Volume 32, No. 2, 1982

the telecommunication journal of Australia

IN THIS ISSUE

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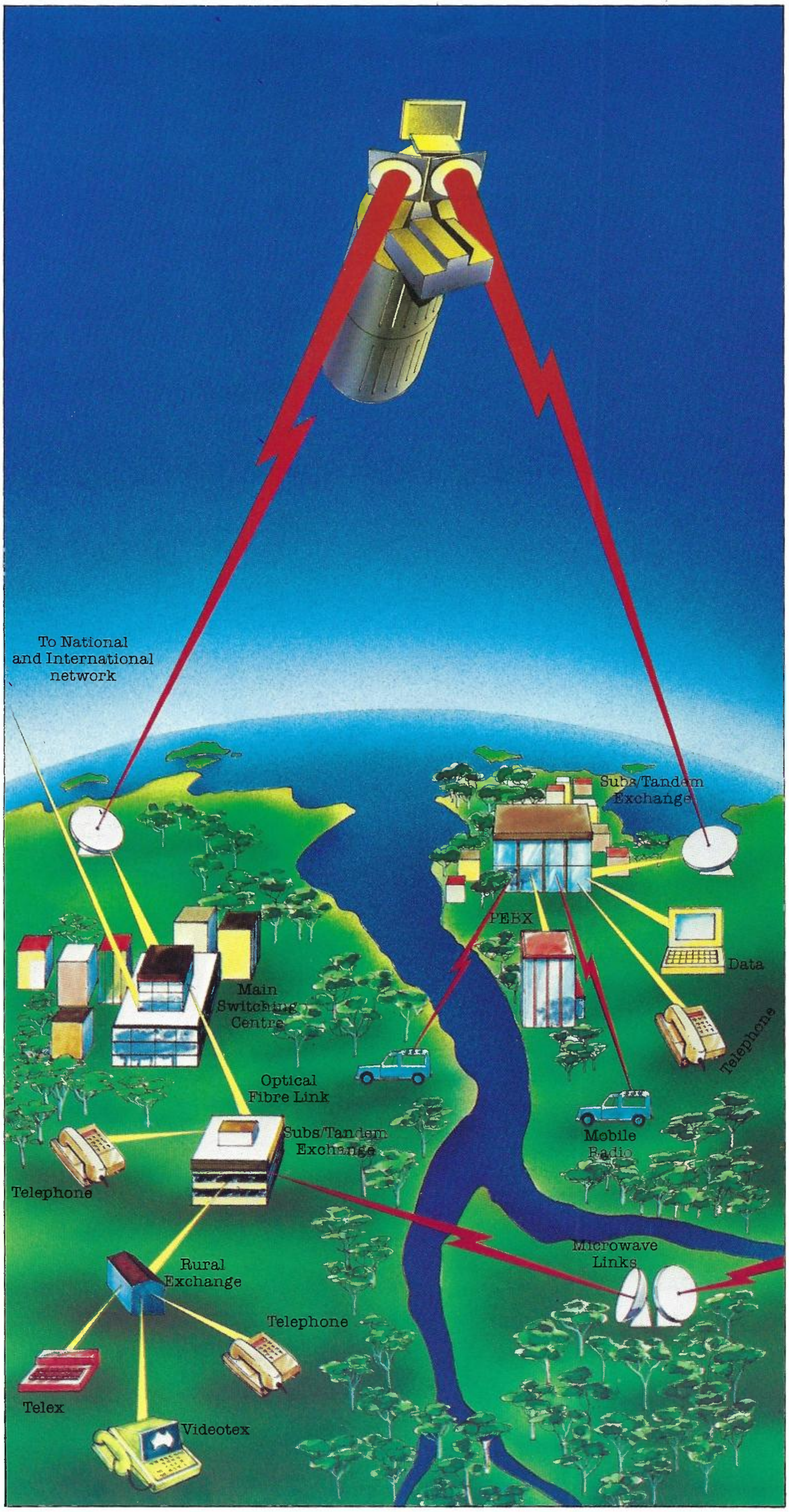
Plessey: now you're talking.



Top: Vutel.
Office terminal providing telephone and videotex communication.

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

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Telecommunications Division
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PLESSEY

PT109

The Society Reporter

Volume 32 No. 3
supplement

A feature of the evening was the presentation to Mr H. S. Wragge of a printer for association with his home computer. This was to mark his retirement from the position of Editor in Chief of A T R and to show the Society's appreciation of his services in that capacity. Mr Wragge founded A T R 25 years ago and had led its editorial team ever since.

The presentation was made by Mr P. R. Brett, Telecom's State Manager for Victoria, who is the immediate past Chairman of the Council of Control.

Council of Control Function

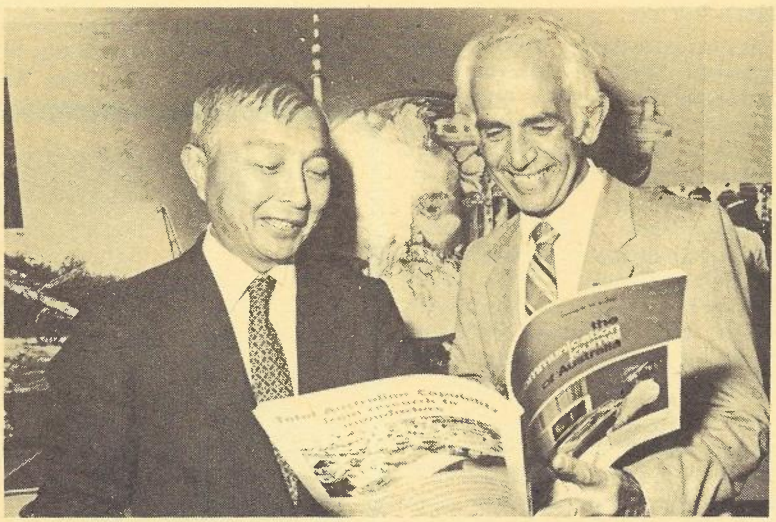
The Chairman of the Council of Control, Mr R. K. McKinnon hosted a function at Telecom Headquarters in Melbourne on July 21 for representatives of management of the telecommunication manufacturing industry, Government Authorities, executives of Telecom Australia and the industry's unions.

Members of the Telecommunication Society's Council of Control and Victorian Division Committee attended.

The object of the gathering was to acknowledge the support which the Society had received from the industry, and particularly from the management of Telecom Australia, over many years and to stimulate interest from outside Telecom in the Society's activities and in the Journal and A T R.

Mr McKinnon briefly outlined the Society's history and objectives, thanked the guests for their past interest in the Society, and invited their attention to samples of its publications, The Telecommunication Journal of Australia and A T R, which were on display and available for the guests to take away.

Harry Wragge receiving the formal expression of appreciation for his editorial services from Rollo Brett, while Chairman Bob McKinnon stands by with the present.



Tony Kashiwabara, Managing Director of N E C Australia, and Lawrie Bennett, Chairman of the Telecommunication Society's Victorian Division, studying the latest issue the Telecommunication Journal of Australia at the Council of Control's function.

PEOPLE in the news

Thanks to Doug Whiteside

At an informal gathering of the Board of Editors of the TJA, Ron Keighley (Editor in Chief) presented a medallion to Doug Whiteside in appreciation of the sixteen years of service that Doug has provided as production manager of the Journal.

Pictured with Doug (second from left) are Lindsay Mitton, Ron Keighley and George Moot, three of the last Editors in Chief to benefit from Doug's efforts.

Untimely Death of Foundation Secretary of NSW Division of Telecom Society.

Staff in Sydney were saddened by the death recently of Mr Bill Brooker, Regional Operations Manager, North.

Mr Brooker, 57, held numerous senior engineering and management positions during a career which began in 1947 as a graduate engineer.

Between 1973 and 1975 he was seconded as a special advisor to the then Postmaster-General, Mr Lionel Bowen.

Senior positions held by Mr Brooker with Telecom/PMG included Divisional Engineer, Primary Works I, Engineering Studies, PABX Installation and Substation Installation; Supervising Engineer, Metropolitan District Works, Metropolitan Southern Region and Redfern Operations; DTM Redfern; Regional Manager, South, and Regional Manager, North. He also relieved extensively as Chief Manager, Operations.

Mr Brooker was involved in several special studies, the results of which had major effects on the organisation. Among them were the long-range telephone development FORCAST (1959) and customer service organisation (1963) which included a visit to Bell (Pacific) and General Telephone in the USA. The latter study led to the establishment of a regional structure in the NSW metropolitan area.

Mr Brooker's service in Telecom and the PMG was complemented by activities in a number of related fields. He was State Secretary of the Professional Officers' Assocation for 10 years, its Executive Councillor for 8 years, a Director on the board of the Eastern Suburbs Hospital for 10 years, Foundation Secretary of the NSW Branch of the Telecommunications Society, PMG representative on the State Electrolysis Committee and Sydney Metropolitan Street Opening Conference, and State Councillor for 16 years and life member of the API.

The loss of his exceptional abilities, wide-ranging experience, administrative strengths, and jovial company, will be keenly felt.

The photographs show Mı
(Left): MR M. F. MULREAD'
marks in specialised modul
(Right): MR W. N. MAYS
marks in specialised modul

REPORT to the USERS of the TJA

THE 1981 SURVEY

Early in 1982, you, the users of the journal, gave the Board of Editors your views on what you expected from the TJA, by way of the USER SURVEY 1981. Without going into the full statistical analysis of this survey, here is what you told us about yourselves:

- you read about 30% of the Journal when you first receive it;
- you all use the Journal as a reference document;
- the average age of the oldest Journal in your possession, is between 7 and 9 years;
- you ultimately read about 60% of the Journal before filing it away;
- a high percentage refer to the Journal regularly;
- you see the Journal as a source of information and only a few see it as a means of publishing papers;
- the Journal meets about 70% of your expectations.

Further, you gave general guidelines on how you would like the TJA developed in the future. You told us:

- the most interesting article (or series of articles) published in the last 12 months, has been on the subject of the Black Mountain Tower (Vol. 31/2);
- you would like to see more sub-features in the Journal and your preferences were recorded in the following order:

  NEW PRODUCTS
  WORLD EVENTS (TELECOMMUNICATIONS)
  SPOT HIGHLIGHTS
  OPERATIONAL AND SERVICE TIPS
  LETTERS TO THE EDITOR
  NOSTALGIA
  PEOPLE
  EDITORIAL COMMENT
  EXPANDED BOOK REVIEW
  EXAM QUESTIONS

- you would like future papers to be less technical in detail, better illustrated and structured for quick reading and assimilation;
- you would like to see one or two papers in each issue devoted to non-technical subjects with a slight preference to computer systems.

THE GOOD NEWS

Your Board of Editors is committed to satisfying a higher percentage of your expectation. In response to your guidelines we have:

- reviewed current papers with a view to better explaining the technical detail;
- re-written our "Notes for Authors" to reflect a need for more generalised papers;
- sought papers from diverse areas outside Telecom to balance the many good papers we are receiving from within;
- selected for our special issue this year, a general interest topic — Telecommunications at the Commonwealth Games;
- discussed with our illustrator and printer, ways to make our papers look better;
- introduced new sub-features:
  - The Society Reporter;
  - Telecommunications in other countries;
  - Letter to the Editor (we need more);
  - Personalities page;
  - Editorial comment; and
  - Expanded book reviews.

There are other changes under consideration, all directed towards increasing your satisfaction. The most important of these is that we are considering FOUR ISSUES PER YEAR to be published, in February, May, August and November.

THE BAD NEWS

Costs are up. All efforts to bring you a more up-to-date, more interesting journal are adding to costs. Besides, subscriptions have not been increased over the last two years and in this time production costs have risen by 60%.

A major effort has been made to offset costs by increasing advertising, but response, in general, from the industry has not been encouraging. Selling our other products, particularly reprints of papers, has also been stepped up and a useful income level is being generated.

In the present economic climate however, no one can escape escalating prices and it is with regret that new membership and subscription rates have had to be set for 1983 which reflect, more accurately, the facts of life within our balance sheet.

WHAT CAN BE DONE

To ensure that we are not faced with a similar rate increase next year, there are three major actions in which we can all become involved, if the Journal is to survive:

1. Reduce costs by value analysing all procedures, processes and materials to get the best product for your dollar.

2. Increase advertising within the Journal and the volume of sales of our products.

3. Increase membership.

The Board of Editors and the Council of Control are committed to all three actions but every member can help with the third.

Every additional member we can gain for the Society, helps spread our costs and builds our strength and power base.

For the good of the Society, which is now in its 109th year, take a few copies of the attached MEMBERSHIP and SUBSCRIPTION RENEWAL form and see if you can interest others in becoming members.

RON KEIGHLEY
Editor in Chief

CALL FOR PAPERS

IREECON is renowned as a forum for engineers, scientists, academics, technologists, and management executives, engaged in every field of electronics.

Authors are invited to submit, for inclusion in the lecture program, papers in electronics, communications and allied engineering fields including managerial or social implications.

The papers will be published in a bound "Digest of Papers" which will be issued to registered delegates.

The closing date for submission of titles is November 19, 1982.

Intending Authors should request a Call for Papers Brochure from:
IREECON International '83.
The Institution of Radio and Electronics Engineers Australia,
Third Floor, 35-43 Clarence Street (Box N127 Grosvenor St. P.O.),
SYDNEY, NEW SOUTH WALES, 2000, AUSTRALIA.
Phone: (02) 29 4051.

IREE

SEPTEMBER 5-9

IREECON INTERNATIONAL SYDNEY '83

TELECOMMUNICATION SOCIETY OF AUSTRALIA

Membership or Subscription Renewal
1983

FORWARD TO:

(1) State Secretary
Telecommunication Society of Australia

☐ Box 6026, G.P.O., Sydney, N.S.W., 2001.
☐ Box 1802 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.
☐ C/- Telecom Australia, Eng. Branch, Hobart, Tas., 7000.

☐ Delete all except the address appropriate to your State

(2) General Secretary, Telecommunication Society of Australia,
Box 4050, G.P.O., Melbourne, Vic., 3001, Australia (Overseas Only).

		SUBSCRIPTIONS (NOTE 2)	
	MEMBER (Aust. Only)	NON-MEMBER (Aust.)	NON-MEMBER (Overseas)
The TELECOMMUNICATION JOURNAL of AUSTRALIA (NOTE 1)	$7.00 ☐	$12.00 ☐	$20.00 ☐
AUSTRALIAN TELECOMMUNICATION RESEARCH (NOTE 1)	$9.00 ☐	$18.00 ☐	$24.00 ☐
AUSTRALIAN TELECOMMUNICATION MONOGRAPH No. 4 "Automatic Telephony in the Australian Post Office (NOTE 3)	$2.00 ☐	$3.00 ☐	$5.50 ☐

TICK APPROPRIATE BOX(ES)

NOTE 1: See inside back cover of TJA or ATR for further details.

NOTE 2: Non-member rates apply where the subscription is in a Company name or where the Company or individual resides outside Australia.

NOTE 3: Contact Secretary for further details.

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Date Received ....../....../......   Allocated to Agençy No. ....

TSA OCT. 82

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TELECOMMUNICATION SOCIETY OF AUSTRALIA

Authority — Deduction From Salary

(TO BE FORWARDED THROUGH SOCIETY STATE SECRETARY)

TELECOM AUSTRALIA

I hereby authorise the Australian Telecommunication Commission, its duly authorised servants and agents to deduct .... each fortnight from my salary/wage, to be paid to the Telecommunication Society of Australia.

The amount to be deducted may be varied from time to time by the Society in accordance with revised rates of contribution.

All payments made on my behalf in accordance with this Authority shall be deemed to be payments by me personally.

This Authority shall remain in force until revoked by the Telecommunication Society of Australia or cancelled by myself in writing.

In consideration of this deduction being made, I indemnify the abovementioned employer and employees thereof against any failure to make deductions and remittances as authorised herein.

Dated this .... day of .... 19 ....

☐ Permanent

☐ Temporary

Signature ....

Designation ....

Branch ....

Commission Address ....

Pay sheet Number or Staff Clerk Code .... Work Telephone ....

PLEASE USE BLOCK LETTERS

A.G.S. No.	Surname	Given Names	Commission Code
			TSOA 685

	Old Basic Rate	New Basic Rate	Certified by Society
This Portion Must Be Completed By The Society	$	$	

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Increase	Decrease			

Computed by .... Processed for

Checked by .... period ending ..../......../........

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Society Agent Identification ☐	TJA ☐	HQ ☐	NSW ☐	VIC ☐
	TJA & ATR ☐	QLD ☐	SA ☐	WA ☐
	Indicate Commencement: Vol. .... Issue ...		TAS ☐	

TSA OCT. 82

Victorian Division News

:ountry Lectures

The Telecommunication Society, ictorian Division, country lecture rogram has been changed. This ear 12 centres will be visited, but) as not to overload the lecturers, vo lectures will be presented, ach to six centres.

Three new centres are included ı the program this year. They are rarat, Swan Hill and Warragul. hepparton is again on the rogram. The other centres are allarat, Benalla, Bendigo, andenong, Geelong, Hamilton, ⁄lildura and Sale.

The lectures in 1982 are OUT-ACK TV by Mr Carl Dillon of the roadcasting Branch, and SULTAN y Mr John McIntyre of the witching Design Branch, HQ.

The Chairman of the Victorian ivision Mr Laurie Bennett is keen) have official representation of ıe Society at Country Lectures. owever, this is not always racticable.

The first lecture on OUTBACK V at Shepparton on 30 March was ttended by Mr Bennett. On the same day Mr Hugh McCall, the Immediate Past Chairman, represented the Society at the Ballarat lecture on SULTAN. On 18 May Mr McCall attended the OUT-BACK TV lecture at Ararat.

The Acting DTM of Ararat Mr Jack Killeen, in welcoming the lecturer Mr Dillon and Mr McCall, expressed appreciation to the Society for extending the lecture tour to Ararat and recommended membership of the Society to those present. In the vote of thanks for the lecture, Mr D. Esam, IPM at Ararat, expressed a wish for continuance of the lectures in Ararat in future years. The interest in the topic was attested by the fact that many members had travelled long distances to hear of the new technology developments in providing TV programs to outback residents by means of a satellite.

Financial Policy in Corporate Planning

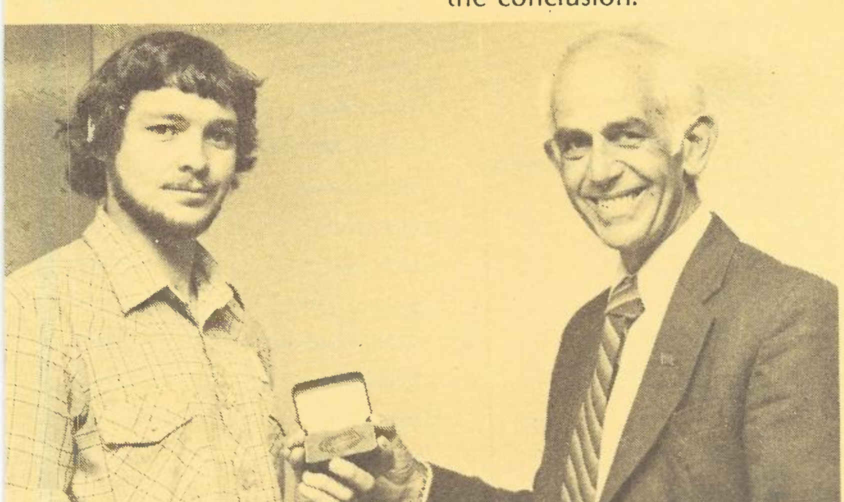
The third of the Melbourne based T.S.A. lectures was held on 21 June, 1982, at the usual venue, H. C. Sleigh Theatrette, 1st Floor H. C. Sleigh Building, Corner of Queen and Bourke Streets.

The lecturer, Mr Fred Cox, is Manager of the Corporate Analysis Unit in HQ and he presented an excellent lecture to a very appreciative audience comprising representatives from many areas which are remote from the financial planning function. He handled the topic extremely well and earned enthusiastic applause at the conclusion.

'raining School 'resentation

On 18th May, the Chairman of ıe Victorian Division, Mr L. ennett, presented awards, ponsored by the Society, to two ainees nominated by the Training ection. The awards consisted of a ertificate, a bronze medallion, nd a year's supply of T.J.A.

naking the presentations to:
prize and achieving highest
ntice Techs).
rize and achieving highest
Tech Officer).



Journal Supplies

Some problems in Journal distribution in Victoria have recently been tackled by the Committee. All members can expect to receive their copies earlier in future. An option being considered is posting to individual addresses. The extra costs involved in such a scheme are being examined.

It is essential that members advise their agent or the Secretary (630 5507) if they move to another work area.

Division Management

The Victorian Division Committee is an enthusiastic group which meets every 2 months. In between meetings a lot of communication takes place on an "ad hoc" basis as the need arises.

Members are invited to contact the Committee with any ideas, comments or suggestions.

The Secretary for Victoria is Mr Andrew Robertson, Switching Design Branch, 15th Floor, 199 William St., Melbourne, telephone 630 5507.

PIN UP

N.S.W. NEWS

Tours for Members in NSW

Members in Sydney are fortunate in having a very active Tours Organising Committee which arranges visits to various industries and Commission activities.

Tours in 1983 will take in visits to McWilliams Wines warehouse, Pyrmont, and the NPAC at Elizabeth Towers, but the highlight of the activities for 1982 was the one-day trip on the new XPT train.

This trip was provided for approximately 100 members, families and friends and consisted of a full day's trip from Sydney to Orange and return. The trip was a huge success and seats much sought after. It was particularly pleasing to note that the unsolicited invitation by the Railway Authority to partake in this trial run was because of the high standing the Society enjoys with the authority from previous negotiations.

NSW Lecture Timetable

The NSW Division of the Society runs a regular lecture program from March to November of each year with lectures presented in the Telecom House Theatrette, Sydney, between 12.30 p.m. and 1.30 p.m. on the third Friday of each month.

The program for the remainder of 1982 comprises the following lectures:

Oct. 15 A.C.D.
R. Backman
Nov. 19 Communications Satellite — 1982 Update
R. Johnson

Lectures are also presented by the branches at Canberra, Gosford, Newcastle, North Shore, Parramatta and Plessey.

Additional lectures are presented on an ad hoc basis on subjects of particular interest and to coincide with the availability of lecturers. In this regard, lectures were given recently by Peter Holmes a'Courte on "Business Telephone Systems" and by Ian Reineke on the 'Davidson Enquiry'.

NSW Field Representatives

The NSW Division of the Society is represented throughout the State by an enthusiastic band of volunteer helpers.

Originally largely employed to collect subscriptions, a duty which is considerably relieved by the deductions from salary arrangements, these people are still very active in recruitment and furthering the interests of the Society and its members.

One of the highlights of the Society's year in NSW is the Field Representatives' Seminar which is held to coincide with the Annual General Meeting. This seminar is used to gather and disseminate information on Society activities and has been most fruitful as the source of many new ideas.

Currently, the representatives who are available to assist members in the several areas are:

ARMIDALE T. E. Faulkner St. 2350	Mr K. T. Farrell	067 72 1111
BATHURST DTM, 1st Flr., P.O. Bldg. 2795	Mr G. J. Grey	063 33 5274
CANBERRA CITY C/- DTM, 5th Flr., MLC Bldg., 2601	Mr P. White	062 45 5128
CENTRAL COAST C/-DTM Gosford 2250	Mr J. Makepeace	043 25 9228
DUBBO C/- DTM, 2830	Mr B. P. Leary	068 82 7700
GOULBURN C/-DTM, P.O. Box 30, 2580	Mr J. Bowen	048 23 1188
GRAFTON C/- DTM, 128 Pound St., 2460	Mr J. K. Wells	066 42 3133
KEMPSEY C/- DTM, 2440	Mr A. J. Maguire	065 62 0266
LISMORE C/- DTM, 2480	Mr G. A. Mergan	066 21 1233
NARRANDERA C/- P.O. Box 375, 2700	Mr B. J. Daly	069 59 5133
NEWCASTLE DTM Newcastle Ops., TE Wallsend 2207	Mr C. Clarke	049 55 9500
OUTER SYDNEY SECTION 34 Phillips St., Parramatta 2150	Mr R. K. Ashpole	635 7177
TAMWORTH Supervising Engineer, Northern 2340	Mr T. A. Crowley	067 67 2641
WAGGA C/- DTM Operations Dept. 2650	Mr A. W. Baxter	069 23 0211
WOLLONGONG C/-DTM, P.O. Box 1787 2500	Mr L. Askew	042 28 2547
BANKSTOWN C/-Sydney South West Section 2200	Mr M. R. Costello	708 9679
BURWOOD C/-District Engineer M O7, 2134	Mr J. E. Usher	81 2131
CHATSWOOD C/-DTM 2067	Mr J. Graham	993 3059
EPPING Field Engineer, P.O Box 320, 2121	Mr F. Hollis	868 1111
NEWTOWN P.O. Box 296 Rockdale 2216	Mr B. Taylor	595 3000
PARRAMATTA C/- DTM 2150	Mr A. Harrison	635 5000
REDFERN 3rd Flr, 189 Phillip St., Waterloo 2016	Mr B. Hogbin	699 9593
ST LEONARDS C/- DTM 2065	Mr A. T. O'Donnell	43 3290
SUTHERLAND C/- SE, Metrop. Ops. No. 6, 2232	Mr W. Y. Fikkers	525 0059
SYDNEY CITY DTB GPO Box 7045, 2001	Mr P. O'Brien	234 1314
COUNTRY INSTALLATION NO. 1 13th Floor, Elizabeth Towers Surry Hills 2010	Mr D. M. Boulton	217 2236
DALLEY NATIONAL EXCHANGE OIC, Sydney 2000	M/s P. A. Reid	27 4989
FIELD ENGINEERING BRANCH 19th Flr., Telecom House	Mr K. K. Chan	267 5315
RADIO SECTION 309 Kent St.	Mr K. Parish	230 6844
TRAINING SCHOOL 15 Baringa Ave. Seaforth 2092	Mr E. J. Tucker	212 24933 x 293
NETWORK PERFORMANCE Elizabeth Towers Surry Hills 2010	Mr K. McDonough	212 4292
CAMPBELLTOWN EXCHANGE 56 Lumeah Rd. 2560	Mr W. Rixon	046 25 9011
TELEGS. & DATA Railway Square	Mr G. Turville	221 4366
OTC (Aust.) GPO Box 7000 SYDNEY 2001	Mr J. J. McDermott	230 5252
PLESSEY TELECOMMUN. Faraday Park Meadowbank 2114	Mr R. Iveson	807 0570

THE TELECOMMUNICATION JOURNAL OF AUSTRALIA

ISN 0040 2486 **Volume 32 No. 2, 1982**

Cover:
DAS/C Work Station

CONTENTS

OTHER ITEMS

Printed by Standard Commercial Printers, 2 Railway Rd., Cheltenham, 3192.

Editorial

Recent and prospective developments in Australia and overseas suggest that the telecommunications and related industries computing and interactive information dissemination will assume increasingly important roles in the economy in the future — and are likely to become indispensable to a wide range of economic, social and other activities.

The outcome of the Davidson Inquiry, the convergence of telecommunications and computers, technology change, and Australia's economic challenges over the next decade, alone warrant a fundamental re-examination of the role of industry and its manufacturing interests in such an environment of change.

Australian industry is already encountering the new combined effects of both an accelerating rate of inflation and a continually appreciating Australian dollar — both trends combining to cause a rapid decline in the competitiveness of those sectors of Australian manufacturing industry competing, with imports.

Australia must increasingly embrace high-technology industry as part of a more general need to rationalise, restructure and become more innovative in the face of current economic pressures. Failure to keep pace with the rate of technological advance in other countries could exacerbate import competition, make the achievement of export growth more difficult and slow economic recovery.

One important pre-condition for the continued viability of manufacturing is finding the appropriate level of technological innovation to optimise performance in Australian domestic and world markets, and, in this regard it may help to keep in mind three basic points about technological change. First, the impact of new technology on society comes about through adoption, not by the mere fact of its creation.

Second, technological change takes place through a rather orderly and predictable series of steps.

Finally, these steps take time. Thus major change casts a long shadow before it, allowing those who have followed the process with some attentiveness to make appropriate adaptive responses.

It follows therefore that product and process innovations developed within Australia are needed to provide the foundation for additional exports of manufactured goods and technological services. High quality products of unique Australian design have been responsible for the outstanding successes of many manufacturing exporters in Australia. Such products are sold on the basis of quality and uniqueness and are not so readily subject to price competition from other countries.

Australia's highly skilled labour force and the diversification and vastness of its resource endowment provide a strong foundation upon which to build a competitive manufacturing sector. In addition, Australia's industrial base is highly diversified and while this creates problems of ensuring the most efficient use of scarce and relatively expensive labour and capital resources, it does provide a basis for the development of more specialised activities.

Although Australia's domestic market is relatively small by world standards it is prosperous and, in some areas, unique. This can encourage the development of indigenous industries and products which, with appropriate modification, can find market opportunities elsewhere in the world.

The Australian electronics industry has national defence significance and must be fostered, not only to enable it to continue in its basic expertise but also to encourage it to develop capacity and capability for exploiting the new areas of technology arising over the next 20 years.

These benefits, however, will not be won without a shift in existing employment patterns.

There will be a need for a gradual upgrading of skills in the workforce, and skilled occupations will be relatively more important by the end of the decade.

The Telecommunications Society of Australia has a major role in this evolution by bringing to the forefront not only new technology developments but also by providing a open forum for the dissemination of knowledge from the various industry sectors. This policy can only be to our Industry's long term advantage as well as assisting in developing a stronger industry capability to meet the future challenges as they arise through to the year 2000 and beyond.

GUEST EDITOR

A. T. DEEGAN
MANAGING DIRECTOR
STANDARD TELEPHONES & CABLES PTY. LTD.
AND
PRESIDENT
AUSTRALIAN ELECTRONICS INDUSTRY ASSOCIATION

The National Computerised Directory Assistance Service — DAS/C

I. BAXTER, H. LYON

National DAS/C consists of a standard IBM data retrieval system, a data base update network which has been designed specifically for Australian conditions and a series of automatic call distributors, which link the retrieval system to the telephone network.

This paper describes, in general terms, the features of the overall system together with some of the operating procedures.

INTRODUCTION

The National DAS/C system selected for use in Telecom Australia is a standard IBM DAS packaged system incorporating standard hardware and, system and application software. However, development of a substancial software package was carried out by Telecom to enable the conversion of the data, from the existing white pages directory compilation systems, for the creation of the DAS data base and for the system which will feed this data base on a daily schedule.

Associated with the overall DAS/C project is the installation of network automatic call distributors (NACDs) in each State. The ACD chosen for this programme is based on the LME ASDP 162. Some adaptation has been necessary to obtain the desired interworking with Telecom services including the DAS/C system.

SYSTEM DESCRIPTION

The system can be divided into two distinct networks with four prime components:

The Data Base Update Network

- Master Update Centre (MUC)
- Data Send Centre (DSC) and Directory Inquiry Centre (DIC)

The Retrieval Network (Fig. 1).

- Retrieval Centre (RC)
- Manual Assistance Centre (MAC)

The DAS/C system functions interactively with DA operators to help provide an improved service, increased operator job satisfaction and reduce operating costs. The DAS/C system has been designed to significantly reduce operator effort and hence work time while promoting consistent, accurate response to customer inquiries. This is achieved by combining the judgement and decision making abilities of the human operator with the computer's ability to rapidly handle and search large volumes of data.

Significant features of the IBM DAS/C are:

- sophisticated file access techniques, uniquely developed for residence, business, and government requests, help provide increased accuracy and speed of search, and significantly reduce the number of "not founds";
- custom designed keyboard/display inquiry terminals allow free-form entry of inquiry arguments and easy request modification, thus increasing operator productivity;
- unique operator keying strategy and specially designated keys for common words and localities, reduces the number of keystrokes required to obtain a requested listing;
- keying strategy is easy to learn and adapts to each individual DA operator's approach, making new operators effective sooner;
- operator and system statistics are collected and produced which allow constant monitoring of the technical performance of the system as well as assisting in DA ongoing training management;
- online national directory files eliminate the costs associated with paper records.

DATA BASE UPDATE NETWORK

Master Update Centre

The MUC located in Clayton (Victoria) Data Processing Centre is the heart of the IBM DAS/C system.

