. These changes have resulted in more efficient methods for processing regulatory matters. The responsibilities of suppliers and customers are clearly defined under the new arrangements and there is an increased awareness of the Telecom regulatory role in the PABX market.

The 'Davidson' committee of enquiry, appointed by the Government to consider the regulation of the terminal equipment market in Australia, including PABXs, presented its report in October 1982. The Government is currently considering the recommendations arising from that enquiry.

BACKGROUND

Prior to 1979 there were five PABX suppliers actively competing in the private or non-government market supplying crossbar electromechanical PABX equipment. These were AWA, Ericsson, Plessey (who supplied and installed the Ericsson range of systems), Siemens and STC. In addition there were five active suppliers marketing Automatic Call Distribution (ACD) systems — Ericsson, E. S. Rubin, Rockwell - Collins, AWA, and STC.

Systems were approved under the TYPE APPROVAL scheme with technical standards being set by Telecom Australia Specification 1080 — PABX DESIGN OBJECTIVES. This approach created a number of problems with respect to the PABX regulatory role which led to the changes that took place in 1979.

Specification 1080 was designed to set technical standards for equipment purchased by Telecom and equipment privately supplied and approved for connection to the telephone network. Telecom Test Centre testing, concentrated upon performance testing against Telecom specifications, with particular emphasis on system reliability. Component quality was assessed, by life testing where applicable. Other aspects considered in the evaluation included equipment safety, load testing, detailed facility checks, system construction and maintenance procedures.

Following the successful completion of these tests an in-service installation was authorised.

At the completion of a satisfactory in-service period of operation, FACE VALUE APPROVAL was granted.

When the equipment had been marketed for a set period and system performance was confirmed, TYPE APPROVAL was issued.

The major disadvantages with the type approval approach were the large resources required to process a system approval and the time taken to complete the approval exercise. Some new procedure was necessary and this, coupled with the advent of SPC technology, led to the introduction of a new PABX policy. Listing aspects of this policy apply to customer switching systems covering PABXs, ACDs and Telephone Information and Management Systems (TIMS). **(Fig. 1 and 2).**

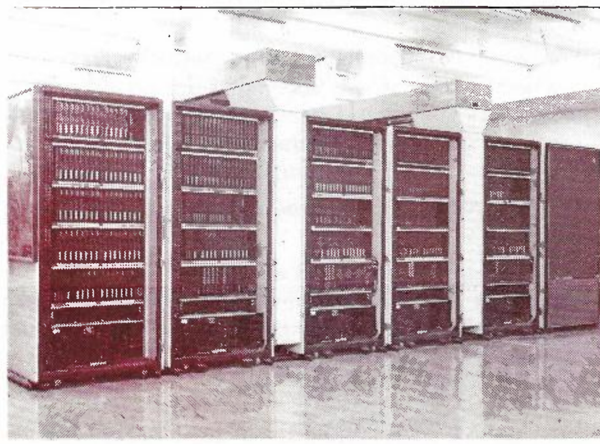


Fig. 1 — AWA —D2000 PABX/ACD Installation Ansett Melbourne.

PABX LISTING POLICY

The key points of this policy are:

- Telecom will issue a LISTING AUTHORITY for systems that comply with all the requirements for listing.
- Suppliers will be charged the cost of a system evaluation.
- Essential requirements for evaluating systems for listing cover network interworking, safety and maintainability.

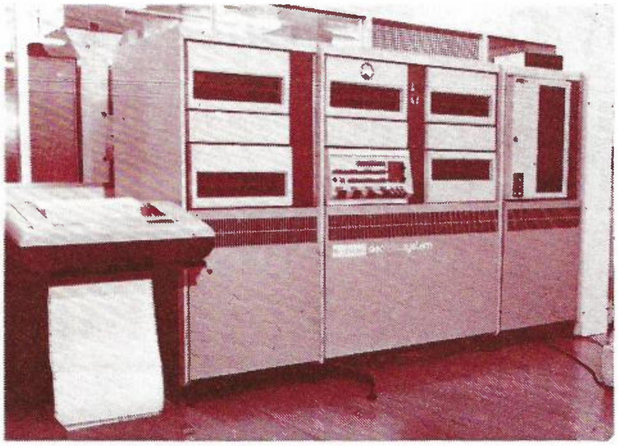


Fig. 2 — AWA - D2000 PABX/ACD Installation Ansett, Melbourne - Management Information System.

- System reliability is no longer a significant function of the Telecom approval process. The onus is now on the customer to establish the reliability of a particular system. Depending on customer knowledge of communication technology, advice from a consultant may be needed.
- Suppliers are to provide at their cost, initial technical training in each Telecom district where the first of a system type is installed (e.g. The Sydney metropolitan area is divided into 10 districts).
- Telecom will maintain all PABXs.
- Suppliers contract with Telecom:
  i. to repair faulty printed board assemblies (PBAs) and/or sub assemblies;
  ii. to provide additional training of Telecom personnel if required.
- Following the completion of a satisfactory system evaluation and when agreement in principle with respect to service and training agreements has been reached, a Restricted Authority to Supply (RAS) for connection to the telephone network is granted.
- During RAS a supplier is permitted to install up to 6 systems.
- When an in-service period of at least one system for 6 months and 12 system-months of operation has been completed, a supplier can apply for listing for that system.
- All privately supplied and installed customer switching systems will be subject to a pre-cutover check by Telecom prior to connecting the equipment to the telephone network.

LISTING PROCEDURES

There are four phases for listing a customer switching system and these are outlined in **Fig. 3**.

Phase 1, covering the formal application and installation in the Telecom Test Centre, can be expected to be completed within 6 weeks. Phase 2 and the granting of RAS would take a minimum of 6 weeks for a medium size system (100-200 lines). Phase 3 is the period during which in-service operation of at least one system for 6 months and 12 system months is achieved.

The fourth and final phase and issue of a Listing Authority, will take place on the satisfactory completion of the RAS phase.

TEST CENTRE EXAMINATION

All equipment submitted for listing is examined against Telecom Australia Specification 1301 which sets the listing standards for customer switching systems connected to the telephone network.

Equipment is examined in the Telecom Test Centre under three broad categories.

- SAFETY
- INTERWORKING
- MAINTAINABILITY

Safety

A safety examination ensures that the equipment is electrically safe in installation, operation and maintenance such that no harm to Telecom personnel working on the equipment or Telecom lines may occur.

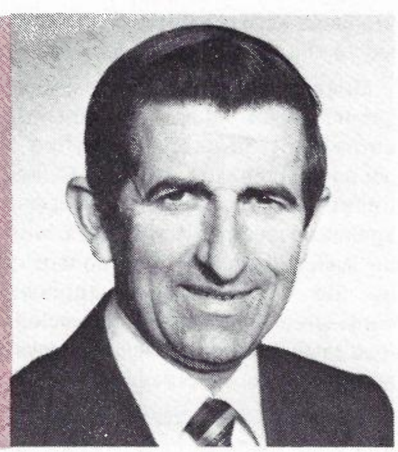
Australian Standards Association specifications such as ASC100, AS3000 and AS3191 are applied in conjunction with Telecom specifications when conducting safety examinations.

Interworking

Customer switching equipment connected to the telephone network must satisfy the Telecom technical standards set for the network in Telecom Specification 1301. Systems submitted for listing are examined to confirm supplier statements of compliance in the areas of transmission and signalling. Other areas of interworking

Ivan Pasco joined the APO in 1955 as a Technician in Training and, after completing this course, worked as a Technician/Senior Technician on exchange and PABX maintenance. He spent six years as a Technical Instructor prior to completing a Diploma in Electronic Engineering in 1974.

Ivan transferred to Telecom HQ in 1976 and was involved in the engineering approval of PABXs, ACDs and TIMS. He is currently Manager, PABX Regulatory Section.



Listing New Systems

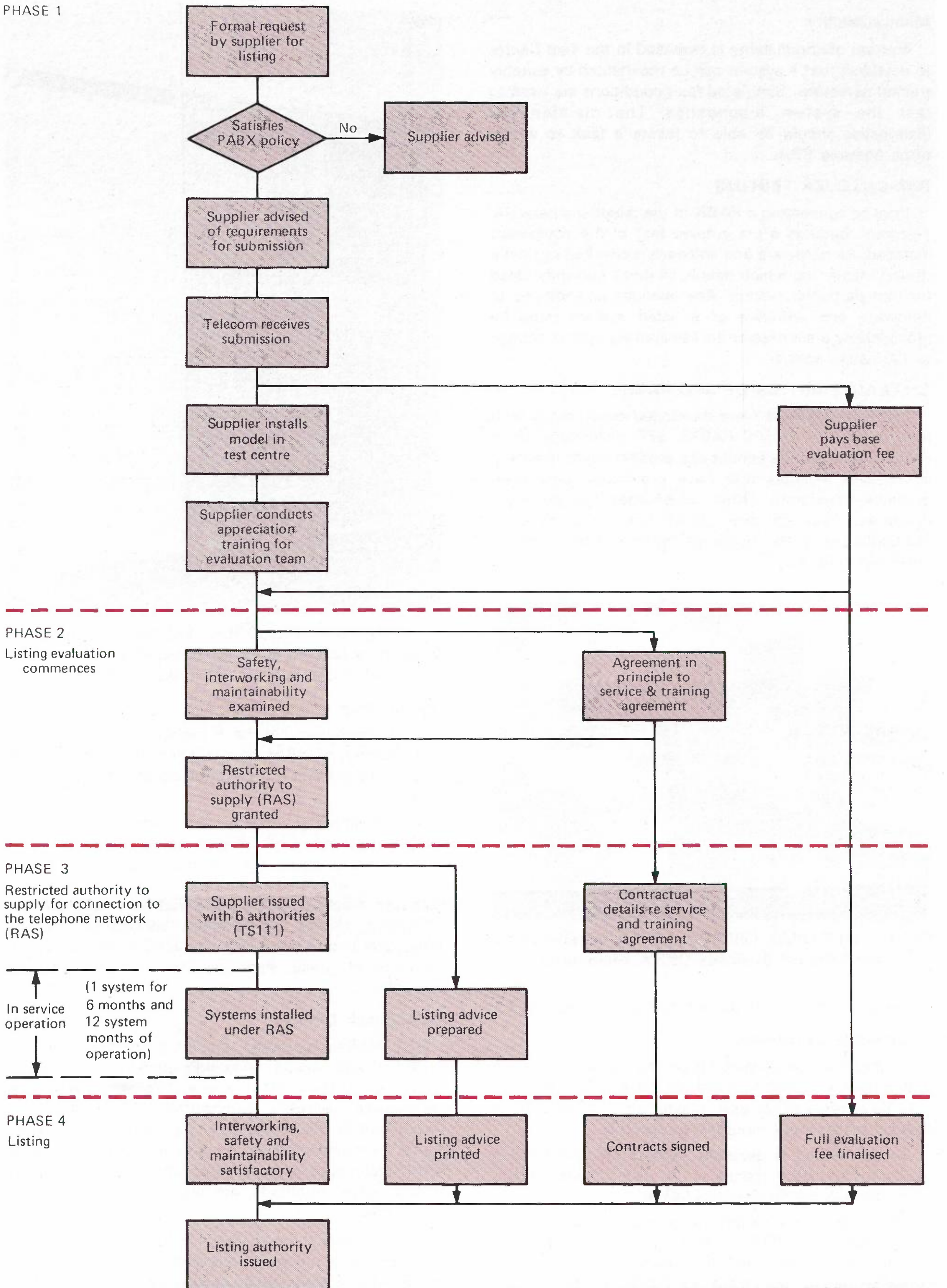


Fig. 3 — Four Phases For Listing a Customer Switching System

that are of a sensitive nature, such as call charge metering will also be subject to examination.

Maintainability

System maintainability is assessed in the Test Centre to establish that a system can be maintained by suitably trained personnel. Simulated fault conditions are used to test the system diagnostics. The maintenance diagnostics should be able to locate a fault to within three possible PBAs.

PRE-CUTOVER TESTING

Prior to connecting a PABX to the telephone network, Telecom conducts a pre-cutover test of the equipment installed. All hardware and software is checked against a design master list which details all items currently listed for that particular system. Any changes or additions to hardware and software of a listed system must be preceded by a submission to Telecom for such a change to the listing status.

CHARACTERISTICS OF SPC PABXs

Listing procedures were developed concurrently with the introduction of SPC PABXs. SPC technology offers PABX customers the benefit of a product which is able to consolidate facilities that have previously, only been available separately. Other advantages include more flexibility, reduced size, quiet operation, ease of installation, a wider range of features and improved reliability. **(Fig. 4).**

Fig. 4 — NEC NEAX 12VS Open Office Installation — City Telecom Business Office, Melbourne.

The present state of the art is described as follows:

Mechanical Construction

Construction techniques follow the modular approach with modules housed in lockable cabinets. Cabinet doors may be removable for easy maintenance access. Some smaller systems are mounted on castors.

Cabinet wiring is generally carried out by means of wire wrapped back planes or by using printed circuit board techniques for the back plane.

The back plane technique is widely used for the interconnection of PBAs, within a module or magazine. Connections between modules use cables with pluggable connections to the front of PBAs or by similar connections at the end of a module or magazine. Flat ribbon cables are frequently used for bus distribution. **(Fig. 5).**

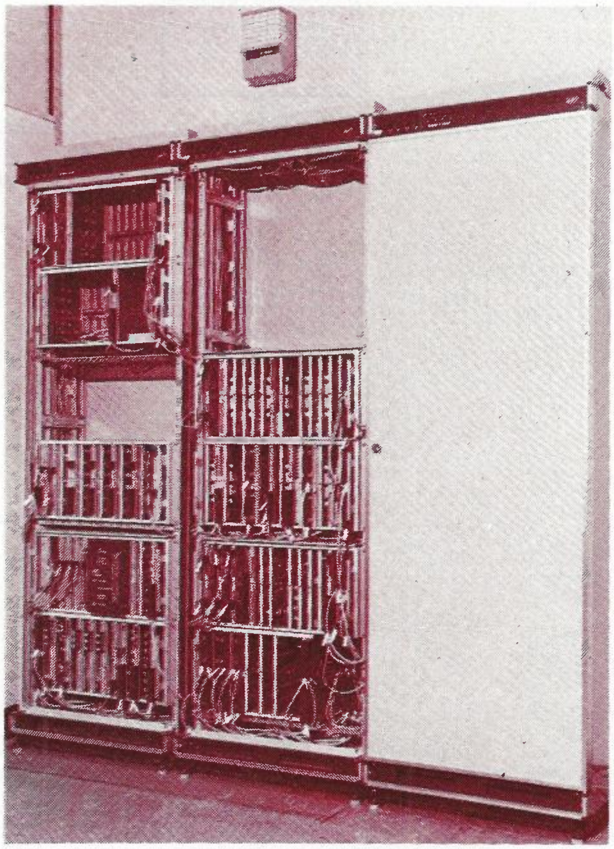


Fig. 5 — ERICSSON ASB900 PABX (Equipment cabinet dimensions are 300 x 600 x 1800 mm with a capacity of 240 lines for 3 cabinets.)

Environment

Heat dissipation can be a problem due to the high concentration of PBAs, the locating of power supplies within cabinets and the high idle current drawn by SPC systems.

Air conditioning plant is not usually required with installations of SPC PABX equipment as most manufacturers claim that normal operation can be maintained with ambient temperatures up to 40°C. However, customers are advised that heat dissipation by equipment should be carefully considered. This is particularly important in large installations and in certain geographical areas such as the Northern parts of Australia.

Switchblock Design

SPC PABXs currently marketed in Australia use analogue and digital switching principles. Analogue switching systems using space division transmission techniques, employ N-channel MOS, thyristor crosspoints or reed relays as the switching medium. Digital switching systems use time division multiplexing (TDM) techniques in the form of pulse code modulation (PCM), pulse amplitude modulation (PAM) or delta modulation.

Speech connections in digital systems are established by means of a digital switchblock. Speech signals are converted to a digital pulse stream via a codec. Multiple pulse streams are then converted into a single high speed interleaved stream, with each channel occupying a particular 'time slot'. Switching is then accomplished by interchanging time slots, by sequentially reading the high speed stream into speech memory **(Fig. 6)**, and then reading it out in a different order determined by the contents of connection memory. With digital switching there is no physical path from input to output.

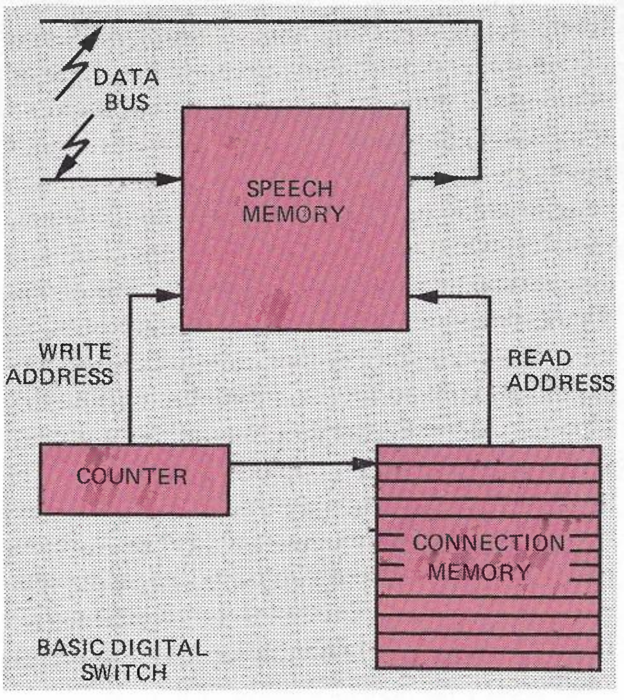


Fig. 6 — Basic Digital Switch.