The hardware components constituting the MUC include:

- IBM 4341 processor;
- display console;
- storage control unit;
- direct access storage subsystem;
- tape control unit;
- magnetic tape unit.

The national master data base will be created by using locally developed programmes to convert the white pages directory compilation files. There are four separate compilation systems involved in this conversion and error rejects will be corrected by Directories Branches and re-inserted to provide the final data base of all Australian telephone customers.

Procedures will be developed to facilitate DA operators reporting data base inconsistencies, identified during "live" working of the system.

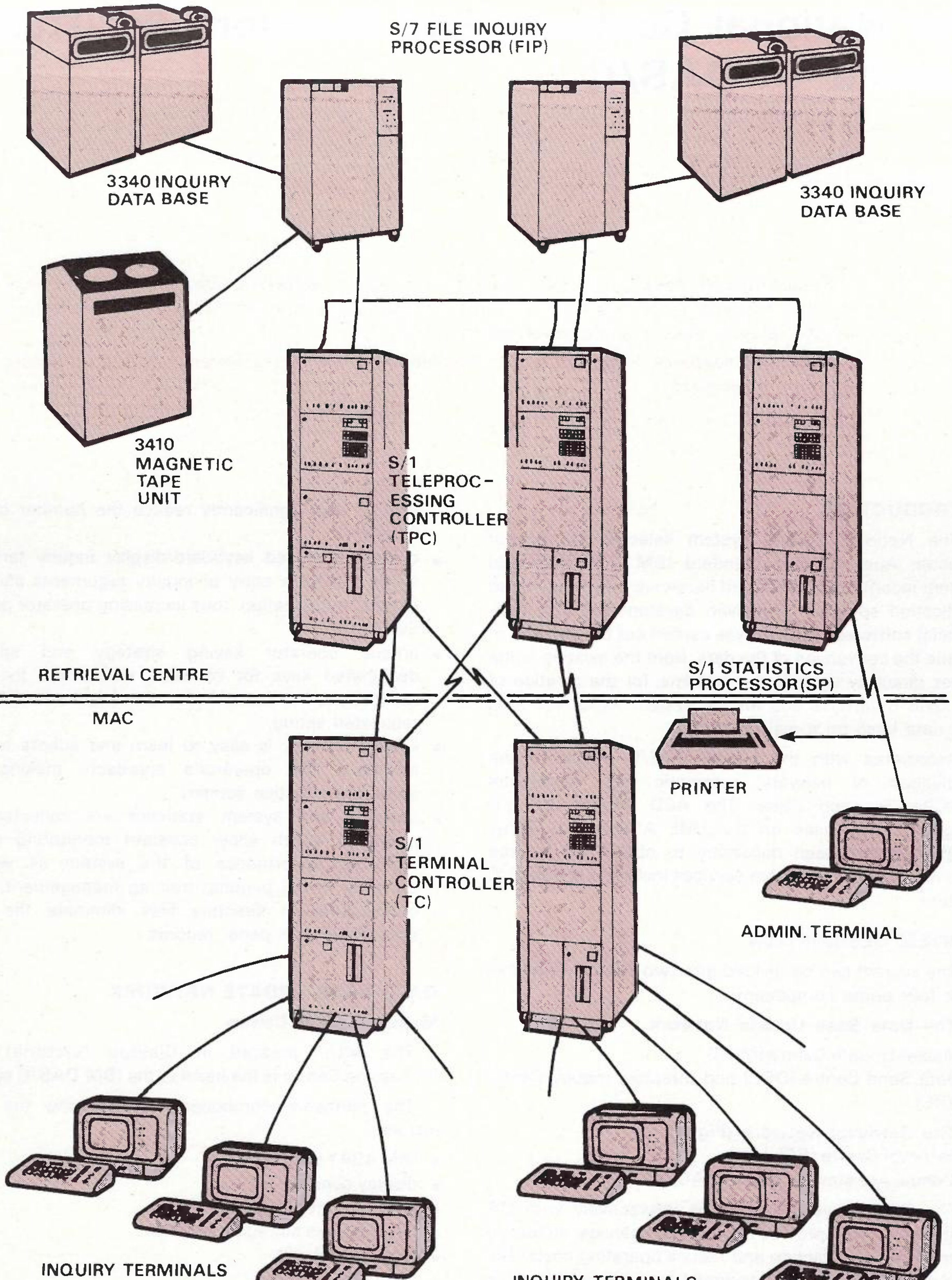


Fig. 1 — Retrieval Network.

When created, the data base will be updated daily from input provided from the DSC. Following completion of the MUC update cycle, tape copies of the new inquiry data base will be generated and conveyed via courier to each RC, daily.

Data Send Centre and Directory Inquiry Centre

DSCs and DICs are to be located in each Directories Branch.

Data Send Centre

The hardware constituting the DSC comprises an IBM Series 1 computer with visual display units. The directory entry information, after editing, is input to the Series 1 via the visual display units which have a formated overlay **(Fig. 2a and 2b)**. The data passes through a validation process and is stored. At the end of the day's input (a scheduled time each day) the data is sorted, formated and transmitted via a data link to the MUC.

At the MUC all data from all Directories Branches will be merged, sorted and interpreted for DAS/C master update. Simultaneously the information required for the various compilation systems will be formated, and output in hard copy.

With the introduction of DSCs in each State, the current telex links with the respective compilation contractors will be replaced. Data input at the DSC will be transmitted to the compilation contractor via the DAS/C MUC. This change in procedures will be almost transparent to the contractors.

Directory Inquiry Centre

The DIC consists of a number of retrieval terminals. The function of these terminals is to interrogate the inquiry data base (resident at the RC) for use in data preparation and error correction. Information, additional to that provided for DAS operators, is provided to permit precise identification of entries by Directories staff. This additional information is the DAS/C number. The prime use of this facility is in the area of complex directory entries.

Administrative Terminal

Within each Directories Branch an administrative terminal will be provided to facilitate file maintenance and error correction. This terminal has access via the statistics processor (SP) to the RC and provides for the following functions additional to normal inquiry:

- hard copy output from the inquiry data base;
- hard copy output of statistical data;
- on-line temporary update of the local inquiry data base.

It should be noted that the administrative terminal and the DIC retrieval terminals have access to the inquiry data base in the RC ***not*** to the master data base in the MUC.

Fig. 2a — Data Send Centre Work station.

Data Base Partition

The master data base (at the MUC) and the inquiry data base (generated for the RC) are divided or "partitioned" into 53 separate "books" or "files". The partitions reflect the configuration of the current published directories.

The IBM DAS/C system was designed to utilise the locality field as one of the prime search arguments. In order to facilitate this, locality tables and associated pseudo-locality tables are established. The partitioning into 53 separate files enhances the use of this facility.

RETRIEVAL NETWORK

Retrieval Centre

RCs are to be located in each mainland capital city.

Ian Baxter commenced employment with IBM in February 1966 as a Customer Engineer servicing IBM computer equipment.

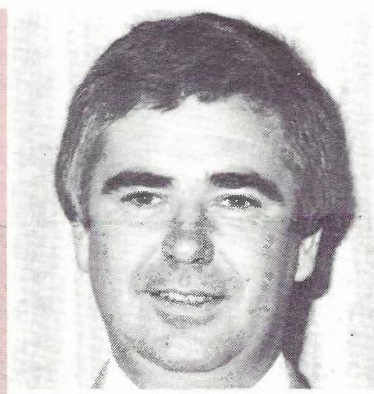
In June 1968 he moved to IBM Sydney to manage a refurbishing project and subsequently became an instructor teaching computer engineering and programming to customer engineers from the South East Asian region.

During that period, Mr Baxter studied at IBM locations in Europe and the USA acquiring new product education specifically in process control systems.

On return to Melbourne in 1972 he becamne a representative in the Office Products Division and later, the General Systems Division.

When Telecom expressed interest in investigating computerising the Directory Assistance Service in 1978 he was appointed to the team formed by IBM to study Telecom's requirements for the computerised Directory Assistance Service and to formulate a tender submission.

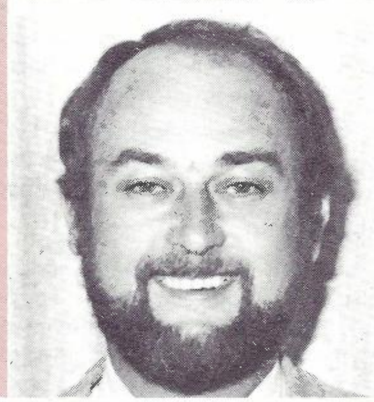
Currently he has the role of Account Manager with the responsibility of coordinating the IBM team and working with the Telecom staff in the imlementing of the National DAS/C system.



Howard Lyon joined the Australia Post Office in 1968 as a computer operator and subsequently undertook the Traffic Officer in Training course in 1970-71.

Mr Lyon worked in a number of Telecom District Offices in NSW between 1972 and 1980, in the Customer Service area.

In 1980 Mr Lyon took up duty with Directory Services, Headquarters, as Project Officer where he has worked on the development of computerised directory compilation systems and, more recently, the DAS/C project.



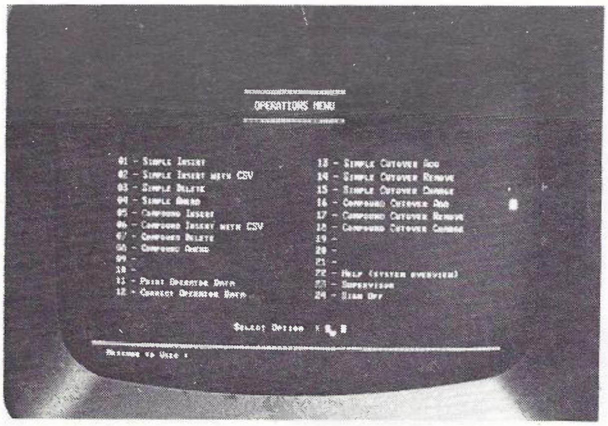


Fig. 2b — Data Send Centre Overlay Menu.

Fig. 3 — Retrieval Centre — Windsor, Victoria.

Tasmania is to share, with Victoria, the retrieval centre facilities located in Melbourne **(Fig. 3)**.

The RCs stand apart from, and have no direct links to, the MUC. They store copies of the DAS inquiry data base and are updated by means of a tape copy of each new inquiry data base delivered daily, via courier, from the MUC. The RCs are accessed by the following terminals:

- inquiry terminals located in MACs;
- directory inquiry terminals located in State Directories Branches and used during data preparation and error correction;
- administrative terminals located in MACs to access the statistics processor to produce performance reports and provide for on-line temporary updates;
- administrative terminals located in Directories Branches for on-line temporary updates and hard copy output.

The equipment making up the RCs comprises a System 7 file inquiry processor (FIP) with disc attachment for storage and retrieval of directory information. A Series 1 teleprocessing controller (TPC) links the System 7 FIP with the Series 1 statistics processor and the Series 1 terminal controller (TC) in the MACs via data links. The TPC manages the DA retrieval traffic.

Manual Assistance Centres (Terminal Equipment)

Directory Assistance Centres (DAC) will be installed in all States in accordance with the National MAC Plan (Ref. 1). The DACs will comprise terminal equipment (IBM Visual Display Units) from which DAS operators will be able to access the RC data base to obtain required directory information (Fig. 4).

Located with each group of VDUs will be a Series 1 TC the function of which is to accept, format, edit and concentrate the inquiry request prior to transmission of this request to the RC. This results in a highly effective operator/machine interface.

The actual installation of the DA centres will employ accepted ergonomic principles in the design, layout, environment and lighting of the positions.

FILE INQUIRY PROCESS

File records (or "listings") consist of a finding name, subscriber's title, occupation, business type, street address, area code and phone number, as appropriate. Listings fall into three basic categories, residence (RES), business (BUS) and government (GOV). To assist operators, certain listings will appear in both the RES and BUS files, eg doctors, barristers, etc. This will be under programme control.

Because the DAS search interval (including operator time to key a request on a terminal) must be significantly shorter than that of the current manual method, a custom inquiry terminal is required. The over-riding consideration in the design of this terminal is keying efficiency; the significant details of a request must be entered (and perhaps modified) with the least possible number of keystrokes. As a result, the keyboard functions are specifically designed to facilitate the DAS inquiry operation .

A keyed request may consist of up to four basic elements, but usually, less are required. These may be entered, re-entered, or modified in any order. The elements are finding name (FN), locality (LOC), street name (SN), and type (RES, BUS, GOV), and correspond to fields on the lower portion of the inquiry terminal display. The request is initiated by depressing one of the "type" keys (RES, BUS, GOV).

The finding name is the name under which an individual, business or governmental entity is listed in a telephone directory. The locality indicates the geographic vicinity in which a customer resides or does business. The street name is part of an address in a directory listing.

Alphabetic keys arranged in a standard typewriter (QWERTY) format are used to specify input field contents. The fields themselves are identified by control keys. For example, the FN key moves the cursor to the finding name field for subsequent entry or modification. The same is true for the LOC and SN fields. Other keys can be used to specify a word or phrase within a field with a single keystroke. For example, several "frequently used words" (eg AUST, BANK, STATE), and "frequently referenced locality" keys are provided.

Cursor control keys are used to rapidly access a portion of a field to be modified. A CLEAR key clears a field.

In general, the technique employed by the operator (called "keying strategy") is to key only enough details of a request to result in a manageable number of listings being displayed — perhaps eight to ten. One reason for this is to minimise keystrokes, but another is to avoid over-qualifying a search, since a customer may reject the

Fig. 4 — Fully Equipped Work Station.

listing that appears to most closely match the request, and reasonable alternate suggestions must be available.

Residence Searching

To search the residence file, all or part of the surname must be keyed into the FN field. This surname is separated from any other FN data by a trailing blank (indicating a fully spelled surname) or a period (indicating a partially spelled surname). Other words of FN may then be keyed, each one terminated by a space or period.

The default book is that file to which the operator position is preset, ie the most commonly used file. This file will be searched unless the operator may choose to over-ride the default book. This is done by depressing one of the frequently referenced locality keys or the LOC key followed by a full or partial spelling of a locality and depression of the LOC STEP key.

The street name may optionally be provided (spelled in full or part) following the SN key.

Finally, the depression of the RES key initiates the computer search of the residence file.

If the locality data has been partly keyed, the system searches a locality table for the contents of the LOC input field. The table entry determines the exact, full spelling to replace the keyed contents of the LOC field, and the book (file area) to be searched. Also, if the specified locality is not in the default book, the book display field is replaced with a correct book name.

Next, the entire group of listings which match the keyed surname (or partial surname) is checked for closeness of match to the other search arguments (inputs). Whatever elements of FN(s) and SN fields are keyed, are compared to the FN and SN fields in the records. In addition, if a locality is specified (as opposed to a book only), the relative geographic location of the specified locality, is compared to those of the records. (If any of these parameters are not keyed, that element of the listing is not used in determining the closeness of the match).

When each keyed parameter has been compared to a particular listing record, the degree of match of each parameter is weighted. This weighted "match value" determines whether the current listing will be at least temporarily retained for display. The result of the entire scan is a display containing the group of best matched listings in alphabetical order to the top of the display, followed by the next best group, and so forth. No more than 20 RES listings are ever displayed on a single screen, or "page". If the first group of equally good listings overflows the display, all other "worse" groups are made available to the operator through the use of the "page forward" key. If the number of listings that match the keyed information exceeds a predetermined number, the operator will receive a "TOO MANY LISTINGS" message and will be required to provide additional data.

If the initial search results in a "Not Found", and if there are alternate spellings for the keyed surname, the operator may depress the alternate spelling key to display the alternates as they are currently shown in the directory. The operator may then select an appropriate alternate, followed by the RES key, to start a new search; it is not necessary to rekey any other parameters. The operator may also delete from the request that information about which the caller is least sure, eg street, initials.

Business Searching

The operator strategy is to select and key an uncommon word as the finding name.

Finding name words are keyed in full or in part along with a book specification and/or an optional locality for BUS searches. It is not necessary to know the first name of a business nor the compound entry header for an indented directory entry in order to retrieve the listing. During data base update a keyword is created for each word of the finding name or indented entry text. These keywords are indexed to the actual listing on the data base. During retrieval, all listings in the specified book or locality containing the keyed words or abbreviations in their FN (in any order) are displayed in alphabetical order. If more listings are retrieved than will fit in a display, multiple "pages" are made available to the operator. The "page forward" and "page back" keys are used to review them. If too many listings match the keyed data the operator will be asked to modify the information.

Government Searching

Government directory listings are characterised by captions and indents. For example, Navy Recruiting might be included under Navy which is under Department of Defence, which is under Commonwealth Government. In a GOV search, full or partial spellings of words appearing in any indent level may be keyed. The resulting display will show all levels of captions above the indent level of the lowest level caption containing any of the keyed words. In addition, all indents below this caption will be displayed. The operator keying strategy and the system execution is the same as for business searches.

AUTOMATIC CALL DISTRIBUTORS

Network Automatic Call Distributors (NACDs) link the switching network to Telecom's manual service levels. Their function is to distribute incoming calls from the network to available manual operating positions in the most efficient manner. Operation of the NACD is on a State wide basis and will allow an incoming call from anywhere within the State to be routed to an available operator anywhere within that State, thus eliminating the condition of "busys" or lengthy delays in one location while other locations have operators available. The ACD terminal is shown on the right hand side of Fig. 4.

CONCLUSION

The implementation of DAS/C sees Telecom moving from a method of providing a service which has been traditional for at least 50 years. For some time it has been recognised that the traditional method has made it difficult to provide the standard of service expected by Telecom's customers. Like other business areas Telecom has turned to the computer to help satisfy the ever increasing demand for Directory Assistance. The general features of the DAS/C system have been discussed in this paper.

GLOSSARY OF TERMS AND ABBREVIATIONS

DAS/C Number:
A system generated number which uniquely identifies each line of entry.

DAS Inquiry Terminal:
Terminals which can access the inquiry data base excluding the DAS/C number.

Data Send Centre (DSC):
The remote data entry installation located in each State Directories Branch which inputs the update data.

Directory Inquiry Centre (DIC):
Directory inquiry terminals located in each State Directories Branch for use in data preparation and error correction. The terminals access the inquiry data base and the response includes the DAS/C number.

File Inquiry Processor (FIP):
A System 7 computer which executes the file search and passes the data back to the TPC.

Inquiry Data Base (IDB):
The data base created in the retrieval centres after each update of the master data base.

Master Data Base (MDB):
The data base retained at the master update centre and updated on a daily basis.

Master Update Centre (MUC):
The central computer installation located at Clayton, Vic. which holds and updates the national data base.

Retrieval Centre (RC):
Located in each mainland capital city and comprising two or more retrieval systems.

Retrieval System:
A file inquiry processor and disk attachment for storage and retrieval of the inquiry data base.

Statistics Processor (SP):
A Series 1 computer which collects statistical data from the TPCs and processes the data.

Teleprocessing Controller (TPC):
A Series 1 computer which co-ordinates inquiry traffic from associated TCs and passes this to and from the file inquiry processor. It also collects accumulated statistical records from the TCs and presents this data to the statistics processor.

Terminal Controller (TC):
A Series 1 computer which controls a number of terminals, accumulates system and operator data relating to inquiries and the data to a TPC and passes the required listing back to the inquiry terminal for display.

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2. IBM Series 1, Directory Assistance System User Guide.

Integrated Circuit Technology — A Telecommunications View

CAROL J. SCOTT, B.App.Sc., Grad. A.I.P.

Semiconductor integrated circuit (IC) technology is assuming growing importance in the design and application of all kinds of telecommunications equipment. This paper provides an introduction to the key features of the technologies which dominate present integrated circuit development. The special requirements of telecommunications ICs are described and relevant IC technologies identified. Examples of new telecommunications ICs are given and their likely impact assessed.

INTRODUCTION

The past twenty years have seen the spectacularly rapid and successful development of IC technology. Virtually no area of electronic equipment design has escaped the influence of this powerful tool. The most significant impact on telecommunications is the widespread movement toward digital switching and transmission. This has been made possible only by the economies resulting from continuing progress in IC technology. Other effects have been the transition to stored program control within the exchange and the use of microprocessors to decentralize that control. IC technology is the key to the development of the equipment presently revolutionizing telecommunications systems and is now the major force shaping future networks. (Ref 1, 2, 3, 4, 5).

In contrast to the existing telecommunications equipment industry, the IC industry is highly volatile and product lifetimes of less than five years are not unusual. In the face of such rapid change, and growing use of custom devices, the traditional component supply and second-sourcing arrangements become meaningless. As ICs further penetrate the network, equipment lifetimes will be significantly influenced and replacement after periods less than ten years may be justified. Planning, purchasing and maintenance programs will all confront new and unprecedented challenges in adapting to the impact of IC technology. Future network planning and management will demand a sound appreciation of the growing technical and economic interaction between ICs and telecommunications.

This paper is intended for anyone who would benefit from a better understanding of IC device developments and their influence on the telecommunications network. It provides an introductory overview to IC technology and as such it assumes no prior familiarity with this area. A glossary is included covering commonly encountered IC terms and is a useful guide for this and other papers on the subject. The major objective of the paper is to highlight the key issues concerning the use of IC technology in the telecommunications network.

OVERVIEW

An IC is a complete assembly of electrical components manufactured as a single unit (Ref 6, 7). A range of components such as transistors, resistors and capacitors are formed and interconnected on a piece of material called the 'substrate'. Typically the dimensions of this rectangular substrate would not be any greater than 0.5 cm on each side and many thousands of components are placed in this area.

Over the past two decades many different kinds of IC technology have been developed, some of these have evolved into the technologies in use today. The early development of ICs was spurred by the demand of large numbers of transistors to be used in the digital circuits of computers and military equipment. A digital circuit is one in which each element operates in the manner of a switch, that is, it is either 'on' or 'off', 'open' or 'closed', 'true' or 'false'. Each element has only two possible states. In contrast, analogue or linear circuits typically involve amplification. Only a few amplifying stages may be linked before the voltage limit of IC technology is reached and thus a relatively clear distinction develops between digital and analogue circuits. This distinction is of considerable importance in telecommunications where the application may require the use of both of these circuit design techniques. Generally it is sufficient to note than an analogue IC usually involves relatively few components and higher voltages, whereas a digital circuit often requires vast numbers of components operating at lower voltages. The degree of integration of an IC refers to the number of transistors contained on the single 'chip' of material from which the device is formed. Knowing the degree of integration is an excellent guide to the complexity of the circuit and the packing density of the components. Four levels of integration are commonly referred to and these are best known by their acronyms; SSI (small scale integration), MSI (medium scale integration), LSI (large scale integration)and VLSI (very large scale integration). As a guide these correspond on a per chip basis to less than twenty devices, less than one hundred devices, many thousand devices and device numbers in excess of five thousand, respectively. The present upper limit of VLSI technology is of the order of several hundred thousand devices.

The ICs first used in switching systems in the mid 1960's were SSI and MSI devices. These were standard components (eg logic, memories), which were easily applied to processor controlled switching equipment. It is the recent LSI and VLSI device development however, which herald the widespread penetration of IC technology into telecommunications. These have produced a number of devices especially designed to perform tasks unique to telecommunications.

It is in terms of economics that integrated circuits offer the designers and buyers of equipment some very substantial advantages. Replacing components with IC reduces costs, firstly, because the devices themselves are cheaper and secondly, they can influence the overhead costs. A key consideration in telecommunications is that integrated circuits are much smaller and consume far less power than the components they have displaced. To the equipment end user this can mean providing less floor space, less operating power and less air conditioning than may have been previously required. These amount to substantial savings in buildings and maintenance costs. A further point is that many of the special functions performed by ICs are not economically feasible by any other means.

INTEGRATED CIRCUIT TECHNOLOGIES

General Considerations

IC technology is largely based on a special group of materials called 'semiconductors'. These materials are neither conductors nor insulators but have the important property of allowing their resistance to be very precisely controlled.

The semiconductor silicon, is the most widely used substrate material for the manufacture of integrated circuits. This is the basis of the expression 'Silicon Chip' much used in modern media. Less widely used is silicon-on-sapphire (SOS) an insulating material and one of the few exceptions to the use of semiconductors. Gallium arsenide (GaAs) has also been extensively investigated in recent years and appears very well suited to circuits requiring very high operating speeds. However, neither SOS nor GaAs are likely to replace silicon as the dominant material for IC manufacture in the foreseeable future.

By the mid 1960's two competing silicon technologies had developed, bipolar and metal-oxide-semiconductor (MOS). The bipolar devices are built from junction transistors which use both electrons and positive electron-holes as charge carriers. It is from the use of two charge carriers that the term 'bipolar' is derived. In contrast MOS devices use only one type of charge carrier; these are either electrons or holes depending on the kind of MOS technology used. MOS technology is based on the field effect transistor or FET as it is commonly known. Junction and field effect transistors use different control and manufacturing techniques and tend to produce ICs with widely different characteristics.

Bipolar and MOS technology (**Figure 1**), continue to dominate integrated circuit design (Ref. 8). They rarely compete now for the same market share and each has evolved a number of forms to cover a wide performance range. Generally, bipolar ICs offer the highest speed for digital circuits and are very well suited to use in analogue circuits. MOS ICs have the advantages of low power requirements and high levels of integration in digital circuits.

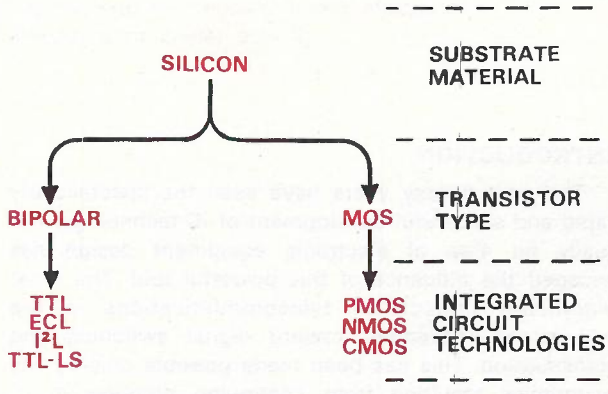


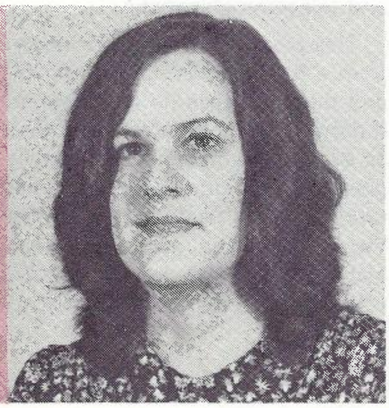
Fig. 1 — The Relationship Between Various Commonly Used IC Terms.

No one IC technology has emerged which provides that combination of features to satisfy all potential uses. Selecting the appropriate IC technology remains a process of compromise between a number of technical and economic issues. The key issues to be considered in each case are:

- speed;
- power dissipation;
- density;
- cost;
- reliability.

These are interrelated issues and cannot be considered in isolation. They are the basic parameters for evaluating an IC technology, but additional considerations can arise for a particular application area. This is certainly the case for the telecommunications network, as discussed later.

Carol J. Scott is a member of the Devices and Techniques Section of Telecom Australia's Research Laboratories at Clayton, Victoria. On completing her Bachelor of Science degree (1973) she joined the laboratories Switching and Signalling Branch (1974). Since that time she has worked in both the Devices and Techniques and Switching Operations and Maintenance Sections on development of new techniques for use in switching applications. Currently she is involved in assessing the impact of new device technologies on the design and application of telecommunications equipment.



Integrated circuit speed and power are closely linked. Each element of a circuit requires power to operate and contributes a delay. The size of the delay is a measure of the circuit speed, the smaller the cumulative delay through a circuit the greater the final circuit speed. One important objective in IC design is to ensure each element develops as little power as possible. This is done for two reasons, firstly so as not to destroy the circuit through overheating and secondly to limit the size of power supplies needed to run the equipment. An example of this second case could be ICs in telephone instruments which must be powered from the exchange over relatively long lines.

Density is important both as a technical and an economic issue. Each element in the circuit needs to be made as small as possible to keep the total circuit area within reasonable bounds. Large area circuits yield fewer ICs from a given area of silicon and also a lower percentage of fault free circuits. The greater the yield of saleable ICs, then the lower the cost of each IC device. Apart from the direct cost benefit, miniaturizing a circuit also increases the speed with which an element operates.

The cost with which a function can be provided in IC form is of prime importance. Some technologies are more complex to manufacture or provide a smaller yield of useful circuits from a given area. All of these factors are reflected in the price of an IC. The key to integrated circuit economics is volume production based on vast numbers of identical devices. The most striking characteristic of the IC industry has been the persistent and rapid decline in the cost of a given electronic device.

Bipolar

The most important virtue of the bipolar technologies is their high operating speeds. Even standard bipolar technologies are capable of producing elements with delays of under ten nanosecond (10^{-8} second). However high power dissipation and a low density of elements per unit area have limited the success of bipolar technology in LSI and VLSI circuits.

Bipolar technology has the longest history in the IC industry. In its simplest form (see **Figure 2**) a bipolar transistor has three major regions, the base, collector and emitter. The arrow indicates the direction of current flow under normal operating conditions. The transistor is controlled by a current applied to the base, which in turn controls the current flow through the device. Of the many bipolar technologies developed, three forms now dominate; transistor transistor logic (TTL) (Ref 8), emitter coupled logic (ECL) (Ref 8) and integrated injection logic (I^2L) (Ref 8).

Transistor Transistor Logic (TTL)

This is certainly the best known IC technology. Widely used in digital devices such as gates, counters, etc it has also found some application in LSI areas such as memory.

TTL has the advantage of being well tried, tested and accepted by IC users. It is considerably more complicated and expensive than MOS technology for an equivalent application. Recent improvements such as Schottky TTL (Ref 8) have provided increased circuit speed without increased power consumption.

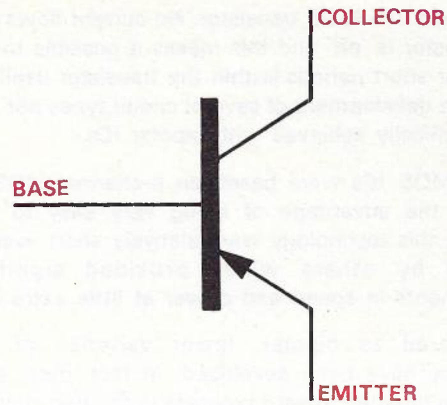


Fig. 2 — Bipolar Transistor.

Emitter Coupled Logic (ECL)

A much later development in bipolar technology, emitter coupled logic is the fastest bipolar technique available. The integration levels of ECL devices are severely limited by very high power dissipation. However ECL is extensively used in applications where speed rather than power is the prime consideration eg mainframe computers.

Integrated Injection Logic (I^2L)

Integrated injection logic is a relatively new development, the basic structure of which is shown in **Figure 3**. Unlike TTL and ECL, this design approach produces a relatively high speed and compact circuit which appears well suited to LSI and VLSI applications. In addition, the power dissipation levels are several orders of magnitude less than TTL. I^2L is also compatible with the standard bipolar technologies (eg TTL) and this makes it possible to combine analogue and digital circuits within the one IC (Ref 9). In such a case, I^2L can provide the high density digital functions and standard bipolar, provides the analogue circuitry.

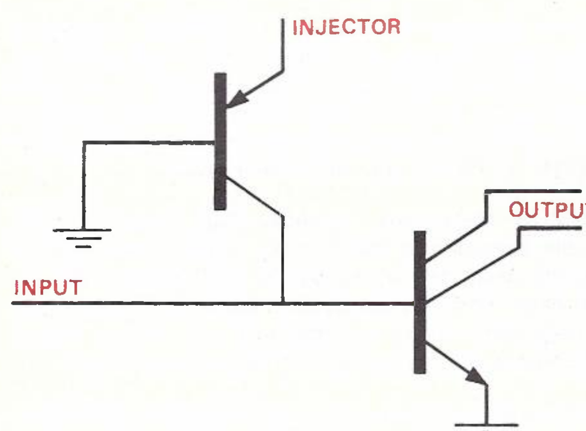


Fig. 3 — I^2L Bipolar Structure.

MOS

The greatest impact on the development of LSI and VLSI circuits has come from progress in MOS technology. The ability of MOS based designs to provide fast, complex digital circuits at relatively low cost have made this IC technology the most widely used.

The key to the success of MOS lies in the special properties of the MOS transistor. No current flows when the transistor is 'off' and this makes it possible to store charge for short periods within the transistor itself. This allows the development of several circuit types not easily or economically achieved with bipolar ICs.

Early MOS ICs were based on p-channel MOSFETs and had the advantage of being very easy to build. However, this technology was relatively short lived and replaced by others which provided significant improvements in speed and power at little extra cost.

Compared to bipolar, fewer varieties of MOS technology have been developed. In fact, most efforts have been directed toward progress in the two key forms n-channel MOS (NMOS) and complementary MOS (CMOS).

N-channel MOS

The n-channel MOSFET plays a dominant role in present LSI and VLSI circuit technology. This is mainly because the individual MOSFET can be made extremely small and hence large numbers can be contained within a single IC.

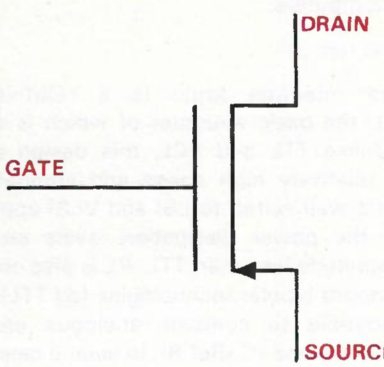


Fig. 4 — N-channel MOSFET Structure.

With reference to **Figure 4,** a MOSFET consists of three major regions, the source, drain and gate. The device is controlled by a voltage applied to the gate which sets up an electric field. The internal field then controls the flow of current through the device. When the MOSFET is turned 'off', no current flows.

NMOS technology produces high density digital circuits operating at much lower voltage levels than is possible using any of the bipolar technologies (Ref 8). The delay of a typical circuit element is around 50 nanosecond which is adequate for many circuit applications but not as fast as bipolar technology.

Although mainly used as a digital process, NMOS can be of value in some analogue applications. The resulting analogue circuits tend to be relatively area inefficient, however a number of switches, amplifiers and reference circuits are available in NMOS.

Complementary MOS (CMOS)

Complementary metal oxide semiconductor (CMOS) technology uses a combination of p-channel and n-channel MOSFETs on the one chip, as shown in **Figure 5.**

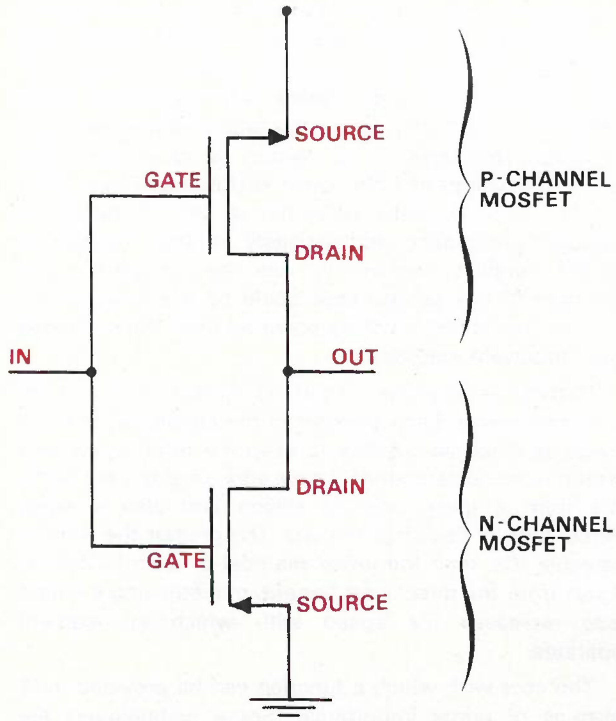


Fig. 5 — A Basic CMOS Circuit Element.

The major advantage of CMOS (Ref 8) is the extremely low power requirement when the circuit is idle. A CMOS element only draws current when changing between the two states the circuit can adopt. So an element, or a larger circuit, used relatively infrequently consumes very little power. Although the speed of a CMOS circuit is comparable to that achieved with NMOS technology, the packing density is much less. The lower density arises from the techniques needed to keep the n-channel and p-channel MOSFETs, on the chip, electrically separate. The analogue capability of this technology is good due to the availability of the complementary (ie n-channel and p-channel) devices. However, in an analogue circuit application, CMOS loses its power advantage since the transistors operate continuously.

As might be expected CMOS ICs are more complex to manufacture than their NMOS counterparts. So in the general case, CMOS components are also relatively expensive.

ICs FOR TELECOMMUNICATIONS

Particular Requirements

Each of the IC technologies in use today has distinct advantages and disadvantages which make it more or less suited to a particular application. Within limits, a circuit can be built using any of a number of available technologies. Selecting the most appropriate one for a particular use, however, is often a difficult task and requires a clear understanding of the key features of both the technologies and the application. Generally the final selection is a result of a compromise between the technical and economic requirements.

The basic requirements for telecommunications ICs are not vastly different from those in other areas where ICs are used. The need for low power, reliability and high operating speed for example, is certainly not restricted to the telecommunications system. In switching systems, and in other network areas, many standard IC devices are used, particularly memories and microprocessors. For such circuits the required quantity for economic volume production is achieved through many other applications in addition to telecommunications.

The interface between the exchange functions and the customers line is an excellent illustration of the special requirements which may apply to telecommuncation ICs. Circuits operating in this area must be capable of withstanding high voltages, providing high current and permit the combination of analogue and digital functions. This particular group of needs is unique to this application and, since they must be provided for each line, would seem suited to economic volume production.

Designers of new telecommuncations system face problems not commonly encountered by other IC users. The design and development phase of a new system can extend over a number of years. Field trials and testing may take several further years to complete. Once in use, the system is expected to have an economic life in excess of twenty years and equipment ages of twice this amount are not presently uncommon.

This situation needs to be considered in the face of IC technologies which are evolving rapidly and sometimes becoming obsolete within a few years. In the early system design stages, the selected IC technologies must be expected to endure at least until the system goes into full production. It is totally uneconomic to maintain outdated IC facilities, and so, individual components may be unobtainable within a few years of installation. From the system designers viewpoint this leads to highly modular designs, where the modules are specified in terms of function and performance, independent of the technology used.

From the equipment buyer and users viewpoint however, the future is not so clear. The volatility of the IC market place makes it almost impossible to ensure that component second sourcing arrangements will last the life of the equipment. Maintenance procedures will also need to be based on modules rather than individual components. It may become economically favourable to consider scrapping equipment after lifetimes as short as ten years, as the full impact of IC technology moves through telecommunications.

Reliability under extreme environmental conditions is also more important in telecommunications than for most other purposes. For this reason some aspects of IC technology, such as the option of plastic packaging, are not acceptable in telecommuncations equipment.

Another issue is the provision of special ICs for switching equipment, terminals etc, which are unique to a particular system. The need for this type of low volume IC is being increasingly satisfied by custom devices developed by, or for, the system manufacturer. It is the custom ICs which contribute to the distinctive architectural features of a system; such devices are not freely available nor is it in any manufacturers interest to make them so. From past experience, system documentation describing the function and behaviour of custom ICs will be, at best, sketchy — and at worst, nonexistent.

Selection of IC Technologies

After reviewing some of the particular requirements for telecommunications ICs it is timely to compare them with available technologies.

In some cases selecting an appropriate IC technology can be extremely straightforward (Ref. 10). For example, if the circuit is digital, and power or speed are not critical considerations, n-channel MOS is the obvious choice. Where power consumption is the main concern CMOS is the only alternative. High performance analogue circuits are best implemented in bipolar technology, so this is the approach used when high current or high voltage tolerance is needed. Many telecommunications tasks need a combined analogue and digital circuit and this area is best served by I^2L/bipolar technology. **Table 1** summarizes some of the key issues in selecting an IC technology for a telecommunications need.

Feature	IC Technology
High Density	NMOS
High Current	I^2L/Bipolar
High Voltage	I^2L/Bipolar
Low Power	CMOS
Analogue	I^2L/Bipolar
Cost	NMOS

Table 1. Key Issues and Technologies for Telecommunications ICs.

It is clear that no optimal IC technology has emerged to serve telecommunications needs. This is further confirmed by the observation that IC manufacturers are currently using NMOS, CMOS and I^2L to produce circuits for the same functions. These three technologies can be expected to provide the basis for all telecommunications IC development for the next five years. Beyond that limit, it is difficult to predict which of the now emerging technologies will be involved in shaping telecommunications products.

AVAILABLE TELECOMMUNICATIONS ICs

As already observed, integrated circuits have been used for some time within the exchange and these tend to be general purpose or customized ICs. The continuing progress of IC technology toward VLSI levels has now made possible the development of ICs to carry out some of the sub-system functions unique to telecommunications. Inherent in this movement toward widespread use of ICs are the advantages of greatly reduced costs and considerable network simplification.

The easiest circuits to provide are those for the telephone instrument itself. Many IC manufacturers now market a range of products including pulse diallers, tone ringers, repertory diallers and tone diallers. The key IC technology for all these designs is CMOS to allow the circuits to be powered using the customer's line.

Receiving the greatest attention at the present time are ICs to handle functions at the interface between the customer's line and a digital exchange (Ref. 4,11,12). The customers line circuits and trunk circuits alone account for over 50% of the hardware in a digital exchange. Savings made in this area are of immense value to an administration managing a digital network. Before describing the available products it is worthwhile briefly reviewing the nature of the functions at this interface. When a customer speaks into the telephone handset an analogue signal is sent down the pair of wires connecting him to the exchange. The analogue signal is received by a subscriber line interface circuit (SLIC) which performs the so-called BORSCHT functions. BORSCHT is an acronym for battery, over-voltage, ring access, supervision, control, hybrid and test. From the SLIC the signal passes to a filter and then to a PCM (pulse code modulation) codec (coder/decoder). The PCM codec converts the incoming analogue signal to a digital form which can be handled by the digital exchange. When information is travelling back to the customer, it is converted from digital to analogue and then filtered before being placed on the line by the SLIC. It is obvious that functions linked with the customers line have the potential volume needed for the economic development of standard ICs. Integrated circuit designers have also realised this, and considerable effort is underway in both the IC and telephone industries to provide standard circuits for the line interface functions.

IC codecs have been available from many sources for several years. Recognizing the size of the potential market, almost all leading IC manufacturers and some systems manufacturers, have produced codecs. The technologies used are CMOS, NMOS, I^2L or recent derivatives of these three. The IC industry generally, sees telecommunications as an important growth area in an intensely competitive market.

Great progress has been made in recent years in the design of IC analogue filters. Three basic techniques have emerged for implementing IC filters:

- active filters, based on RC networks;
- charge coupled device (CCD) delay filters;
- switched capacitor filters.

The last two, CCD (Ref. 13) and switched capacitor filters, (Ref. 14, 15) are relatively recent developments derived from, and compatible with, MOS technology. Using CCD techniques the signal is filtered using numerous CCD delay lines of varying lengths. Switched capacitor techniques use a capacitor switched at high frequency to emulate a resistor. This allows classic RC filtering techniques to be used in an integrated circuit form. A growing number of manufacturers now offer filter devices based on switched capacitor techniques. However, to date, CCD filters have not found widespread acceptance.

It is the SLIC function which has proved hardest to build in IC form. Only two manufacturers (Motorola, Harris) have made a monolithic SLIC device commercially available, and these fulfil only a few of the required tasks. Additional components must be added in each case to achieve the complete SLIC function. Equipment manufacturers with expertise in IC design and fabrication (Siemens, ITT, etc.) are known to be working on advanced forms of IC SLIC and these will eventually appear in new systems designs.

The basic problem is that the SLIC is the component which comes in closest contact with the outside world. Specific difficulties include the need to provide protection against lightning or other line overvoltages, satisfying the stringent specifications required by the external environment and arranging a means of establishing test access to the customer's line. In addition, since it provides battery power to the customer's telephone, the SLIC must handle the greatest power of any of the individual line circuits.

All of these requirements are extremely difficult to satisfy in a single integrated circuit. Earlier approaches avoided this difficulty by choosing a technology appropriate to each part of the problem, eg transformers, relays, air gap isolators etc. Completely monolithic SLICs are unlikely to appear for a few years yet, but the efforts to achieve them have already influenced IC design and technology. This is an example of the growing interaction between telecommunications and IC technology.

The areas covered so far; telephone ICs, codecs, filters and SLICs, are all subject to intense research and marketing activity. Some of the telecommunications IC developments are further summarized in **Table 2**. Less

Application Area	Function	Technology	Status
Customer's Line	Codec	CMOS, NMOS I^2L	Widely available
	Filters	CMOS, NMOS	Widely available
	SLIC	I^2L/Bipolar	Some implementations available which do not provide all functions.
Exchange	Digital Switching	NMOS, CMOS	Generally Custom ICs. Some standard devices emerging providing only limited facilities.
	Analogue Crosspoint	NMOS, CMOS	Widely available.
Telephone Instrument	Tone Ringer	CMOS	Widely available.
	DTMF Generator/ Detector	CMOS	Widely available.
	Repertory Dialler	CMOS	Widely available
	Pulse Dialler	CMOS	Widely available

Table 2. Summary of Recent Telecommunications IC Developments.

well known examples of long term importance include an echo canceller chip (Ref. 16), PCM repeater chips (Ref. 17), IC crosspoint switches (Ref. 17) and a number of very large capacity digital switches (Ref. 18,19,20). Future network developments will see the use of digital transmission extended to the customers network (Ref. 21) with transmission systems being realized in IC form. Data communications developments include a number of protocol control ICs (Ref. 22).

The components described in this brief review do not represent a final state of development. They will change and evolve with progress in IC technology. Generally the functions will remain the same but the partitioning of the functions will increasingly reflect the influence of ICs. An early example of this is the trend toward combining the previously separate functions of the filter and the codec within the one device.

CONCLUSION

This paper has outlined the basics of IC technology and highlighted the impact that developments in this area are having, and will continue to have, on telecommunications.

The evolution of digital switching and transmission has been fuelled by progress in IC technology. Within our own sphere of interest, the development of an Australian digital network will include the rapid introduction of complete sub-systems (eg SLICs, protocol controllers) on a single chip. This will demand that network designers and planners understand the nature of the various IC technologies if they are to evaluate competing systems.

It is also clear that progress in telecommunications is now closely linked with developments in the IC industry. Those concerned with the viability of the network require an appreciation of what technological advances may shape its future development.

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IC Technology Glossary

Analogue IC	An IC, the output of which varies smoothly over a continuous range of values rather than in discrete steps.
Chip	The single piece of silicon on which the individual integrated circuit is formed.
CMOS	Complementary metal oxide semi-conductor. This technology combines both p-channel and n-channel MOS transistors in the one device.
Custom IC	A device designed to perform one special function within a circuit. Such devices are not sold individually but are contained in equipment which may be sold.
Digital IC	A device composed on elements which behave as switches ie they are either 'on'

	or 'off'. The resulting output is discrete rather than continuously variable.
ECL	Emitter coupled logic, a form of bipolar IC technology offering very high speed at the cost of high power consumption.
FET	Field effect transistor
IC	Integrated circuit. Complete assembly of electrical components manufactured as a single unit during the same sequence of operations.
I^2L	Integrated injection logic. A bipolar IC technology offering increased density and high speed. Also compatible with standard bipolar analogue circuits.
Linear Circuit	A linear circuit is one which performs analogue functions.
LSI	Large scale integration. The accumulation of a large number of transistors (>100) on a single chip. Characteristic of many ICs developed during the mid 1970's.
Monolithic	An integrated circuit that is formed as a unit on a single piece of silicon.
MOS	Metal oxide semi-conductor. An IC technology. The term refers to the layers of material involved in fabricating devices. MOS circuits achieve the highest component densities of any IC technology.
MOSFET	Metal oxide semi-conductor field effect transistor.
MSI	Medium scale integration. The accumulation of many transistors, usually less than 100, in a single integrated circuit.
NMOS	N-channel metal oxide semi-conductor. A form of MOS IC technology providing the highest packing density in digital circuits.
PMOS	P-channel metal oxide semi-conductor. The earliest form of MOS IC technology, now largely displaced by NMOS.
Semi-conductor	A material with resistivity between that of conductors and insulators, and whose resistivity may be changed by light, an electric, or a magnetic, field.
SSI	Small scale integration. An accumulation of less than 20 transistors in a single integrated circuit.
Substrate	The supporting material upon which, or within which, an integrated circuit is built.
TTL	Transistor transistor logic. The most common form of IC logic and the simplest bipolar process. TTL is considerably more complicated and expensive than MOS.
VLSI	Very large scale integration. An accumulation of a very large number of transistors in a single IC. Typically this number would exceed 5000 and recent developments have taken the number beyond 100,000.
Wafer	A slice of single crystal silicon on which many hundreds of ICs may be fabricated simultaneously.

Videotex — an Emerging Public Information Service

R. I. DAVIDSON B.E.E., A. R. JENKINS ARMTC

One aspect of image processing that is often not fully appreciated is the need for transmission and presentation of images in conjunction with an information data base. This paper discusses videotex, an emerging service for the transmission and display of textual and graphical information. The point is made that technological development on its own is of limited value unless the end result is one that the user will accept and is prepared to pay for.

INTRODUCTION

Many years have passed since the days when a telephone company survived simply by installing cables, exchanges and "plain old telephone services". In these days of high customer expectations and heavy commercial competition, telephone companies around the world are beginning to supply newer and novel value-added services. One such service which has captured the interest of many administrations is the information service referred to generically as videotex. Videotex is known by a variety of names in different countries with some of the better known being Prestel, Bildschirmtext, Telidon, Captain and Teletel. Installations are now proceeding or are under consideration in so many countries that the future of videotex as a public information service seems assured. In addition several commercial organizations are also developing private videotex systems based on the various standards currently in use and intended primarily for "in-house" data base information. These developments are expected to augment further the public service by providing increased penetration into the commercial sector.

SYSTEM DESCRIPTION

Videotex is an interactive information service in which pre-formated information from a computer data base is displayed in textual and graphical form on terminals which are either modified domestic television receivers or dedicated business terminals. Two-way communication with the computer is achieved over normal telephone circuits, using standard data transmission techniques.

Prestel, or Viewdata as it was known initially, was an original development by the British Post Office (now British Telecom). The first in-house demonstrations were in late 1973 and a pilot trial was commenced in early 1976 [1]. The early 1970's also saw the BBC and the IBA experimenting with a broadcast data service, an early version of which was demonstrated in January 1973. This work culminated in an industry standard in 1974 for the broadcast television service called Teletext [2]. This was the first manifestation of the home TV receiver as a mass market video display unit. It was the existence of this hardware with its specialised data decoding circuitry that made possible the speedy introduction of Prestel, the UK videotex service, as a full public service in 1979 [3].

Unlike its broadcast counterpart, videotex is a fully interactive data base service with two-way data communications, normally at up to 1200 bits/second data rates over standard dial-up telephone lines. Connection is made to relatively low cost time-share ports on a centralised computer data base **(Fig. 1)**.

Videotex is a unique service in that for the first time it brings together three significant industries; the television receiver suppliers, computer companies and the communications administrations. A complex symbiotic relationship must exist between these industries in the creation and operation of a successful videotex service. Further, the information in the data base must be both useful and attractive to the eye or the user will look elsewhere for the information. Graphic designers will therefore play an important role in the design of information for videotex.

The future of videotex now seems assured. British Telecom have sold their Prestel system to many countries; several others are conducting trials in co-operation with Prestel International, while many other countries are implementing videotex systems designed to their own specifications.

INTERNATIONAL VIDEOTEX DEVELOPMENTS

While the British system [4] has continued developing along lines based on the Teletext display standards, other countries have taken the initial concept and developed videotex in unique ways. The French system called Teletel has been adapted from the original design to operate over a packet data network and is compatible with their broadcast Antiope system [5], whereas the Japanese have continued development of the dot-by-dot description of characters to handle their written language, in their Captain system [6,7]. The Canadians, in their "second generation" videotex system, Telidon, have developed a completely new approach to graphics transmission and display. They transmit picture description

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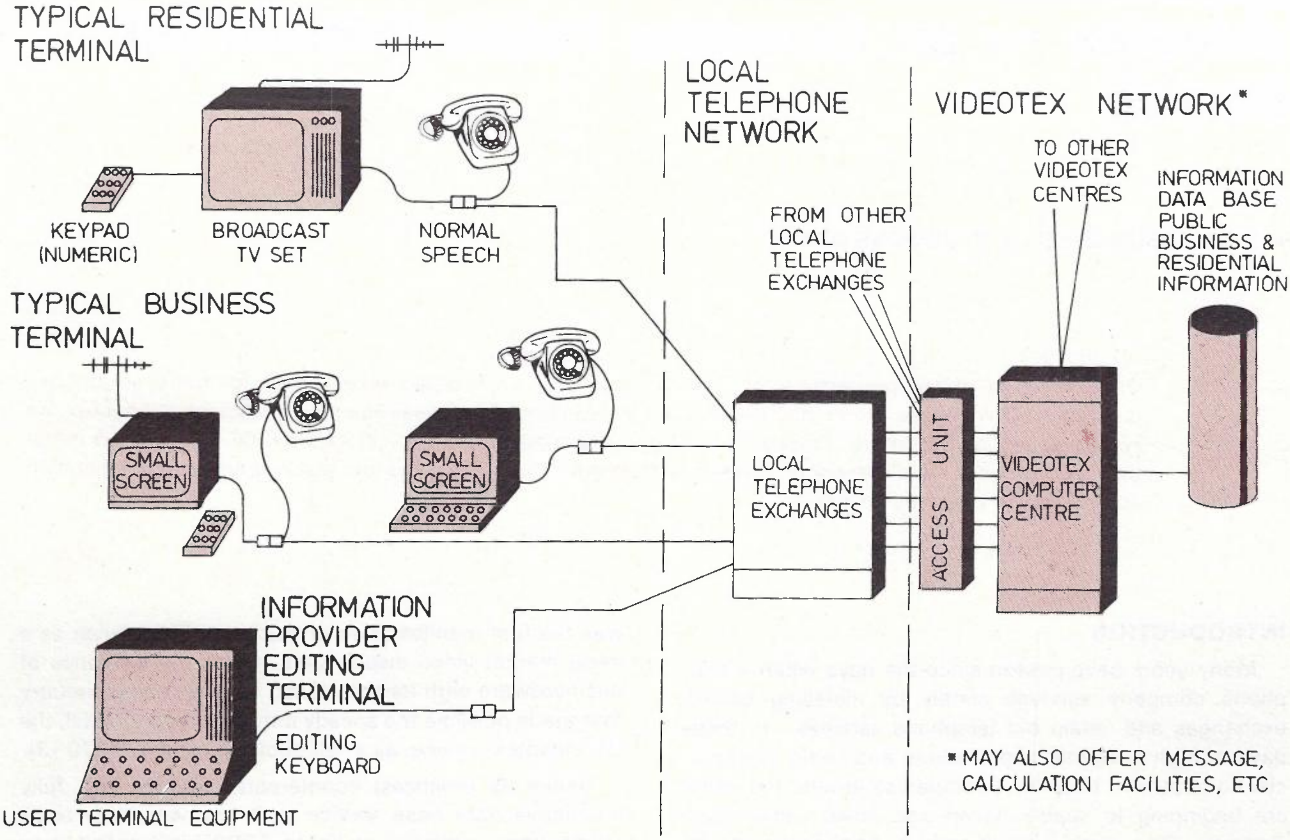

Fig. 1. — Typical Videotex System Outline.

instructions (PDI) which are used to control the creation of detailed pictures on the screen [8].

With the number of apparently incompatible videotex systems under development, it is appropriate that an international standards body is currently attempting to rationalise the situation. The CCITT (International Telegraph and Telephone Consultative Committee) has published a set of recommended standards for videotex under the guidance of Study Group VIII, in an attempt to bring about compatibility between systems. To take into account the major differences between competing systems, CCITT has standardised the common elements of videotex and has proposed alternative display options in such a way that future rationalisation is possible. In the CCITT draft recommendation (to become REC. S.100 -

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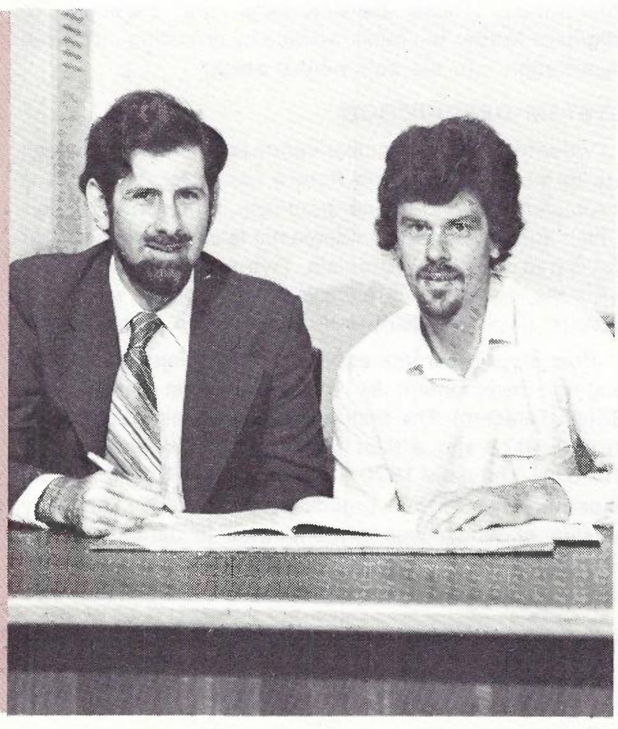
Alan Jenkins (right) graduated with a Diploma in Communication Engineering from the R.M.I.T. in 1965.

He commenced working with Philips Telecommunications designing remote control and telemetry systems and since joining Telecom Australia, he has worked in the Switching and Transmission fields including long distance television transmission.

Mr Jenkins is currently Senior Engineer in the Customer Systems and Facilities Branch of Telecom Australia Research Department where he is studying future facilities for videotex systems and group communications using visual techniques.



International Information Exchange for Interactive Videotex), common features and major options are identified [9].

The basis of the coding and transmission structure is the 7-unit CCITT Alphabet No. 5. The basic set includes 34 control codes (the CO set) and 94 alpha (printing) characters known as the primary character set or GO set (See **Fig. 2**). The shift-out (SO) code invokes the G1, or supplementary, set of graphic characters while other command sequences invoke alternative sets or subsets of graphics or controllers.

The control characters are used to support transmission protocols, to enable the selection of appropriate character sets and to provide cursor control functions. In these latter respects videotex is an extension of the Teletext approach in which successive transmitted characters represent successive character positions on the screen with fixed line length format. In the case of videotex the cursor can be moved through the display freely, using the cursor controls. The recommended options for videotex allow at least six fully saturated colours plus black and white although the required colours are invoked in a different manner under the various videotex options.

DISPLAY OPTIONS

The major options identified by CCITT are related to the graphics presentation. Four alternatives are described [9]:

Alpha-mosaic Option

The display screen is composed of defined character positions which may be occupied by any characters of the repertoire, alpha characters or graphics elements. To present graphical pictures each character position is further subdivided into a matrix of 2 x 3 elements. There are 63 different combinations of these elements, each combination identified by its own code word. Prestel, Teletel and the German Bildschirmtext as well as many other Prestel-based systems employ this option. The transmission code and character set for the Prestel system is shown in **Fig. 3.**

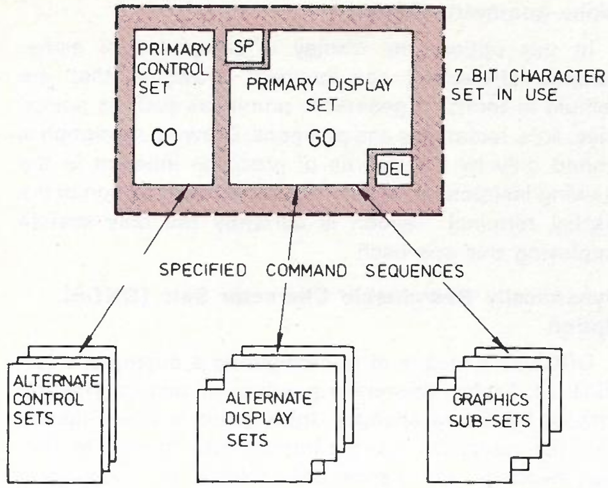


Fig. 2 — Code Extension Scheme For Alternative Videotex Character Sets.

NOTE:
Columns 0 and 1 form the C0 control character set.
Columns 4b and 5b form the C1 set of display attribute control codes.
Columns 2, 3, 4, 5, 6 and 7 form the G0 character set.
Columns 2a, 3a, 4, 5, 6a and 7a form the graphics character set.
*From terminal to computer only.

Bits $b_4 b_3 b_2 b_1$	Row	0	1	2	2a	3	3a	4	4b	5	5b	6	6a	7	7a
b_7		0	0	0		0		1		1		1		1	
b_6		0	0	1		1		0		0		1		1	
b_5		0	1	0		1		0		1		0		1	
0 0 0 0	0	NUL				0		a		P		–		[illegible]	
0 0 0 1	1		Cursor on	!		1		A	Alphanumeric Red	Q	Graphics Red	a		:	
0 0 1 0	2			"		2		B	Alphanumeric Green	R	Graphics Green	b		[illegible]	
0 0 1 1	3			£		3		C	Alphanumeric Yellow	S	Graphics Yellow	c		[illegible]	
0 1 0 0	4		Cursor off	$		4		D	Alphanumeric Blue	T	Graphics Blue	d		[illegible]	
0 1 0 1	5	ENQ		[illegible]		5		E	Alphanumeric Magenta	U	Graphics Magenta	e		[illegible]	
0 1 1 0	6			&		6		F	Alphanumeric Cyan	V	Graphics Cyan	f		[illegible]	
0 1 1 1	7			'		7		G	Alphanumeric White	W	Graphics White	g		[illegible]	
1 0 0 0	8	Cursor left	Delete line*	(		8		H	Flash	X	Conceal Display	h		[illegible]	
1 0 0 1	9	Cursor right		)		9		I	Steady	Y	Contiguous Graphics	i		[illegible]	
1 0 1 0	10	Cursor down		*		:		J	End edit*	Z	Separated Graphics	j		[illegible]	
1 0 1 1	11	Cursor up	ESC	+		;		K	Start edit*	←		k		¼	
1 1 0 0	12	Cursor home & clear screen	Single shift 2	,		<		L	Normal Height	½	Black Background	l		‖	
1 1 0 1	13	Cursor return	Single shift 3	–		=		M	Double Height	→	New Background	m		¾	
1 1 1 0	14	Shift out	Cursor home	.		>		N	Start insert	↑	Hold Graphics	n		÷	
1 1 1 1	15	Shift in		/		?		O		⌗	Release Graphics	o			

Fig. 3. — Transmission Code And Character Set For Prestel.

Alpha-geometric Option

In this option, the display is composed of alpha-numeric characters and pictorial drawings that are defined in terms of geometric primitives such as points, lines, arcs, rectangles and polygons. Drawing resolution is limited only by the degree of precision inherent in the drawing instructions and by the absolute resolution of the display terminal. Telidon is currently the only system employing this approach.

Dynamically Redininable Character Sets (DRCS) Option

DRCS is a means of re-configuring a customer's terminal to display alternative graphics or text information without hardware changes. Information is down-loaded from the computer over the normal data channel to alter the meaning and hence the display of subsequent information. DRCS allows the production of a universal terminal which can be "tailored" to specific applications as required. The principle is under study for addition to most videotex systems although DRCS offers advantages only when compared with the lowest resolution alpha-geometric options or the alpha-mosaic option.

Alpha-photographic Option

In this case the image is produced by the transmission and display of individual picture elements, much as in a facsimile or slow scan TV transmission. This option is available on Telidon and is being considered for addition to other systems.

Because of the many thousands of characters in their written language the Japanese have chosen not to use a character generator at the videotex terminal. The written Japanese language uses over 3,500 different characters including Kanji (Chinese), Katakana (Japanese square form) and Hiragana (Japanese cursive form). The Japanese videotex system (Captain) does however use a common character generator at the central computer and conveys the information to the terminal by dot-pattern transmission. The picture can be built up line by line or character by character as selected by the information provider. Redundancy reduction techniques are applied to the data which is transmitted at up to 3,200 bits/second to create a page in about 8-10 seconds, only slightly slower than with most other videotex systems [6,7,10].