Software/Firmware

Similar techniques are used for program and customer data storage. A factor which influences the method used, is the frequency of changes to customer data programmed into the system and this is likely to increase with the size of the system.

Customer data relating to facilities such as abbreviated code dialling, group diversion, and group night service, may be loaded into CMOS RAM which is protected against power fail by nickel cadmium batteries mounted on the PBA, or burnt in EPROM. The advantage of RAM is that information may be loaded on site and changes can be more easily implemented. In the case of EPROM, these PBAs can become customer unique and consequently pose maintenance problems when PBAs need replacement. Extension class of service information may also be loaded into RAM; however, some systems use micro DIP switches.

System programs are stored either in RAM, PROM, or EPROM. Techniques for on-site program loading include magnetic tape, floppy disk or cartridge.

Diagnostics

The flow chart method is the most common form of system diagnosis in use. Flow charts may be used in conjunction with built-in system diagnostics which generally are designed on a self checking basis. For example, the condition of exchange line circuits is continually monitored and any abnormal condition is noted by the processors and recorded in memory or printed out as a hard copy. If the circuit or line is faulty, the circuit is automatically blocked.

Maintenance aids vary, but all follow the system interrogation principle. High level interrogation principles using keyboard printers are employed in the Ericsson, Plessey and Siemens PABX systems. **(Fig. 7)**. Whereas the AWA and NEC PABX systems use specially designed maintenance consoles.

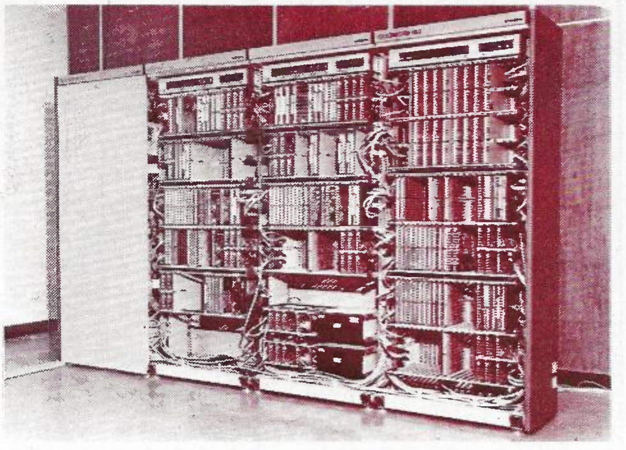


Fig. 7 — SIEMENS EMS 12000 PABX (SBTF test panel with LED display top shelf second cabinet from right.)

Economies of Scale

The present PABX market provides customers with a considerable choice of systems. This has created a highly competitive market encouraging suppliers to consider carefully, economies of scale. Those systems which are simpler in design and perhaps lack some of the flexibility and convenience of other types have the advantage of being more cost competitive. On the other hand, the benefits of a well developed system often appear in the larger size range where they can be equally competitive.

PRIVATE NETWORKS

One of the trends in private network development, following the introduction of SPC PABX technology, has been an increasing demand for sophisticated private networks utilising transit switching with access to the public network. In order to meet these market demands suppliers have had to undertake additional system development to satisfy the public network requirements.

In general these requirements are best served by a PABX having a four wire switching capability and pad switching to match the network loss standards for various network switching configurations.

Table 1: Summarises the characteristics of listed SPC PABXs currently being marketed in Australia.

TELEPHONE INFORMATION AND MANAGEMENT SYSTEMS (TIMS)

There is an increasing demand for this feature, especially by the hotel/motel industry.

TIMS vary considerably depending upon customer requirements. The more elaborate systems provide a record of called number code, time, date, duration, caller and charges accumulated. This information can be further processed using dedicated processing facilities

* APPROVED SUPPLIER	SYSTEM TYPE	SPACE DIV'N ANALOG SWITCH	TDM DIGITAL SWITCH	MEMORY STORAGE			DIAGNOSTICS			CABINET BACK PLANE		COOLING SYSTEM	
				CUS-TOMER DATA	PROGRAM	CUST. DATA LOADING	BUILT IN	FLOW CHARTS	MAINT. AID	WIRE WRAPPED	PRINTED CCT	FAN	CONVEC-TION
AWA LTD.	DIMENSION D SYSTEM	–	PAM	RAM	RAM	CARTRIDGE	X	X	MAINT. & ADMIN. PANEL (M.A.A.P.)	X	X	X	X
L.M. ERICSSON PTY. LTD.	ASB 30	THYRI-STOR	–	RAM	EPROM	OPERATORS CONSOLE	X	X	OPERATORS CONSOLE		X		X
	100	THYRI-STOR	–	RAM	ROM	OPERATORS CONS./TTY	X	X	TTY	X			X
	900	THYRI-STOR	–	RAM	RAM	CARTRIDGE	X	X	TTY	X			X
N.E.C. (AUST.) PTY. LTD.	NEAX 12 SERIES	THYRI-STOR	–	RAM	EPROM	OPERATORS CONSOLE/ DIAGNOSTIC MAINT. CONSOLE (DMC)		X	DIAGNOSTIC MAINT. CONSOLE (DMC)	X			X
	NEAX 22 SERIES	THYRI-STOR	PCM	RAM	EPROM	CARTRIDGE /TTY+	X	X	TTY+	X		X	X
PHILIPS ELECTRONIC SYSTEMS	DIGITAL D 1200 SERIES	–	DELTA MOD.	EPROM	EPROM	FACTORY ONLY		X	–	X	D1203	X	
	DLS-1	–	PAM	EPROM RAM	EPROM	OPERATORS CONSOLE		X	OPERATORS CONSOLE	X	X		X
PLESSEY COMMUNI-CATION SYSTEMS PTY. LTD.	ROLM CBX SERIES	–	PCM	RAM	RAM	PORTABLE CASSETTE	X		TTY		X	X	
SIEMENS LTD.	EMS 60, 150	REED RELAY	–	RAM/ EPROM	EPROM	SG 302 SERVICE UNIT		X	BTF (SERVICE PANEL)	X			X
	EMS 12000	REED RELAY	–	RAM	EPROM RAM	FLOPPY DISK	X	X	SBTF (SERVICE PANEL)/TTY	X	X		X
STC PTY. LTD.	UNIMAT 4020 (X)	N-MOS	–	RAM	EPROM	OPERATORS CONSOLE		X	–	X			X
	4060	N-MOS	–	RAM	EPROM	TTY		X	TTY	X			X
	4080	N-MOS	–	RAM	RAM	FLOPPY DISK	X	X	TTY	X		X	X

* APPROVED SUPPLIERS MAY BE LICENCED TO MANUFACTURE AND SUPPLY PARTICULAR SYSTEMS IN AUSTRALIA.
X INDICATES PRINCIPLE USED
TTY - CONSISTS OF KEYBOARD AND PRINTER FACILITIES
+ NEAX 22S—SA USE A DMC

TABLE 1. CHARACTERISTICS OF LISTED SPC PABXs.

associated with the TIMS feature or the information may be stored on tape for further processing on an in-house or external computer processing system.

TIMS are used by business organisations to bill departments within the organisation, and also to determine most effectively the communication needs of various departments.

Some PABXs can provide TIMS as an integral feature, and there are also system independent TIMS which may be connected to existing PABX installations.

At present there are six suppliers of system independent TIMS and ten PABX types have system integral TIMS.

FUTURE TRENDS

Interest is now growing in third generation PABX systems. These will be fully digital integrated systems designed to meet the combined voice and data demands of the electronic office.

The digital integrated PABX will be required to support a wide range of voice and non-voice services. These include existing services such as analogue telephony, telex, facsimile, and datel, along with network layer services such as digital telephony and data transmission via AUSTPAC (packet switching) and DDN; and new application services such as teletex, videotex, and electronic mail.

Fig. 8 — STC UNIMAT 4060 Operators Console — International Public Relations, Melbourne.

Economic Analysis — Principles & Problems

C.W.A. JESSOP, BSc, MESc, MIEE, CE., B.M. YEOH, BSc (Hons), C.W. PARRY, Dip PA, BEc.

Economic analysis of proposals for telecommunication projects is becoming increasingly important. This series of articles will, following a brief introduction of general principles, discuss some aspects which cause problems when evaluating telecommunication projects. The articles intend to explore areas of contention, discussing the advantages and disadvantages of various approaches, leaving the reader to decide which approach is relevant to a particular case for which an economic analysis is required.

INTRODUCTION

"Long range planning is very important, but I haven't time for it right now." A common attitude and somewhat understandable in the light of the pressure on management to uphold or improve both earnings and service in the short run. In this regard, long range planning may seem like a nice-to-have luxury which will not contribute helpfully to the immediate problem of running the business. Actually, nothing could be further from the truth. The lack of long range planning in the past will probably cause some unknown amount of improper spending today, and the lack of current long range planning is certain to adversely affect the soundness of current spending and future operation.

Telecommunications technology is changing rapidly as a result of developments in the computer industry but, unlike the computer industry where the normal life span of a computer system would be 7-10 years, telecommunications plant is expected to be kept in operation for a considerably longer time, often 30 years or more. To determine the best course of action, particularly with the large capital investment involved, a long range plan is essential and a vital component of this is an economic study and comparison of the available options.

Such a study generally involves the development of alternative plans of action which are then evaluated in economic terms. This article will present an outline of the techniques for preparing and/or understanding economic studies and will discuss in more detail those aspects related to telecommunications. These techniques of economic analysis are common to all disciplines and there should be agreement on them between accountants, economists, and engineers, although each group may focus on different aspects of a problem. The techniques presented in this article are used by all groups interested in economic studies; differences in emphasis will be discussed where relevant.

TRADITIONAL METHODS

So called "Traditional" methods of project evaluation have been displaced by "Discounted Cash Flow" (DCF) methods for most purposes. However, the traditional methods provide useful supplementary information and can be used for a quick analysis of projects. The following methods will be briefly described:

- Pay-back period
- Return on investment

The effectiveness of these methods will be compared with that of the DCF method to show why it has replaced the traditional methods.

Pay Back Period

The aim of this method is to assess cash-flow and determine how long it takes to recover our investment from net cash inflows. Alternatively, it tells us the liquidity effect of the project.

Where estimated earnings are the same for each year:

$$\text{Pay back period} = \frac{\text{Investment}}{\text{Annual Earnings}}$$

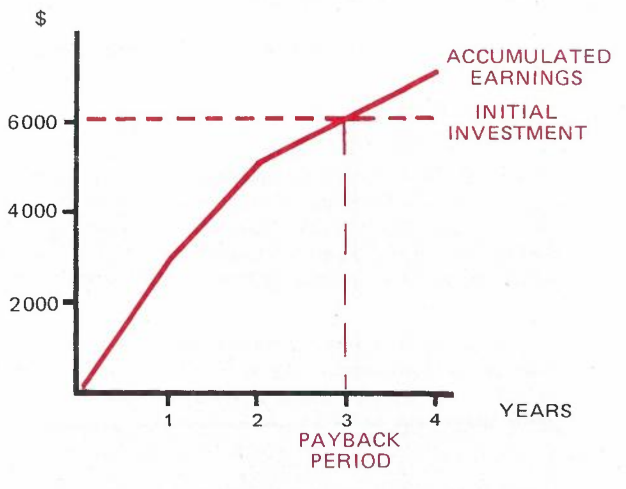


Fig. 1 — Illustration of Pay-back Period.

Where earnings vary from year to year, earnings are accumulated as shown in **Fig. 1**. Although the method tells us how long it takes to recover our initial investment it does not indicate the profitability of the project and completely ignores what happens to the investment after the cash recovery of the original capital expenditure.

Return on Investment

This method is also known as the "Financial Statement" method as well as the "unadjusted" or "accounting" rate of return and expresses the annual accounting profit as a percentage of the investment. Although there are many variants to the method of calculation, the basic formula is:

$$\text{Rate of return} = \frac{\text{Earnings}}{\text{Investment}} \times 100\%$$

This method considers the total earnings over the life of the project, unlike the pay-back method, but conversely, does not tell us anything about the timing of these earnings.

	Project A	Project B	Project C	Project D
	$	$	$	$
Initial investment Year 0	6,000	6,000	6,000	6,000
Cash earnings Year 1	4,000	2,500	1,000	6,400
Cash earnings Year 2	3,000	2,500	2,000	—
Cash earnings Year 3	2,000	2,500	3,000	—
Cash earnings Year 4	1,000	2,500	4,000	3,600
Average cash earnings	2,500	2,500	2,500	2,500
Annual Depreciation	1,500	1,500	1,500	1,500
Average net earnings after depreciation	1,000	1,000	1,000	1,000
Traditional measures				
Pay-back (years)	1.6	2.4	3	1
Unadjusted rate of return on original investment $\frac{\$1,000 \times 100}{\$6000}$ %	16.7%	16.7%	16.7%	16.7%
D.C.F. Measures				
Net present value	$2,299	$1,925	$1,546	$2,277
Equivalent annual value	$724	$606	$487	$718
Internal rate of return	31.4%	24%	19.2%	32.5%

Table 1 — Comparison of Traditional and DCF Measures.

Tony Jessop (right) is an Engineer Class 5 in Telecom's Planning Division, HQ. He had been concerned with the planning of trunk switching and manual assistance for a number of years until taking up the position of Section Manager, Engineering Plans in 1979. Presently, he is leading a small team responsible for preparing an overall plan for the development of an Integrated Digital Network for Telecom Australia. Prior to joining HQ in 1973, Tony was with the N.S.W. Administration involved with telephone switching planning.

Barbara Yeoh (centre) graduated from the University of Melbourne in 1969 with an Honours Degree in Science majoring in Mathematics. She spent three years as a Research Officer with the Bureau of Statistics before joining the PMG Department as a Senior Statistical Officer. Barbara has been with the Finance Directorate since 1976 and is currently Chief Finance Officer in the Financial Studies Section.

Bill Parry (left) is a Project Officer in Plans & Programmes Branch, Planning Division, Telecom HQ. He worked in engineering and personnel training in the PMG Department, and in Establishments in the Department of Transport and Telecom before gaining his present position. Bill has completed a Diploma of Public Administration and an Economics Degree.

Examples of traditional method analyses are shown in **Table 1**. These traditional methods provide complementary information which may not help in making a decision between two competing projects. That is, which is better, a project which returns the initial investment quickly then earns limited further amounts, or one with a longer pay back period but with greater earning potential beyond this time?

The technique which has replaced these traditional methods combines both the timing and overall earnings aspects of the traditional methods and is known as the DCF method. To utilise this method we must first explore the relationship between time and money, which is the basis of DCF techniques.

THE TIME VALUE OF MONEY

Different amounts of money at different points in time can be considered as equivalent. For example $1.00 now, invested at 10% per annum (p.a.) will be worth $2.00 in 7 years' time. (If we set the interest of 10c aside each year it would take 10 years to accumulate to $2.00, but if we re-invest the interest at the end of each year it will only take 7 years). We can say that $1.00 now is really equivalent to $2.00 in 7 years' time (at 10% compound interest rate). This provides us with a basis to compare alternative plans which involve spending money at different times.

The following relationships are useful in economic studies. An explanation of their derivation can be found in the references at the end of this article.

- Present value (P) from a future value (F)

$$P = \frac{F}{(1+i)^n}$$

where i = interest rate per period
n = number of periods

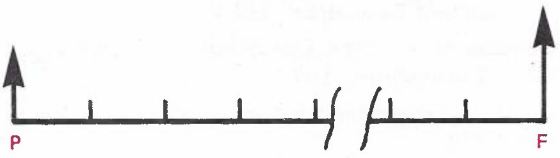


Fig. 2 — Equivalence Between a Present and a Future Amount

Clearly the future value of a present amount is given by $F = P(1+i)^n$ by re-arranging the above equation.

- Present value from a series of equal annual payments (known as an annuity)

$$P = \frac{A(1+i)^n - 1}{i(1+i)^n}$$

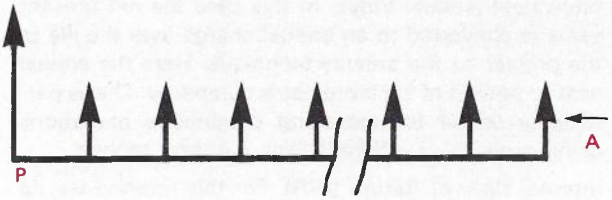


Fig. 3 — Equivalence Between a Present Amount and an Annuity

And conversely the annual payment from a present amount is given by:

$$A = \frac{Pi(1+i)^n}{(1+i)^n - 1}$$

As an example of the use of these concepts, **Fig. 4** shows six equivalent ways of showing the same financial value. The example assumes an 8% rate of interest with lump sums valued at the beginning of the year and annual payments at the end of each year.

A. $1,000.00 at the beginning of year 1990.

B. $2,158.92 at the beginning of year 2000.

C. 6 annual end-of-year payments of $294.31 for years 1994 / 95 / 96 / 97 / 98 and 99.

D. $1,360.60 at the beginning of year 1994.

E. $583.56 at the beginning of year 1983.

F. 7 annual payments of $112.08 at end of years 1983 / 84 / 85 / 86 / 87 / 88 and 89.

This "time value of money" concept allows us to compare alternative plans, where money is spent and received at differing times, from an economic viewpoint.

DISCOUNTED CASH FLOW METHODS

There are three basic techniques which use DCF methods.