PAGE DESIGN

Most videotex terminals when displaying alpha-numeric characters resemble conventional video display units (VDU) with the screen display providing high contrast white (or fully saturated colour) characters on a black or coloured background. However the display is not optimised as in a VDU in that, room illumination is usually uncontrolled, larger screens (particularly in the home) produce coarser characters, and the 25/50 Hz flicker results in the vertical jitter of horizontal lines. The readability of the text may be further degraded by the inappropriate use of colour changes within pages, paragraphs or sentences or, equally, by inappropriate use of graphics.

With alpha-mosaic graphics only limited detail is available to page designers and the most obvious use of this facility is to generate borders, underlines and area designation with the screen. Sufficient resolution is available for example to produce stylised but recognisable forms of most company logos, etc. but illustrative graphics are severely limited. In fact, in alpha-mosaic systems the graphics are at best an aid to the text material and thus their use should not distract from the text by over use of colours, flashing symbols, etc. [11].

While the design of a good page using alpha-mosaic symbols is difficult, with alpha-geometric capability it approaches an art form. Not only does the designer have a choice of six colours plus white and flashing for the text but has the ability to describe almost any area (within the limits of the screen resolution) in eight levels of grey, six colours and flashing characters all with the capability for multiple overlay and limited animation. Thus the technology places virtually no inherent limits on the types of images which can be displayed. The penalty of course, is the increase in data storage and transmission time, the escalation in skills needed to generate customer-acceptable pages and the increasing dependence on small computers to assist page designers.

TERMINAL DESIGN

Terminals are required to perform three functions: to establish a connection to the central computer over the switched telephone network, to store and display the information transmitted to the terminals and to communicate between the user and the central data base. The requirements of the information providers (IP's) are significantly different from those of the ordinary users and an IP input terminal might range from the very simple to the highly complex, depending on the particular display and editing options required.

A videotex terminal will comprise 5 main elements although the configuration and appearance may vary with application. The complexity of a terminal will also depend on application and on the videotex option employed. The main components are:

- the display, which may be a visual display unit designed for the purpose (although a simple home TV receiver will be adequate for most applications);
- the memory store, where the current page is held for display on the screen; optionally, additional pages may be held "for reference";
- the data modem, essential to provide data communication facilities;
- an auto dialer, optional but highly desirable for ease of use;
- the keyboard; the minimum keyboard will include the numerals 0-9 and some control keys necessary for communicating with the computer. If message communication is desired a full alpha-numeric keyboard is necessary.

The above elements may be integrated into a single unit or supplied as separate units depending on the application.

Two types of customer terminals will be manufactured apart from the IP terminals. The videotex equipment will either be built into a domestic receiver or a specially designed monitor by the television manufacturer or all the necessary hardware will be supplied as an adaptor to connect to the RF or video inputs of existing television receivers. Although there are cost and quality penalties associated with external adaptors, they offer a quick method of penetrating a domestic market such as Australia where existing levels of colour television ownership are high. Long term development will however tend toward integrated videotex/television receivers for domestic use and dedicated small screen terminals for commercial or public use.

USER ACCEPTANCE

The fundamental success of a videotex service depends to a large extent on the customer acceptance of the videotex terminals, their price and capability and on the perceived usefulness or value of the information available.

The main area which directly affects the ultimate success of a videotex service is the data base structure. The information on the data base must be both valuable and immediately available to a customer. While in a commercial world the information provider who supplies information of limited value may fail, it is the responsibility of the videotex service provider to ensure that all information is readily accessible.

The simplest data access structure which requires the least learning time and which is being used in all major videotex trials is known as the modified tree structure. The access and routing paths appear like an inverted tree with initial access at the trunk and paths down successive branches to the information at the end. The tree system is "modified" in that direct jumps between non-adjacent points are built into the system. While this (generally) allows a more rapid path to the required information it results in loss of continuity when an incorrect path is chosen and the route back up the tree is not known. Most systems will however remember the last few pages accessed and thus provide a retrace path. A simplified structure using up to six choices per page is shown in **Fig. 4.** However, more powerful search techniques such as a key word index are desirable, as studies have shown [11] that a failure rate of 20% can be expected using a tree system routing structure. The Prestel system in fact offers both a software and hard copy index to supplement the routing information offered on each page.

APPLICATIONS

The principal application for the videotex service on current experience is the business user, and it is significant that both Prestel (with over 85% of current users in this category [12]) and Telidon have data bases designed to serve this market. The data includes information such as economic forecasts, transport timetables, government statistics, financial and share indices, etc. and, as may be expected, makes little or no use of graphics. It is interesting to note that in a recent survey of Prestel business sets in use, 42% are in the transport industry and 13%, the next highest group, are in finance (British Telecom and the TV industry figures are excluded) [13].

As the price of acquiring a videotex terminal falls to a level acceptable to domestic markets, the proportion of domestic users is expected to rise rapidly, ultimately exceeding business users [14]. However significant changes to the type of information available in the data base must occur to attract users in the domestic market. This will probably generate a requirement for graphics superior to those currently available in the Prestel based system.

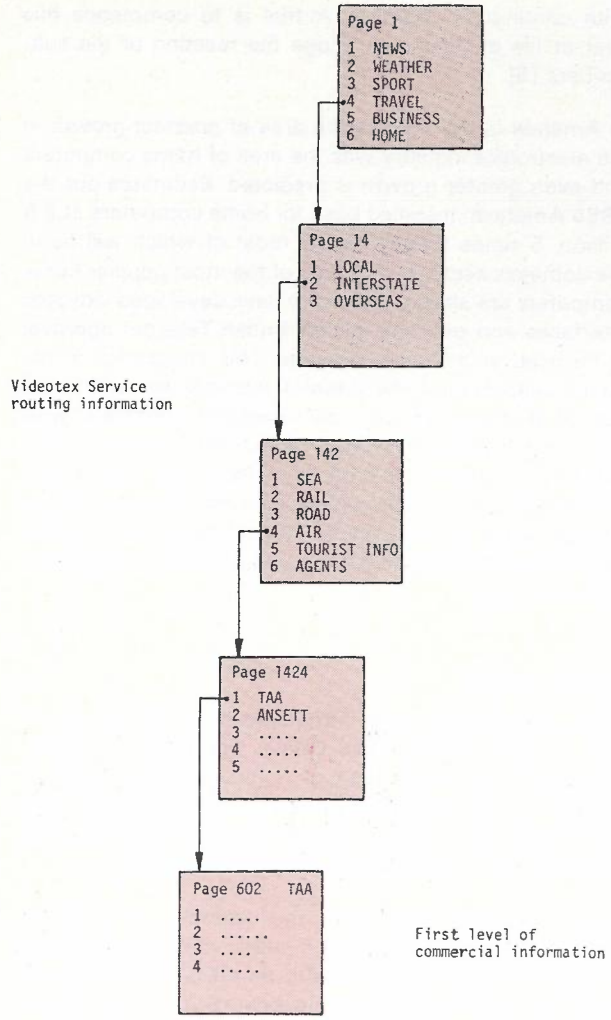


Fig. 4. — A Branch Of The Data Base "Tree".

One major application of the Canadian videotex service, Telidon, is in education. The Ontario Educational Communication Authority (OECA) is currently taking part in Telidon trials [15], examining the relationship between interactive and broadcast Telidon and broadcast television. During regular television broadcasts to schools, viewers are invited to access the specially prepared "pages" of broadcast teletext (in Telidon format), which are designed to support the program material. For further information the viewer is referred to the appropriate "pages" of the interactive Telidon service.

Other services that are currently being considered for Telidon are electronic order services, electronic telephone directory, business information and statistics, electronic books and SDI (selective dissemination of information) services [12].

The first commercial Telidon service, in Manitoba, Canada, in April 1981, supplies specialised information to farmers to assist them in making decisions on planting, harvesting and marketing [16]. Project "Grassroots" will supply current market prices, feed costs, grain futures and other variables at public centres for easy access by the farmers.

In France consideration is being given to providing the entire telephone directory on Teletel (30 million subscribers by 1990), offering a faster, more reliable service with continuous updating. A trial is to commence this year at Ille et Vilaine to gauge the reaction of the subscribers [5].

In America in the 1970's the area of greatest growth in the electronics industry was the area of home computers and even greater growth is predicted. Estimates put the 1985 American installed base for home computers at 2.5 million, 5 times today's figure, most of which will be in the domestic sector [15]. Three of the most popular home computers are already known to have developed videotex interfaces and one has gained British Telecom approval to be used as a Prestel terminal. This integration of the home computer and the videotex terminal will lead to the use of home computers as intelligent terminals with multipage storage, key-word search and simple editing facilities. The dissemination of software for home computers, using the videotex facilities is inexpensive and extremely likely to eventuate, with libraries of software listings becoming available through videotex to the home computer user.

CONCLUSION

When the telephone was introduced in the 1870's, an official of the British Post Office, doubting its future, declared "They have need of it in the colonies but in England we have an abundance of messenger boys". The fact that he was proven wrong illustrates the difficulties in predicting future uses of present technology.

In this present age when the quantity of recorded information is doubling every 5 years, videotex, a product of today's technology, can offer an efficient new way of locating and retrieving information. The major outstanding task is to identify the requirements of potential users so that the service providers may optimise the facilities available.

Only when videotex is matched to the real needs and wants of the user will this new information service be able to achieve its full potential and then achieve the growth and acceptance levels predicted by current forecasts.

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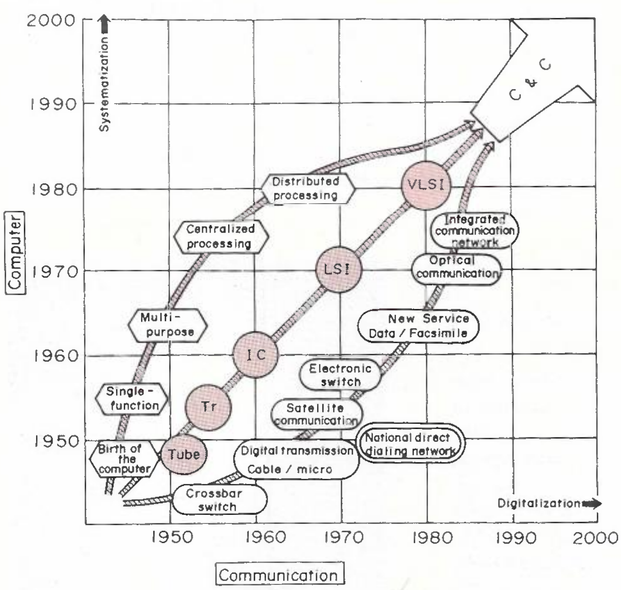
Computers, Communications And Man

KOJI KOBAYASHI

The convergence of computers and communications has been evident for some time. This paper expresses a formulated concept of the convergence and predicts the integration by the end of the century. The paper adds to this concept, the thought that integration will not only be through a series of technological developments but also in order to meet the needs of mankind. A third variable, the human (M) variable is therefore introduced to the process of integration.

HOW ARE COMPUTERS AND COMMUNICATIONS RELATED TO MAN?

The importance of integrating computers and communications ("C & C") in the two decades leading up to the year 2000 has been advocated for a long time (Ref. 1-16). The computer first made its appearance in Japan in the 1950s, based on communications technology. For the next 30 years, these two technologies — computers and communications — tended to develop in relative isolation from each other. It will be extremely important to fuse these two technologies together in the 1980s into a single "C & C" technology. Many, both in Japan and overseas, have now come to agree with the view that this technology will lead to an entirely new dimension of applications, and its sound development will have a great and beneficial impact upon society.



(notes) IC : Integrated Circuit
LSI : Large Scale Integrated Circuit

Fig. 1 — The Future of "C & C".

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Fig. 1, illustrates the concept of how computers and communciations will become integrated and develop as a unity. On the vertical, or Y axis, we have computers developing toward greater systematization; on the horizontal, or X axis, we have communications developing toward greater digitalization. Technology development from the TUBE to VLSI is shown on the diagonal. This is what is called the development of "C & C" technology.

"C & C" Technology Should Begin and End With Human Needs.

It should be noted especially here that the advance of "C & C" technology is sustained by the rapid development of semi-conductor devices, LSIs and others. Another noteworthy feature in both fields is the way in which research, development and application have sought wherever possible to satisfy needs as human beings and as a society, and thus to make both individual and social lives fuller and more convenient. "C & C" technology must exist for the sake of humanity, and must truly contribute to society. In other words, "C & C" technology must begin and end with human needs.

To present the progress of "C & C" more clearly in these terms, there is a need to add a Z axis, representing the human factor, or M, to the two existing axis; Y for computers and X for communications. This gives a three-dimensional "C & C" space which might be called an "M and C & C" space, or a "C & C and M" space.

The Interaction Between Man and "C & C"

In the three decades since the first computers came into use, computer technology has progressed just as spectacularly as communications and semi-conductors.

During this time, computer users and those developing software and computer systems have been pursuing two goals. One is to close the wide gap between the standard level of human concepts, thought and behavior and the level of corresponding computer intelligence. The other is to make the optimum use of the computers and related hardware available at any stage of the development process. These efforts already have a distinguished history, and of course, even greater efforts will be necessary in the future.

The interaction between man and "C & C" can be divided into three stages, as shown in **Table 1**.

ERA	FEATURES
1) M in "C & C" 1950-1960	Humans had to approach the machine level to use the machines.
2) M on "C & C" 1960-1980	The functions and performance of both computers and communications were improved.
3) M with "C & C" Since 1980	"C & C" systems, with improved intelligence and better man-machine interfaces, are more closely approaching human faculties; man coexists with "C & C".

Table 1 — Stages of Interaction Between Man and "C & C".

Charting these three stage in terms of decades, **Fig. 2 (a)** is obtained which shows three indices of the human factor, M:

- improvement of the man-machine interface;
- increase in the intelligence of machines and systems;
- human efforts to approach closer to the machines and systems.

The closer man approached "C & C" systems, the greater the amount of human labour and operations the interface required. In fact, it is often found people spend more time in preparing to use the systems than in considering the actual tasks to be accomplished.

Since the early 1970s, methodology for the human side of this interaction has been developed and applied: for example, the use of high-level languages, TSS on-line systems, structured programming methods, and so on. Thus the systems have become easier both to use and to construct.

At the same time, "C & C" systems have gained greatly in intelligence due to the development of the facsimile, digital transmission networks, and TD-ESS: the formation of an integrated communications network; and the development of LSIs as component devices.

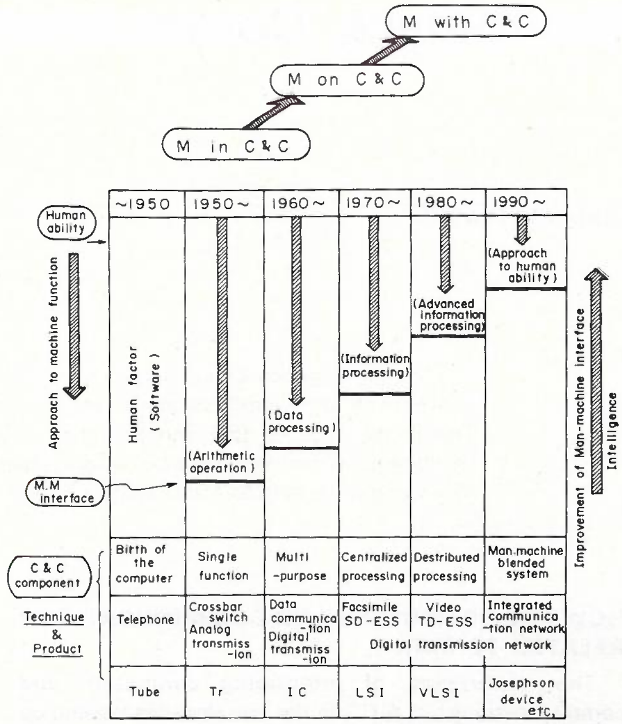

Fig. 2 (a) — Development Stages Of M and C & C (1).

The 1980s: Toward "C & C" Systems That Co-exist With Man

In the 1980s, we can look forward to further progress toward establishing a useful methodology for the human side of the interaction. As information processing technology advances still further, these efforts will help make more effective use of "C & C" systems. They are likely to include research on application technology, or how to use computers and communications in particular industries or operations. The objectives here are to widen the area of "C & C" applications, on the one hand, and to standardize the common features of diversified "C & C" usages, on the other. Efforts will also focus on software engineering, especially in the development and maintenance of software products, and in the requirement engineering area, so that software production and quality-control can proceed rationally and efficiently in spite of software's growing diversity, volume and scale.

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This progress will need to be matched by research in the man-machine interface — for example, in the development of verbal in-put and out-put, image processing, diagram processing, word processors, very high level languages, and pattern recognition technology. At the machine level we can also expect to see rapid development of specialized machines for databases, high level languages, and ultra high speed machines. Terminal level development will include intelligent terminals with more sophisticated functions, compound terminals incorporating facsimiles and industrial-use terminals with optimized application designs — as well as information network systems to link them. Office automation combining these features will also be researched, developed and put to widespread use.

The 1990s: Toward a Man-Machine Blended System

The 1990s should see "C & C" approach even nearer the level of human faculties, and we can expect human beings to be able to devote their energies to more creative, more intellectual undertakings. The decade will see the practical use of knowledge bases, artificial intelligence, and natural speech processing as basic functions, as well as the development of LSI software that incorporates software into VLSIs in each applicable area. In terms of the man-machine interface, terminals will probably have been created that more closely approach human functions.

At the same time, there is rapid development in communications technology in PABX, commercial satellite communications, optical communication systems, and image transmission.

These advances, it is predicted, will accelerate the trend away from centralized processing, which was emphasized so heavily in the 1970s, toward decentralized processing adapted to the needs of user organizations, and ultimately toward the age of man-

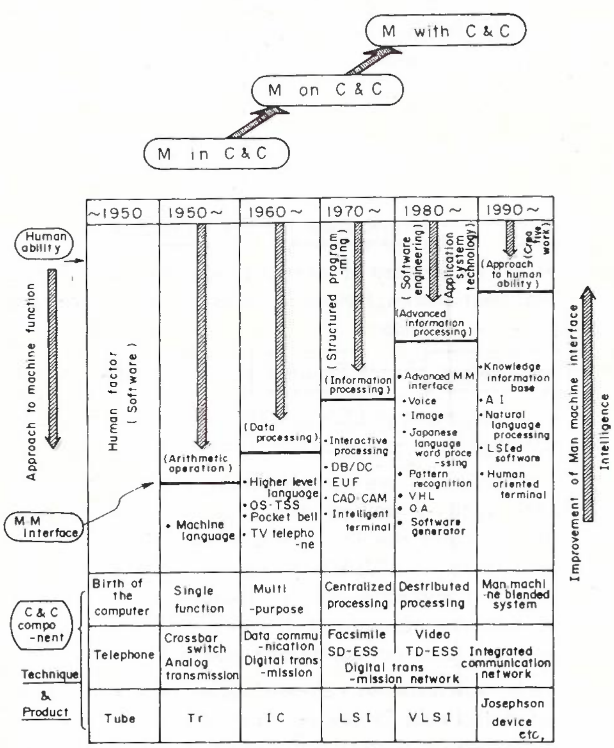

Fig. 2(b) — Development Stages of M and C & C (2).

machine blended systems — a trend backed up by the progress in "M and C & C" technology.

The process of developing the software to fill the gap between man and machine is illustrated in **Fig. 2 (b).**

The Inter-relationship Between Man and "C & C".

Man is generally thought to have four relationships with "C & C" systems: as (1) owners, (2) users, (3) managers, and (4) indirectly affected people, as **Fig. 3** shows.

Full account needs to be taken of the benefits and impacts that "C & C" systems may have on society or individuals. This means assessment of the impact of "C & C" systems and technology.

To take a fairly concrete example, the introduction of the on-line banking system using teller machines and cash dispensers has enabled banks to extend their hours of service and establish mini branches. These have made the banks highly convenient for depositors and made it possible for depositors to withdraw funds from any part of the country. However, any system breakdown will have a very large impact indeed. It will not only affect bank customers, but may also render it impossible to cash cheques from third parties who have business dealings with those customers.

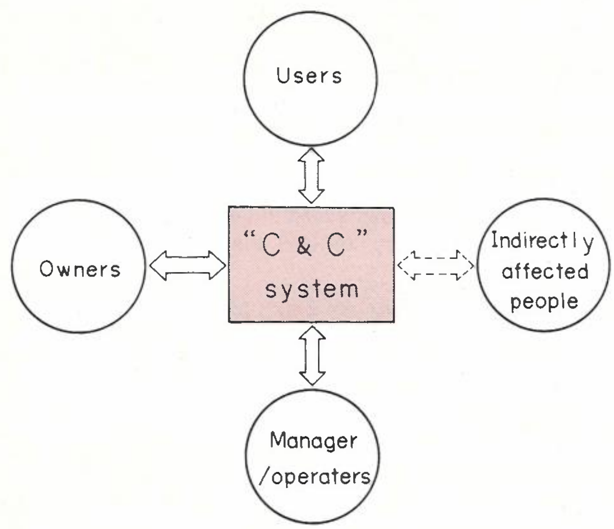

Fig. 3 — Mutual Relations Between Man and "C & C" System.

Moreover, when society at large changes through the introduction of various "C & C" equipment, a new "C & C"-based culture is likely to arise. This will probably have a gradual but definite impact on our societies.

BASIC ANALYSIS OF "M AND C & C" SPACE

It is easy enough to talk of "the human factor", but humans are of course complex beings. Thus, our requirements are extremely diverse when using "C & C" technology and products, and it would be extremely difficult to represent them all by a single index.

In other words, the human factor incorporates a wide variety of aspects including philosophy, ideology, emotions, individual behavioral criteria apparent in human character, group culture and traditions, and biological considerations. This article deals only with those human factors connected with the use of "C & C" technology and/or products.

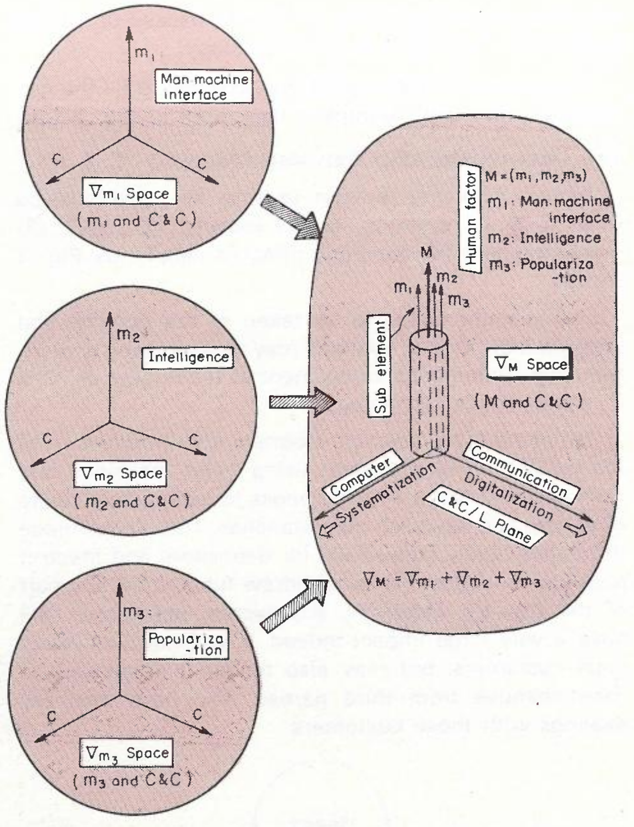

Fig. 4 — Relation of M and C & C And Its Sub Spaces.

Formal Expression of the Human Factor M

If the many component factors which make up the human factor M, are expressed in terms of m_1, m_2, . . . m_n (where n is an arbitrary number), then M itself becomes a set of m_1, m_2, . . . m_n).

Letting the space whose Z axis is the human factor M be V_M = "M and C & C", and the space whose Z axis is the single component factor m_i be Vm_i = "m_i and C & C", we can visualize V_M as the sum of all the spaces Vm_1, Vm_2, . . . Vm_n superimposed on one another. Stating this in equation form, we have:

$V_M = Vm_1 + Vm_2 + \ldots + Vm_n$, and
"M and C & C" = $(m_1 + m_2 + \ldots + m_n)$ and C & C.

If we let n = 3, for example, we obtain the space shown in **Fig. 4**.

Component Factors of M on Z Axis

Here, let us examine these components of the human factor, M, and the indices of measures which apply to them. The three factors and indices of Table 2 have been selected, since they are relatively comprehensive in meaning:

First, taking m_1, we have the trend shown in **Fig. 5 (a)** that is, those who use "C & C" systems are gradually applying their thought processes (or information processing) to contents of a higher level; they are moving on from ***data*** (objective facts) to ***information*** (data as understood by the human mind) to ***knowledge*** (the results of reasoning, experimentation, etc.). In other words, the "C & C" level of service is approaching closer to our own human level of thought.

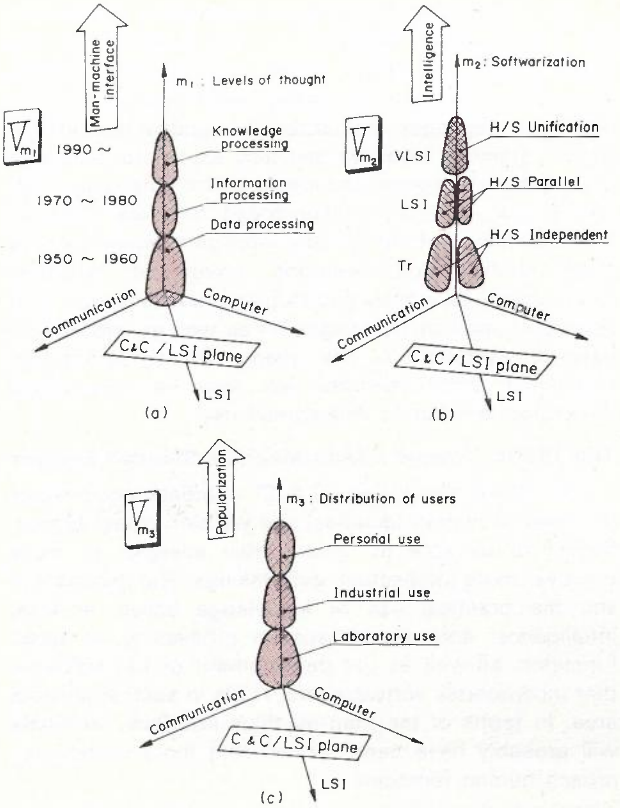

Fig. 5 — Examples of Human Elements (M).

	Component Factor	Index/Measure
m1	Level of thought process	Man-machine interface
m2	Conversion into software	Intelligence
m3	Social distribution of "C & C" users	Changes in access to the benefits of "C & C" (popularization)

Table 2 — Components and Indices of The Human Factor

Data — ***Information*** — ***Knowledge***

Next, the movement of m2 over time is shown in **Fig. 5 (b)**. The relationship between hardware and software progresses as follows:

Independent — ***Parallel*** — ***Unified***

The development of LSIs and VLSIs has enabled us to give "intelligence" to hardware components.

Put another way, we can expect the rise of "intelligent products" with a unified structure of software and hardware through the incorporation of software as an intelligent factor into VLSIs themselves. In this way, an age in which software will be treated as intellectual merchandise will be realized. It will be an age in which we see a true fusion of computers and communications.

Already, software on cassette tapes is being widely distributed and sold for the microcomputer and personal computer markets. Greater emphasis will also be given to raising productivity and quality in the so-called "knowledge-intensive industries" which will be responsible for the software throughout its life cycle, including both development and maintenance.

Thirdly, we have m3 as shown in **Fig. 5(c).** As the man-machine interface and "intelligence" become more advanced, the social distribution of "C & C" use will continue to change. We can trace a movement away from the era when only experts could enjoy the benefits of "C & C" to an era in which it will serve broader groups — business, corporations and society as a whole — and, beyond that, to an era in which "C & C" will work for the benefit and convenience of individuals.

Computers were initially used jointly by universities, research institutes and large organizations. Then individual laboratories and divisions within these organizations gradually came to have their own minicomputers. Now we are seeing personal computers being used by private individuals. Microcomputers have come to be used as a core element in a variety of home electronics devices, starting with air conditioning and heating equipment.

C & C Space With Man As An Axis

The course of "C & C" and LSI development has already been expressed on a plane diagram using X and Y axes. As can now be seen however, we can take the improvement of the intelligence content and the man-machine interface (ie the degree to which the technology approximates human faculties) as a component of the human factor on the Z axis. Thus the course of these developments can be expressed with a three-dimensional spatial diagram, as in Fig. 6. By projecting "M and C & C" directly on to the X-Y plane along the Z axis, the same plane diagram as in Fig. 1 can be obtained, ie the "C & C/LSI" plane.

CONTRIBUTING TO SOCIETY IS THE ESSENTIAL GOAL OF "C & C"

Fig. 6 reflects an important fact about "M and C & C". Its aim is not merely to advance the "C & C" technology, but to contribute to social development by refining and applying systems to meet the individual user's needs, through the user of increasingly advanced "C & C" technology and products.

The ultimate aim of "M and C & C" is to create a society in which humans and "C & C" coexist — an "M and C & C" society — as represented by the cylinder on the right in Fig. 6. This s the great challenge awaiting us in the latter half of the 1980s and beyond.

In meeting this challenge, we must give special consideration to many components of the human factor, including the improvement of the man-machine interface and intelligence content, popularization, and cost reduction. Ultimately, by making "C & C" resemble our own faculties more closely, we enhance its contribution to our own lives.

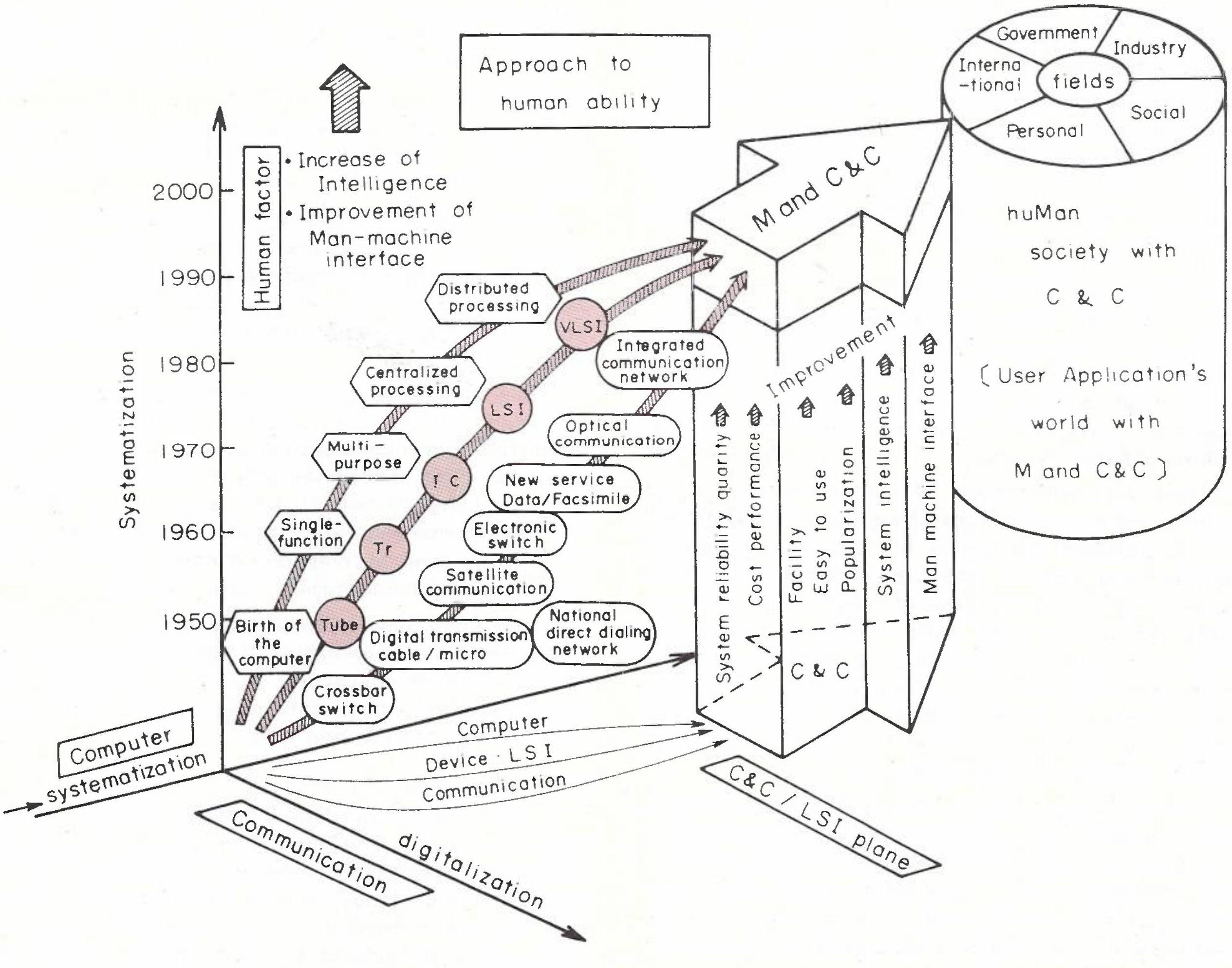

Fig. 6 — Development of M and C & C.