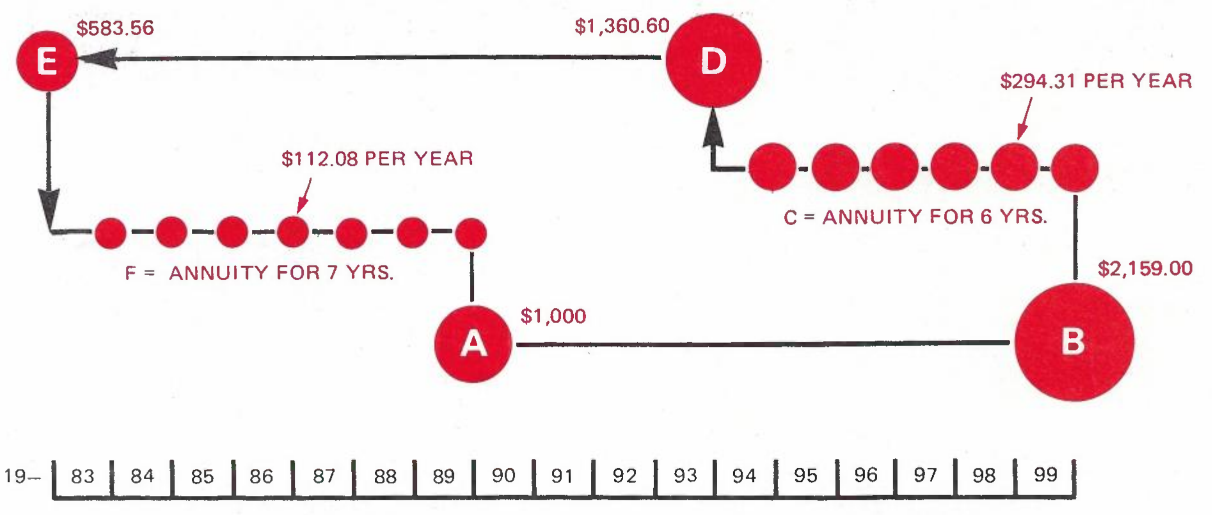


Fig. 4 — Equivalence of money

- Net Present Value (NPV). All the costs and benefits (revenue) associated with a project are converted to "Present values" at the beginning of the project using a specified interest rate called the discount rate which represents the minimum return on investment required. This measure allows the absolute profitability of each project to be compared.
- Equivalent Annual Value. In this case the net present value is converted to an annual charge over the life of the project by the annuity technique. Here the annual cost or benefit of each project is compared. This is particularly useful for assessing continuous operations using projects of different lives e.g. taxi service.
- Internal Rate of Return (IRR). For this method we do not assume a discount rate, but calculate the rate of return which would balance the investment outgoings with the expected benefits. That is, the rate which gives us a Net Present Value of zero. There are no simple formulae for this, and so the Rate of Return is estimated, the Net Present Value calculated, and then the procedure iterated until we achieve a value of zero for the NPV.

  When comparing projects, IRR gives us a relative measure of the profitability of each project. However, this assumes that the net profits can be reinvested as they are generated at the internal rate of return obtained for the project. This may not be a realistic assumption, particularly if high internal rates of return are estimated. (The IRR calculation can be adjusted to allow for more realistic investment rates. This method is called the Actual Rate of Return method).

The DCF approach has been criticised for the following reasons:

- No measure is obtained of the short term profitability of the project.
- Estimation of future cash flows, and the economic life of the project, is subject to uncertainties, especially for projects with a long life.
- Determination of the appropriate discount rate involves a number of assumptions.

Table 1 compares the Traditional and DCF measures of four projects for comparison purposes. The discount rate used for the calculations is 10%.

INTERPRETATION OF RESULTS

1. Pay-back method. Project D is ranked first. However, this method does not take into consideration the pattern of cash flows in later years. Zero net cash inflows in years 2 and 3 of the project may have serious implications for the organisation's liquidity position.
2. Accounting Return on Investment. This method fails to distinguish between the projects.
3. Net Present Value. Project A is ranked first as it has the highest absolute level of profitability and is marginally better than D.
4. Equivalent Annual Value. This measure is similar to NPV.
5. Internal Rate of Return. Project A is ranked first, again marginally superior to D. However, the calculations for Projects A and D assume that all profits generated could be reinvested at 30% p.a. or more. This may not be realistic.

SUMMARY

This article, the first in the series, has dealt with the need for, and basic principles of, economic analysis techniques. Further articles are planned covering such aspects as:

- Costs — what to include
- Handling inflation
- Accuracy and use of results
- Post audit review

REFERENCES

1. Finance Directorate — Telecom Australia "Guidelines for Investment Evaluation" 1981.
2. Middleton K. A., "The Economics of Capital Expenditure" Butterworths, 1977.
3. Carrol K. J. "Economic Studies" Telecom Australia ED 0004 1978.

Current Status of the ISO/CCITT Reference Model of Open Systems Interconnection and its Associated Protocols and Services.

P. H. GERRAND B.E., M.Eng.Sc., M.I.E. Aust.

This paper draws attention to the current state of development within the international standards developing bodies ISO and CCITT of the Reference Model of Open Systems Interconnection (OSI), which became a draft international standard within the ISO in April 1982. The paper describes the objectives of the reference model and explains its most basic concepts; it describes the ISO and CCITT timetables for the completion of new standard protocols and services for data communications based upon the reference model; and it explains the importance and relevance of these standards for the Australian telecommunications community.

INTRODUCTION

The Reference Model of Open Systems Interconnection (OSI) is a highly ambitious attempt by the two major international standards organisations dealing with computer technology and telecommunication, the ISO and CCITT respectively, to fix a common architectural framework for the specification of new protocols and services for data communications, computer networking, telematic* services and (hopefully) even voice services within a multi-service digital network. The reference model's current applications are heavily oriented to public and private data communications networks, intended to serve an open-ended set of data and telematic applications.

The basic objective of the standards is to permit effective interconnection of all computer systems, networks and terminals which obey the OSI standards. That last qualifying clause, "which obey the OSI standards", is crucial. OSI can only be "open" to those systems whose means of interconnection follow the OSI standards. The true "openness" in OSI lies in a different dimension: interconnection of OSI systems is intended to be effective not only in providing existing OSI services (such as packet switching as an economical network service) but also in providing any future telecommunication services whose interconnection procedures have been specified in conformance with the reference model. Whether this highly ambitious aim can be met, without requiring continuing adjustments to the reference model, will be observed with interest through this decade.

The reference model has been continually evolving as a working document since the 1970's, and will not become truly stable until it has become an ISO full international standard (scheduled for 1983) and a CCITT approved recommendation (possibly at about the same time). Now that the reference model has reached draft international standard status in the ISO (Reference 1), which provides the stimulus for the writing of this paper, it is safe to say that most of the basic concepts in the reference model are now unlikely to change, and the simplest of these concepts are explained in the next section of this paper. Much fuller explanation of the OSI reference model can be found in References 3-4. Serious students of digital telecommunications technology should of course consult the latest available version of the reference model itself (Reference 2 at the time of writing), but they should be forwarned that the reference model is written in terminology owing far more to database concepts in computer science than to communication concepts in telecommunications engineering, and that some of the terms have been carefully defined to have anything other than their normal English meaning!

* 'Telematic' is a term the CCITT has borrowed from the French 'telematique', a word coined by Simon Nora and Alain Minc to describe new services made possible by the integration of telecommunications and computer technology. Examples of telematic services are electronic mail, teletex and videotex.

BASIC CONCEPTS IN THE REFERENCE MODEL

The OSI reference model concerns itself with only those functions and facilities in a system which are necessary to permit interconnection of "application processes". Examples of application processes are you or me working on a terminal, or machines working under remote control, or simply activated computer programs needing to access remote data under the control of other processes.

As shown in **Fig. 1**, two systems, A and B, physically interconnected by "physical media", are considered to be each functionally divided into:

- a local System Environment, usually containing the user application processes, and not subject to OSI standards; and
- a layered set of functions, providing the means for intercommunication of the application processes residing in A and B; this set of functions is defined to be part of the OSI environment (OSIE).

The "physical media" are assumed to lie outside or "be transparent to" the OSIE; it is worth knowing that the digital interface between the physical layer of the

OSIE and the physical media is the only interface which the ISO intends to standardise in the course of defining the OSIE.

The basic concepts of the OSI reference model are layering, services, protocols and data units. The main use of the OSI reference model is to permit standardisation of services and protocols within a common OSI architecture.

Layering

The layering approach, familiar to computer communications people in the structure of IBM's SNA and to telecommunications people in the structures of the CCITT X.25 packet switching interface and the CCITT No. 7 signalling system, is justified for two reasons:

- simplification of complexity. The problem of defining protocols between modern systems to support a host of applications is too complex to be understood by ordinary human beings without conceptually partitioning the general problem into smaller, manageable parts; and
- minimising the impact of technological change. The layered reference model is intended to accommodate changes in technology which may lead to changes in the standard OSI functions in one or two layers while hopefully not requiring changes in the rest.

However, in the short history of development of the reference model, we have already seen modifications to its definition to accommodate such technological changes as the introduction of X.25-based packet switching networks and the use of datagrams (instead of virtual circuits) within certain commercially successful packet switched networks.

The horizontal lines separating OSI layers within each system in Fig. 1 were once called interfaces in the reference model, but so strong is the feeling by some ISO member organisations that these interfaces should never be standardised (since this is regarded as an unwarranted interference in the internal design of systems), the term 'interface'* has been all but banished from the ISO reference model, and communication between layers has to be expressed by technical concepts whose complexity far exceeds the scope of this 'overview' article.

Services

Each of the reference model's bottom six layers is defined to provide a 'layer service' to the next layer above it. In the case of the seventh layer, the application layer within the OSIE is defined to provide an application service to application processes within the local system environments (See **Fig. 1**).

The basic service provided by each of the OSI layers can be summarised as follows:

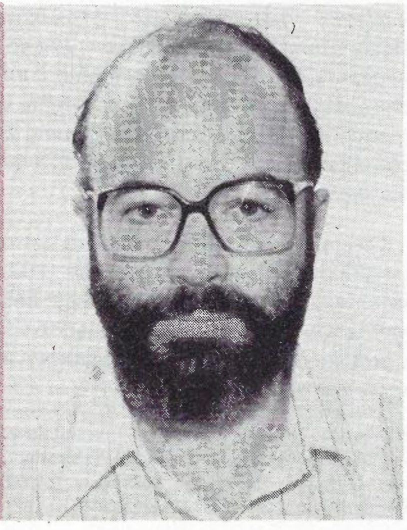
- the ***Physical Layer*** provides a digital interface to the physical media, and is responsible for relaying bits of information via the physical media:
- the ***Data Link Layer*** performs framing functions, error detection and error recovery in the transmission of frames between adjacent systems. (A "frame" is a regular pattern of data, whose recognition gives meaning to the role of the rest of the data according to their positions relative to the frame);
- the ***Network Layer*** performs the relaying of packets of data, and the routing of both packets and data circuits through a telecommunication network;
- the ***Transport Layer*** performs end-to-end control (eg flow control) and end-to-end optimisation (e.g. cost minimization) of the transportation of data between systems connected via a telecommunication network;
- the ***Session Layer*** performs those functions necessary for co-operating application processes in different systems to organise and synchronise their dialogue and to manage their exchange of data;
- the ***Presentation Layer*** provides for the presentation of information that application processes wish to exchange or manipulate; it is concerned with ensuring the correct syntax for the presentation of information, and if necessary it provides the transformation of the syntax of the application data stored in one system into the syntax demanded by the other system. (This is a highly ambitious service, but it is also a highly necessary service if OSI is to permit interconnection of different manufacturers' computer systems);
- the ***Application Layer,*** as the highest layer in the reference model, provides a means for the application

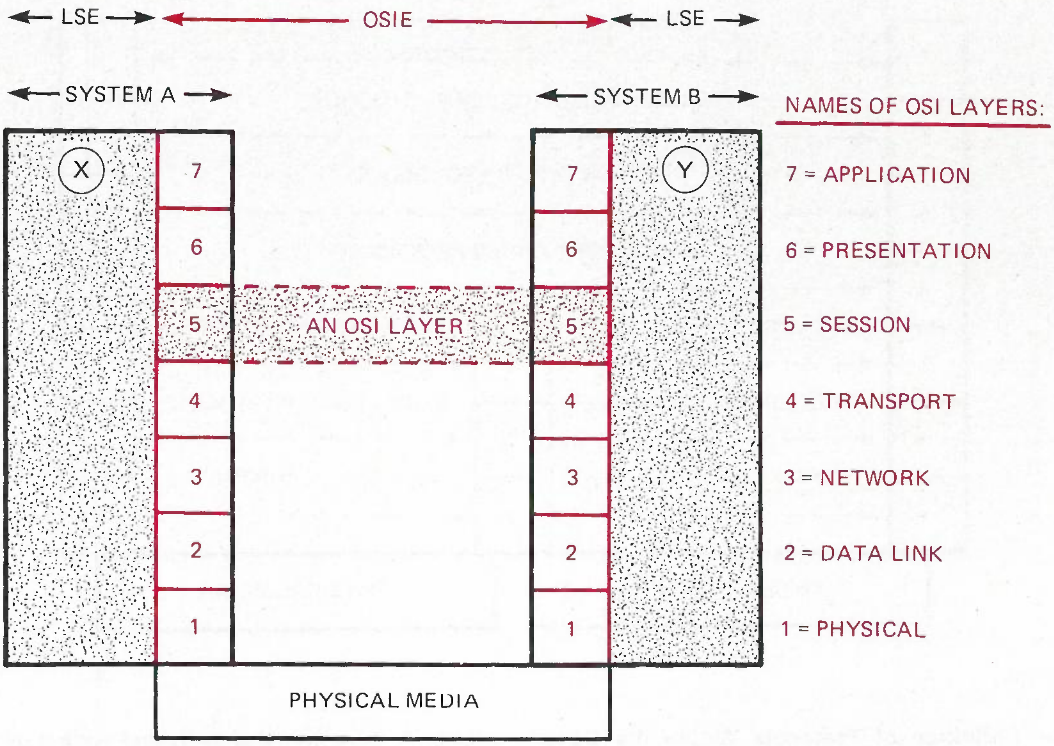
* The CCITT, Reference 2, now uses the term 'boundary' where the ISO, Reference 1, uses the term 'interface', but with identical meaning.

Peter Gerrand is Head of the Signalling and Control Section in the Switching and Signalling Branch of Telecom Australia's Research Laboratories, based in Clayton, Victoria. He has been the Research Laboratories' representative on the national Standards Association of Australia (SAA) Subcommittee MS 20/16 on Open Systems Interconnection since its first meeting in February 1980, and is the convenor of its working group on the reference model and its associated formal description techniques.

His current research interests include common channel signalling systems, abstract data description languages, computer-aided system specification, modelling and design techniques, performance objectives for fault-tolerant real-time systems, and functional analysis of the OSI reference model.

As an extension of his research activities within Telecom, he is currently an honorary industrial fellow in the faculty of engineering at the Royal Melbourne Institute of Technology, and an honorary research associate of the Department of Electrical Engineering at Monash University. He is also a member of the Board of Editors, **Australian Telecommunications Research**.





KEY: LSE = Local System Environment
OSIE = Open Systems Interconnection Environment
X, Y represent application processes in the LSE

Fig. 1 — Layering in the Open Systems Interconnection Environment (OSIE).

processes in the local systems environments to access the OSI environment. It also encompasses network management functions, when viewed as OSI applications.

Each OSI layer (except the highest layer) provides its service to entities (active elements) in the layer directly above it, and each layer is assumed to be oblivious of the functions performed in layers other than its own, apart from knowing the service provided by the layer directly below it. Thus, for example, the transport service is a service provided to the session layer by the combined transport, network, data link and physical layers but is only perceived by the session layer as being provided by a single transport layer. It is the current intention of the ISO and CCITT to standardise a single service specification initially for each of the bottom six layers, while anticipating an open-ended set of application services, many of which will not be seen as needing standardisation.

Protocols

Each layer is considered to contain active elements called "entities" which provide the layer service by communication with peer entities (ie entities within the same layer, usually in different systems) and with entities in the adjacent layers (in the same system).

Looking at Fig. 1, it is evident that communication can only really occur directly between peer entities in different systems if the peer entities belong to the physical layer (in which case their communication takes place by passing data to each other via the physical media). However the reference model introduces the concept of ***protocols*** to permit the definition of strict rules and formats for communication between peer entities in different systems, as though the lower layers (which physically pass the communication messages down to the physical layer, across the physical media to the other system, and up the other system to the original layer) did not exist.

Fig. 2 gives an example of the identification of protocols (shown by the broken lines) in all layers of the reference model for the case where two end-systems, A and B, are interconnected via a network an intermediate switching node C. Note that it is not necessary for each system in the OSIE environment to include all upper layer functions. The advantage of defining protocols for each layer independently of the lower layers should be evident: the complexity of the interactions in the lower layers can be effectively masked. Any failure of the lower layer services to correctly convey a message between peer entities is interpreted in the layer protocol as simply a failure in the underlying logical (non-physical) "connection" between the peer entities.

Data Units

The mechanism in the reference model for defining layer protocols and layer services, such that layer protocols properly 'serve' their layer service, depends heavily upon conceptual building blocks called data units.

As mentioned earlier, the reference model is based heavily upon data base concepts and not on communication concepts, and so the reader with a traditional telecommunication background will look in vain for such familiar concepts as signals, outputs, inputs,

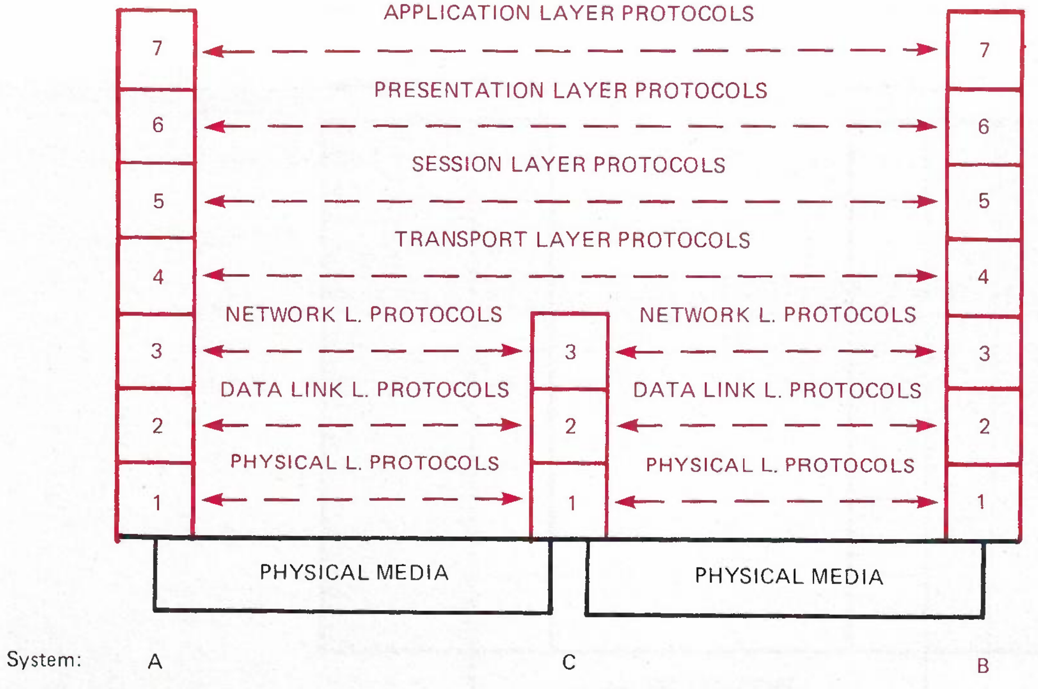


Fig. 2 — Definition of Protocols Within the Open Systems Interconnection Environment, Showing Interconnection of Systems A and B via a Network Containing a Simple Switching Node (System C).

Note: A more complex switching node might have OSI functions in higher layers, eg network management functions in the application layer.

transmitters, receivers, buffers, queues, nodes or paths. (And you will find that some familiar terms are defined with quite different meanings in a data communicating context, e.g. blocking, concatenation). The basic concepts in the reference model are not necessarily any more complex than those in, for example, stored program controlled telephone exchanges, but they can take a lot of getting used to.

In the reference model, all communication takes place using data units. The principal classes of data units are:

- (N)-protocol-data-units
- (N)-interface-data-units
- (N)-service-data-units

where the prefix "(N)" — identifies the data units with the Nth layer of the reference model.

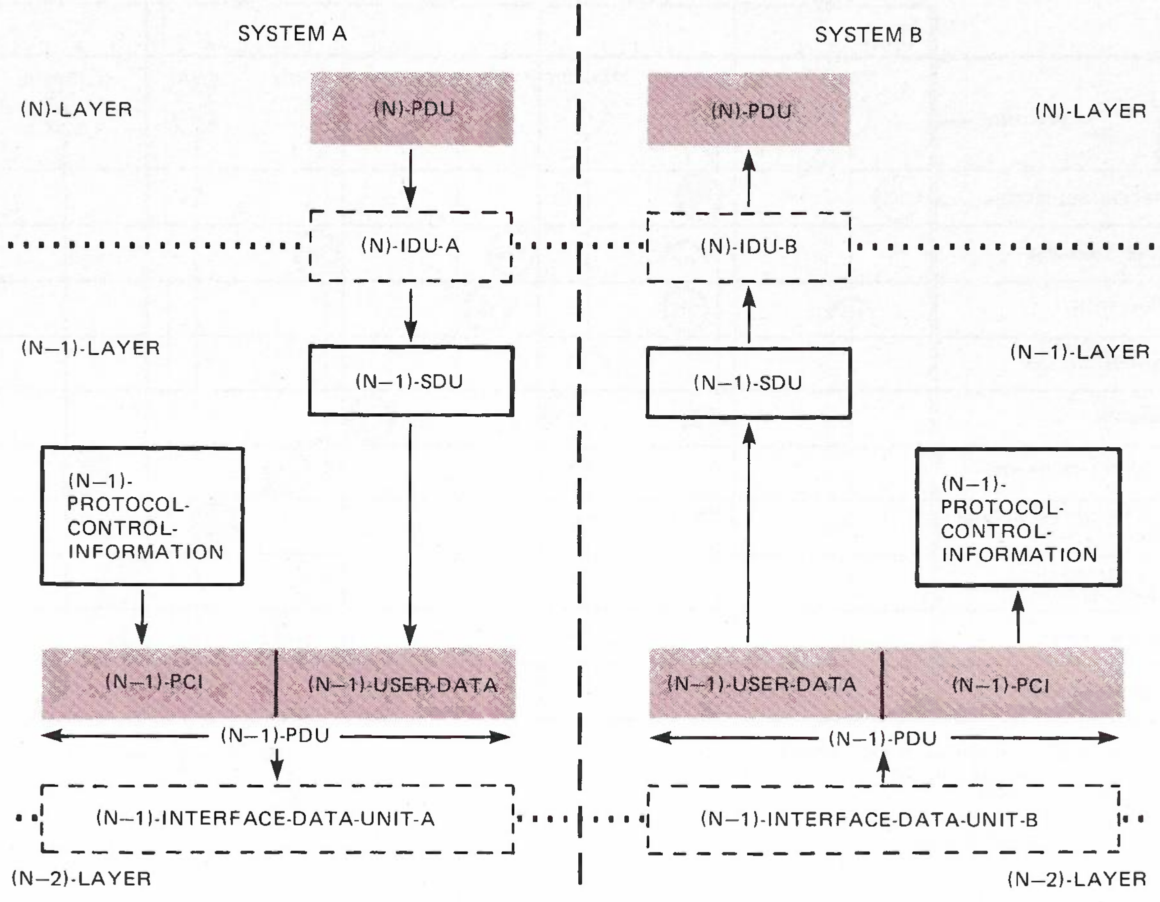
Each of these classes of data unit can be decomposed further into two subclasses: data units comprising ***control*** information (ie data treated as control signals) and data units which are simply treated as "data" (to be passed on to a third party). In the case of protocols, this latter subclass is called ***user data.***

Fig. 3 shows a simple relationship (actually the simplest possible relationship) between protocol-data-units (used in defining OSI layer protocols), service-data-units (used in defining OSI layer services), and interface-data-units (not defined at all in OSI standards, as a matter of policy, except for the physical layer, N = 1).

The explanation of Fig. 3 is as follows. The (N) - protocol - data - unit is passed from system A to system B via the lower layer (N-1). In the simplest possible design, the (N) - protocol - data - unit is copied directly into the (N-1) - service - data - unit; in the general case, it is mapped first into an (N) - interface - data - unit, representing part of the manufacturer's design interface between the (N)-Layer and the (N-1)-layer within system A, and is then mapped into the (N-1)-user-data part of the (N-1) - protocol - data - unit. There is no restriction on how these mappings are performed, provided that the information is retrievable by inverse mappings in the receiving system (B), so that the (N) - protocol - data - unit eventually received by system B's (N)-layer is identical to the (N) - protocol - data - unit transmitted by system A's (N)-layer.

If N = 1, then the (N-1) - interface - unit can be transmitted directly via the physical media; if N > 2, then the procedures shown in Fig. 3 must be repeated in the (N-2)-layer, and so on.

You can deduce that by the time an application layer protocol data unit has been passed down to the physical layer interface, the (1) - interface - unit will effectively contain protocol control information from all seven layers, accompanying the (probably now encoded) single piece of user-data from the application layer. This may result in very heavy overheads, in both processing load and transmission link occupancy, when all seven OSI layers protocols and services are implemented. Indeed, it has been suggested that special distributed operating systems may be necessary in OSI systems in order for them to efficiently provide throughput of application user data. This is seen by OSI reference model enthusiasts as a small price to pay for the massive benefits of being able to access and communicate with a potentially enormous range of computer systems, data bases and terminal equipment, around the world.



LEGEND:

PDU = Protocol-Data-Unit
IDU = Interface-Data-Unit
SDU = Service-Data-Unit
PCI = Protocol-Control-Information
(N)- = Particular to the (N)-Layer
-A, -B = Particular to System A, B

Fig. 3 — Example of a Simple Relationship Between Protocol - Data - Units (used in defining OSI layer protocols, Service - Data - Units (used in defining OSI layer services) and Interface - Data - Units (not specified in OSI standards, except for layer N = 1).

CURRENT STATUS OF STANDARDISATION

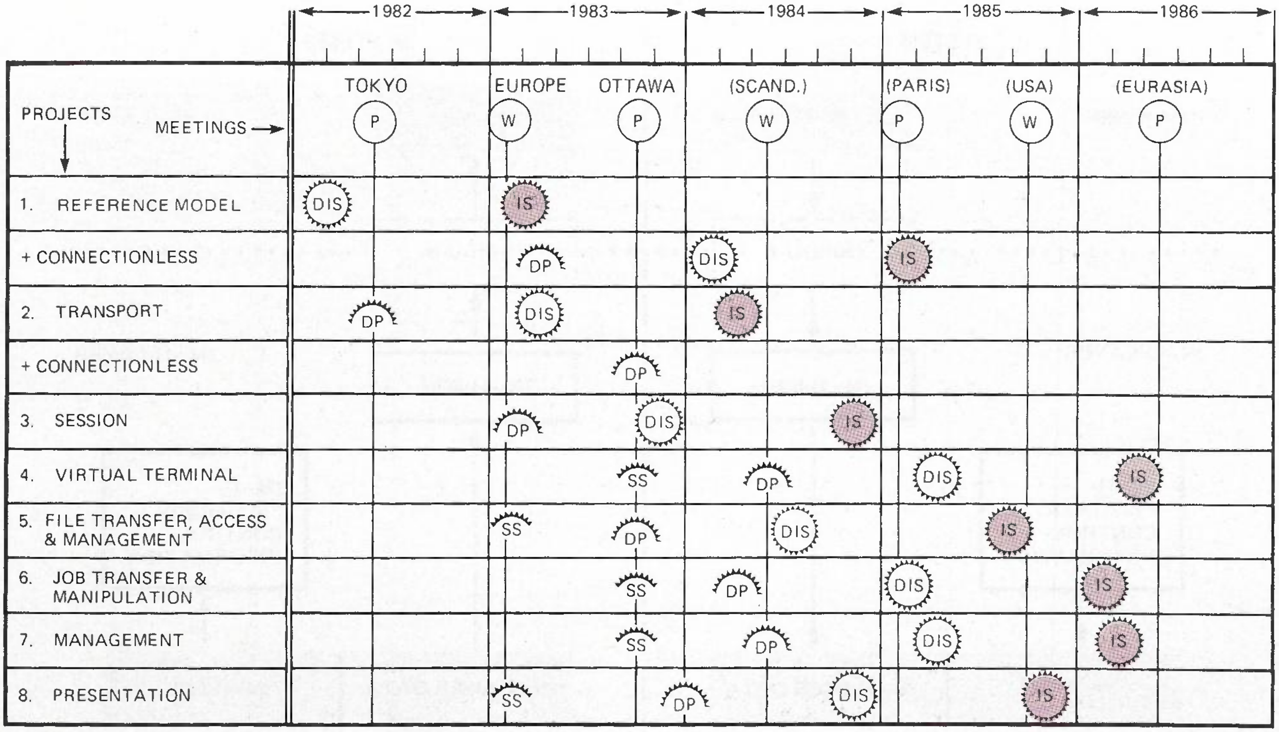
The CCITT and ISO have made a mutual policy decision to seek minimum conformity and "harmonisation" between the texts of their eventual Recommendations (in the case of CCITT) and International Standards (in the case of ISO) on the reference model and on the new protocols and services they wish to base upon the reference model. To help implement this policy, a procedure has been set up since 1981 where the output draft standard / recommendation produced by each meeting of the CCITT Special Rapporteur's Group of experts in the reference model becomes an input to the next meeting of the ISO working group on the same topic, and vice versa. This iterative procedure applies also to the working groups on the network service and transport service and protocols.

It must however be noted that despite this iterative procedure of close feedback between the ISO and CCITT groups of experts, the two current versions of the reference model (References 1 and 2) are still quite a distance apart in matters of structure, explanation and fine detail. Similarly, on the subject of the transport layer protocols, agreement has yet to be achieved on what should be the preferred, minimum set of protocols (the ideal being a single transport protocol, containing optimal features which can always be negotiated by entities in higher layers). However both the relevant standards bodies have sufficient time left in their work programmes to achieve a much closer degree of "harmonisation" between their final products.

Status within the ISO

The relevant ISO standards body is the Sub-committee 16 of Technical Committee 97 (Information and Data Processing), abbreviated as TC97/SC16. SC16 is responsible for the reference model and for standards associated with its upper four layers. Its current work plan is shown in **Fig. 4**.

It will be seen that the earliest international standard to emerge will be the reference model itself, scheduled for April 1983. The standards for the layer services and protocols will come considerably later, from 1984 to 1986.



LEGEND: P = WG/Plenary meetings, W = WG (Working Group) meetings only
SS = Stable Service Definition
DP = Draft Proposal
DIS = Draft International Standard
IS = International Standard
'Connectionless' = Extention to permit a Connectionless mode of data transfer, e.g. with datagrams

NOTE: DP → DIS = 10 months delay
DIS → IS = 12 months delay

Fig. 4 — The ISO's Current Work Plan (Technical Committee 97/Sub-Committee 16).

Status within the CCITT

The relevant CCITT body is its Study Group VII (Data Communication Networks), which, like other CCITT study groups, aims to produce most of its recommendations for approval at the CCITT plenary assemblies held every four years. There is reason therefore to believe that the CCITT's version of the reference model and most of its associated layer services and protocols, would achieve standardisation at the 1984 plenary assembly. A mechanism for the accelerated approval of important standards does exist however, and this may conceivably be invoked by Study Group VII in 1983 if it wishes to issue its recommendations on the reference model and the transport layer protocols and services, in about the same time period as the ISO.

In the view of the CCITT, some of its standards for protocols in data communications already exist in the OSIE; for example, it views the X.25 recommendation as a de facto OSI standard for layers 1 to 3 protocols for packet switching networks. The draft reference model has been influenced by the need to be compatible with the 1980 X.25 recommendation, as has the draft network service specification; and the transport layer service and protocol specifications have been influenced by the need to be compatible with the 1980 Teletex recommendations (eg S.70 for the Teletex network and transport layer function).

Status of Formal Description Techniques

Both the CCITT and ISO share the objectives of using formal description techniques to define much more precisely the OSI reference model itself, and its associated protocols and services.

To date, no progress has been made in choosing or developing a formal description technique to apply to defining the reference model.

On the other hand, considerable progress has been made within CCITT and ISO in developing suitable formal description techniques to define the OSI protocols. There currently exists an agreement in principle between the relevant CCITT and ISO groups of experts to use an enhanced form of the CCITT's Specification and Description Language (SDL) as the sole graphical form of the formal description technique, and CCITT's Study Group XI (the originator and 'custodian' of SDL) is co-operating with Study Group VII in introducing the necessary enhancements to SDL, in a revised set of SDL recommendations, with sufficient speed to have the "enhanced SDL" ready for Study Group VII's users by the end of 1982. The most significant enhancement to SDL will be the definition of data elements.

In the ISO, the principal activity on formal description techniques has been developing two quite different non-graphical languages: a "linear program-like form", called the Subgroup B language, based on extending the PASCAL language with finite state machine concepts and inter-process communication concepts; and temporal logic, a highly mathematical language which describes sequences of interactions and their relationship in time.

Within the CCITT, there is a reluctance to standardise on any particular "linear program-like form", for use in addition to SDL, because each CCITT member organisation's preference for the host programming language (e.g. PASCAL, CHILL or ADA) will depend upon what software support systems the organisation has, or expects to purchase. The CCITT is more likely to simply develop guidelines for the translation of the "enhanced SDL" specifications into CHILL, and possibly into other candidate host languages. The CCITT Study Group XI is also putting effort into developing a program-like form of SDL, called SDL/PR, to facilitate computer editing, drawing and validation of SDL specifications.

RELEVANCE TO AUSTRALIA

Australia already has a variety of private computer communication networks and within a few years it is likely to have a variety of public switched data networks together with many more private networks. For the sake of sanity, economy and operational flexibility there are obvious advantages in trying to adopt not only common standards for terminal access to the major data networks (e.g. X.25 access), but also to offer a common network service. Since many customers will want to exchange information with data bases or terminal users in other countries, there is a compelling motivation to adopt international standards as these common (national) standards wherever possible. An additional motivation is the expectation of lowering the costs of purchasing systems developed to meet the larger international market.

Several experts working in the forefront of computer networking technology, also anticipate a strong customer demand for higher-layer services (the transport service and above) to be provided in the terminals and host computers of the data networks, in order to facilitate the transfer of data between dissimilar systems and equipment.

The OSI reference model also has relevance to the design of the future integrated services digital networks (ISDN) within Australia, since the CCITT has made a policy decision to develop the new protocols and services required to permit customer access to the ISDN in conformance with the reference model.

For these reasons it is important for the telecommunication community in Australia to keep abreast of the ongoing development of the OSI reference model and its associated services and protocols. Opportunities for Australian contribution to the ongoing development of standards is provided, in the case of ISO, via the Standards Association of Australia's subcommittee MS20/16 (Open Systems Interconnection), and in the case of CCITT, via the Study Group VII coordination meetings of the Australian member organizations of the CCITT.