The design of "C & C" systems in the 1980s and beyond must satisfy these basic needs, while also giving adequate consideration to their cost efficiency and quality as systems. The importance of the role played by software and its increasing volumetric expansion has already been pointed out. Software production methods, quality improvement policies and many other aspects of "C & C" need further study.

Creating an "M and C & C" Society

The goal of "M and C & C" is to benefit society by supplying technology and products that will serve to bring into being, from the 1980s onward, a new world of "C & C" uses and applications.

To achieve this goal, we need to give some thought to the future environment for the use of "C & C". This can be summed up as follows.

More Diversified, Broader Fields of Application

As "C & C" products and systems gradually extend to all areas of society, they will be used in a wide variety of forms. Office automation, for example, will come about through the combination of office machines and computers. In 1980, some 65,000 computers were in use in Japan, a figure that is expected to exceed 120,000 by 1985. Personal computers are also spreading rapidly; there will be 2-3 million units in use by 1985.

In these circumstances, it will become very important to study the fields of application themselves, ie, the ways in which "C & C" can be used. It will also be important to standardize methods in different industries and businesses. Such measures will also help increase the efficiency of software development and production.

Moreover, as the number and range of users increase, there will be a drive to make "C & C" systems themselves easier to use. This need will have to be met by further improvements in the man-machine interface and the intelligence of the systems.

Progress in Systems for Public and Personal Use

In the past, efforts to increase the utilization of computers and communications have tended to concentrate on huge systems such as those for government, society and companies. In the future, however, there will be more and more emphasis on individual-based systems.

There are two spheres of human life: the purely private, and the public. Today there is a growing interest in the potential application of computers to leisure activities and study by individuals in their purely private capacity — not as members of a company, society or state. But on the other hand, no one in this rapidly changing world can remain entirely aloof from what is happening in society at large. Thus computers are finding applications as "home utilities" for information and knowledge in the home, and for pooling knowledge among different members of society.

Then what about people within organizations? There is now a growing awareness that human beings should be freed to do the work most suited to human capabilities — that is, creative work. Thus most of the office work involving the preparation of documents or the transmission of information should be left to computers.

To make this possible, there is an urgent need to develop simpler, cheaper word processors and terminals and provide trouble-free computer and communications equipment featuring high quality and reliability and low maintenance requirements.

Greater Quantity and Diversification of Data and Information

The trends just discussed inevitably give rise to a major problem: how to cope with the growing volume and diversity of data and information.

As information processing resources expand, we will need better hardware — including memory devices and input/output devices — with larger capacity and higher processing speed. At the same time, the changing nature of the data being processed has resulted in a new demand for smaller-sized memory devices and other components.

As companies expand, their organizations become decentralized. This trend has accelerated the development of distributed processing systems which collect and process data where it is to be used, instead of concentrating all information in a single place.

In the future, mutual development of local intelligence — provided by a personal computer — and host computers will be an important factor in computer operation.

Increasing Costs of Social Resources

Since the 1973 oil crisis, the future problems such as food and energy shortages and the population explosion — have taken on extreme urgency and seriousness. Our resource-depleted, polluted planet faces numerous problems which must be solved over the next few decades with both a national and an international perspective.

Here too, "C & C" is expected to play an effective role in speeding up the flow of information and assisting accurate decision-making.

Already the use of computers has achieved many results in terms of higher productivity and rationalization, and is thus helping to counteract spiralling labor costs and the effects of the energy shortage. No doubt computers will continue to be used in the modernization of industry in future.

While the developing countries are facing a population explosion, industrialized countries are experiencing a rapid shift of their population structures toward the older age group. This shift brings with it serious problems in welfare and health care. Thus there is a strong demand for the development and introduction of information systems and hospital computer systems to assist medical research and promote fuller medical services.

Furthermore, new types of educational systems and "refresher" systems for individual skills will be needed for use in "lifetime education," that is, to facilitate the absorption of new knowledge and encourage constructive use of leisure time.

Components of an "M with C & C" Society

It can be seen from **Fig. 7** that an "M with C & C" society (a society in which human beings and "C & C" co-exist) consists of an environment, the fields of "C & C" application and various "M with C & C" system groups. The fields of application may be divided into personal, social, industrial, national, and international. These fields interact with such factors as politics, economy, industry,

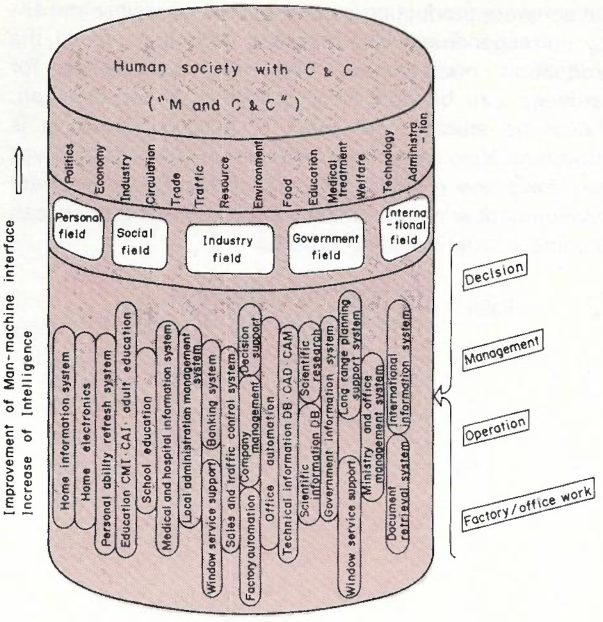

Fig. 7 — M with C & C Society.

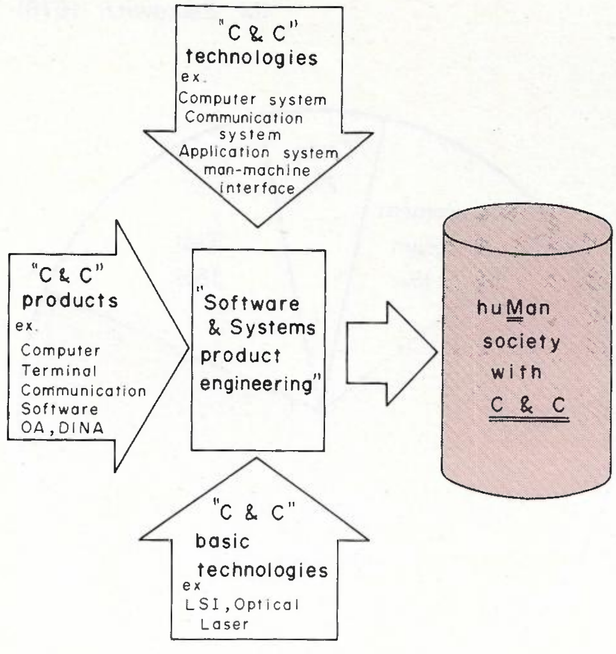

Fig. 8 — Realization of Human Society With C & C.

distribution, trade, transportation, natural resources, environmental pollution, food, education, medical treatment, welfare, technology, administration, and international relations to create the overall environment.

"M and C & C" technology creates multi-faceted, diverse and easy-to-use systems which support all fields of human activity and enable humans to lead high quality lives. "M and C & C" system groups are set up at each level of human work, be it decision-making, management, operation, or factory or office work. The set of systems depicted in Fig. 7 is only a fraction of the total; it is clear that even more systems and products will be presented for development in the future.

Construction of an "M with C & C" Society

Consider now the process of formation of the user systems which constitute an "M with C & C" society such as that shown in **Fig. 8.** The basic components of "C & C" era systems include: computer systems; terminals; communication systems; office automation system products; network architecture products; and application programs satisfying the user requirements. These components are called "C & C" products.

We also need to have the technologies for constructing a variety of easy-to-use and efficient "C & C" products possessing high-level artificial intelligence and man-machine interfaces. These technologies are called "C & C" technologies.

LSIs, VLSIs, and optical fiber communications are the fundamental driving forces behind the rapid development of "C & C"products and technologies. These technologies may be considered to be "C & C" basic technologies.

Both software and system product engineering play central roles that combine these "C & C" products, technologies and basic technologies into a total technology for constructing systems which meet the real demands of man and society. They relate to the whole system life cycle, ranging from the analysis of system requirements to its development, manufacture and maintenance. Considerable R & D is also required for the development of systems, particularly those where human factors are concerned, for the 1980's and beyond.

IMPORTANCE OF SOFTWARE IN "M and C & C"

There can be no "M and C & C" society without overcoming the problems of software.

Improving Software Quality and Productivity

Software is coming to play an increasingly important role in the creation of a "C & C" society. The tremendous increase in the application of microcomputers is causing a rapid expansion of the software sector and its work force, not only in the field of computer application for information processing but in virtually every industry.

If software development and maintenance technology remain at more or less their present level, within a few years software development will be completely unable to keep pace with demand. At that point, it is predicted, the 'software crisis' that has been felt in some areas for several years will spread throughout the industrial sector.

It is therefore vital to establish modern and practical technology for the production, management and quality control of software.

Standardization of software and its production and distribution in modules or packages will also greatly improve productivity and quality.

As can be seen in **Fig. 9,** between 60 and 70 percent of the processes in the lifetime of software are thought to be involved in updating and maintenance. Maintenance needs to be regarded more positively in the future, and improving the productivity and quality of maintenance will be important tasks.

Software production can at present be characterized as basically a manual industry. Software is a product of mental effort, which is why until now each software production process has had a distinct manual flavour. This has also been a primary contributing factor to the incorporation of software bugs. Moreover, it is known that software productivity and quality levels vary widely

(M. Zelkowitz, 1978)

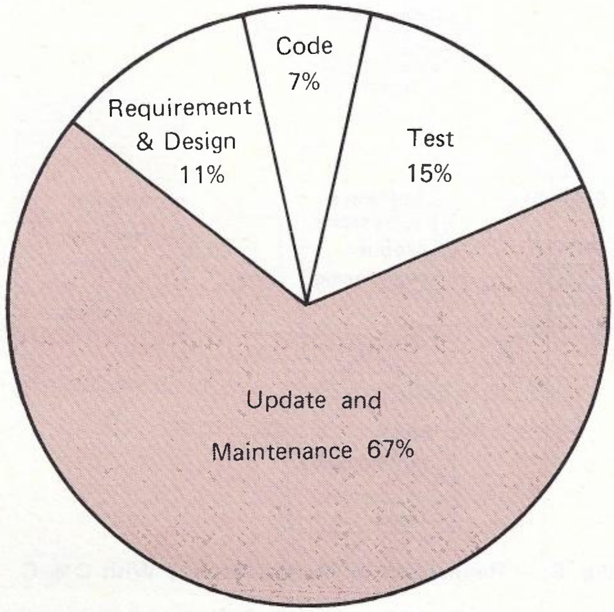

Fig. 9 — Software Life-cycle Cost Breakdown.

according to the individual developer. (The quality of individual programmers is said to vary by as much as 1:25 to 1:30. Experiments at NEC indicate that a well-organized women's team has twice the productivity of a poorly-organized men's team).

For these reasons, it is necessary to develop and educate software engineers in the use of effective design, production and testing methodologies in conjunction with operation standardization, provision tools to aid development and maintenance, and modernization of the working environment. Our human engineering knowledge will need to be brought to bear on these areas.

The physical working environment also has an important bearing on software. It will be important to make comprehensive improvements in this area to create an environment suitable for software work. This entails attention to such details as the size and shape of desks, the area and structure of the room, the siting of files and terminals, and the size and location of conference, programming and computer rooms.

In addition to software work by individuals, teamwork is also important. It will therefore be important to study the make-up of development teams.

New Ideas Needed By Software Workers Themselves

NEC is already moving to modernize its software production by introducing a large number of terminals in its software plants to enhance the designing, programming and testing phases by utilizing interactive systems. Software labour cost increases at around eight percent or more annually while hardware cost goes down (**Fig. 10**). Software productivity might be improved through greater utilization of terminals. We refer to this as the "arming" of our software plants, since we are introducing the "weapons" of computer technology. We have built up a substantial history and experience and a number of methodological tools in hardware production; but software production processes are less visible and enjoy correspondingly less progress. Although not all the production management tools and approaches for hardware can be applied to software, those that can, should be studied and used. A positive approach is important. New ideas from software workers themselves may have the greatest effect in modernizing software development and maintenance work so that software can become a true industrial product.

$$\text{Ratio} = \frac{\text{Terminal Installation Cost}}{\text{Software Labour Cost (per head)}}$$

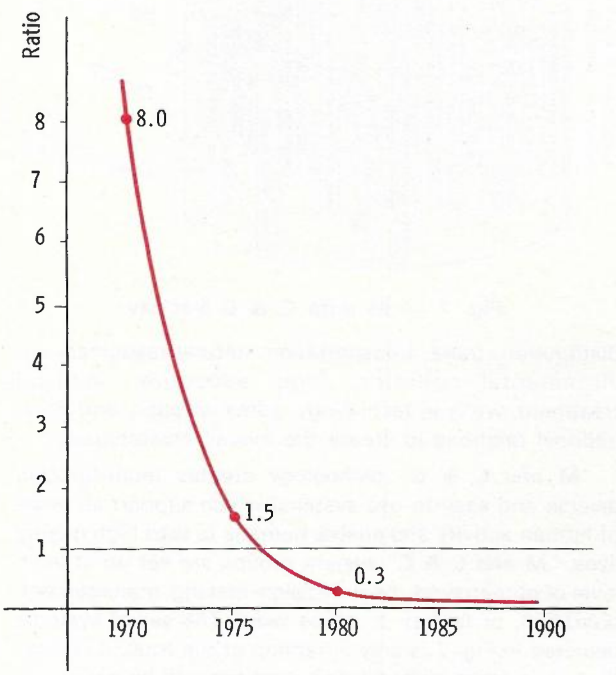

Fig. 10 — Trend of Terminal Cost.

The Importance Of Recognizing Software As An Industrial Product With Commercial Value.

The foregoing has postulated that human factors will increase in the "M and C & C" society as years go by. This indicates the importance of software as a medium between human beings and computers. In fact, software is accounting for a rapidly increasing proportion of systems.

We must consider two aspects of software. One is the rationalization of software production and the measures, premised on this, taken to ensure that there are enough personnel skilled in software work. The other aspect is the need to recognize software as an industrial product and to put an economic value on it as a matter of course. This latter aspect has been widely taken up by computer manufacturers, but users in Japan have so far shown little understanding of software's proper economic value. There has thus been little progress in this regard.

The proper economic evaluation of software is not a problem only of computer manufacturers. Users need to see it as their own problem, too, especially in view of the trend toward increasing the number of personnel employed in their software work.

At present about 250,000 people are engaged in software work in Japan. This figure is predicted to increase to 650,000 in five years' time. These people will not be working only for computer makers, the majority will be employed by users — government offices, public bodies, universities, research institutes, and industry. Attaching economic value to software will lead to proper recognition of the worth of their work.

Higher Software Production Efficiency And Climbing Mt Fuji

As depicted in **Fig. 11**, the production of software may be likened to climbing Mt Fuji's beautiful volcanic cone. Mountaineering, by definition, means relying on one's legs. No one needs to have a mountaineer's legs to reach the fifth station, which is halfway up the mountain, since the slope is gentle and easy to climb. We can even get there by car. The real ascent of Mt Fuji starts when we set out on the steep slope stretching from the fifth station to the summit. Here, we have to rely entirely on the strength of our own legs, and the going gets very hard.

The ratio of cubic volume of mountain above and below the fifth station might be about 1:10. This applies to software, too. Software corresponding to the part of Mt Fuji below the fifth station is overwhelmingly greater than that above and the ordinary methods of quality and production control that have so far been exercised over hardware, can be applied to this level of software as well. For the 'final ascent' however, greater efforts should be made to develop a rational form of software production that does not rely entirely on individual ability. Software standardization would make it possible to have full-scale packaging and modularization for joint use. Computer-aided design (CAD) and computer-aided manufacturing (CAM) will be used in the future wherever possible, just as in other industries.

At any rate, software must acquire citizenship as a complete industrial product. When this is realized, it will heighten greatly the morale of software workers. Accordingly, both manufacturers and users must recognize the economic value of software and endeavour to make it a reality in practice. Manufacturers and users alike should make redoubled efforts to lower software costs.

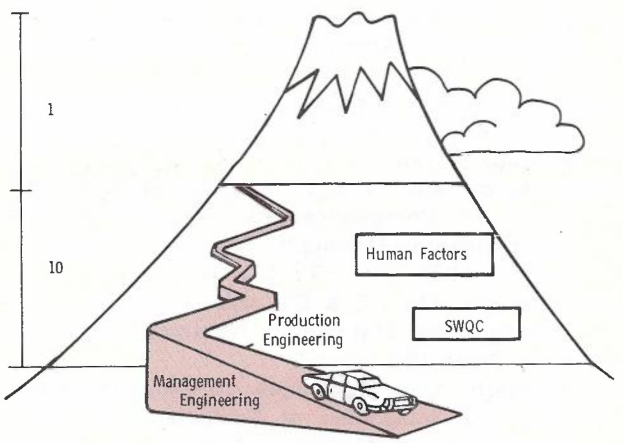

Fig. 11 — Software Production and Climbing Mt Fuji.

FROM HARDWARE QUALITY CONTROL TO SOFTWARE QUALITY CONTROL

Quality Control (QC) Since the War

Shortly after the end of World War II, when the biggest task confronting those responsible for the reconstruction of Japan, was getting the communications network back in order, the quality of products from the NEC factories was judged by American experts to be unsatisfactory.

Before the war, relatively unsophisticated methods of QC, based on the application of statistical theory for economic production, were employed.

It was often said in those days however, that Japan's products used to have a reputation for being cheap and shoddy. More recently, Japanese products are earning a name for being cheap and good and this outstanding change has been brought about by the development of modern QC techniques. As stated, Japanese quality control was based on Dr Schewhart's statistical approach but with the addition in recent years of some new concepts: namely, feedback and small group activities.

Small Group Activities Take Root

Returning to the immediate postwar period, NEC was faced with the problem of how to expand and reinforce quality control so that it was enforced throughout the company; it was felt that a QC program would have no effect unless this was done. We wanted both production line and staff to use quality control, and we were thinking in terms of small group activities. However, because everything was on too theoretical a plane, everyone steered well clear of the program and it was almost impossible to get QC implemented on a company-wide basis.

In 1952 Dr W E Deming, an American QC expert, visited Japan, and his advice was sought. Essentially, his reply came down to the need to "plot the quality of a product on a piece of paper and make sure there's not too much variation. That is, the first thing to do is record variations in product quality on paper."

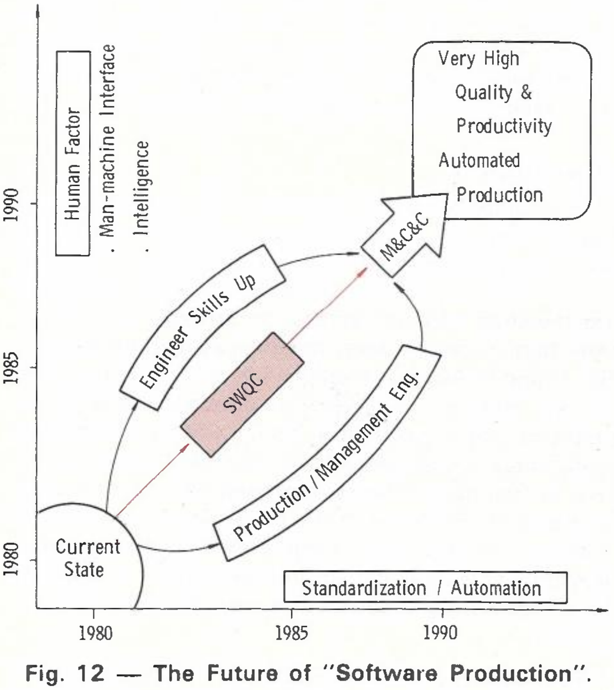

Fig. 12 — The Future of "Software Production".

The next step was made by the establishment of small QC circles. However, efforts to achieve a major advance in these small group activities met with stiff resistance due to prejudices against QC until the zero defect (ZD) movement got underway. The ZD movement was relatively well received within NEC and has since spread nationwide through the Japan Management Association. The Association holds an annual meeting which is attended by several thousand people. Altogether some 7-8 million people are said to be involved in ZD movements, which have been going now for some 16 or 17 years. This appears to indicate that small group activities are now fully established.

Quality control of hardware has thus been tremendously successful; but the time has now come for quality control of software.

Software Quality Control (SWQC)

As stated, the improvement of software quality will be the most important task of the 1980s, (see **Fig. 12**) and NEC is actively engaged in software quality control. The easiest area to understand and in which to implement is in the reduction of bugs. It is a question of how to turn out bug-free software. Nothing is gained by spending money making bugs and spending more money taking them out again.

Many activities are involved in the overall life cycle of software: those of systems engineers and designers, who find out users' needs and perform specification requirement analysis to achieve optimum systems; those of programmers; evaluation tests; and the various software-related activities involved in application. All these are subject to our efforts to improve quality control.

Our first goal is to obtain the active involvement and participation of the people working with software. Groups of between 4 and 10 people are organized depending on the work load. These groups aim not merely to seek out the immediate causes of bugs, but to trace them back to their true roots, which we then try to eliminate. The groups also seek to make suggestions for improvements — often covering aspects of the environment. We are looking forward to a quantum jump in software quality, and ultimately a great increase in software productivity, as a result of these quality control activities.

CONCLUSION

The author has long maintained that computers and communications will be integrated as one system in step with technological advances towards the end of this century in order to meet the needs of mankind. This paper has therefore tried to express the process of computer and communications development in a plane, as shown in Fig. 1, and to forecast the direction of this development and the problems involved. This development is not as simple as may be thought; in fact, it will be considerably complicated by the human factor involved. This is why a Z axis, for the human factor, has been added to the two-dimensional expression of the development, through the X-axis for communications and the Y-axis for computers, thus creating a three-dimensional expression. In this way the essence of the problems has been demonstrated and clarified.

In the years ahead the author will continue to work toward building a new society for the new era beyond the 1980s — a society where all can realize a wide range of human activities, both as individuals and as members of organizations, nations, and the world. The author will base his efforts on the concept of "M and C & C" as outlined above, as it is believed that this will lead to the greater happiness and prosperity of mankind.

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Sydney Stock Exchange Annunciator Lights

D. A. B. SANGSTER, BSc. (Eng.), MIE (Aust.)

The Sydney Stock Exchange required annunciator lights for a new trading floor. Suitable equipment was not available commercially and Telecom custom designed and provided the facility described in this article.

BACKGROUND

Stock Exchange brokers carry on their trading by calling from the floor, while facing the chalkboard on which the prices are marked. Behind the brokers are rows of benches at which their telephones are located. It is not appropriate to have telephone bells ringing in the trading area, and, in any case, the noise of trading would often overcome any audible signals. To indicate incoming calls on the telephones, an illuminated display is mounted above the chalkboard **(Fig. 1.)**. The broker returns to his bench to answer his telephone. This is the system supplied to the trading floor in the new Sydney Stock Exchange building.

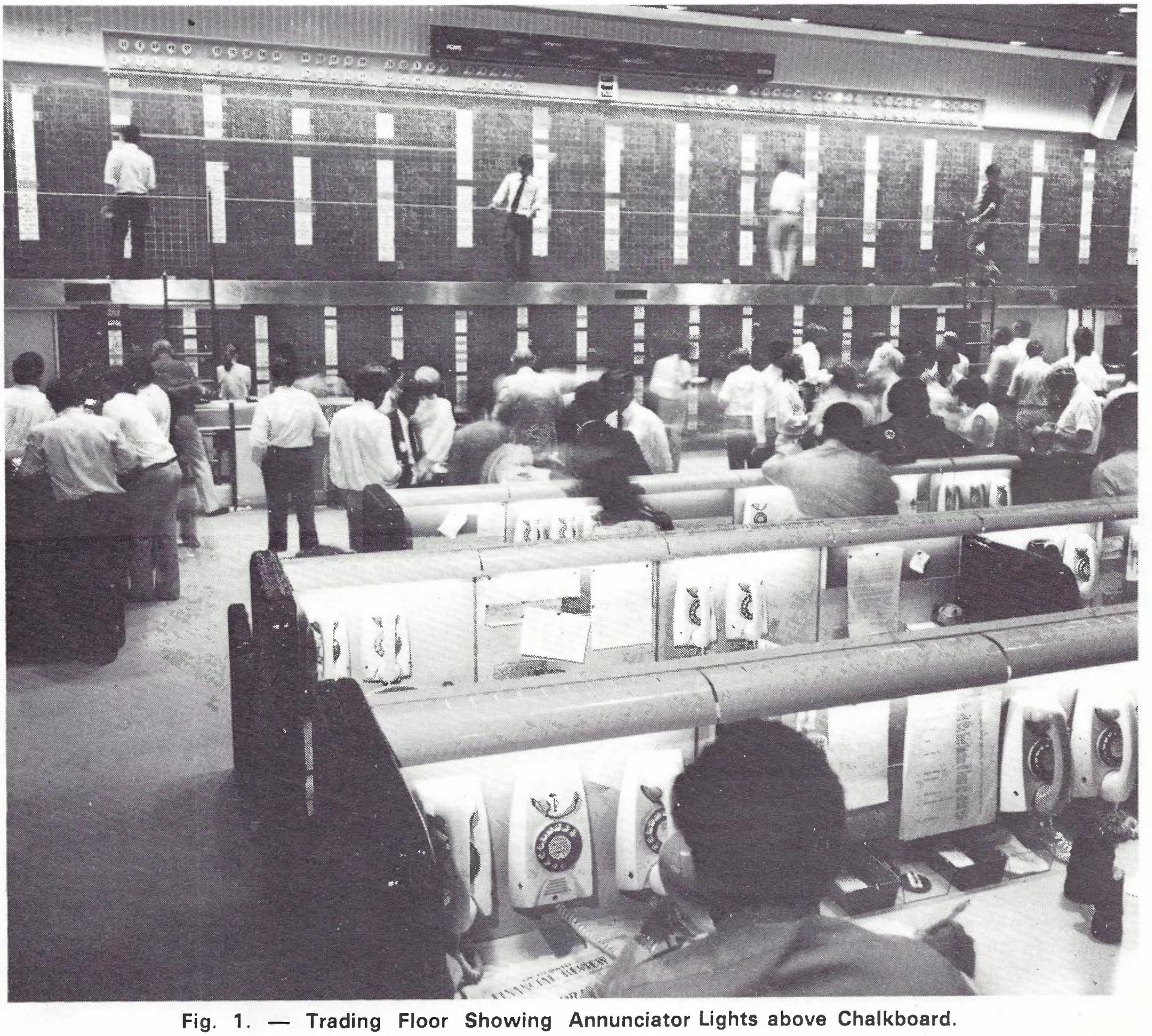

Fig. 1. — Trading Floor Showing Annunciator Lights above Chalkboard.

NEEDS

Before proceeding with the design of the annunciator lights system, the designers determined the needs of the various interested groups including Sydney Stock Exchange brokers, construction architects and engineers, and in Telecom, the requirements of the installation and maintenance groups, were established.

DESIGN FEATURES

The essential design parameters were:

- annunciator lamp display/ring detect facilities;
- ability to terminate a range of terminal equipment on the brokers benches, eg telephones, intercom telephones, PABX extensions;
- reasonable cost;
- high reliability components (the old system used relays, with consequent maintenance problems). Preferably no relays or contacts;
- all control equipment to be housed away from the trading floor to facilitate maintenance at any time. Access to the trading floor is not possible during trading;
- use of standard Telecom parts to ensure availability of spares;
- equipment to be modular with common modules to minimise the variety of replacement units, eg common printed board assembly (PBA) for all terminal equipment;
- ability to simply detect burnt-out annunciator lamps by routine inspection of the lamps;
- easy to install and maintain.

A search was made to see if any existing equipment or design would meet the requirements, but none was available. Telecom therefore proceeded to develop the equipment described below.

DESCRIPTION

The proposal was for Telecom to supply, install and maintain a facility to give visual indication for incoming telephone calls to the trading floor. The visual indication consists of a maximum of 100 X 15W/50V incandescent lamps (telephone exchange alarm lamps), mounted in a customer-supplied and Telecom-approved pelmet above the chalkboard. At each telephone there is a signal indication given by light emitting diodes (LEDs), one mounted on each side of every telephone. The installation permits a maximum of 300 telephones, the Wallfone being the instrument used. These critical operating choices were made by the customers, following a demonstration of alternatives by Telecom.

OPERATION

For one or more incoming calls to a broker, the individual broker's lamp above the chalkboard will glow brightly, and also the LEDs on the called telephone(s) will light. The broker's lamp above the chalkboard will remain bright until the handsets are lifted on all the telephones being called.

At all other times each lamp will glow faintly, thus enabling identification of blown lamps, and also avoiding cold switch-on to give longer lamp life. The LEDs on a telephone are extinguished when the handset is lifted. For lines, such as from a PMBX, which give only a single burst of incoming ring, the line circuit can be strapped to "lock-up" the annunciator; for exchange lines, the line circuit will generate the annunciator signals only while the incoming ring persists.

EQUIPMENT

The PBA equipment rack and the jumpering frames are located in a small equipment room behind the trading floor, close to the incandescent lamp display. Due to space limitations, the 35A/50V rectifier to power the system is located in the PABX room some distance away, and connected to, the annunciator equipment room by a heavy power cable to minimise voltage drop.

The trading floor telephones are modified Wallfones; the bell is disabled, four wires are connected to the telephone, two for speech and two for control of the LEDs.

As requested by the customer, no back up batteries were supplied for the rectifier, as it was felt that if power goes off the stock exchange then the trading floor would be unusable, and there would be no point in having telephone service.

Ten pair cables connect each broker's booth on the trading floor to the equipment room cross-connecting frame which consists of eight 200 pair verticals. Thus, all jumpering is away from the trading floor. **(Fig. 2.).**

Line Circuit Boards

Each telephone requires a line circuit board to detect incoming ring and to control the annunciator lamps. The

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He worked in the NSW Radio Section on system design and installation, then on exchange maintenance in the Bankstown area. In 1970 he joined Sydney City Operations and worked initially with external plant, followed by involvement with subscribers equipment and PABX maintenance.

During 1979 he moved to the Customer Voice Equipment Section to work with PABX maintenance and customer special designs. In September 1981 he joined consulting engineers Addicoat Hogarth Wilson Pty. Ltd. as a telecommunications engineer.

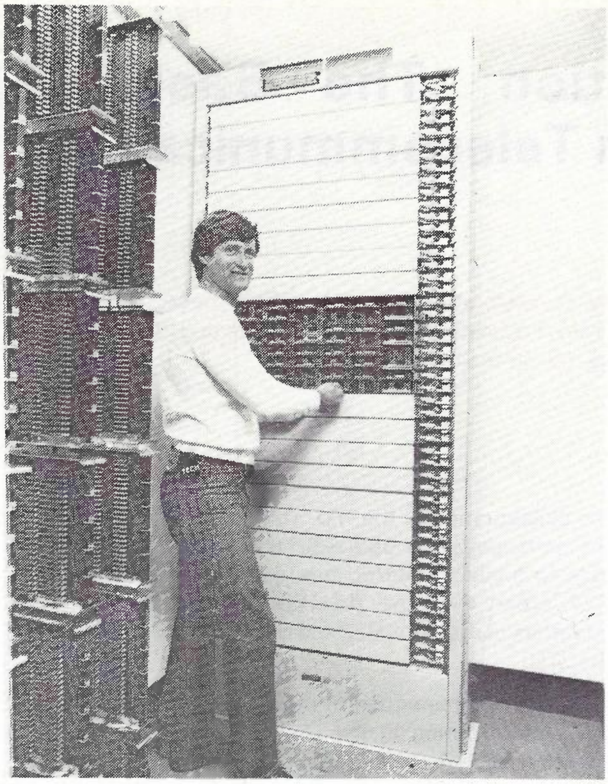


Fig. 2. — Rack and Jumpering Frame.