CONCLUDING REMARKS

The open systems interconnection concept attempts to provide for computer users, a scale of international interconnectability equivalent to that achieved by the international telephony network and the international telegraphy/telex network. This is a highly ambitious goal, given the current heterogenous assortment of mutually incompatible computer systems and languages around the world.

The OSI concept is even more ambitious, because the OSI environment is intended to support an open-ended set of new information processing services: computer-to-computer services such as virtual file transfer and manipulation; terminal-to-computer interactive services such as videotex and teletex; and terminal-to-terminal services such as electronic mail, digital facsimile and even voice services.

The OSI reference model provides the reference framework or 'architecture' within which the development of new OSI services and protocols can be defined. It is a layered architecture, designed that way so that new upper layer services and protocols can be implemented with (ideally) no changes being required in lower layer protocols — and vice versa. For example, the basic network service provided by OSI telecommunication networks should be, ideally, the same, independent of whether it is provided using packet-switching technology (eg with AUSTPAC) or circuit-switching (eg the current circuit-switched public data networks in Scandinavia and West Germany, and the future ISDN, whose protocols will be quite different).

The full details of the reference model are not easy for telecommunication people to come to grips with, partly because of its elaborate and unfamiliar terminology, and partly because of the absence of physical interfaces to give substance to the very abstract structure of the model.

The absence of a clear interface between the user application processes outside the OSI environment and the application services within the OSI environment is a case in point.

It should be stressed that this article has only attempted to focus on, and explain what the author believes to be the most important and basic features of the model as far as its use in telecommunications is concerned. To gain a deeper appreciation, it is recommended that you read one of the more detailed explanatory papers on the subject (References 3,4) before tackling the full complexity of the current ISO and CCITT drafts (References 1,2).

The overriding importance of the OSI reference model is not that it is an intellectually elegant model (which it isn't), nor that it promotes the design of efficient protocols (which it doesn't pretend to do), but the fact that so many member organizations of the two most important standards-setting organizations in the world, ISO and CCITT, are determined to make the OSI concept happen and work. Therefore the specifiers and designers of all future computer-based networks, switching systems and customer terminals for the Australian telecommunications network will need to take account of the need for compliance with the OSI reference model and its associated standardised protocols and services, or risk their products being needlessly "shut out" from the potential of international open systems interconnection, with all its attendant consequences.

REFERENCES

1. ISO TC97/SC16: "Draft International Standard 7498, Open Systems Interconnection Basic Reference Model"; April 1982.
2. CCITT Study Group VII, Special Rapporteur's Group draft document: "Reference Model of Open

Systems Interconnections for CCITT Applications"; May 1982 version.

3. H. Zimmerman: "Progression of the OSI Reference Model and its Applications"; IEEE National Telecommunications Conference, December 1981.

4. N.Q. Duc: "ISO/CCITT Reference Model of Open Systems Interconnection"; Chapter 2 in Telecom Australia Research Laboratories Report No. 7554 by F. J. W. Symons, N.Q. Duc, P. A. Kirton and J. Snare, August 1982.

GLOSSARY OF TERMS

Boundary	=	CCITT term (equivalent to ISO term 'Interface') which describes the functional border between adjacent OSI layers.
CCITT	=	International Telegraph and Telephone Consultative Committee.
Entity	=	An active element within a layer and within a single system.
Interface	=	(See 'Boundary')
ISDN	=	Integrated Services Digital Network.
ISO	=	International Organisation for Standardisation.
Layer	=	A vertical subdivision of the OSI architecture (See Figs. 1, 2, 3).
OSI	=	Open Systems Interconnection.
OSIE	=	Open Systems Interconnection Environment (See Fig. 1).
Peer-entities	=	Entities within the same OSI layer.
Protocol	=	A set of strict rules and formats which defines the communication behaviour between peer entities (See Fig. 2).
(OSI) Service	=	A capability of a particular OSI layer and the layers beneath it, which is provided for the use of entities in the layer above (or for the application processes outside the OSIE, if the service being described is a service of the application layer).

Thoughts on a New Telephone Network Structure for Australia

C. W. A. JESSOP BSc., M.Eng Sc., MIEE, C.Eng. N. W. McLEOD BSc, MIE Aust.

This paper explores the possibilities of using a non-hierarchical network structure for the IDN. Benefits of adopting this approach to network development are outlined, and aspects requiring further investigation noted.

INTRODUCTION

Australia, in common with the rest of the world is turning to digital techniques for the development of the telephone network. Digital switching systems and digital transmission systems are becoming more economic than analogue systems. Like other Telecommunications Administrations, Telecom Australia is taking advantage of the economic benefits derived from the integration of digital switching and transmission, resulting in an Integrated Digital Network (IDN). A network so developed switches speech traffic using 64kbits per second (kbps) transmission.

A further advantage from building an integrated digital network is realised when customers can be connected to the network via digital subscribers links. This 64kbps link, initially provided for speech, will enable customers to transmit messages from end-to-end using the 64kbps link as a transport service, allowing a wide variety of data uses to be integrated with telephony. This is known as the Integrated Services Digital Network (ISDN). The essential infrastructure for ISDN is IDN. This paper will briefly outline the possible development and new network structure of the Integrated Digital Network in Australia.

DEVELOPMENT STRATEGIES

The strategy to be employed by an Administration for the introduction of a digital network will be dependant on many factors, the importance of each being influenced by the current state of the network and the need for general network growth and new services and facilities.

Some Administrations' networks are constrained by old generation equipment and technical limitations including electro-mechanical switching and limited capability signalling. These networks require a programme of total replacement, as quickly as possible, to meet the demands of their customers for modern facilities. Replacement is performed on an exchange-by-exchange basis and a link-by-link basis, often resulting in the development of "digital islands" within the analogue network, with additional links joining these islands.

Other Administrations have a more modern network with extensive amounts of (analogue) SPC working and with more advanced facilities best provided by digital techniques.

The Australian network is in an intermediate situation with:

- extensive quantities of crossbar (much of it upgraded to ARE, providing basic SPC facilities)
- a sophisticated and powerful information signalling system (MFC)
- the AXE system, with digital group switch, being introduced
- an annual growth rate of subscribers connections in excess of 6%
- a programme to replace step-by-step equipment (currently about 25% of terminations) by year 2000 A.D.

Hence the development of the Australian network will be characterised by the overlay of digital equipment to cater for growth and advanced facilities, together with the digital islands where step-by-step exchanges are replaced. This digital network will be developed separately from, and in parallel with, the analogue network.

CALL ROUTING RULES

The great majority of telephone networks are planned around hierarchies of exchanges, different hierarchies being employed in trunk and large city networks (see **Fig. 1**). This hierarchical structure serves many purposes, including defining rules for routing of calls and the control of transmission loss throughout the networks.

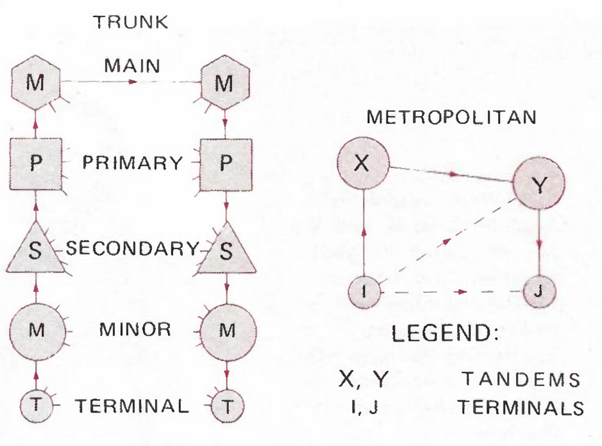


Fig. 1. Traditional Network Hierarchy

Routes are allowed between all levels of exchange in any two "legs" of the hierarchy, but calls are not permitted to transit switch via an intermediate leg. This restriction to call routing can be overcome with a non-hierarchical structure as will be shown later.

Within an integrated digital network the speech signal is encoded at the entry point, and decoded on exit with ***NO*** loss in level. Thus the need for a hierarchy to control loss levels disappears in an IDN. Where a separate network strategy is used, the IDN can have a different structure from that of the existing analogue network which can retain the existing hierarchy. The new IDN structure should not, of course, prevent interworking of the old and new networks.

NON-HIERARCHICAL NETWORKS

In considering a non-hierarchical approach to network structure it must be stressed that it is not an anarchical network — sensible rules can be applied to control call routing and ensure efficient operation of the network.

Simply described, traffic in such a network would head towards its (geographic) destination, transitting via switching stages en route. This effect can be likened to "tunnelling" through the network, exchange by exchange, as opposed to "climbing and descending" the traditional hierarchy.

Alternate routing and economic dimensioning theory can be applied to the network, with the provision of direct routes as appropriate. Moreover, it is not expected that a call would normally transit switch through a large number of exchanges on a path. This is discussed in more detail below.

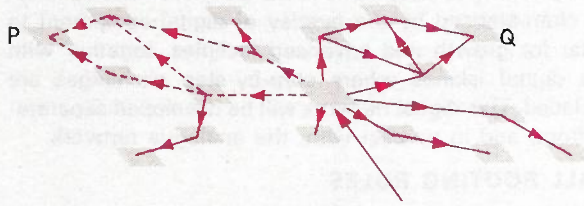


Fig. 2. Non-hierarchical Network Routing

Fig. 2 shows call routing possibilities between an originating exchange O and two destinations P & Q. The direct routes to P & Q from O and other earlier exchanges have been omitted to simplify the diagram.

Route selection could be achieved in three ways:

- ***Sequential, Stage-By-Stage Selection.*** Each switch on the path performs route selection in turn. This approach is compatible with current crossbar exchanges and MFC signalling practices. Common channel signalling is desirable but not essential.
- ***Originating Exchange Controls Route Selection.*** Exchange data tables contain a set of paths to each destination. The originating exchange signals to subsequent exchanges on a selected path to check availability of that path. Common channel signalling is essential.
- ***Central Selection.*** Originating exchange signals to a central control point with A-party & B-party numbers. Central control selects routes and instructs exchanges involved in the call. Common channel signalling is essential.

For each method it is assumed that a failure to establish a path would result in a re-attempt, via an alternative path.

At present the authors favour the first method for its compatibility with the current practices, and distribution of routing intelligence throughout the network. However, further investigation is required before any decision can be taken.

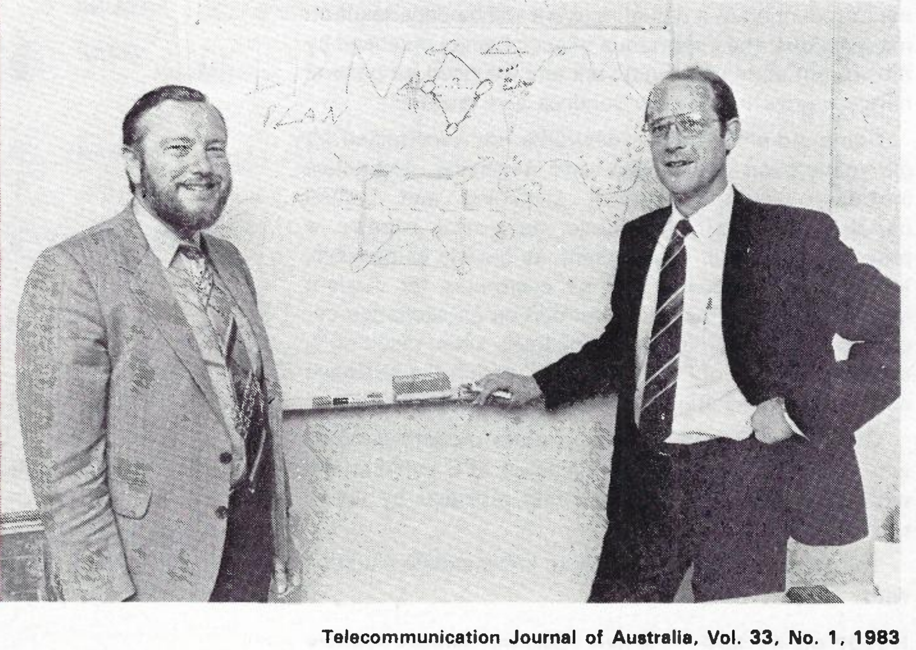
NETWORK APPLICATION

In the Australian national network there are two basic networks to consider; metropolitan and trunk.

Metropolitan

The IDN network will be composed of nodal switching stages parenting a number of remote subscriber stages at other locations. These "nodes" will thus be originating traffic for some 10-30,000 customers and will hence justify large direct routes between all other nodes on economic grounds. Current studies show that greater

C. W. A. Jessop (left), Engineer Class 5, and N. M. McLeod (right), Engineer Class 4, are currently members of a project group in Engineering Planning, HQ, Telecom, assembling an IDN framework plan for Australia.



than 80% of traffic may be carried on such direct routes. Even for nodes at opposite ends of the network the amount of traffic transitting more than two exchanges will be small, as shown in **Fig. 3**.

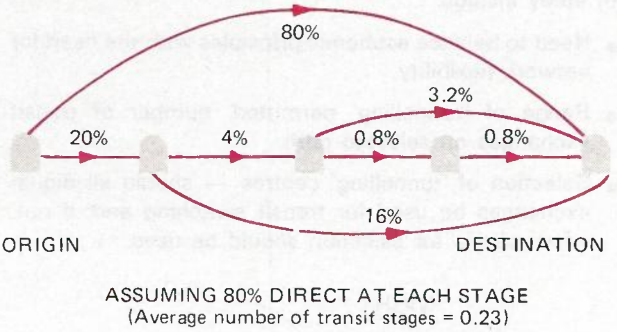


Fig. 3 Traffic Routing Employing Tunnelling Principle

Although the amount of traffic which is transit switched is small, the existence of some transit switching will improve the flexibility of the network and is thus recommended.

Fig. 4. Distribution of Major Trunk Centres in Australia

Trunk

Fig. 4 shows the distribution of major trunk switching centres in Australia of secondary or higher status. It can be seen that the centres are spread around the coast with little penetration inland. This distribution favours a network structure built as a chain (as is a non-hierarchical network) rather than the traditional hierarchical network built around regional centres with a star configuration.

The following diagrams **(Figs. 5 & 6)** indicate the improvement in flexibility and economy provided by a non-hierarchical structure, featuring the tunnelling principle. The existing network, based on conventional hierarchy, requires separate provision of plant to meet day and evening traffic peaks, where these peaks have different geographic distributions, i.e. the capital city to capital city traffic is higher during the day, whereas the country to capital city and intra-country traffic is higher at night.

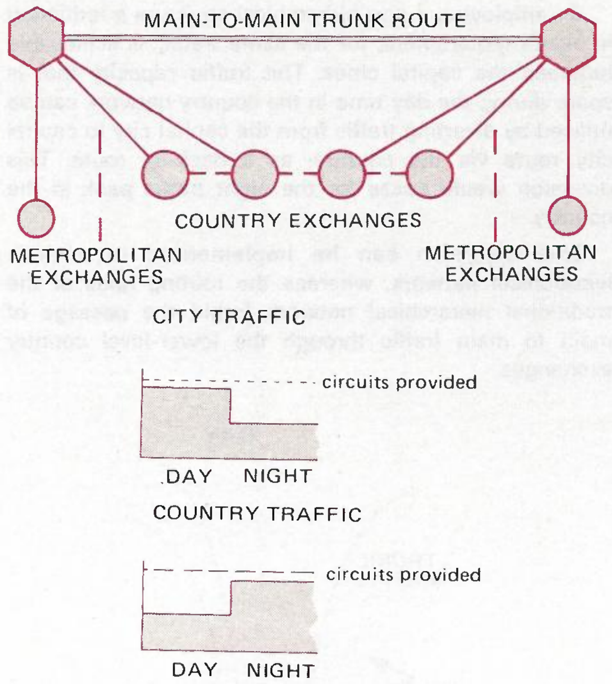


Fig. 5. Trunk Traffic Optimisation: Conventional Hierarchy

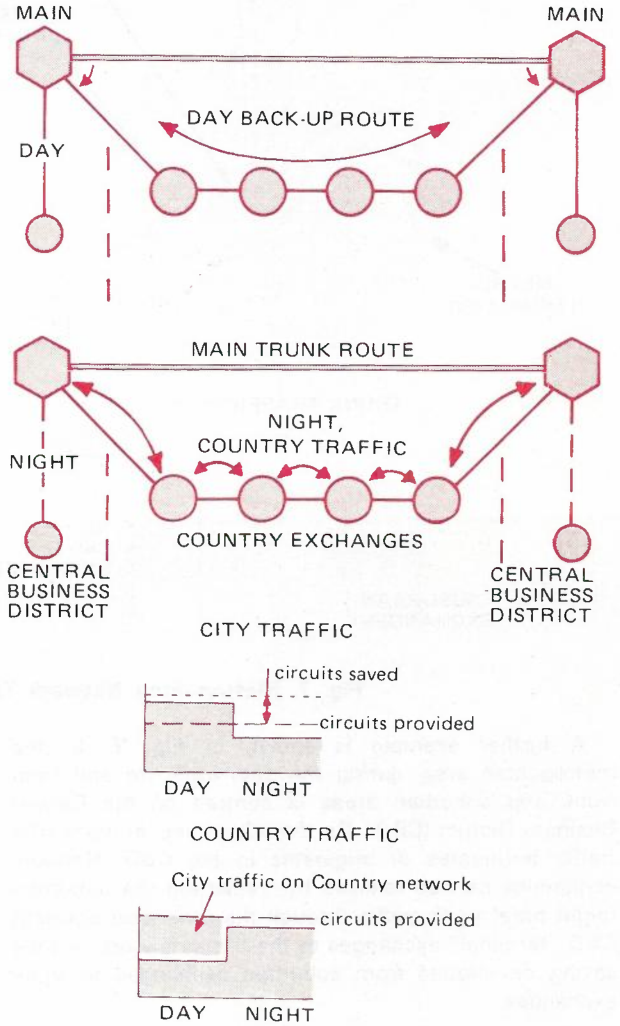


Fig. 6. Trunk Traffic Optimisation: Non-hierarchical network

By employing a non-hierarchical structure a reduction in circuit requirement, for the same traffic, is achievable between the capital cities. The traffic capacity that is spare during the day time in the country network can be utilised by diverting traffic from the capital city to capital city route via the country, as a back-up route. This diversion would cease for the night traffic peak in the country.

This diversion can be implemented in a non-hierarchical network, whereas the routing rules of the traditional hierarchical network forbid the passage of main to main traffic through the lower-level country exchanges.

networks are based on hierarchical structures. The introduction of a non-hierarchical network with 'tunnelling' will require new modelling procedures which are currently under consideration. Some aspects worthy of study include:

- Need to balance economic principles with the need for network flexibility.
- Range of 'tunnelling' permitted, number of transit exchanges on selected path.
- Selection of 'tunnelling' centres — should all digital exchanges be used for transit switching and, if not, what criteria for selection should be used.

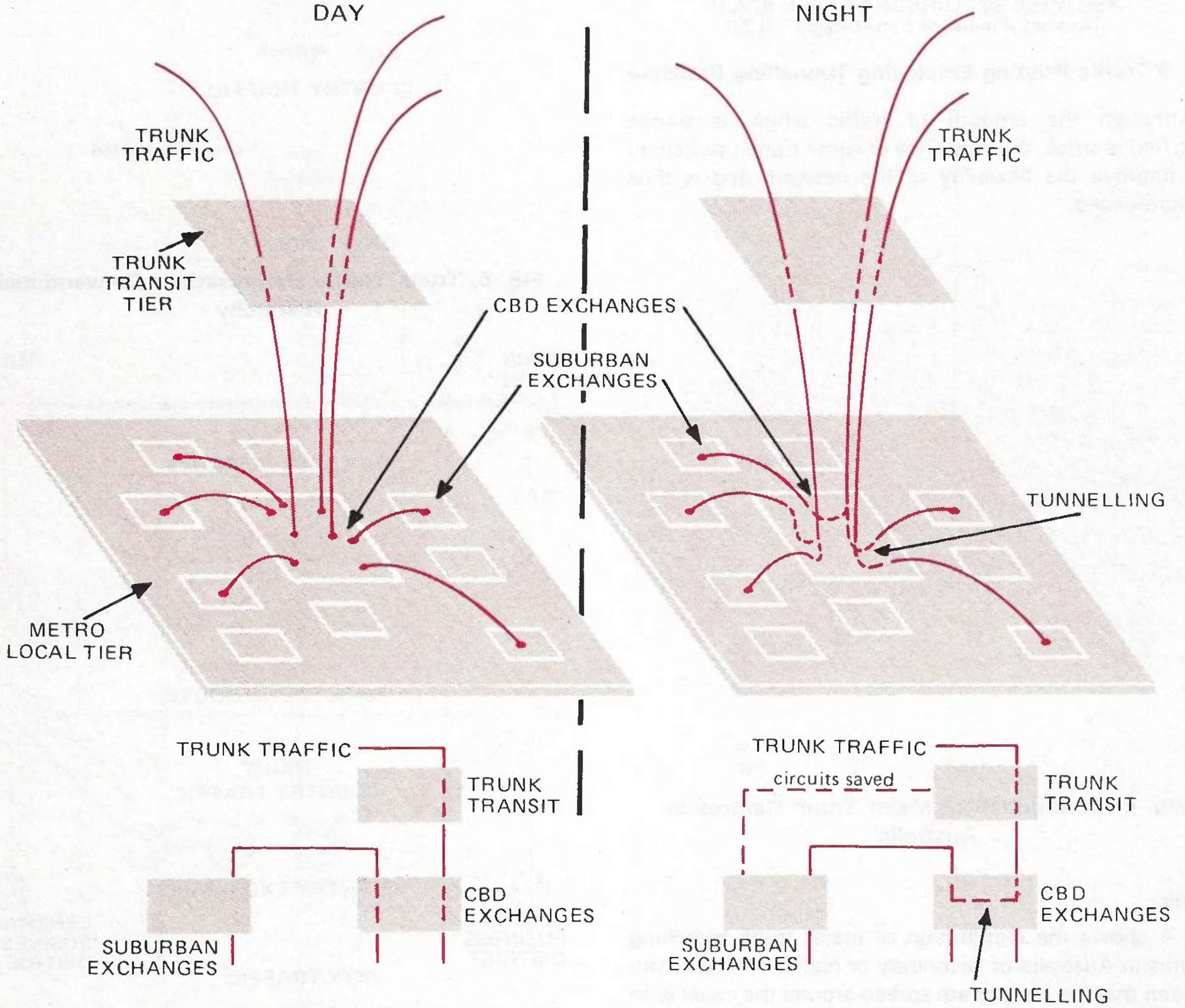


Fig. 7. Metropolitan Network Trunking: Non-hierarchical Network.

A further example is shown in **Fig. 7.** In the metropolitan area, during the day, traffic to and from trunk and suburban areas is centred on the Central Business District (CBD). On the other hand, at night little traffic terminates or originates in the CBD. Network economies can be realised by transiting the suburban (night time) trunk traffic through the otherwise dormant CBD "terminal" exchanges to the trunk network — thus saving on circuits from suburban exchanges to trunk exchanges.

DIMENSIONING PROCEDURES

Current dimensioning techniques for Australian

BENEFITS OF A NON-HIERARCHICAL APPROACH

There must be a good reason for changing from a proven network structure (hierarchical) to one that is significantly different (non-hierarchical). Some aspects considered which tend to favour the non-hierarchical approach are:

Economics. Studies have shown a 5-10% improvement in overall network economics using non-hierarchical routing. Although this difference is not significant statistically, it does indicate that there is unlikely to be a cost penalty in adopting the new network structure.

Robustness. The non-hierarchical structure, when combined with the common channel signalling facility, is likely to lead to a more robust network. It is possible to route around blockages caused by faulty equipment with normal routing disciplines and, as indicated in Fig. 2, final routes can be split over two or more exchanges on different paths thus providing survivability through diversity.

Flexibility. A non-hierarchical structure allows multi-purpose usage of switching and transmission facilities, ie traffic can be terminated or transit switched as required. This flexibility is useful in meeting changes in traffic dispersion during different periods such as seasonal or day/evening dispersion changes (as shown in Figs. 5, 6 and 7).

Network Management. In addition to inbuilt flexibility of operation it is feasible to modify network routing rules to meet changing circumstances. This is facilitated by the lack of hierarchical rules as each exchange can be used to provide the required switching function.

Telecom Australia is considering the introduction of network management principles which would be phased in over a number of years, with traffic re-routing perhaps not introduced until the 1990s. The network structure outlined in this paper would, however, assist in introducing active network management to the Australian network.

CONCLUSION

This paper has outlined some thoughts on a non-hierarchical network structure for the Australian IDN. It has shown the approach to be economic, feasible and, above all, flexible in meeting the future demands of telecommunications in Australia. Further work is being undertaken to define network routing rules that will result in an optimal network with all these qualities.

REFERENCES

1. G. R. Ash, R. D. Cardwell, and R. P. Murray, "Design and Optimisation of Networks with Dynamic Routing", Bell System Technical Journal Vol. 60 No. 8, Oct. 1981.
2. F. J. Schramel, "Trends in Digital Switching and ISDN", ITU Telecommunication Journal Vol. 49, 1982.

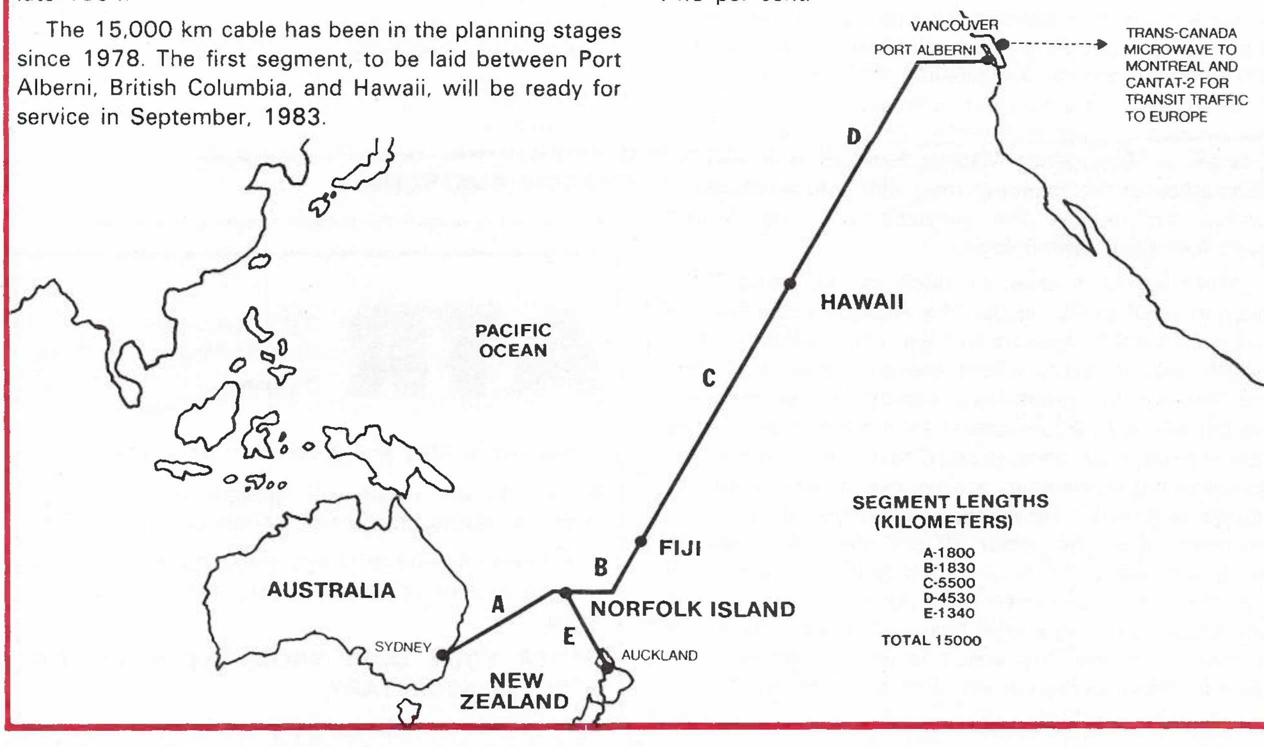
In Brief

ANZCAN

ANZCAN is a $480 million, 1840-circuit submarine cable of the utmost importance in expanding the range and quantity of international telecommunication services to Pacific Rim countries. It will link Australia and New Zealand with Canada, Hawaii, Fiji and Norfolk Island by late 1984.

The 15,000 km cable has been in the planning stages since 1978. The first segment, to be laid between Port Alberni, British Columbia, and Hawaii, will be ready for service in September, 1983.

The major partners in this, the largest international telecommunication project of its kind ever undertaken, are the Overseas Telecommunications Commission of Australia, with a 49.7 per cent interest, Teleglobe Canada with 15.7 per cent and the New Zealand Post Office with 14.5 per cent.



BOOK REVIEW

TELECOMMUNICATION FOR HEALTH CARE

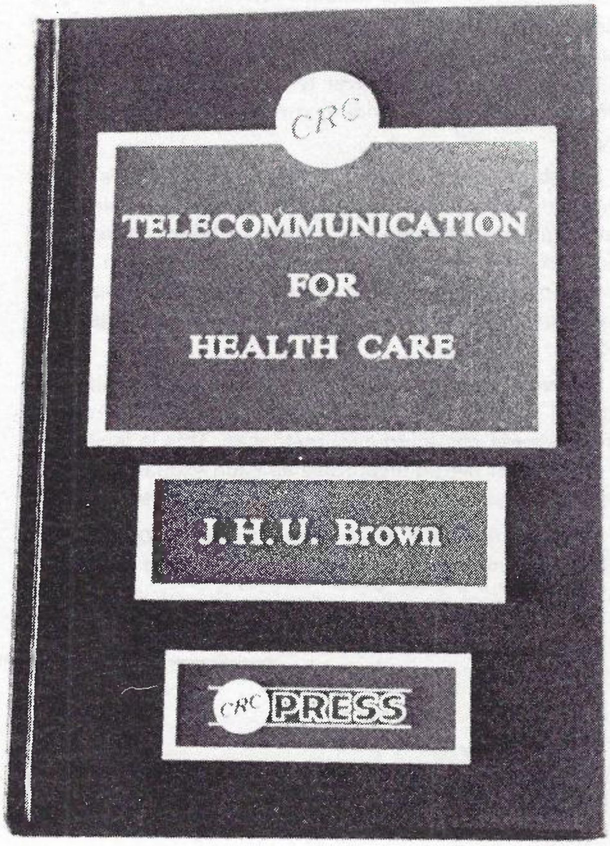
J.H.U. Brown, CRC Press, Boca Raton, Florida 1982, pp 99.
(DA Book Depot Pty. Ltd., Mitcham, Vic.)

Telecommunications already have an important role in the delivery of health care and this role may well increase and diversify in the future. A book which comprehensively outlines the techniques and issues would be useful to engineer and physician alike. Unfortunately this is not it.

The book has 11 chapters including General Problems in Telecommunication, Modes of Communication, Special Applications, Satellites and Emergency Systems. The writer has gathered extensive information but has organised it poorly so there is repetition on the one hand and obscurity on the other. I would have expected the book to be systematically organised about the types of telecommunications available (radio, telephone, TV, cable TV, Prestel, Satellite) or about types of medical services. Instead the book is a salad of facts, sometimes referring to a technology and sometimes to a type of health care. There is a lack of a clear statement as to the purpose of the book and the definition of telemedicine as "health care delivery to a remote site through the use of communication links" is imprecise. It does not define "communication" which later in the book seems to mean computer systems as much as electronic media. Also the book generally discusses conventional doctor-patient consultations but inconsistently deals with health education and other aspects of "health care" which one would expect from the title.

The Australian reader would probably be interested in the application of telecommunication technology to urban and outback settings. The historic pedal radio link to the flying doctor service is a bench mark against which later improvements in outback settings could be checked. It is briefly referred to but not discussed, although it is a major achievement. Urban telephone medical information services are scarcely mentioned although some (such as VD Hotline in Sydney and Lifeline), have been successful and are an interesting example of providing medical information cheaply and readily. On the other hand the chapter on Emergency Medical Services is a succinct description of the linking of the public into a network of police, ambulance, fire services, etc., by various communications technologies.

Much space is given to satellites and using TV to support rural health aides. The Alaskan experiment of radio via satellite appears to have been useful to village health aids in areas where ordinary radio was often blocked out by atmospheric conditions. An extensive experiment with a land based TV system in an Arizona Indian reservation demonstrated that "many of the conventional high technology approaches to health care may not be necessary". For example, the radio link was more important than the colour TV and the cost-benefit of black and white TV is very debatable. A satellite TV nutrition education experiment in India was of very limited success and a land based TV system for health workers in Puerto Rico was a failure. All this suggests need for much caution in any plans to use Aussat in outback health services. Almost universally, better radio facilities would be more useful than TV for rural health aides. Cheap, solar-powered, all weather radio transmitters are needed globally for village health workers, yet there is no discussion about appropriate technology in the book.



This is a book to borrow and browse through to get some ideas on the subject. But comprehensive and critical discussion must be sought elsewhere.

Reviewed by:
Dr B. Hocking
OCCUPATIONAL HEALTH ADVISOR
TELECOM AUSTRALIA

AUSSAT — Space Segment Overview

The general features of the Australian National Satellite System (AUSSAT) are described together with some launch details and transmission coverage.

INTRODUCTION

Australia's national communication satellite will be a spin stabilised spacecraft, a technique developed by the Hughes Aircraft Company. While the two cylindrical solar panels spin at 50 rpm and provide not only gyroscopic stability, but twice the power of earlier satellites of this type, the antenna assembly remains pointed toward the coverage zone, ensuring continuity of the satellite's communication services.

The unique design permits the spacecraft to be stowed inside the launch vehicle in a configuration that is less than half the overall height of the satellite in orbit. With the antenna folded down and the outer solar panel covering the inner solar panel, the spacecraft is only 2.8 metres high. Once in orbit, the antenna is erected and the outer solar panel extended — like a telescope opening — bringing the overall height to 6.6 metres.

The satellite system will consist initially of two operational satellites and an on-ground spare. The typical 'life' of each satellite will be at least 7 years.

POSITION IN ORBIT

The first two operational satellites will be placed in geostationary orbit approximately 36000 kilometres above the equator at 156°E longitude and 164°E longitude. The satellites **(Fig. 1)** are 2.2 metres in diameter and will weigh about 655 kilograms at the beginning of life in orbit.