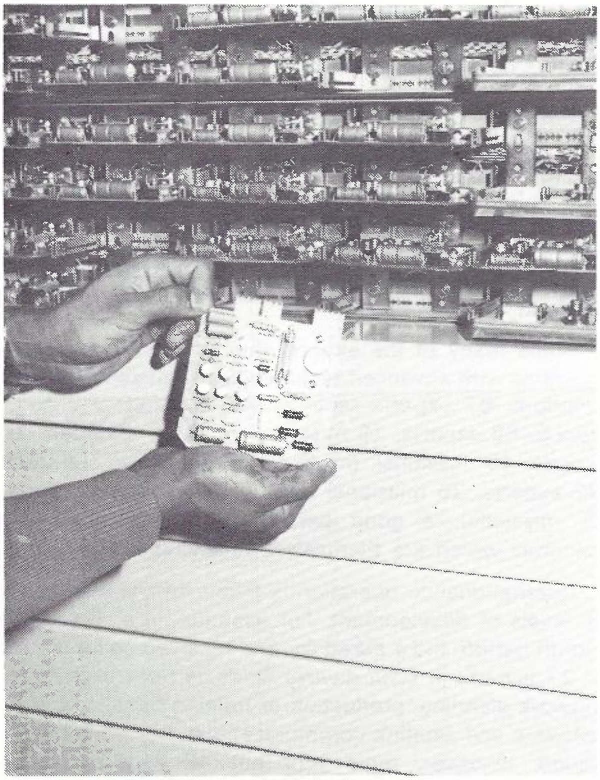


Fig. 3. — Line Circuit Boards and Equipment Rack.

equipment rack in the equipment room can accommodate 312 line circuit boards, with each of 24 shelves having capacity for 13 boards. (**Fig. 3.**).

A switch is provided on each board to cater for the possible variations in ring voltage feed. One position caters for ring voltage between the two wires of a telephone line; the other position caters for ring voltage between earth and either (or both) of the two wires of a telephone line. A strapping option is available on each board for the continuous ring voltage, as from a normal exchange line, or for a line presenting one burst of ring voltage, as from a manual switchboard.

Each ring detector line circuit board is fused individually to enable continuous service to be maintained to other telephone circuits, in the event of an annunciator lamp failing in a short circuit mode. In such circumstances the individual fuse would operate, preventing failure of the common battery supply to a group of lamps if a common fuse link were provided, say, to a shelf of 13 boards.

More than one telephone line may be connected to one annunciator lamp, but each line must have its own ring detector circuit board. Thus, one broker could have five telephones all signalling on a single annunciator lamp above the chalkboard.

Multivibrator Circuit

One multivibrator is provided on each shelf of the rack (1 per 13 ring detect boards).

The stable multivibrator drives the line circuit board light switch which can be adjusted to provide a variable period for which the lamp is "on" and "off". This adjustment enables the brightness of the lamp during the idle period to be set to meet the customer's requirements. At the Sydney Stock Exchange the idle brightness was set so that the lamps were not visible during normal use of the room but were visible, for routine inspection, when most of the lighting in the room was extinguished.

Thus, each lamp is driven by the multivibrator continuously and glows dimly, even when there is no incoming signal. This is a design feature of the system, with two objectives:

(i) to avoid cold start conditions, giving longer lamp life and reliability; and

(ii) to permit immediate detection of lamp failure, by means of daily routine inspections. A lamp failure, preventing receipt of incoming calls, could have vital consequences for a broker.

All 24 multivibrator boards (ie 24 shelfs/rack) run independently and are not synchronised. Thus the total current drawn from the power supply is not a large peak for a short duration, but is randomly and evenly distributed as a continuous small current.

All telephones for the same broker, ie all lines sharing the same lamp, must be on the same rack shelf, so that the idle lamp brightness is only driven by one multivibrator. Otherwise it would be necessary to synchronise several multivibrators. This requirement has not proved to be a limitation to the system.

CONCLUSION

This novel development, preceded by a careful analysis of the customer's requirements, has provided a very worthwhile result in terms of customer satisfaction, customer goodwill, and Telecom staff satisfaction.

International Co-operation: The Basis of Technical Co-operation in Telecommunications

On 17 May, World Telecommunication Day is celebrated each year throughout the world by administrations of countries who are members of the International Telecommunication Union (ITU). This paper, prepared by the ITU, is published to mark the event in Australia.

The spirit and practice of international co-operation is at the very heart of technical co-operation in the field of telecommunications.

When the technical development of the electric telegraph occurred in the mid-1800's, countries had to co-operate in order to use this new "miracle" for sending messages. They had to agree on certain standards for the sending and receiving devices in order for them to "talk to each other". They had to agree on the technical means of sending the messages, and they had to agree on how to charge for messages sent.

This need for a forum in which to reach such agreements led governments to create the organization that is called the International Telecommunication Union in 1865. As developments in telecommunications advanced more and more rapidly — telephone, radio, television, sensing and broadcasting satellites, human space flight, digital switching, integrated networks, etc. — the role of ITU became increasingly important. Within the organs of ITU, study groups and commissions of government representatives and other experts work out the common agreements and "ground rules" to harmonize the increasingly sophisticated technologies of telecommunications and assure non-interference among the many types of transmissions.

This established and successful system of international co-operation is also the basis for technical co-operation and development in telecommunications. Advanced technologies and equipment are very unevenly distributed around the world. For example, there are an estimated 550 million telephones on the globe. Yet 75% of these are in eight developed countries only.

To bring the social, cultural and economic benefits of modern telecommunications to the world's peoples on a more equitable basis, is an important part of the ITU's work today. To have adequate and reliable local and national telecommunication networks, to evolve the regional — and eventually world — networks needed for social and economic development at all levels, is the goal of the intensive internationally co-operative efforts of the ITU.

EXPERTISE: a two-way flow

Expert knowledge and guidance is a key ingredient in realistic planning and eventual installation or upgrading and operation of modern telecommunication systems. In recognition thereof, ITU Member Administrations solicit the collaboration of the ITU. Thus in 1981, the ITU, with the participation of 582 experts from 64 countries, was able to organize and/or arrange for the continuation of 727 expert missions. (In 1980, 525 experts from 55 countries carried out 630 missions under the auspices of the ITU).

While the greater part of these missions formed part of ITU's participation in the United Nations Development Programme (UNDP), a certain percentage of the co-operation activities were financed from other sources (governments, banks, regional organizations) under a trust funds arrangement. Furthermore, on the basis of agreements concluded with the governments of the Federal Republic of Germany, Denmark, the Netherlands and Sweden, a number of ITU training projects benefited from the services of associate experts provided to these projects on a cost-free basis by the donor governments.

On receipt of a request from a government for expertise, the ITU approaches the telecommunication administrations of other Member countries likely to be able to provide the required specialist candidates either from within their own Administrations or from technical universities and other educational institutions or telecommunications equipment and systems manufacturers in their country.

While many of the experts thus secured come from countries with advanced technologies such as the United Kingdom (87 experts sent on 108 missions in 1981), France (66 experts, 79 missions in 1981), Sweden (39 experts, 48 missions), the Federal Republic of Germany (32 experts, 35 missions) and Switzerland (30 experts, 32 missions), a good percentage are proposed by countries which are themselves receiving expertise.

International co-operation is thus a two-way street at all levels of development. For example, in a recent 12-month period, India asked for and received collaboration of 27 experts in such diverse fields as telex exchanges, network planning, production of training films, computer software and satellite communications. During the same period, however, India sent out 48 experts on 55 missions to other countries to provide expertise on, for example, telecommunication accounting in Egypt, telephone switching instruction in Nigeria, television techniques in Trinidad and Tobago and radio frequency management in Thailand.

In the same 12 months, Egypt received 9 experts in such fields as educational technology, sound broadcasting transmitters and telecommunication feasibility studies, while itself providing 15 missions to other countries to share expertise in telecommunication power plants, radio broadcasting. Even though countries need their own experts to plan, install, operate and maintain their own developing telecommunication systems, the spirit of co-operation pervades worldwide. Countries receive the expert co-operation they need and willingly share their own expertise with others who need it. Typically, in a recent year, Argentina received visits from five experts and sent three of their own to other countries. Ethiopia received one and sent out three. Malaysia received three and sent out one. Turkey received four and sent out two and so on around the globe.

The ITU programme of arranging for expert missions in response to governmental requests provides an interesting index of the development of telecommunication systems around the world. In early stages, experts are needed for long periods of time, often several years, to provide guidance and advice on the many aspects of network development. As systems become more complete and more up-to-date, expertise is required for shorter periods on more specific problems. In 1973, for example, of the 129 new expert missions begun, only 20.8% of them were "short-term" (under 11 months). All the rest were for a longer term. By 1976, of the 179 new missions begun, the short-term missions had increased to 61%. In 1981, although the number of new missions initiated had grown to 426, 80% of them were short-term.

The ITU, by bringing an individual's specialized knowledge into a situation where it is required, not only collaborates in resolving specific problems but, more important, provides the occasion for imparting to national cadres and counterpart staff the specialized knowledge and modern techniques through both formal and on-the-job training.

FELLOWSHIPS: an educational strategy

Another educational strategy for the transfer of technology is the ITU's "fellowships", also managed by the Technical Co-operation Department. Operating very flexibly, it is designed to improve the specialized knowledge of the "fellow" using a variety of possible learning situations. The study grants administered by the ITU, mostly funded in conjunction with UNDP projects, cover all travel, daily living costs, any fees for courses and materials and, in some cases, language instruction.

The implementation of each individual or group fellowship must be customized to meet the needs of the requesting administration. Many factors must be considered in each case. A suitable host country must be found, ie an administration, factory or learning institution able and willing to provide the needed training. The time for the training must be convenient for both the trainer and the trainee. There may also be educational prerequisties and language requirements. One key to the smooth implementation of 650 to 700 fellowships per year (727 in 1981) is the very close, personal relationship between the ITU staff that makes the arrangements, and those responsible in the host country.

Some fellowship situations are relatively simple such as the short-term ones. When a one or two-week specialized seminar or other educational event takes place, often for a multi-country area, the award of fellowships can enable engineers from less developed countries to participate and benefit from the lectures given by experts, in some cases the world's best specialist in one or another field. For example, fellowships enabled 20 engineers from Ethiopia, Malta, Mauritania, Morocco, the Palestinian Liberation Organization, Syria, Tunisia, Turkey, the Yemen Arab Republic and the People's Democratic Republic of Yemen to participate in a two-week seminar on "Electronic Switching" in Amman, Jordan. This was an important event within the framework of the growing Middle East and Mediterranean Telecommunication Network, MEDARABTEL. Many such events are held each year with fellowship grants enabling the maximum benefit to be derived from each learning opportunity.

Some fellowships are used to make it possible for an engineer to follow a more extended specialized course at a technical university. At present, these include an Algerian following a two-year course in telecommunication engineering in Switzerland and four Lesothans taking a three-year course in electrical engineering in the United Kingdom.

Most of the study grants are to individuals who study special topics in a single country. For example, in a recent 12-month period, there were 17 fellowships awarded to Tunisians. Their countries of study included the Federal Republic of Germany (telegraphy), Belgium (TV-radio broadcasting), Turkey (teletraffic engineering), Sweden (power plants) and France (telegraph switching).

Frequently the ITU arranges for a group to travel and study their special subject in one country. Four Albanians studied TV techniques in France together for 5½ weeks. Five engineers from the People's Republic of China learned more about data communications in Canada on a six-week group trip. The United States hosted seven Greek engineers for three months to study electronic switching.

The study requirements often call for more complex arrangements to visit appropriate facilities in more than one country. A Burmese engineer studied satellite earth stations in the United Kingdom and Singapore for six months. Fellowship grants enabled two telecommunication officials from the Yemen Arab Republic to learn more about the management of training in Sweden, ITU headquarters in Switzerland, Jordan and Syria for nine weeks. A Kuwaiti learned techniques for developing telecommunication training courses in Switzerland, India, Singapore and Malaysia on a two-month programme. A Singapore trainer sharpened his skills in broadcasting training for two months in the United States, Canada, the United Kingdom, the Netherlands and Australia.

In the implementation of fellowships, too, countries co-operate increasingly to exchange their technical knowledge. Indonesia has linked its vast nation of nearly 5,000 km of islands by satellite. In the recent past they hosted 15 fellows from Malaysia, the Philippines, Singapore and Thailand to share their knowledge in satellite communications. During the same period, UNDP/ITU grants enabled four Indonesians to study the same subject in France, Sweden, Canada and the United States and improve their own capabilities in this modern branch of telecommunication technology.

As might be expected, countries who are more advanced are the ones called upon most often to host fellows. France, the United Kingdom, Singapore, the United States, Sweden, the Federal Republic of Germany, Canada, Italy, India and Japan are the most frequent hosts, but a total of 43 countries, many of them generally considered to be "developing", hosted fellows for study visits last year (outside of seminars). The spirit of international co-operation helps all countries to share and spread their knowledge and mutually increase their communications capabilities and take the best advantage of the opportunities it brings for the social and economic benefit of the people.

TRAINING: multiplying the skills

It takes a great number of people with a wide variety of skills at many levels to put telecommunication equipment into place and to make it function productively.

It is fellow human beings that must learn enough to design and produce practical equipment, to install it properly, to operate it efficiently, to maintain it (often under difficult conditions), and to manage the overall operation.

Experts share their knowledge when they go on professional missions. Fellowship recipients go abroad to gain needed skills not available locally. All this makes a significant contribution to meeting the world's expanding needs for telecommunication services.

But it is not enough. Countries need eventually to have the resources readily available to meet most of their own needs for trained telecommunications personnel. This is the concern of the ITU's Training Division in the Technical Co-operation Department. Their combined educational and telecommunication skills are helping improve the quality of training and multiplying its global availability.

For training of individuals, someone must train the trainers. In 1981, the Training Division conducted international workshops for national instructors in Burma, Honduras, Indonesia, the Philippines, Somalia and Sri Lanka. Since 1979, over 200 national instructors have received training in modern training methods.

Courses on specific subjects must be created, tested and made available with supporting training aids. Tremendous time and effort would be wasted if each country had to "re-invent the wheel" on its own. The ITU is solving this with a co-operative concept called CODEVTEL. Although the ITU itself develops certain course "modules", especially at advanced and "train-the-trainers" levels, countries volunteer to develop course modules they need themselves within given guidelines. Once a course is completed and accepted into the system, it becomes available to other countries to use, often with minimal adaptation. In 1981, the ITU conducted "Workshops for Course Developers" in 12 countries on all continents for participants from 25 administrations. Over 500 course developers have now been trained in the application of the "Training Development Guidelines".

Their co-operative effort has produced 28 training courses as of March 1982 on widely varying subjects, of which over 260 copies have been distributed around the world. As of the same date, more than 130 courses were under development in accordance with the "Guidelines" and this number is steadily increasing.

Training centres are an important element in the "development of human resources". Here again the ITU, often with financial support of the UNDP, assists countries in the planning, physically preparing and operation of such centres.

Increasingly, national training centres are opening their doors to trainees of other countries in the region. This is especially effective for smaller countries where it is not practical to set up a course for the technical specialities needed by only a few staff in their system.

There are also an increasing number of fully regional or sub-regional training centres around the world. Typically, an ITU/UNDP project set up a centre to serve the Pacific Islands and territories based on the national centre at Suva, Fiji. This has expanded in facilities, curriculum and numbers of students and is now co-operatively operated by the territories served. Similar centres are productively operating and expanding in the Americas, Africa, the Middle East and other parts of Asia/Pacific region.

International co-operation in training and the introduction of new common standards have tended to alter the role of the training manager. On request, the ITU is assisting training managers in Member Administrations with a "Training Management Workshop" which helps them orient themselves towards their new responsibilities.

International co-operation is resulting in many training "products" useful to all as countries jointly request, plan and produce through the ITU such items as the recent "Reference Manual for Training Centres", a "Directory of Training Centres", "Training Development Guidelines" and a "Training Development Quarterly" periodical to exchange training news and ideas among telecommunication trainers and training managers around the globe.

As these three examples — experts, fellowships and training — from among the ITU's many international programmes illustrate, in the realm of telecommunications, international co-operation is more than a hope. It is the practical, normal way of sharing knowledge and skills daily around the globe. Telecommunications, a critical element in progress in all sectors, is a good example of the ability of governments to work together for the mutual benefit of their own interests and of their peoples.

Telecommunications in Australia

W. H. Thurman, BSc. M.I.E. Aust.

A broadly descriptive review of the Australian National Telecommunications Network in the 1980's and an examination of the interaction between technology and service in some of the new services which Telecom intends to offer.

GEOGRAPHY, DEMOGRAPHY, HISTORY AND THE NETWORK

In Australia, 70% of its 15 million population live in the capital cities of the six States. Since World War II, the population has almost doubled, immigration contributing 40% of the 7 million increase, with 40% of the immigration increase coming from non-Commonwealth countries.

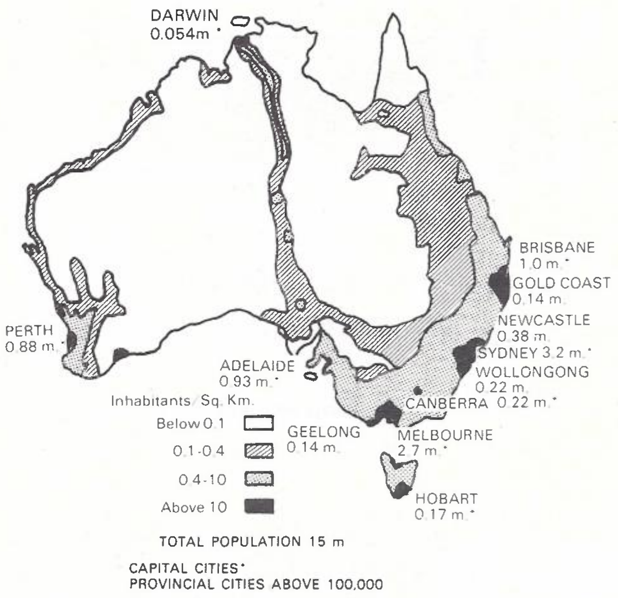


Fig. 1 — Population Distribution in Australia

Figure 1 shows the population dispersion within this predominantly flat and comparatively dry country, which although equal in size to the United States will probably always be limited to a population of not more than 20 million people. The concentration of population on the narrow eastern and south eastern coastal strip is highlighted in the figure.

Although originally an agricultural country, less than 12% of the population is now directly engaged in primary industry, with the remainder divided fairly evenly between secondary and tertiary industry.

In 1880, only four years after Alexander Graham Bell had demonstrated a practical telephone, a telephone directory published in Melbourne included more than 40 customers. By 1883, Sydney had a total of 340 customers. This was at a time of physical remoteness from western civilisation, when a journey from London to Australia might take 12 weeks and a voyage from North America might take 7 weeks.

This paper, originally titled "Telecommunications Down Under," was completed in 1981 and has been reprinted from IEEE Communications Magazine, March 1982.

In spite of the low surface population density, telephone penetration has always ranked reasonably high by world standards and is now over 50 telephones per 100 population with nearly 80% of homes having service. The existing telecommunications network also provides all of the other basic telecommunications services, including telex, data and facsimile.

Approximately three-quarters of the telephone customers are in the capital cities and the few provincial cities with populations over 100,000 depicted in Figure 1.

The networks in capital cities with radius ranging from 30 to 40 kms, where only a unit fee is charged for a call, are quite large. Those in Melbourne and Sydney consist of some 150 and 250 exchanges serving 1 million and 1.25 million customers respectively. The transmission networks in each State tend to radiate from the capital cities; the adjacent capital cities being linked by major trunk routes. An important group of telecommunications users reside "on the land", distant from, but having a community of interest with, adjacent towns. The telecommunications needs of these rural areas have long attracted the attention of the administration providing telecommunications — from 1901 until 1975, the Postmaster - General's Department, and since 1975, the Australian Telecommunications Commission (Telecom Australia).* Even more attention has been directed to this area since 1975; one section of the Act of the Australian Parliament which set up the latter semi-government authority requires it "to have regard to the special needs for telecommunications services of Australian people who reside or carry on business outside the cities".

At the extremes of the existing network in ***rural*** areas

* At this time a separate postal commission and a new department of state were also created. The department, now called the Department of Communications (DOC) became responsible for postal, telecommunications, and broadcasting policy matters; radio spectrum regulation and licensing, planning and technical standards for broadcasting, and the ownership and funding of transmitters for the government broadcasting service.

(areas having population densities typically within the range of .002 to 0.2 customers per sq. km), customers lines of 30 kms or more in length are not uncommon. Many of these have been erected in part by the customers. Beyond these, in ***remote*** areas, are isolated potential telephone customers estimated to number 2,500 by 1985 and rising to approximately 5,000 in the year 2000. Telecom Australia provides only a limited number of high frequency radio telephone systems connected to the national telecommunications network, to serve customers in remote areas and the telecommunication needs of most of these people have been met, so far, by high frequency message radio networks. These networks, which are operated by private non-profit organisations, also provide medical surveillance, and educational facilities in daily "school of the air" broadcasts to Australia's far-flung population. Many large mining ventures are located in the remote areas and serving these has been a great challenge.

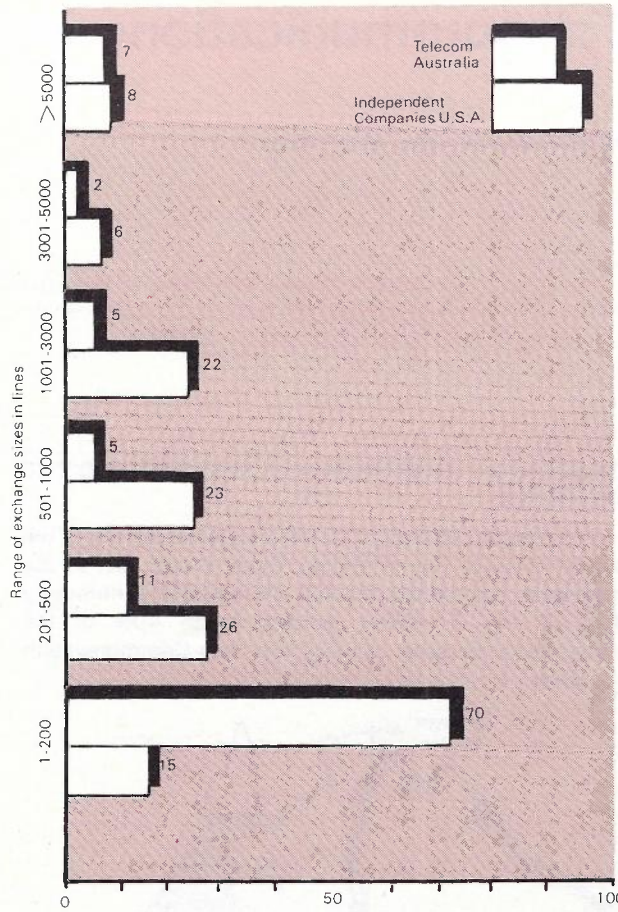
An insight into the effect of Australia's population dispersion on its telecommunications technology can be derived from **Figure 2**, which provides a frequency distribution of telephone exchanges of various size.

HISTORY OF THE NETWORK

Switching

Automatic switching has progressed rapidly since its introduction in 1911. First being employed in the urban areas, it progressed quickly into the rural areas. Only 4.4% of the telephone population in the latter areas are now without automatic service which is provided on an exclusive line basis. Only 15% of the remaining manual subscribers have party line service.

In 1960 following detailed study of the telecommunication needs of the Australian people, the Government White Paper "Australian Community Telephone Plan" was published. Essentially, the plan provided for a full national closed numbering scheme and a progressive introduction of nationwide subscriber trunk dialling (STD). It also outlined the means by which these



	Independent Companies U.S.A.	Telecom Australia
TOTAL EXCHANGES	9778 (1978)	5592 (1.7.80)
TOTAL TELEPHONES	33.2 million (1.1.80)	7.2 million (1.7.80)

Fig. 2 — Distribution of Exchange Sizes

W. H. Thurman has worked for the Australian PMG Department and Telecom Australia since 1948 after earlier banking and clerical experience and war service with the RAAF. He received his BSc. Degree at the University of Melbourne, in 1951.

He occupied engineering positions in the PMG Victorian operating administration until 1969. These positions entailed management of outside plant operations and workshops, special engineering investigations, and urban cable network planning. In 1956, he was involved in technical liaison and planning of telecommunications for the Melbourne Olympics.

Between 1958 and 1962, he worked as an advocate for the Professional Officers Association in a major industrial arbitration case dealing with professional engineer salaries.

Since joining PMG Headquarters in 1969, he has been engaged mostly on transmission system planning, being involved in the introduction of PCM, and preparatory planning for optical fibre systems. He has written papers on the application of digital transmission systems and optical fibre systems in national telecommunications networks, and represented Australia at meetings of the CCITT GAS3 Working Party.

In recent years, he has also been involved closely in Headquarters aspects of engineering capital works programmes, engineering planning and programming processes related to network development, new service introduction, and operations activities.

objectives would be achieved. The plan recognised the need to change from the basic Strowger-2000 type step-by-step switching technology to a register-controlled high speed system using automatic alternative routing.

An important economic decision taken at this time was that metering of trunk calls would be by a repetitive pulse operation (multi-metering) of the simple customer call meters permanently associated with each line to record local calls (untimed in Australia).

Purchase of step-by-step equipment ceased in 1962 when the first crossbar switching systems were introduced. The step-by-step equipment has been recovered since 1968 at an annual rate of 20,000 lines and virtually all equipment installed before 1936 is now replaced. Seventy-five percent of local switching equipment in metropolitan areas is now crossbar.

In 1974, centralised stored programme control (SPC) trunk switching machines commenced to supplement the 4-wire crossbar trunk switching exchanges which had been introduced simultaneously with crossbar local switching.

Transmission

Major Trunk Network

The introduction of subscriber trunk dialling with the consequent need for large increases in trunk circuits, combined with the need to provide TV relays from the capital city studios of the Australian Broadcasting Commission to regional transmitters, (following the introduction of television broadcasting in 1956), led to the provision of a broadband transmission network which now provides the transmission links between the major population centres. This network, depicted in **Figure 3**, consists of both microwave radio and coaxial cable systems and provides links for telephony, data, telex and other services. It also provides standard and "thin line" television relays to transmitters dispersed throughout the country.

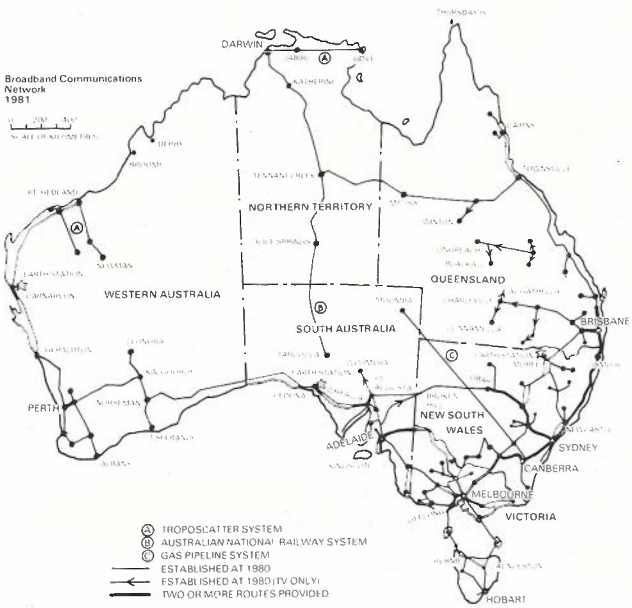


Fig. 3 — Existing Broadband Transmission Network

Minor Trunk Network

In the minor trunk networks low-level small and medium-capacity cable systems are employed extensively. Many of these make use of a two-pair symmetric high frequency cable readily installed by mole-plough. Small and medium capacity radio systems are also used. Open wire carrier systems which were introduced in Australia relatively soon after their development, are still employed in some remote areas. The generally long thin single cable routes occasioned by the demographic dispersion in the rural areas have so far remained conducive to the use of analogue transmission systems.

Links to mining ventures have frequently been provided by spurs from the broadband transmission network in the form of microwave radio, tropospheric scatter, medium capacity carrier cable and, on occasion, high frequency radio links.

Urban Inter-exchange Networks

In these networks virtually all circuits were provided by voice-frequency cables until the late 1960's. At that time broadband coaxial cable systems began to prove economic for the longer, more dense routes in the larger capitals.

Thirty-circuit pulse code modulation (PCM) systems were introduced as standard urban inter-exchange network components in 1977; nearly 10 years after the first trial PCM systems were installed. Some of the more significant factors which contributed to this delayed situation, include:

- the existence in the larger capitals, of the broadband coaxial cable systems. Continued exploitation of these systems was facilitated by a very favourable market for the purchase of the associated multiplex equipment;
- adequate conduit routes were generally available because of strong external planning groups, and the fact that labour rates did not experience a high rate of inflation until the mid 1970s;
- low discount rates, then prevailing, favoured cable installation rather than low cost shorter-life, higher-maintenance short-haul carrier alternatives;
- other technical and economic factors contributed, including the fact that the crossbar switching system did not cause a large step-function in signalling costs versus circuit-length over comparatively short distances for physical circuits. This had a major influence on application of PCM in other networks.

Nevertheless, under the conditions prevailing in the late 1970s, a high growth rate was foreseen for the use of PCM in capital city networks. The potential for even higher growth rates, if forecast trends in time division switching costs were to mature, was recognized. (The forecasts have been borne out. In 1981/82, 30% of all new circuits are to be provided by PCM, and two years later the percentage will be 75%).

BROADCASTING IN AUSTRALIA

The installation and operation of transmitters for the Government broadcasting service provided by the Australian Broadcasting Commission (ABC) is a function of Telecom who also provide permanent and itinerant relay facilities for the ABC, public and commercial broadcasters.

Sound

Australia has been well served by medium frequency (MF) AM sound radio stations. In June 1980 there were 129 independent commercial stations, and 93 national stations transmitting ABC programmes. In addition, there are a number of "public" broadcasting stations and a series of multi-cultural broadcasters, some Government funded, others publicly funded. The MF broadcasting service generally provides programmes to areas with populations of 0.1 inhabitants/sq. km. In addition, the ABC service is broadcast into the remote areas by a small number of high frequency transmitters.

Although experimental VHF FM broadcasting services operated in several capital cities from 1947 until 1963, FM stereo broadcasting was introduced into capital cities in 1975 and is being extended gradually to provincial centres.

Television

Television broadcasting, introduced in 1956, comprises 50 commercial stations and a total of 85 high power national stations carrying ABC programmes. The larger capital cities now have access to five channels including one multicultural service which broadcasts foreign language, English-subtitled programmes. Ninety-eight percent of the population have access to programmes of the ABC, and 90% have access to at least one commercial programme in addition. Translator station chains are used to extend programmes into the areas of lower population density.

The effect of earlier legislation and regulation has been to protect the viability of regional commercial broadcasters serving the provincial centres and the surrounding rural areas. The original intention of the Government when setting up television broadcasting was to preserve a local identity for the commercial stations by preventing networking. The low population densities and limitation of the VHF spectrum originally combined to allow only one commercial and one national transmitter at each regional centre.

The population with almost no access to television is in the remote areas where there is no telephone service. Some limited facilities have been provided at locations such as mining centres in the form of low powered transmitters provided by employer groups. These make use of taped programmes supplied from the national and commercial networks.

Cable Television

Cable Television has, until recently, been limited by regulation to that necessary to overcome "off-air" reception problems in a stations' primary service area. Because of the small size of such pockets, few of these services have been viable.

In the capital cities with good primary service "off-air" coverage, and a reasonable number of channels, there has not been great public pressure to introduce cable television. In regional areas, again in the interests of preservation of the viability and local identity of the regional commercial stations, the broadcasting regulatory authorities have not allowed cable distribution of signals from the capital city stations.