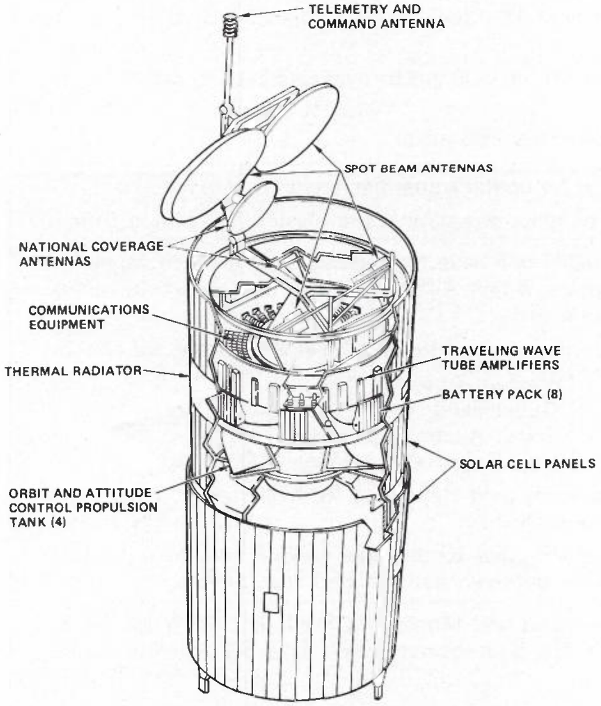


Fig. 1 — AUSSAT Spacecraft Configuration

Heat generated by the spacecraft's electronic equipment is radiated to space through a quartz mirror thermal radiation band around the middle of the satellite. The solar panels use high-efficiency K-7 solar cells and generate more than 1 kilowatt of power when fully deployed at the beginning of life. Two nickel-cadmium batteries supply full power during eclipse operations and are re-charged by the solar cells.

ANTENNA CONFIGURATION AND CAPACITY

The spacecraft is similar in design to other current systems, with one significant difference. While all other spacecraft of this type use a single antenna structure for the transmit and receive signals, each AUSSAT satellite **(Fig. 2)** has three separate dual surface antennas, providing six reflectors in total. In other words, all three antennas are dual polarised; each can form transmission beams in the 12.25 and 12.75 GHz band on both polarisations. The satellite receives signals in the 14.0 and 14.5 GHz band on both polarisations.

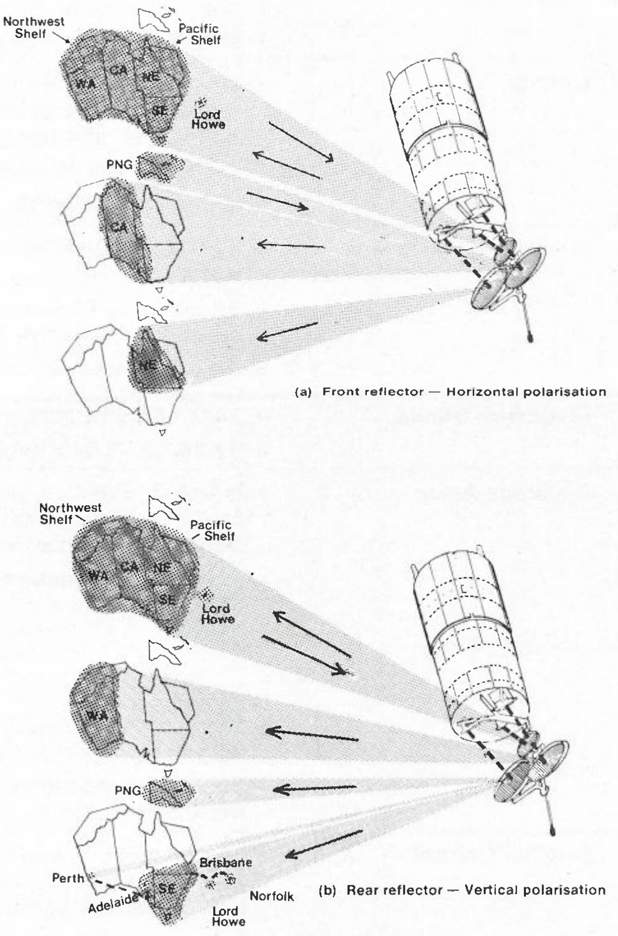


Fig. 2 — AUSSAT Antenna Coverage

The vertically and horizontally polarised signals do not interfere with each other and combined with the three dual polarised antennas, permit the satellite to provide total and multiple nationwide and spot beam coverage.

The advantage of using multiple antennas instead of a single antenna is that with a separate reflector surface dedicated to each homestead and community broadcasting satellite service (HACBSS) coverage area, a significant improvement in antenna performance is achieved.

The largest antenna is 112 centimetres in diameter and forms the transmit beams to Central and Western Australia as well as the receive beam for Papua New Guinea. Alongside the largest antenna is a second antenna, 102 centimetres in diameter, which forms the transmit beams to the North-East and South-East regions of Australia and to Papua New Guinea. The smallest antenna is 61 centimetres wide and is centred below the larger antennas. This antenna provides both the transmit and receive beams for national coverage.

These three antennas are mounted on a common support structure made of a lightweight thermally-stable graphite fibre composite which is deployed once the spacecraft reaches geosynchronous orbit. The entire antenna assembly is gimballed to provide exact positioning.

Pointing accuracy of the antenna system is better than 0.05 degrees. This is achieved by a specially designed radio frequency beacon tracking system carried on board the satellite which locks the antenna system onto a beacon signal transmitted from the ground control station in Sydney. This technique has been used by other Hughes satellites and was pioneered by the earlier ANIK A, PALAPA A and WESTAR satellites.

The spacecraft has 15 channels or transponders, each 45MHz wide. Eight channels use the horizontal polarisation and seven use the vertical polarisation. Four of the channels use 30 watt K-band travelling wave tube amplifiers necessary for the high-power requirements of the homestead and community broadcasting satellite service (HACBSS). The remaining 11 channels use 12 watt travelling wave tube amplifiers.

Satellites	• 2 satellites in geostationary orbit, 36000 kms above equator. (156°E longitude, 164°E longitude) • one on-ground spare • mass — initial mass of each satellite 655 kilograms • size — 2.2 metres in diameter. 6.6 metres high • service life — minimum 7 years
Launch	• bookings have been made on — * Ariane (Arianespace) * Space Shuttle (NASA) * Delta rocket (NASA) • launch due mid 1985
Transponder Capacity	• each satellite will have capacity of 15 transponders — 4 x 30 watts and 11 x 12 watts • 30 watt and 12 watt transponder back-up will be available in each satellite in the event of transponder failure • radio frequency power approximately 250 watts
Frequency Bands	• 14.0-14.5 GHz frequency band for **uplink transmission** (ground to satellite) • 12.25-12.75 GHz frequency band for **downlink transmission** (satellite to ground)
Coverage Areas	• in **uplink direction,** each satellite will have two national beams each capable of receiving signals from anywhere within Australia and a spot beam to receive signals from Papua New Guinea • in **downlink direction,** each will have two national beams and four spot beams covering: * Western Australia * Queensland * South Australia/Northern Territory * New South Wales/Victoria/Tasmania • There is also provision for covering Lord Howe and Norfolk Islands, as well as a spot beam to cover Papua New Guinea • 30-watt transponders will be allocated to the spot beams and most 12 watt transponders will be switchable between national and spot beams
Satellite Control	• two Tracking, Telemetry, Command and Monitoring Stations (TTC & M) will be installed at Sydney and Perth. The Sydney station will have the Satellite Control and Operations Centre.

Table 1 — Summary of Technical Specifications

TRACKING TELEMETRY CONTROL AND MONITORING (TTC & M)

Control of the orbiting satellites will be performed through two TTC & M stations to be located in Sydney and Perth. The satellite Control and Operations Centre (SCOC) will be co-located with the Sydney TTC & M station and will provide full visibility and control of the entire satellite network. The station also provides the up-link beacon for active tracking of the spacecraft antenna system. Identical control functions will be capable of being performed by the Perth TTC & M station.

Orbital control (station keeping) manoeuvres using the satellite's positioning system will be made about every three or four weeks on command from the control stations. Spacecraft attitude (spin axis orientation) adjustments will be made more frequently at around 5-6 day intervals. Communications performance will be monitored by separate equipment at Sydney, Perth, Adelaide and Brisbane.

AUSTRALIAN MANUFACTURE OF SUB-SYSTEM

AWA will build two of the TTC & M sub-systems.

- The Communications System Monitor (CSM), which measures specified parameters of the communications system and spacecraft to monitor performance and verify correct utilisation of satellite capacity, by customers.
- The Station Management Sub-System (SMSS), an automated computer-controlled facility to assist the operations and maintenance staff to run the TTC & M efficiently.

The Communication System Monitor

Fig. 3, an overview diagram of the AUSSAT CSM, shows that the complete system comprises a CSM Type A and CMC located in Sydney, and three CSM Type B located respectively in Perth, Adelaide and Brisbane. The CSM sub-systems operate in conjunction with the co-located TTC & M and/or communications stations at each site.

The primary function of the CSM Type A is to measure satellite parameters such as EIRP, frequency, frequency deviation etc., of carriers transmitted from the satellite. A secondary function of the CSM Type A is to measure and characterise certain parameters of the satellite and to provide support for testing other communication stations in the National Satellite System. To perform the above functions, the CSM Type A has both uplink transmit and downlink receive capability. All communication carrier measurements are performed under computer control while manual intervention will be required when measuring satellite parameters or testing other communication stations.

The function of the CSM Type B is to measure, under computer control, the set of spot beam downlink received carrier parameters not accessible from Sydney.

Under normal operational conditions most carrier measurements will be performed by the CSM Type A in Sydney, which can receive both the National and South Eastern spot beam.

Consequently, the CSM Type B sub-systems in Perth, Adelaide and Brisbane are strategically positioned to measure carriers in the Western, Central and North Eastern spot beams which are not visible from Sydney.

The primary function of the Communication Master Control (CMC) in Sydney is to maintain overall system supervision, co-ordination and monitoring of the performance of the satellite communications sub-system. It will allow anomalies and interference problems to be investigated and will provide data to permit optimisation analysis of transponder loading. In addition, it will permit regular reports on communications usage and communications payload performance to be produced. The CMC provides historical and real time data display of all parameters measured by the CSM sub-system.

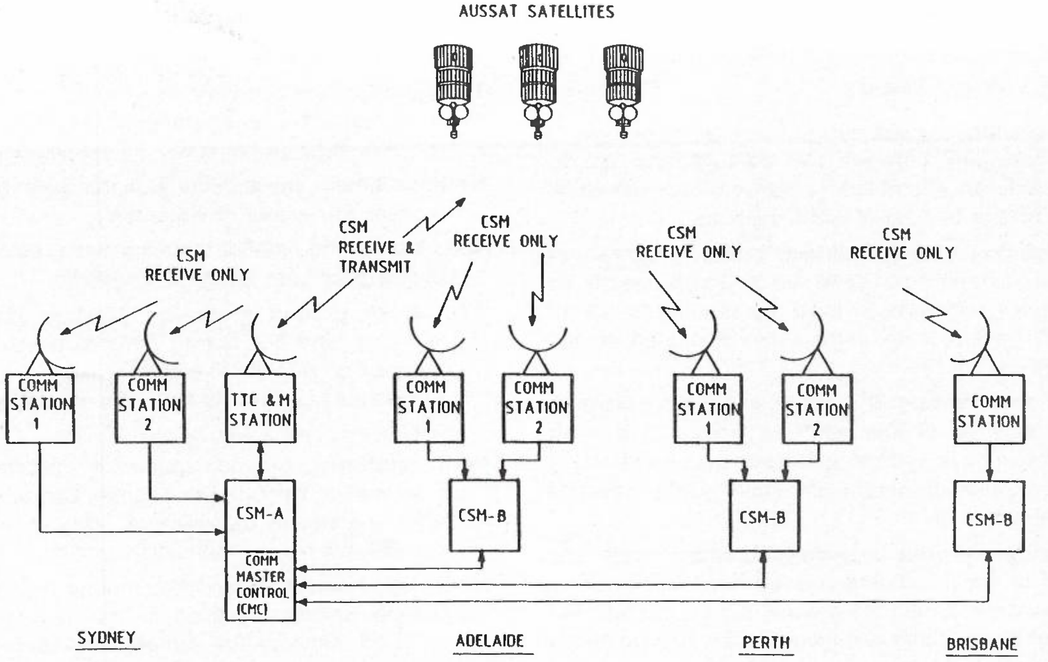


Fig. 3 — AUSSAT CSM Overview Block Diagram

Control of the CSM sub-system is centralised at the CMC facility, local data interchange is with the CSM Type A, while the three remotely located CSM Type B are connected via satellite or terrectrial data links.

The Station Management Sub-System

This sub-system comprises a computer controlled automated facility to assist station operations and maintenance staff in the efficient running of the station.

The SMSS will allow an operator to control selected station equipment parameters and to become aware of station events from a CRT terminal. A color video monitor will display mimic diagrams of the station status.

Station log and other records will be provided to station staff.

Fig. 4 illustrates the SMSS interface with the various system areas.

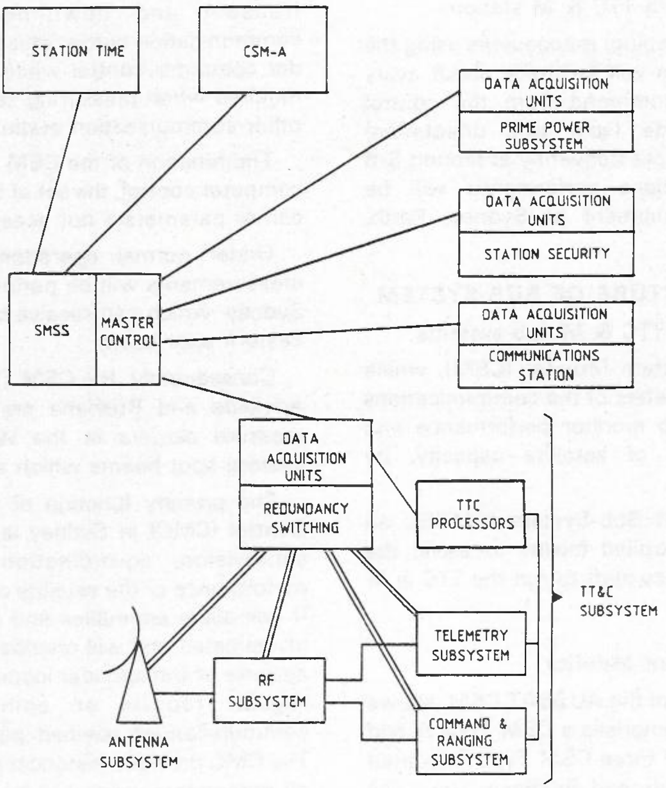


Fig. 4 — Station Management Sub-System

GLOSSARY OF TERMS

Fixed satellite service mode: the satellite provides a two-way link between two defined fixed points. Used as an alternative to conventional terrestrial microwave or coaxial cable systems.

Broadcasting satellite service mode: programs or other material (e.g. data) are received directly by one-way transmission from the satellite by use of small 'receive-only' earth stations located on the users's premises.

"Spin" stabilisation: the design uses solar panels on the exterior of the spinning "drum"; spinning motion provides gyroscopic stability. Communication antennas remain pointed towards coverage zone.

Geostationary orbit or geosynchronous orbit: the orbit in which satellite appears fixed or stationary when viewed from the ground; orbit is circular and in equatorial plane at a height of 35,790 km above earth.

Transponder: the combination of receiver, frequency down-converter and transmit amplifier. Each AUSSAT satellite will carry 15 transponders.

National beam: the satellite antenna beam designed to cover the whole of Australia.

Spot beam: the satellite antenna beam designed to cover a particular region of Australia.

TTC & M ground stations: Tracking, Telemetry, Command and Monitoring stations which control and monitor satellite in orbit. Two stations — one in Sydney and one in Perth — will control AUSSAT satellites.

Earth stations: ground equipment necessary to communicate through the satellite. Can be 'receive only', or transmit and receive. Vary in size (and cost) depending on application.

HACBSS: Homestead and Community Broadcasting Satellite Service designed to transmit radio and television services to remote and underserved areas.

READERS

WHEN NEGOTIATING WITH SUPPLIERS TELL THEM YOU SAW THEIR ADVERT. IN THE

T J A

FOR FURTHER INFORMATION

CONTACT

READER INFORMATION SERVICE

BY COPYING THIS PAGE AND SEND TO BOX 4050, GPO MELBOURNE, 3001.

Please send me further information on editorial items listed below

. . . .

. . . .

I would also like further information on the following advertisers

. . . .

. . . .

. . . .

NAME . . . .

ORGANISATION . . . .

POSITION . . . .

ADDRESS . . . .

. . . .

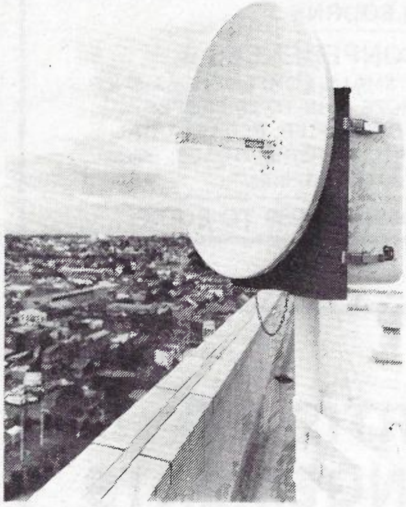
TELEPHONE . . . .

New Products

This listing is compiled from paid advertising and does not represent a recommendation by the Society. If you desire to have your product listed, contact the Advertising Manager.

MINI-LINK — A SPACE-RACE SPIN-OFF

The demands of economic, more effective technology for space and defence applications has led to the release on the commercial market of an extremely low-cost, medium range microwave transmission system from Ericsson. The MINI-LINK range of equipment offers television, voice and data transmission over line-of-sight distances of up to 40 kilometres.



The MINI-LINK units are completely self-contained and can be mounted in one compact installation on a small tubular steel mast. This eliminates the complex and costly requirement for bulky and expensive antenna towers, large dish reflectors and wave guide feeders.

MINI-LINK can handle up to 120 voice channels using frequency division modulation (FDM) or 30 pulse code modulated (PCM) channels. Alternatively it can carry video transmission including 60 control signals and one speech channel.