TELECOMMUNICATIONS AT THE BEGINNING OF THE 1980's

A selection of network services and network plant details is shown in **Figure 4**. Broadcasting services are depicted in **Figure 5**.

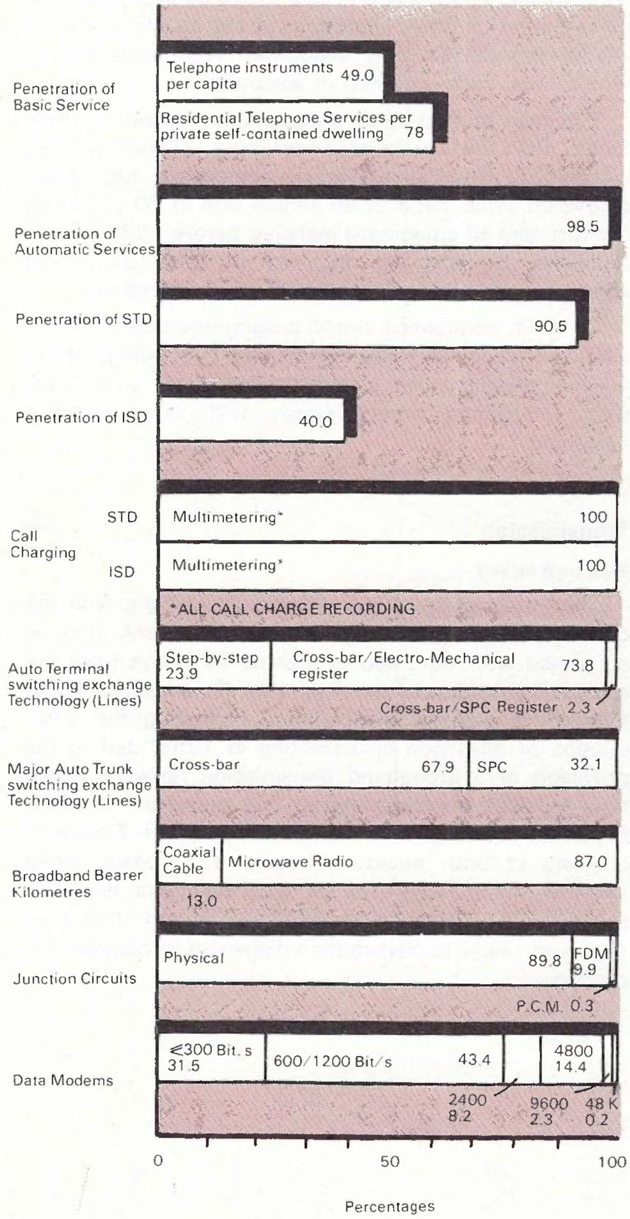


Fig. 4 — Some Network Services and Network Plant Indicators (1981)

Major developments planned in the late 1970's are now gaining momentum. These include the exploitation of digital technologies which will cause fundamental changes in the network of the 1980's. Three transitional programmes begun at the close of the 1970's, and which will not be completed until well into the 1980's, will cause major changes in the service offered to some groups in the community.

SOME IMPORTANT TRANSITIONS

A $500 million programme to complete automation of telephone services in rural areas is underway. This will provide automatic exclusive service for each existing manual customer and the upgrade of all external lines to

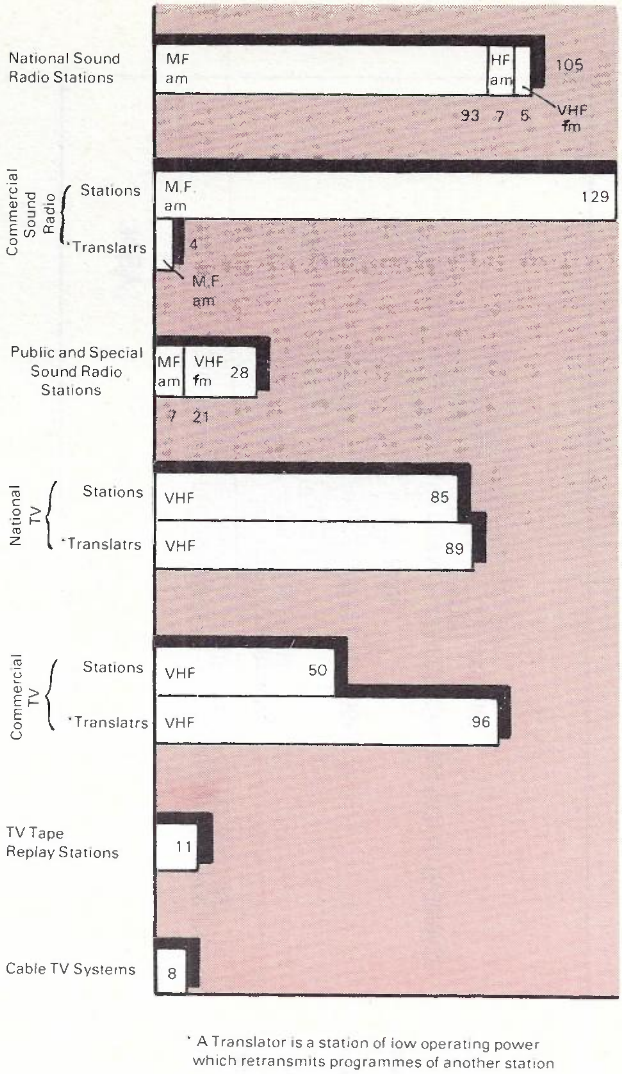


Fig. 5 — Some Statistics of Broadcasting Services at June 1980

Telecom construction standards. The prime motivation for this programme is to improve service to customers. Only 10,000 manual lines are expected to remain by 1985 and completion of the programme by 1988/89 is seen as a desirable objective.

The end of the rural programme would overlap a probable new programme, to serve those potential customers in the remote areas who rely on high frequency radio for their communications.

The objective of providing every Australian with a telephone service is therefore in sight within the current decade, and is dependent only on the availability of financial resources.

A second programme which will provide a bridge between the existing crossbar switching system and the next generation electronic switching systems is "crossbar modernization." This will result in a network which is more reliable and easier to operate and maintain. The programme provides a retrofit of all existing crossbar exchanges, with upgraded control systems, either by register modification or, in the case of most urban exchanges, by replacement of existing electro-mechanical registers with a stored programme control sub-system. It will enable calling line identification (CLI) to be provided, which is a prerequisite to a call charge recording (CCR) system which can supplement and later replace the multimetering charging scheme previously mentioned.

Significant savings in international manual switching costs have been realised by making an international subscriber dialling (IS) facility available to those customers willing to be charged for these calls by the multimetering process. However, CCR is an important network requirement to increase penetration of ISD and to pave the way ultimately for the use of a similar recording system for STD. As well as providing CLI for ISD/CCR, the crossbar modernisation programme offers many service improvements which would be more expensive and would have to await replacement of crossbar switching with the next generation switching systems. An ISD/CCR facility which is being introduced, uses a call charge recording capability in the existing SPC trunk switching machines. This capacity will be supplemented in other parts of the network before an extensive penetration of call charge recording for STD will be offered.

A third transitional programme is the provision of the remote area television service. This service came into operation in September 1980 and will provide ABC TV programmes to about 70 remote communities. Links to about 60 of these will be provided initially through INTELSAT IV pacific ocean satellite making use of relatively small satellite receiving terminals. Two Australian regional programmes, one each for the eastern and western halves of the continent, are transmitted to the satellite from two major earth stations of the Overseas Telecommunications Commission (Australia) (OTC(A))+. Twenty-five stations in this programme had been completed by December 1980. It is expected that after 1985, links will be provided by means of an Australian domestic satellite.

DEVELOPMENTS OF THE 1980's

During the decade, progress will continue in increasing penetration of various network services, eg targets of 97% STD, and 74% ISD by 1985. Extensions to the country's broadcasting services beyond the situation depicted in Figure 5 will also take place (eg since June 1980 a number of commercial VHF FM stereo sound stations have commenced operating).

The regular programmes of network extension and route enlargement will, also continue. For example the broadband transmission network will continue to be expanded to serve more distant areas, to meet growth, and planned objectives of route duplication and triangulation, and to exploit solar energy where this is practicable.

Network Technology and New Services

Some major new services and extensions of existing telecommunications and broadcasting services planned to be introduced into Australia during the 1980's are indicated in Tables 1 and 2.

+ The Overseas Telecommunications Commission (Australia) is responsible for Australia's international telecommunications links, and the use of INTELSAT facilities is arranged through that organisation.

Year of Introduction	New Service or Service Extension
1981	Public Automatic Mobile Telephone Service
1982	Software Controlled Small Business Systems
1982	High Capacity Radio Paging
1982	Public Videotex
1983	Teletex

Table 1 — Some New Services or Service Extensions Independent of Significant Changes to Network Technology

Year of Introduction		New Service or Service Extension
1982	Network Services	Digital Data Service
1982		Packet Switched Data Network (Multi-address system via Satellite 1987-88)
1983		Increase Penetration of ISD/CCR
1984		STD/CCR
1984		Selected Custom Calling Services
1985		Extend Rural Automation
1985		Remote Telephone Programme
1987		More Comprehensive INWATS
1987-88		High Capacity Data Links (via Satellite)
Continuing	Broad-casting	Extend FM Sound Broadcasting
1986		Homestead and Community Broadcast Satellite System

Table 2 — Some New Services or Service Extensions Dependent on New Network Technology

Table 1 shows new services which, although flowing from recent technological developments, do not require significant changes in underlying network technology.

Table 2 includes a number of planned new services, extensions or enhancements of services, which are dependent on the availability of new network technology. **Figure 6** illustrates the dependence of many planned new services, extensions or enhancements of services on the availability of new network technology, and displays many of the items of new technology planned to be introduced.

The Australian domestic satellite has been treated as a telecommunications network element, although it will include a direct TV and radio broadcast facility.

The dates shown are approximate, especially for the later years, because not all of the new services have yet been authorized, and important customer surveys are incomplete. Also, under a procedure recently agreed with the trade unions, mutual discussion must take place at defined stages between the contemplation and installation of new technology.

The introduction of services dependent on new network technology will generally raise more difficult problems for a telecommunications administration, than those for 'stand-alone' services. These include the call on additional capital, installation co-ordination, and, possibly, the need for the accelerated retirement of older plant.

KEY:

ISD/CCR — CALL CHARGE RECORDING FOR INTERNATIONAL SUBSCRIBER DIALLING
STD/CCR — CALL CHARGE RECORDING FOR SUBSCRIBER TRUNK DIALLING
CLI — CALLING LINE IDENTIFICATION
INWATS — INWARD WIDE AREA TELEPHONE SERVICE
PSN — PACKET SWITCHED DATA NETWORK
DDS — DIGITAL DATA SERVICE
DDN — DIGITAL DATA NETWORK
ISDN — INTEGRATED SERVICES DIGITAL NETWORK
DAVID — DIGITAL ABOVE VIDEO
DAV — DIGITAL ABOVE VOICE (RADIO)
DIV — DIGITAL IN VOICE
HACBSS — HOMESTEAD AND COMMUNITY BROADCASTING SATELLITE SERVICE
IDN — INTEGRATED DIGITAL NETWORK
* — UTILIZING OPTICAL FIBRE "TAIL" SYSTEMS
⊘ — WITH SUBSCRIBER DIGITAL LOOPS

EXPECTED DATE OF PLANNED NETWORK INTRODUCTION
LIKELY TIMING OF INTRODUCTION UNRESOLVED
EXPECTED COMPLETION OF PROGRAMME
CONTINUING PROGRAMME
LINKS BETWEEN NETWORK TECHNOLOGY AND SERVICES

Key to Fig. 6.

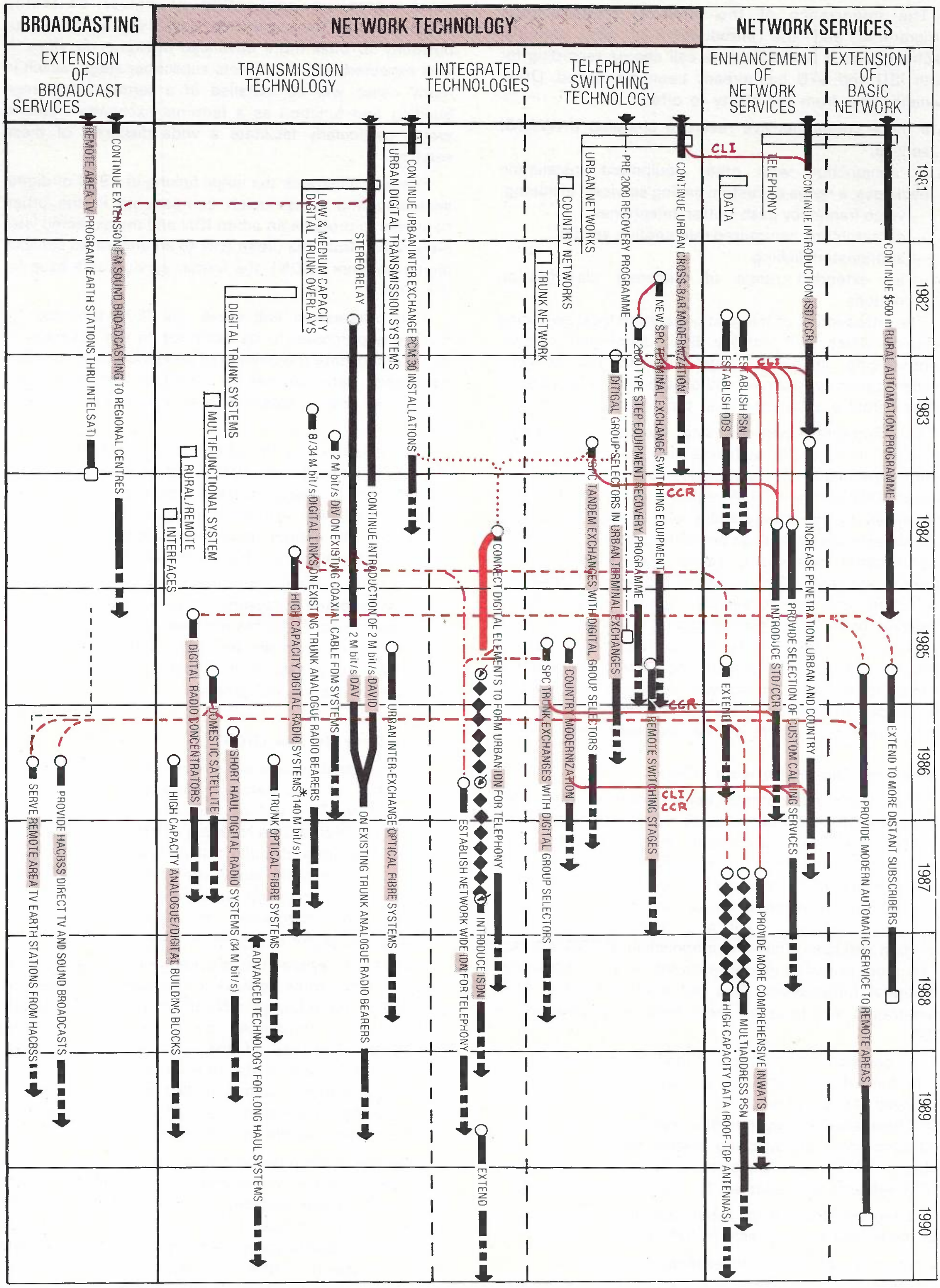


Fig. 6. — Some New or Extended Services Dependent on Significant Changes to Network Technology.

New Switching Technology — Rate of Introduction.

The importance of the crossbar modernisation programme and the introduction of SPC terminal exchanges as a prerequisite to call charge recording for both ISD and STD has already been mentioned. Other benefits flow from the ability to offer:

- a more comprehensive revertive charging (INWATS) service;
- in conjunction with other equipment installation packages, a range of custom calling services, including:
  - — voice frequency push-button telephones,
  - — an automatic centralized interception service,
  - — abbreviated dialling,
  - — an extended range of customer classification options.

The introduction of the next generation local switching system, which will employ SPC distributed control, commencing in 1982, together with the crossbar modernization programme will enable new services to be offered from a substantial and growing network base.

The currently approved step recovery programme depicted in Figure 6, achieves quite a useful rate of return, due mainly to maintenance cost savings, and has a year 2000 end-point. Although the rate of return is also influenced by the marketability and profitability of the various services, which can be readily provided with more sophisticated equipment, earlier replacement of the obsolescent equipment would still provide a positive rate of return and better service, sooner. There would, however, be a call for greater capital in the shorter term. Because of the buoyant demand for telecommunications services a major influence on the current policy is the availability of skilled manpower resources which would be needed to accelerate the step recovery programme. The current programme will be reviewed in the future.

Integrated Digital Network (IDN)

The concept and potential benefits of IDN came closer to realisation when PCM systems were first introduced as practical network transmission links. However, rapid reductions in the price of memory which have driven down the costs of time division switching (TDS) have made the latter attractive in its own right producing an "explosive" economic justification for digital transmission in urban networks. Thus, the introduction of TDS will have a far more powerful influence on the rate of introduction of digital transmission than the level of existing PCM penetration will have on the timing of introduction of TDS.

A decision to proceed firmly toward setting up integrated digital networks in urban areas of Australia followed the selection in 1977 of a distributed control SPC local switching system as a replacement for the then standard crossbar switching system for local networks. Also, in 1977, digital transmission in the form of primary PCM systems was adopted for use in local networks.

It was decided that the urban telephone system would be developed on the basis of IDN and the use of:

- digital group switches in terminal exchanges;
- digital group switches in transit exchanges for local and trunk switching;
- remote subscriber stages.

It was recognised that in addition to the direct economic benefits, other benefits would flow from the more extensive application of newer switching technology and the consequent earlier and increased opportunity to offer more advanced customer services. It was expected that the remote subscriber stage, which in many cases will be installed in a terminal exchange building and function as a terminal exchange element, would particularly facilitate a wide dispersal of these services.

Figure 6 illustrates the initial linking in 1984 of digital switching and transmission components in the urban networks to produce an urban IDN and the expected later progression from the urban IDN to an integrated services digital network (ISDN), the former serving as a base for the latter.

This progression will allow the IDN, provided for telephony purposes, to be extended to the customer. It will also facilitate the offering of combined telephony and low speed data services, or alternative telephony and high speed data or facsimile, over common transmission plant.

Also illustrated is the potential to extend the urban IDN to a network-wide IDN which will exist after the introduction of digital trunk tandem exchanges. This potential will be extended and accelerated by the availability of greater long haul digital transmission capacity than might have been expected a short time ago.

Common channel information signalling (CCIS) is being investigated in conjunction with the introduction of digital switching. There has not been pressure to examine this in detail previously because of the sophisticated multi-frequency signalling system associated with Australian cross-bar equipment.

Digital Data Service (DDS)

An important service enhancement dependent on the introduction of new network technology is the Digital Data Service. This will be provided by a TDM based hierarchical Digital Data Network (DDN) for the provision of point-to-point and multipoint dedicated data services, which will eventually supersede the current analogue techniques for providing data services. Faster service provision and restoration, and greater flexibility in rearrangements are expected at lower overall cost.

Australia's approach to providing digital transmission capacity in the trunk network for this service will be very different to that adopted in North America. New network technology is influenced by a network's existing technology. The use of the data-under-voice (DUV) technique is not practicable in Australia because the frequency bands of the Australian FDM multiplex equipment leave insufficient spectrum below the voice hierarchy in which to insert significant digital information.

After the initial provision by group-band data-in-voice (DIV) data modems, digital transmission capacity for the DDN will be made available in a variety of ways. On most routes in early stages it will be possible to employ 2Mbit/s data-above-voice (DAV) modems which operate within the spectrum of a microwave broad-band bearer, above the voice hierarchy. Digital-above-video (DAVID) systems are already being employed to transmit stereo programme signals. It may also be possible to employ 2 Mbit/s DIV modems being developed to operate within the existing FDM hierarchy. Some problems have been encountered with use on radio systems but application on coaxial cable systems seems very likely.

It will be necessary, at a fairly early stage, to equip analogue radio bearers on major routes with modems operating at 8 Mbit/s and 34 Mbit/s. The resultant extra demand on radio bearer capacity will expedite requirements for provision of new transmission systems to meet telephony requirements.

Recent studies have suggested that on intercapital routes these systems should be 140 Mbit/s digital radio systems operating in the 6.7GHz band and generally overbuilt on existing routes, with limited modifications in some locations. They should carry most of the data traffic thus freeing the analogue bearers for telephony. Providing capacity in this way will also provide digital links for the network-wide integrated digital telephony network.

Australian Domestic Satellite

The Australian Government in 1979 announced a decision-in-principle to establish an Australian Government Satellite System. Tenders for the system were issued in October 1980.

Aussat Pty. Ltd. has been formed as the Australian company to own the space segment and the major city earth stations of the system. Initially the Government owns 100% of the share capital but it intends to convert the company to a public company with up to 49% of shares issued to the public.

Offers have been received for both earth and space segments of the system and a contract for the supply of the space segment consisting of 3 satellites and 2 control stations has been signed between Aussat Pty. Ltd. and Hughes Communications International, in May 1982 with the objective of having the first satellite launched in mid 1985.

Expectations are that most of the transponder capacity will be utilised for broadcasting services and television relay purposes. However, capacity will be available for telecommunications network and point-to-point services. The satellite planners also intend to utilize some capacity to augment the medical consultancy and "school-of-the-air" services.

Telecom Australia has had the possible use of a satellite, under almost continuous review since 1966, and has completed a number of important engineering experiments. In 1969, use was made of INTELSAT circuits to provide temporary relief on the East-West transcontinental trunk route. Also, as referred to previously, INTELSAT is being used to provide a remote area television service.

Telecom intends to exploit the satellite's ability to provide a number of facilities which are otherwise technically difficult and costly. However it is expected that most of the usual point-to-point and network telecommunications services within Australia will be more economically provided by means of the terrestrial network.

A very important potential Telecom application of the satellite is to extend a fully automatic telephone service into those remote locations where it proves to be the most practical means of providing service. In this connection the satellite system concepts allow for:

- provision of single telephone circuits from remote subscribers utilizing small earth stations at isolated homesteads, fixed and portable versions being specified;
- provision of multi-circuit stations for small communities or homesteads where one circuit would not provide an adequate grade of service;
- the switching and interfacing of the terrestrial network with the satellite system.

The extent of the satellite's role in providing telecommunication service to remote areas will depend on specific customer requirements, economics and the availability of funds.

Figure 6 indicates how the satellite will interact with a number of new services and continuing programmes of major interest to Telecom. The figure does not include a network security facility which has also been called up in the tender schedule on Telecom's behalf. This is the temporary thick route satellite service (TTRSS) which would enable two-way video and large blocks of multiplex telephony services to be provided at short notice.

It is proposed that a number of ABC and commercial television station relay links, currently provided over the terrestrial network, would be provided by satellite. One significant factor which will affect utilisation of the satellite is the extent to which the current restrictions on commercial broadcast television networking will be modified.

A potential large user of transmission capacity in the satellite is the Department of Civil Aviation, to improve air traffic services. The Department proposes to link its ground-to-air VHF communications stations via satellite circuits to its traffic control centres.

Tender documents refer to the use of a 15 transponder satellite operating in the 14/12 GHz bands with the normal working and standby arrangements. Eleven low-powered transponders would be available for point-to-point telecommunications and network purposes. Four medium powered transponders with spot beam coverage giving high intensity signals over four regions of Australia would provide a homestead and community broadcasting satellite service (HACBSS) for the ABC. These would allow direct reception of a single regional TV programme and up to four sound programmes in each of the four regions using receiving antennae of about 1.2m to 1.8m in diameter. Programme distribution to some regional transmitters could also be effected in this way. The system design also ensures that with the aid of a second operational satellite, a second HACBSS service could be provided.

Telecom carries a broad spectrum of responsibilities in the overall satellite project. These include the role of purchasing agent for the HACBSS ground stations, extending to purchase, evaluation, and installation of the ABC programme relay service regional receive-only stations, as agent for the DOC. For the remote telephone satellite service (RTSS) and the TTRSS, Telecom carries responsibility from system design concept and specification through to selection, installation, operation and maintenance of the equipment.

Digital Radio Concentrator System (DRCS)

Analogue radio concentrators which enable up to 20 customers to share four pairs of radio channels to a local exchange are currently employed as network components as part of the programme to upgrade rural services.

After considerable research into the advantages and feasibility of a digital radio concentrator, Telecom has entered into development and supply arrangements for provision of such a system. The advantages expected over the equivalent analogue radio include low power requirements (suitable for solar power), capability of regenerative repeaters, lower costs, enhanced supervisory capability, and the conservation of frequencies when one or more links in tandem are required.

The DRCS is expected to be a powerful tool in providing a large number of customer links for the later and more difficult phases of the rural upgrading programme, and to be useful in the programme to provide high quality service in some of the remote areas.

Systems are expected to be available in 1984.

OTHER FUTURE ASPECTS

In 1974, some 14 years after the Government's adoption of the Community Telephone Plan, a multi-disciplinary team within Telecom accepted the task of examining "the capabilities and the role of telecommunications in the society of the future". At that time the ferment of ideas and the wide range of possible future telecommunication services precluded the development of a formal plan in the style of the 1960 plan. Nevertheless a report — Telecom 2000 — provided the organization with "a guide to possible directions in Australia's social, economic and technical future, and to likely trends in demand for telecommunication facilities which the early 21st century will impose." The report recommended strategies which Telecom should embrace. Comment on this report was invited and received from many areas in the community, and a further report — Outcomes of Telecom 2000 — was published in 1979.

Following other studies Telecom has made changes to its organizational structure to reflect trends in the changing mix of its products. These changes recognise that a larger proportion of future development work will be directed to non-voice products. Other major changes recognize that much of the future growth will be in products and service for business customers.

In recent years the Australian Government has arranged public inquiries into two important aspects of telecommunications. Those concerning the possible introduction of a domestic satellite led to the present position described above. A current public inquiry concerning the future of cable television and radiated subscription TV in Australia could also have significant results.

Telecom's submission to the latter inquiry draws attention to the many advantages resulting from placing the responsibility for provision and management of cable television networks, as distinct from the operation of a cable television service, with Telecom. There could be considerable economic advantage from preventing duplication of the infrastructure for such networks.

The effect of only small percentage economies in a country's telecommunications budget is considerable in absolute money terms, the annual capital requirement in advanced countries being of the order of 1% of gross domestic product (GDP). The Australian percentage has fallen from 1.2% in previous years to 1.0% more recently.

More recently, the Australian Government has established a major inquiry (Davidson Inquiry) into Telecom's activities to determine the extent to which the service it offers might be more effectively provided by private enterprise. The Government has stated that this is consistent with an election promise to reduce "big Government" in Australia.

CONCLUSION

All groups involved in setting policy, establishing and operating telecommunications services in Australia have set themselves a number of challenging tasks. At the end of the decade it will be interesting to look back. However if the past and present are useful guides there will be little time for such an exercise. Those responsible will be concentrating on solving the challenges of the next decade.

Digital Facsimile

R. I. DAVIDSON B.E.E.

This paper outlines the importance of high speed document facsimile to the business user and discusses the relevant factors in ensuring compatibility of equipment. Image coding and transmission techniques recommended by the CCITT for use with document facsimile equipment are described.

The author concludes by observing that the high speed facsimile printer, because of its capability of printing almost any type of image, may be one of the key elements supporting the integration of services in the office of the future.

INTRODUCTION

Most businessmen when considering their needs for office communication facilities are aware of the capabilities and limitations of the telephone, telex, visual display units and, more recently, communicating word processors but few businessmen appreciate the full potential of high speed digital facsimile equipment.

In business communication, the transmission of images is important. The written word can be reproduced a thousand kilometres away by a telex or teletex machine but any document incorporating a graph, diagram, letterhead or signature relies on facsimile for transmission. In addition any existing typed or printed document can be transmitted by facsimile more economically and more accurately than by a medium such as telex that requires the document to be retyped.

Document facsimile equipment has evolved specifically to meet the needs of business viz, to transmit black and white documents, up to the size of an ISO A4 sheet, over any distance across the city, the country or around the world.

In business, time also is often an important factor. As transmission time, particularly over long distances can be expensive, business has sought and has been supplied with, "sub-minute" facsimile machines. The greater the number of documents to be transmitted the more there is to be saved in transmission charges. The faster machines therefore have the potential to save time and money despite the greater initial cash outlay (in 1981 prices). The typical all up costs per message over a long distance connection, including machine rental, consumables, operator time and transmission charges are shown in graphical form in **Fig. 1.**

Newer and improved communications networks also allow operation at higher transmission rates with fewer errors. Many overseas countries have installed or are considering public data networks (PDN) and packet switched networks (PSN) both of which will support high speed facsimile transmission.

Both a PDN and a PSN are planned to be operating in Australia by 1982. By the end of this century it is likely that many digital subscriber connections will be made at 64 kbit/s in place of the now familiar voice frequency connection, thus providing the capability of a high speed data circuit to the customer.

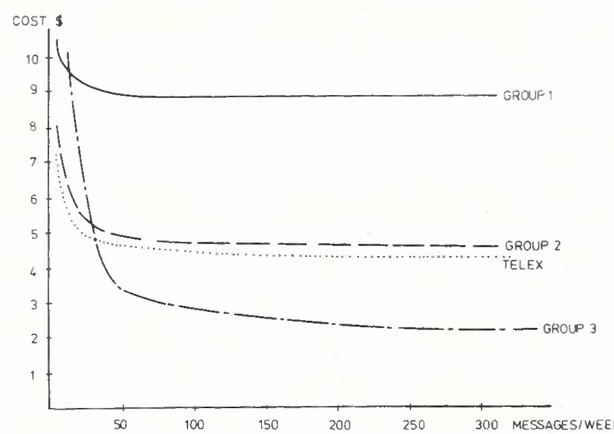


Fig. 1 — Cost per Message — Interstate Call (example only, at 1981 Australian prices. Telex cost assumes 400 words/message).

Facsimile equipment too, is being developed to take full advantage of network enhancements and new facilities and network options are constantly appearing. However, a facsimile machine is of little use to any business unless it is capable of two-way communication with a network of facsimile machines on the communications network. The one notable exception to this rule is where services such as the American ITT FAX-PAK are operational. The FAXPAK network combines a facsimile store and forward facility with message switching and packet switching technology and, in the process, provides for the conversion of facsimile formats between otherwise incompatible equipment. In countries where this service is unavailable, compatibility is essential.

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COMPATIBILITY OF EQUIPMENT

Compatibility of equipment implies compatibility at each of four independent levels:

- mechanical considerations, such as scan rate, paper feed rate, document size, etc.,
- use of standardised data encoding/decoding algorithms;
- compatibility of signal frequencies and modulation techniques;
- compatible data protocol or handshake procedures.

The international body for recommending communications standards, the International Telegraph and Telephone Consultative Committee (CCITT) has taken a leading role in defining appropriate standards to ensure compatible interworking of facsimile machines. The CCITT standards for facsimile equipment and transmission are known as the T Series Recommendations and are revised and re-issued every four years.

CLASSES OF FACSIMILE EQUIPMENT

Four classifications of document facsimile equipment are currently identified by the CCITT and are fully endorsed by most telephone administrations in the world, including Telecom Australia. The four equipment classifications or groups are written in terms of user requirements and reflect basic technical design differences.

In the words of the CCITT:

"Group 1

Apparatus which uses double sideband modulation without any special measures to compress the bandwidth of the transmitted signal and which is suitable for the transmission of documents of ISO A4 size at nominally 4 lines per mm in about six minutes via a telephone-type circuit.

Apparatus in this group may be designed to operate at a lower definition suitable for the transmission of documents of ISO A4 size in a time between three and six minutes.

(An A4 size document is 210 mm x 297 mm).

Group 2

Apparatus which exploits bandwidth compression techniques in order to achieve a transmission time of about three minutes for the transmission of an ISO A4 size document at nominally 4 lines per mm via a telephone-type circuit. Bandwidth compression in this context includes encoding and/or vestigial sideband working but excludes processing of the document signal to reduce redundancy.

Group 3

Apparatus which incorporates means for reducing the redundant information in the document signal prior to the modulation process and which can achieve a transmission time of about one minute for a typical typescript document of ISO A4 size at nominally four lines per mm via a telephone-type circuit. The apparatus may incorporate bandwidth compression of the line signal.