This capability makes MINI-LINK ideal for a wide range of applications, including:-

- Security — television coverage by remote control cameras for offices, factories, airports, defence installations, industrial complexes and public places, both internal and external.
- Digital Data Transfer — telemetric and computer data transfer for general purpose commercial use where it is uneconomic or impracticable to lay cables. (The standard 30 or 120 channel PCM and 24 or 120 channel FDM mode are both ideal for telecommunications services.)
- Remote radar operation — broad band radar systems can use MINI-LINK systems to aid aircraft and ship control as well as many other remote radar transmission needs without affecting the raw data, by means of a bandwidth compressor unit.

Because MINI-LINK systems are completely portable their flexibility in commercial applications is greatly increased. Plus their range can be extended over longer-than-normal distances by using an adapter kit for multiple hops with branch drops along the way. This approach can be very useful for companies, for example, who are involved in outback work such as pipeline construction or off-shore oil exploration. It provides a means by which a crew on the job has complete access to its base office telephone and data processing facilities.

Only the most extreme of weather conditions have an effect upon the system's performance — making it an attractive proposition in Australia's harsh climatic environment.

Overseas experience has shown that MINI-LINK can transmit on-the-spot T.V. pictures of robberies and burglaries to a central police operations room, thus cutting dramatically the police response times.

In other overseas applications, systems have been used to:-

- control high-capacity vehicle ferries by operating traffic signals direct from the ferry's bridge
- centrally control a series of seaport lifting-bridges and locks
- supervision via T.V. of numerous critical high-density traffic areas
- connect rural mobile and fixed communications links
- solve problems of over-water or difficult terrain telecommunications networks where cabling would be impossible or impracticable.

Telecom have had a system on trial and have found that MINI-LINK can supply either short term or permanent answer to the shortage of telephone cabling in certain areas. A unit is simply installed on a building's roof-top to provide direct line-of-sight connection to a local Telecom exchange. It can be in use today while permanent cables go in tomorrow.

Being completely solid-state and unitised, MINI-LINK needs no preventive maintenance, no matter what the climatic conditions.

Contact: John Platts, Ericsson Information Systems, 202 Bell St., Preston, 3072. Telephone (03) 480 4888.

NEW ECHO SUPPRESSOR

Plessey Australia has designed and produced a new echo suppressor which is compact and "highly intelligent" in minimising echoes in telephone communications. (See Ad on inside front cover).

Claimed to be the only echo suppressor wholly designed and built in Australia and the smallest (138mm × 96mm × 30mm) available on the market, it is applicable to satellite and terrestrial circuits. Its development was accelerated for use in international circuits at the Commonwealth Games during September 1982 and is now being used by Telecom Australia.

The unit incorporates thick film hybrid technology and is designed to the latest international standards (CCITT recommendation — G164). It is of terminal differential, and is a far-end operated type with tone disabler and adaptive break-in facilities.

The suppression and break-in modes are effected automatically by a change in relative signal levels between the transmit and receive paths. The data bypass facility may be initiated manually or on receipt of a disable tone.

Other features of the unit include smooth and noiseless break-in and suppressor performance. It is a plug-in, printed circuit module to be used in conjunction with a Telecom Type 72 compatible panel or sub-rack.

Contact: Mr R. Yue, Plessey Australia, Faraday Park, Meadowbank, 2114 (02) 807 0414.

The Telecommunication Journal of Australia

ABSTRACTS: Vol. 33, No. 1

COMMAND-AND-CONTROL COMMUNICATIONS IN THE RAN: Captain Richard Arundel, Telecom Journal of Aust., Vol. 33, No. 1, 1983, page 3.

The use of telecommunications for command and control purposes in the Royal Australian Navy, is described.

THE DISCON PROJECT; I. H. Maggs, Telecom Journal of Aust., Vol. 33, No. 1, 1983, page 9.

Defence fixed or strategic communications are described from a background of requirements leading to an outline of the new concept of a digital network which has been approved by the Australian Government. The project to introduce this network has been titled DISCON and the paper concludes with an indication of the present status of that project.

OPERATIONS AND MAINTENANCE FACILITIES PROVIDED BY AXE; R. L. Orton, D. P. Kitchen, Telecom Journal of Aust., Vol. 33, No. 1, 1983, page 19.

The introduction of AXE switching equipment into the Australian telephone network will provide sophisticated facilities for improved network operation and exchange maintenance. AXE is the next generation of SPC telephone exchanges following on from the ARE-11 system which is now prevalent throughout the Australian network. This article reviews the operation and maintenance facilities provided by AXE and examines the affect on the role of the various Network Operation Centres.

PROBLEMS IN RADIO COMMUNICATIONS — SOLUTIONS AND ADVANCES; J. E. Lamprey, Telecom Journal of Aust., Vol. 33, No. 1, 1983, page 27.

This paper outlines some general characteristics of the unguided electromagnetic medium with particular reference to new radio communication frontiers in the extra high frequency part of the spectrum. Associated equipment developments and new signal processing techniques directed towards exploitation of these frequencies are also reviewed.

CALL CHARGE RECORDING IN THE PAPUA NEW GUINEA TELECOMMUNICATIONS NETWORK; J. P. Steendam, Telecom Journal of Aust., Vol. 33, No. 1, 1983, page 31.

Call Charge Recording (CCR) is a facility which provides telecommunication authorities with details of all long distance telephone calls (STD/ISD) made by each of its customers. The information obtained can consist of the calling and called partie's numbers, date, answer time, call duration, charging units and the costs.

In Papua New Guinea, existing ARF-102 primary exchanges are being converted to ARE11 type exchanges and incorporate an electronic charging system which provides for storage on electronic accumulators of all charging units and the generation of CCR.

The CCRs are passed in real time via dedicated data links, to a central computer system and are used to substantiate bulk billing and telephone account queries. In addition, the electronic meters can be directly unloaded into the computer system for billing and automatic price advices.

NETWORK PLANNING FOR THE UPGRADING OF TELECOM'S DIRECTORY ASSISTANCE SERVICE; Charles J. Dougall, Telecom Journal of Aust., Vol. 33, No. 1, 1983, page 37.

In the late 1970's the need was recognised for the upgrading of the procedures used for the look up of directory information in the Directory Assistance Service. A project team was established to plan this upgrade through the implementation of computer information storage and retrieval systems and Automatic Call Distribution Systems. This paper outlines the background to the upgrading plans and the main strategies leading to implementation throughout the Australian network.

DAS/C AND NACD PROJECT MANAGEMENT; R. Backman, J. A. Fraser, Telecom Journal of Aust., Vol. 33, No. 1, 1983, page 41.

The introduction of an automatic Directory Assistance Service (DAS/C) and associated Network Automatic Call Distributor (NACD) is a complex project with many interdependent activities involving Telecom, IBM and L. M. Ericsson. The paper describes the arrangements established for the management and control of this significant project.

BEYOND THE BLACK STUMP — SATELLITE COMMUNICATIONS IN OUTBACK AUSTRALIA; F. A. Coates, Telecom Journal of Aust., Vol. 33, No. 1, 1983, page 45.

There are few engineering adventures that can capture the imagination like today's space technologies. Australia is about to join the sky-high club with the purchase of a domestic telecommunications satellite. Optimising the use of this national asset worth hundreds of millions of dollars, is essential. The provision of telecommunications to Australia's remote areas is one of the facilities now being evaluated. This article briefly describes the possibilities under consideration following launch in 1985.

SPC PABXs — REGULATORY DEVELOPMENTS AND SYSTEM CHARACTERISTICS; Ivan Pasco, Telecom Journal of Aust., Vol. 33, No. 1, 1983, page 49.

In 1979 Telecom Australia introduced a new PABX policy which had a major impact on the PABX market. Additional suppliers were allowed into the market, approval procedures were radically changed, and a greater responsibility was placed on customers in choosing a system to suit their needs.

This article describes regulatory procedures for listing customer switching systems including PABXs. The new listing procedures coincided with the introduction of new generation SPC PABXs. The characteristics of these systems, and possible future trends are also discussed.

ECONOMIC ANALYSIS — PRINCIPLES & PROBLEMS; C. W. A. Jessop, B. M. Yeoh, C. W. Parry, Telecom Journal of Aust., Vol. 33, No. 1, 1983, page 55.

Economic analysis of proposals for telecommunication projects is becoming increasingly important. This series of articles will, following a brief introduction of general principles, discuss some aspects which cause problems when evaluating telecommunication projects. The articles intend to explore areas of contention, discussing the advantages and disadvantages of various approaches, leaving the reader to decide which approach is relevant to a particular case for which an economic analysis is required.

CURRENT STATUS OF THE ISO/CCITT REFERENCE MODEL OF OPEN SYSTEMS INTERCONNECTION AND ITS ASSOCIATED PROTOCOLS AND SERVICES; P. H. Gerrand, Telecom Journal of Aust., Vol. 33, No. 1, 1983, page 59.

This paper draws attention to the current state of development within the international standards developing bodies ISO and CCITT of the Reference Model of Open Systems Interconnection (OSI), which became a draft international standard within the ISO in April 1982. The paper describes the objectives of the reference model and explains its most basic concepts; it describes the ISO and CCITT timetables for the completion of new standard protocols and services for data communications based upon the reference model; and it explains the importance and relevance of these standards for the Australian telecommunications community.

THOUGHTS ON A NEW TELEPHONE NETWORK STRUCTURE FOR AUSTRALIA; C. W. A. Jessop, N. W. McLeod, Telecom Journal of Aust., Vol. 33, No. 1, 1983, page 67.

This paper explores the possibilities of using a non-hierarchical network structure for the IDN. Benefits of adopting this approach to network development are outlined, and aspects requiring further investigation noted.

AUSSAT — SPACE SEGMENT OVERVIEW; Telecom Journal of Aust., Vol. 33, No. 1, 1983, page 73.

The general features of the Australian National Satellite System (AUSSAT) are described together with some launch details and transmission coverage.

THE TELECOMMUNICATION JOURNAL OF AUSTRALIA

POLICY. The Journal is issued four times a year (1983 objective) (February, May, August and November) by the Telecommunication Society of Australia. The object of the Society is to promote the diffusion of knowledge of the telecommunications, broadcasting and television services of Australia by means of lectures, discussions, publication of the Telecommunication Journal of Australia and Australian Telecommunication Research, and by any other means.

The Journal reports on the latest developments, both technical and commercial, in telephony, radio and TV and is distributed to professional engineers, executives and technical staff engaged in the planning, marketing, installation and operation of telecommunication services in Australia and overseas, also to manufacturers in this field, government departments, universities and consultants.

The Journal is not an official journal of the Australian Telecommunications Commission. The Commission and the Board of Editors are not responsible for statements made or opinions expressed by authors.

Editors of other publications are welcome to use not more than one-third of any article, providing credit is given at the beginning or end, thus, "Reprinted from the Telecommunication Journal of Australia". Permission to reprint larger extracts or complete articles will normally be granted on application to the General Secretary.

Information on how to prepare and submit manuscripts and contributions for the Journal is available from members of the Board of Editors.

SUBSCRIPTION AND MEMBERSHIP RATES. Residents of Australia may order the Journal from the State Secretary of their State of residence, others should apply to the General Secretary.

RATES. All rates are post free (by surface mail). Remittances should be in Australian currency and made payable to the Telecommunication Society of Australia. The 1983 subscription fee is $7.00. Non-members may secure copies of the Journal for an annual fee of $12.00 within Australia or $20.00 for overseas. Single copies of the Journal may be purchased by members for $2.00, non-members $3.00 and overseas $5.50. Reprints of papers are also available at $1.00 per copy. Bulk orders will attract special quotations.

ADDRESSES OF STATE AND GENERAL SECRETARIES ARE:

The States Secretary, Telecommunication Society of Australia,

Box 6026, G.P.O., Sydney, N.S.W. 2001.
Box 1802Q, G.P.O., Melbourne, Vic. 3001.
Box 1489, G.P.O., Brisbane, Qld. 4001.
Box 1183, G.P.O., Adelaide, S.A. 5001.
Box T1804, G.P.O., Perth, W.A. 6001.
Box 10,000T, G.P.O., Hobart, Tas., 7001.

The General Secretary, Telecommunication Society of Australia,
Box 4050, G.P.O., Melbourne, Victoria, Australia, 3001.

ADVERTISING: The total net advertising revenue is paid to the Telecommunications Society of Australia, whose policy is to use such funds in the dispersion of knowledge within the telecommunication industry.

Advertising Manager: Mr. R. Keighley, Tel. (03) 772 8927.

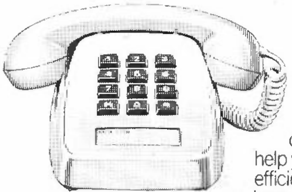
Advertising Contractor: ADTEL — Contact B.H. Worrell. Tel. (03) 772 9398. Address: P.O. Box 67, Mentone 3194. Rate Cards giving full details of specifications and charges are available from ADTEL.

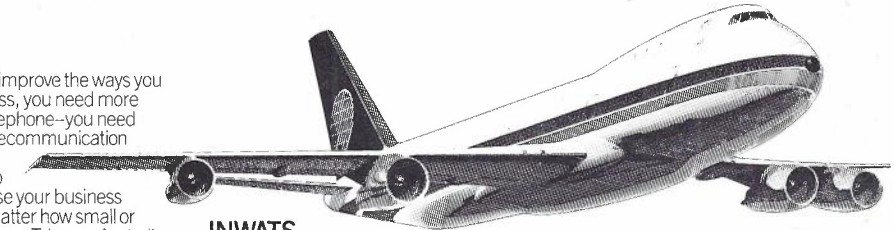
CIRCULATION. Average circulation during year ending December 1982:

Within Australia:	6462
To Overseas Countries:	461 (60 Countries)
Total Readership (estimated by survey)	10,548

Printed by Standard Commercial Printers, 2 Railway Rd., Cheltenham, 3192.

There's no end to the ways you can improve your business.



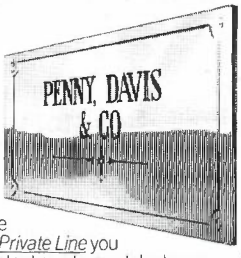


To improve the ways you do business, you need more than a telephone--you need a total telecommunication service designed to help you increase your business efficiency. No matter how small or large your business, Telecom Australia can provide the know-how and service to help you.

INWATS

Many businessmen have already discovered how to attract customers on an Australia-wide basis. *INWATS* enables people anywhere in Australia to call you for the cost of a local call.

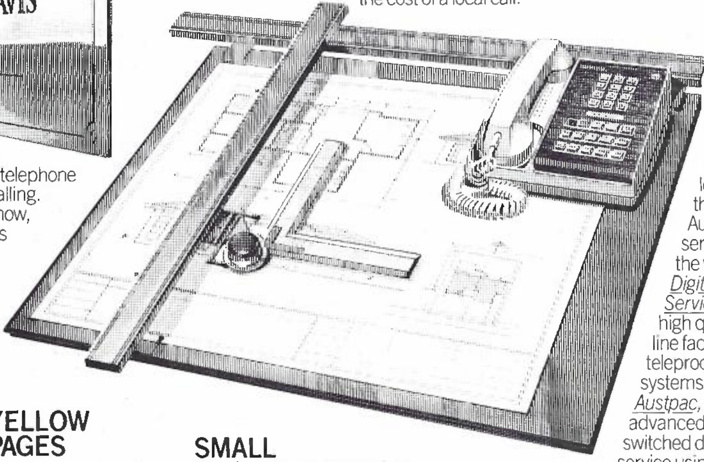
An *INWATS* phone number has a simple 008 prefix to put every one of your customers– no matter where they are– a local phone call away.



PRIVATE LINES

There are times in business when your communication needs extend beyond a switched telephone call. With a leased *Private Line* you can establish an instant one-to-one telephone link–in some cases without even dialling.

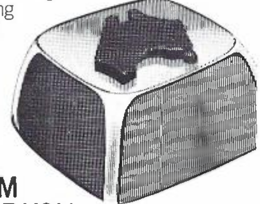
And, as people in computers know, data transmission along private lines is fast and cost-efficient.



DATA

You can enhance your business operations with a cost-effective and reliable on-line data service tailored to meet your individual network needs.

The *Datel Service* provides switched and leased line services throughout Australia. Two new services are on the way: *Digital Data Service* offering high quality leased line facilities for large teleprocessing systems, and *Austpac*, an advanced switched data service using packet switching techniques.



YELLOW PAGES

Wherever there's a phone, there's a *Yellow Pages* directory. Your listing in the Yellow Pages puts your business name beside every telephone in your city. Everyone with a phone is your potential customer.

SMALL BUSINESS SYSTEMS

If your business is still growing, you and your staff need to be flexible. You probably don't have the budget or the space for a full-time receptionist or telephonist, you may need a specialised telephone system tailored to suit your specific needs.

The *Commander* allows you to answer calls at any desk, with hold and transfer facilities, internal paging and a built-in intercom. It's a time-saving, cost-efficient telephone system that's as versatile as you want it to be.

GET TELECOM WORKING FOR YOU

The Telecom Business Office listed in the front of your telephone directory can solve most of your problems. Or we'll arrange for one of our specialists to evaluate your specific needs.

ISD

Dialling your own calls with *ISD* is the cheapest, quickest and easiest way to phone around the world. Connection is free and, for a small additional charge many exchanges are able to provide you with a bill itemising the details of your overseas calls. International businessmen rely on *ISD*.

MOBILE PHONE

When you're out and about in Sydney and Melbourne you need never be out of touch. With an Automatic *Mobile Phone* in your car, you can make and receive local, *STD* and *ISD* calls as easily as you would from your office.

Telecom Australia
Working for you

TAT 2671/B