Group 4

Apparatus which incorporates means for reducing the redundant information in the document signal prior to transmission mainly via the PDN. The apparatus will utilise procedures applicable to the PDN and will ensure error free reception of the document. The apparatus may also be used on the general telephone network where an appropriate modulation process will be utilised."

TRANSMISSION

As can be seen in the definitions, equipment from each of the four groups transmit their information using different techniques and are by definition, incompatible except through translation networks.

Groups 1 and 2 employ analogue transmission techniques and as such are outside the scope of this paper. Groups 3 and 4 both employ digital coding and data compression, with the information being transmitted by recognised data transmission techniques.

Data transmission has the advantage that the information signal can be regenerated at the receiver and the effects of noise, instability and interference that usually plague analogue signals can be minimised. Disadvantages however are its current higher costs and, with coding algorithms in current use, an inability to handle shades of grey. With the transmission of documents, however, a black and white response is all that is usually required.

A Group 3 facsimile apparatus transmits coded digital data over the switched telephone network by employing

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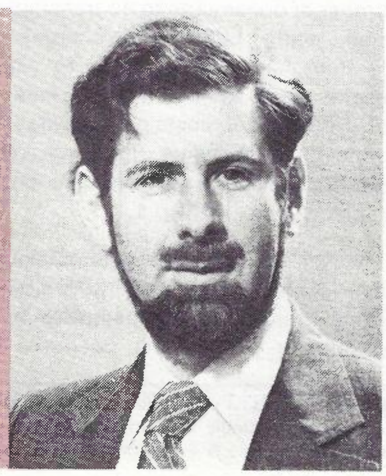
During this period he participated in the activities of CCITT Study Group XIV (Facsimile Transmission and Equipment).

Mr Davidson is currently employed as a Principal Engineer in the Customer Systems and Facilities Branch of the Telecom Research Laboratories, where he is actively studying new and future business communication facilities.



standard data modulation techniques. The transmission speed is 2400/4800 bit/s using the CCITT defined modulation techniques of Recommendation V27 TER (although an approved option is 7200/9600 bit/s using the V29 modulation scheme). The serial data stream to be transmitted at 4800 bit/s is broken up into groups of three consecutive bits (tribits), each of which is encoded on an 1800 Hz carrier as a phase change relative to the preceding tribit, as shown in **Table 1**.

Tribit values			Phase change
0	0	1	0
0	0	0	45°
0	1	0	90°
0	1	1	135°
1	1	1	180°
1	1	0	225°
1	0	0	270°
1	0	1	315°

Table 1 — Phase Change Modulation of V27 TER

Should the error rate prove to be too high the machine drops in speed to 2400 bit/s, dividing the data stream into pairs of bits (dibits). Each dibit is then encoded as one of four phase changes relative to the phase of the preceding dibit. The demodulator at the receiver reconverts the signal to a bit serial form where the signal is decoded and fed to the print head to reproduce the document.

DIGITAL TRANSMISSION TECHNIQUES

Group 4 facsimile machines will be fully digital machines capable of error free transmission over digital data networks. As the CCITT standards for Group 4 equipment are not yet finalised it may be one-two years before Group 4 facsimile equipment is widely available but this timing is appropriate for Australia considering the digital data network plans.

Although the coding and control circuitry will be more complex for Group 4 machines than is necessary with Group 3, there will be a potential cost saving in that the expensive high speed data modem required for transmission over the voice frequency network, will be unnecessary. This cost saving will to some extent be offset by the higher cost of the more complex circuitry in the Group 4 machine.

In Group 3 and 4 facsimile machines, the information from the document scanning head is processed to reduce the redundant information prior to transmission. At the recommended facsimile scan resolution of 3.85 lines per mm, an A4 page would require 1145 scan lines total. At the recommended 1728 samples per line, almost 2 million samples are taken per page. If these samples are transmitted as uncompressed data in a stream of 1's and 0's representing black and white, at say 4800 bit/s, it would take almost seven minutes to transmit each page. However, by reducing the redundancy of the signal using a special coding scheme the data to be transmitted can be reduced by a factor of 10 or more making it possible to transmit one page in as little as 40 seconds. The actual reduction factor and transmission time will depend on the detail in the document and on the compression technique used.

DIGITAL CODING TECHNIQUES

As part of the process leading up to setting a recommended standard, a number of alternative coding schemes for minimising the redundant data were submitted to the CCITT for consideration in the study period 1976 to 1980. After much detailed evaluation by the appropriate study group, comprising representatives of telecommunication administrations, manufacturers and service organisations, a recommendation was finalised late in 1980. In comparing the proposed coding schemes, the study group took into account compression efficiency, error sensitivity, patent status, field experience, cost of implementation and future extensions. A one dimensional run length code (modified Huffman) is the recommended standard for Group 3 with a two-dimensional modified relative element address designate (READ) code as an option.

The modified READ code is proposed as the standard for Group 4. Worked coding examples shown in figs. 2, 5 and 6 will be described more fully later.

The document is first optically scanned by the machine's reading head which is typically a large scale integration (LSI) device, about 5 cm long containing at least 1728 photodiodes and charge coupled storage elements. The source document is passed through the machine by a stepping motor at 3.85 steps per mm and a reduced image of the "line" to be scanned is projected onto the LSI sensor and its output scanned electronically. Although the photodiode sensors may be able to handle shades of grey, the digital encoding circuitry interprets the output of the sensing chip as a binary "I" or "O" (representing white or black) for each picture element. This data is then coded to reduce its redundancy before being transmitted.

THE MODIFIED HUFFMAN CODE

In modified Huffman run length coding, the encoding circuitry examines the picture elements in each scanned line and replaces all continuous runs of black and white picture elements with the appropriate code words (see **Fig. 2** for a worked example).

To minimise the total set of code words necessary to code a maximum of 1728 picture elements in a line, two types of code words are used. Run lengths of 0 to 63 picture elements (pels) are encoded with terminating code words while run lengths in the range 64 to 1728 pels are encoded first by a make up code word, representing the run length which is equal to or shorter than that required and then by a terminating code word to make up the required run length. Code tables are published in CCITT Com XIV No. 129-E and the new CCITT recommendation T4 (1981).

The use of a "modified" Huffman code refers to this use of the two code tables, as well as some other minor changes. A true Huffman code would require a unique code for each of the 1728 possible run lengths of each "colour" but the modified code requires only 90 code words for each.

There are different lists of code words for black and white run lengths reflecting the different probability of occurrence of the various run lengths. The measured

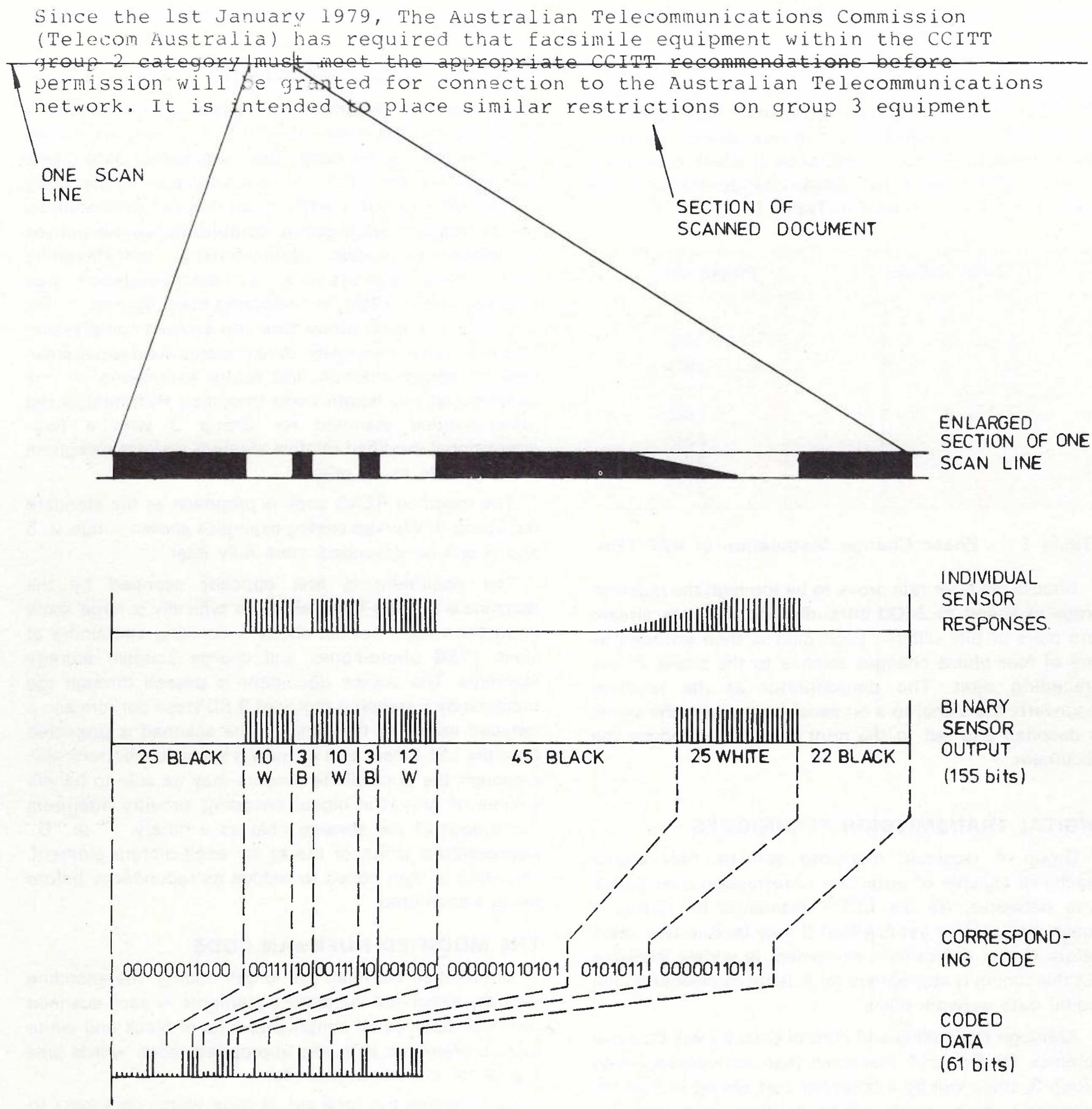


Fig. 2 — One Dimensional Coding of Data Using Modified Huffman Code. (Example shows 155 bits coded to 61 bits).

distribution of black run lengths on a typical document is shown in **Fig. 3**. The code table is so designed that the data run lengths that are more common on CCITT standard documents have been allocated the shortest code words.

In order to ensure that the receiver maintains synchronisation all data lines begin with a white run length code word. Should the scanning line actually start with a black run a white run-length of zero is sent.

Each encoded scan line is followed by an end of line (EOL) code of format 000000000001. This is a unique code word that can never be found within a line of valid data thereby allowing re-synchronisation of lines of data after an error burst.

The essence of the modified Huffman code set which makes decoding possible is that no complete code word

Fig. 3 — Typical Length Distribution — Normal Resolution.

corresponds with the beginning of any other code word, regardless of length. For example as the code word 011 has been defined to represent a run length of 4 "black" bits, there is no code word in the "black" list commencing with 011. Once a terminating code word has been recognised it may be processed immediately and the circuitry re-set to search for the next complete code word of the opposite "colour". The process of decoding received data can be visualised as horizontal movement through a decision tree shown diagramatically in **Fig. 4**.

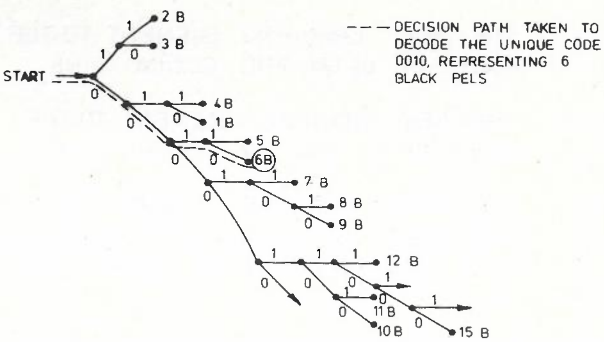


Fig. 4 — Decision Tree For Decoding Received Data (Modified Huffman).

THE MODIFIED READ CODE

Some years after the modified Huffman code was first proposed for Group 3, the two-dimensional READ code was proposed and the modified READ has now been recommended as an option for use with the Group 3 equipment and will probably become a recommended standard for use with Group 4. Whereas one dimensional run length coding converts strings of like coloured pels along a single scan line into shorter code words for transmission, two dimensional coding takes advantage of the high correlation that usually exists between successive scan lines. In this instance code words are transmitted which identify the "colour" (ie. black or white) changes on one scan line (the coding line) in relation to similar colour changes on the previous transmitted, scan line (the reference line).

Any element whose colour differs from that of the previous element on the same scan line is defined as a "changing element". The changing element on the reference line that is to become the next "reference element" is chosen in accordance with the coding rules described below. There are three coding modes available in the modified READ coding procedure specified by the CCITT and the mode to be employed in each circumstance will depend on the data to be coded (see the two-dimensional coding flow diagram in **Fig. 5** and a worked example in **Fig. 6**).

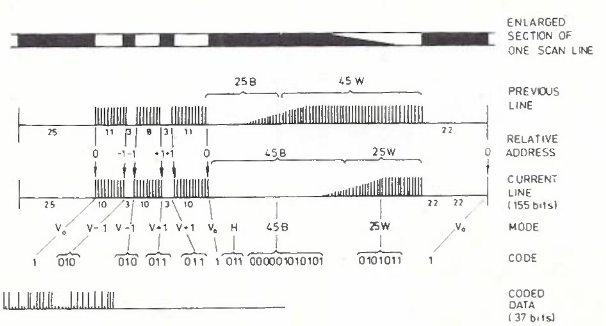


Fig. 6 — Two Dimensional Coding of Data Using Modified READ Code. (Example shows 155 bits coded to 37 bits for transmission).

Pass Mode

If the next element to be coded is beyond the next two changing elements on the reference line, pass mode is coded. Pass mode thus implies that the coding line maintains the same "colour" up to at least this new reference point.

Vertical Mode

The relative distance between the reference element on the previous line and the current element is coded. The changing element to be coded is restricted to being no more than three positions away from the reference element in either horizontal direction.

Horizontal Mode

When a changing element cannot be coded by either a pass mode or a vertical mode then it is coded in a one-dimensional horizontal mode. The run lengths on either side of the changing element are transmitted as modified Huffman codes and the reference point is moved to the next changing element of the same côlour on the reference line.

To the end of every line is added the same EOL word as in modified Huffman coding plus one extra tag bit, either a "1" or "0", to indicate whether one dimensional or two dimensional coding respectively, is to be employed on the next line.

As with one-dimensional coding, CCITT has recommended a modified version of a standard coding scheme, in this case the READ code, owing to the particular requirements of the facsimile application.

The READ code has been modified such that coding in the vertical mode is restricted to within ± 3 pels because in the case of document facsimile, worthwhile correlation seldom exists outside this range. Other modifications involve redefining the EOL code to be the same as with one-dimensional coding and the selection of a code which will allow for future extensions to such facilities as an uncompressed mode, grey scale, a pattern recognition code or an extension to a line length of 298 mm (and 2600 pels) for transmitting A3 size documents.

The inherent disadvantage with vertical coding is that any uncorrected errors will be propagated from line to line until a one-dimensionally coded line arrives. For this reason it is specified that for Group 3 machines, no more than (K-1) successive lines may be transmitted using two-dimensional coding.

The value of K is set by CCITT as follows:

Normal resolution	(3.85 l/mm) K = 2
High resolution	(7.7 l/mm) K = 4

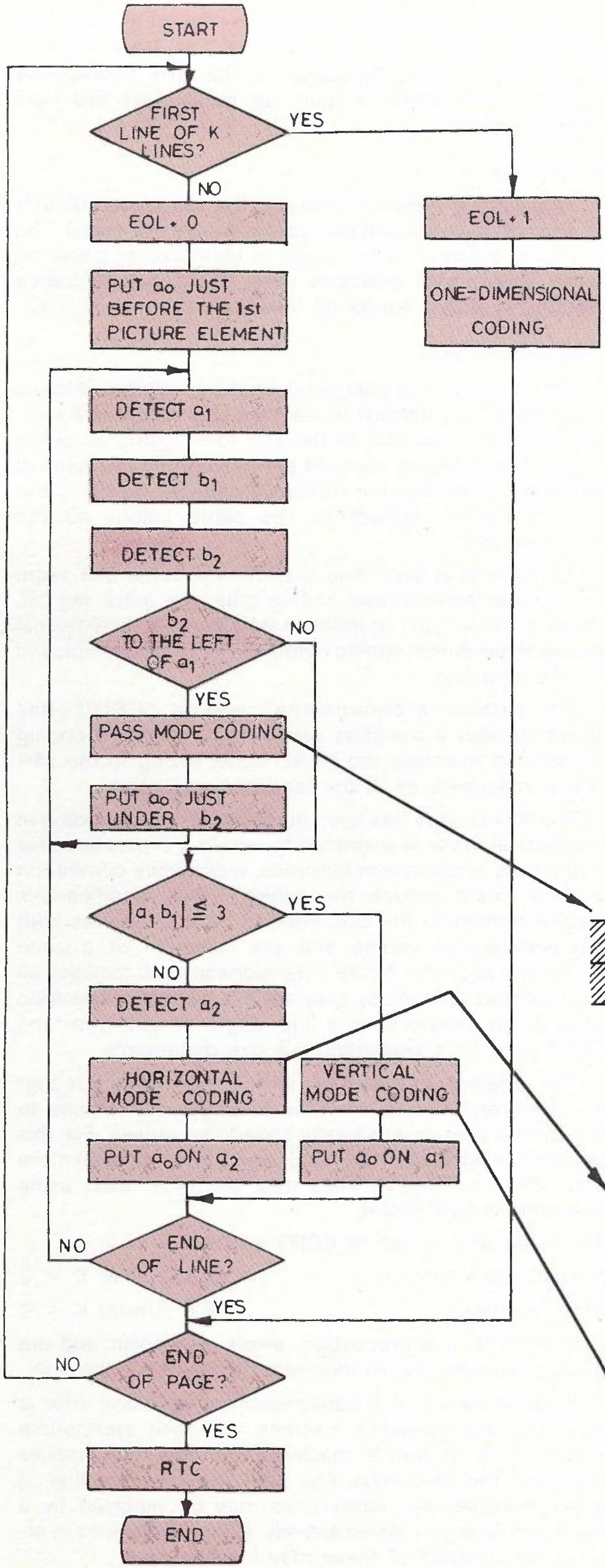
Even with this precaution, errors can occur and are usually detected by an incorrect bit count for the line.

If the presence of a transmission or decoding error is indicated the receiving machine will take appropriate action. In a Group 3 machine this generally implies replacing the erroneous line with the previous line, if good. Alternatively, faulty lines may be replaced by a black line or even deleted entirely. For multiple lines in error a combination of these may be employed.

A Group 4 machine would automatically request a retransmission of any line of data in which errors are detected and, as a result, the value of K can be set to be considerably greater than in Group 3 equipment, leading to an improved compression ratio.

PROTOCOL

One of the major areas of importance in ensuring compatibility is in the protocol. Protocol allows different



2-D CODING PROCESS

a_0	THE LAST ELEMENT CODED ON THE CODING LINE. AT THE START OF A LINE a_0 IS SET ON AN IMAGINARY WHITE ELEMENT PRECEDING THE FIRST ELEMENT OF THE CODING LINE.
a_1	THE NEXT CHANGING ELEMENT TO THE RIGHT OF a_0 ON THE CODING LINE.
a_2	THE NEXT CHANGING ELEMENT TO THE RIGHT OF a_1 ON THE CODING LINE.
b_1	THE FIRST CHANGING ELEMENT TO THE RIGHT OF a_0 ON THE REFERENCE LINE AND OPPOSITE IN COLOUR TO a_0.
b_2	THE NEXT CHANGING ELEMENT TO THE RIGHT OF b_1 ON THE REFERENCE LINE.
•	POINT BEING CODED.
a_0', a_1'	INDICATE NEXT a_0, a_1......

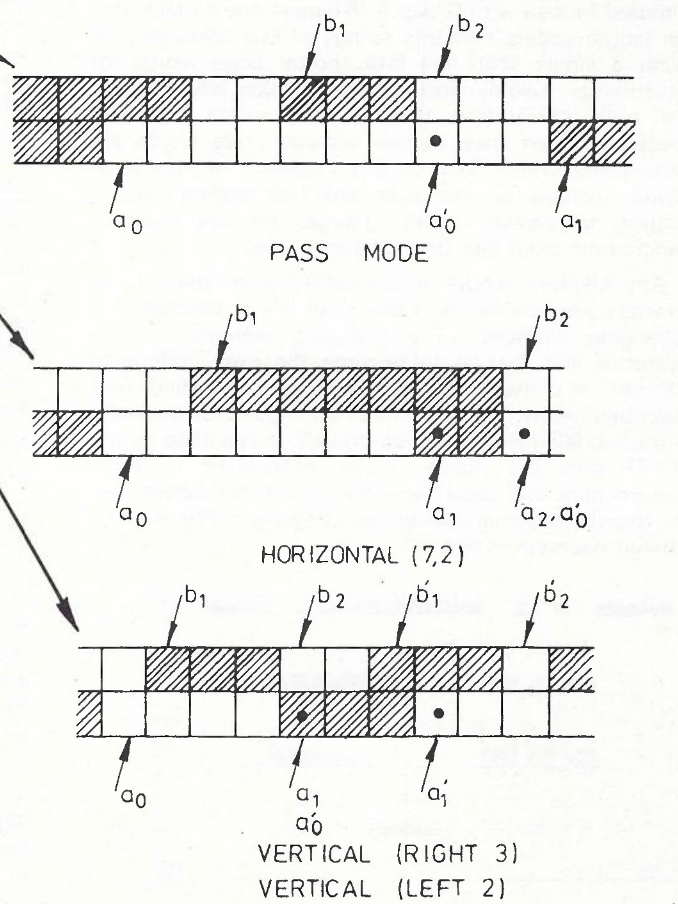


Fig. 5 — Two Dimensional Coding Flow Diagram and Code Examples.

machines to "converse" with each other to set up compatible options and to control transmission but the protocol itself must be compatible.

Line protocol, or handshaking as it is commonly called, serves several essential functions:

- ensures that the machines are from compatible groups;
- makes ready any compatible options;
- advises the transmitter that the receiver is switched on and ready to receive, with sufficient paper and toner;
- enables the machines to commence operation at the maximum common data rate;
- ensures that the transmitter is advised of any reception or timing limitations of the receiver (eg coding techniques, time per scan line, data rate);
- enables the data rate to be dynamically re-adjusted if too many errors are received at the high data rate;
- allows the call to be aborted promptly if a low error rate cannot be achieved;
- conveys confirmation of receipt of a document to the transmitting terminal.

Group 1 and 2 equipment transmit a series of unique tones before, during and after the message to convey the handshaking information.

Group 3 equipment employs a 300 bit/s full-duplex data channel for the protocol which is fully specified in the CCITT Recommendation T.30.

Group 4 equipment being fully digital, will handshake in a fully digital format at the data network rate. The Group 4 procedures will be based on the ISO high level data link control (HDLC) procedures and the CCITT intention is that they will ultimately be compatible with the protocol of other services such as teletex and videotex.

THE FUTURE

Many telephone administrations are now studying and planning for the fully digital telecommunications network. On such a network all traffic will be carried digitally by pulse code modulation (PCM) transmission from customer to customer at 64 kbit/s, with signalling and other services occupying an additional 16 kbit/s. When speech is not required the full 64 kbit/s channel will be made available for services such as data transmission, facsimile or slow-scan television. By suitably multiplexing the speech, signalling and data, it may also be possible that a data rate of up to 80 kbit/s could be made available to the customer for a completely integrated communications facility.

The concept of a multi-service network is universally attractive and these options are under active study in Australia. Terminal equipment designers are working towards the development of more sophisticated integrated terminals, centred around a combination of video display, keyboard and printer/plotter, combined with premium telephone facilities.

A hard-copy printer associated with an integrated terminal such as this will need to handle a wide range of information from VDU images, text, graphs and drawings. It must be able to replace the current stand-alone telex machine, data teleprinter, facsimile printer and graphics plotter.

In this context it is foreseen that the role of the future facsimile printer could be extended from the present stand-alone unit to one of the essential centre-pieces of the much-heralded electronic office.

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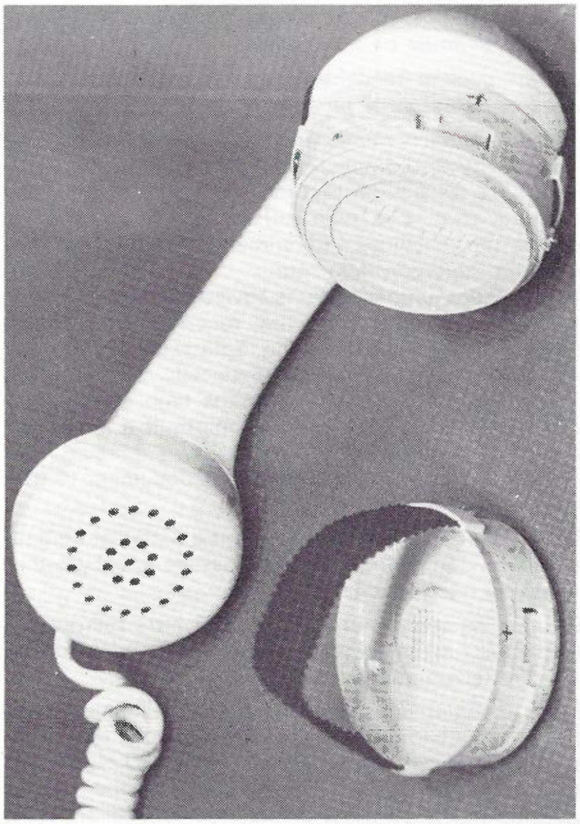
In Brief

HEARING AID COUPLERS

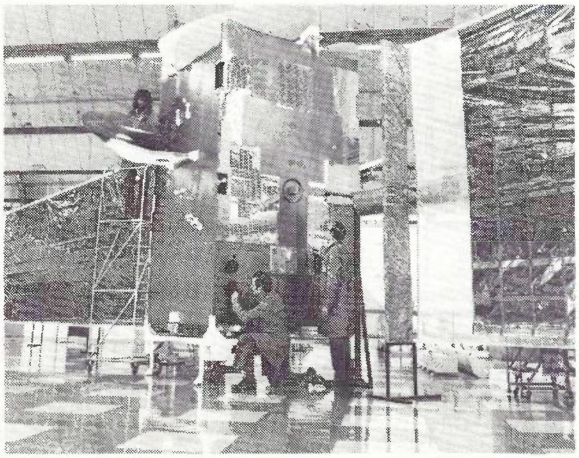
Hearing aids are frequently fitted with a magnetic induction input which may be used as an alternative to acoustic coupling for telephone reception by hard-of-hearing persons. For some years a hearing aid coupler has been available (on request) for installation in the Telecom 800 series handset to enhance the audio magnetic field and improve telephone listening by hard-of-hearing telephone users. Magnetic coupling is generally superior to acoustic coupling to hearing aids because the levels of environmental magnetic noise are effectively lower than acoustic levels, particularly in places such as railway stations, airports and large offices.

The existing hearing aid couplers are fitted to individual telephones in response to customer requests and there is a need for a portable coupler which can be used on any telephone.

Telecom Research Laboratories have designed such a coupler and the design concepts were recently evaluated in field experiments with telephone users receiving the services of the National Acoustic Laboratories and the Australian Association for Better Hearing. Although there were some difficulties arising from the wide range of sensitivities among the hearing aids used, together with other difficulties due to the type and degree of hearing impairment, as well as transmission quality variation on telephone connections, almost all of the participants were enthusiastic about the benefits they derived from the use of the portable coupler. As their confidence in the use of the coupler increases, hard-of-hearing people are expected to significantly increase their usage of the telephone service.



The new hearing aid coupler detached (lower) and fitted to a telephone handset. The coupler is intended to be used with modern ear-level hearing aids.



THE L-SAT.

The proportions of L-Sat 1 — destined to be one of the most powerful communications satellites in the world — are conveyed by the photograph of a full scale model built in U.K. Spanning 55 metres (180 feet) and rising 7.6 metres (25 feet) from the shop floor, the model was made to aid design work on equipment the satellite will carry when it is launched by Ariane rocket in 1986.

L-Sat 1 is being constructed under a contract from the European Space Agency. It will weigh about 2,300 kg (5070 pounds) and carry an array of solar cells developing 3,000 watts — three times the power of current communications satellites.

The L-Sat system will extend and improve the reception of television signals beamed direct to the home where domestic dish aerials will allow the user to pick up a wider range of programmes and ensure better reception in areas previously beyond the reach of ground-based transmitters. Business communications will also be possible between small earth stations installed on commercial premises; and interference will be reduced through the use of much higher frequencies.

Operations and Maintenance Aspects of the Mobile Control Centre and Mobile Base Stations

J. L. SEAMONS, Grad I.E. Aust.

A general description of the operations and maintenance facilities that have been provided with the Mobile Control Centre (MCC) and the Mobile Base Stations (MBS), and an outline of how the maintenance approach to this equipment has been organised.

INTRODUCTION

Telecom Australia has introduced stored program controlled (SPC) switching systems into both the trunk network (Metaconta 10C system) and the terminal telephone network (ARF conversion to ARE-11, and installation of AXE equipment). With the selection of the NEC tendered Mobile Telephone System (MTS), a further SPC system was introduced into the telephone network with the cutover of the Melbourne system during September 1981.

Although the system as originally tendered had many favourable maintenance and operational features, the experience gained with the knowledge of the other SPC systems led to Telecom specifying further additional operational features that were to be included in the equipment purchase. The introduction of these added facilities allowed Telecom to introduce a maintenance approach to the MCC equipment, which was consistent with the approach used in maintaining other SPC switching equipment.

This paper provides a general description of the operations and maintenance facilities of both the MCC and it's associated MBS, and then outlines how the maintenance approach to this equipment has been organised.

MOBILE CONTROL CENTRE FACILITIES

The MCC equipment contains a substantial number of operations and maintenance facilities that are available for maintenance purposes. **Fig. 1** is a block diagram of the MCC and a MBS with the red shading highlighting those items of equipment which include or provide the maintenance facilities described within this section. Table 1 of Ref. 1 provides a complete explanation of the abbreviations in this figure, however, it should be noted that this figure includes an updated arrangement for maintenance activities which, along with other facilities, are described within this section.

Man-Machine Communication

Interrogation of the MCC and MBS components of the overall system is provided via standard input/output terminals. As can be seen from the system block diagram, there are at present four such terminals connected to the MCC, although it is possible that with provision of additional interface equipment, up to 12 such terminals could be connected. A unique system command language is used for all man-machine communication. The individual terminals may be categorised to define which operations may be performed from each terminal; password restriction can be allocated to commands to further provide security of access to the system.

Alarm Structure

Alarms within the MTS system are structured on a three tier level, consisting of major alarms (MJ), minor alarms (MN) and caution alarms (O1).

All alarm information is stored in software alarm buffers, which may be interrogated from an input/output terminal. The individual buffer for any of the three categories of alarms may be interrogated, or information contained within all buffers may be interrogated with a single command. When a display of alarms is requested, the typed out response indicates the time of day, an error message number, and a brief description of the alarm condition. The error message number directs the maintenance personnel to a particular fault restoration procedure contained within the System Maintenance Manual.

Switchblock Supervision

Supervision of the switching network (TLN) of the MCC can be performed by either a manual or an automatic test. The conditions that are checked during these tests are continuity (CON) and false cross and grounds (FCG).

In performing a manual test, a command is entered via an input/output terminal indicating the tertiary junctors and trunk links to be used. The CON test may be performed on almost any switching path through the network, whilst the FCG test is performed on the ring back trunk (RBT) to incoming trunk (ICT) connections only.

To perform an automatic test, a separate command is required, with a further command being necessary to cancel the initial command. The command for the automatic test is structured such that a counter may be set to vary the frequency of the test. ie, the counter may be set so that the test is performed on every call, every second call, or up to every 255th call. In the event of a fault being detected, the information relating to the connection is stored in the alarm buffer (as a minor alarm)

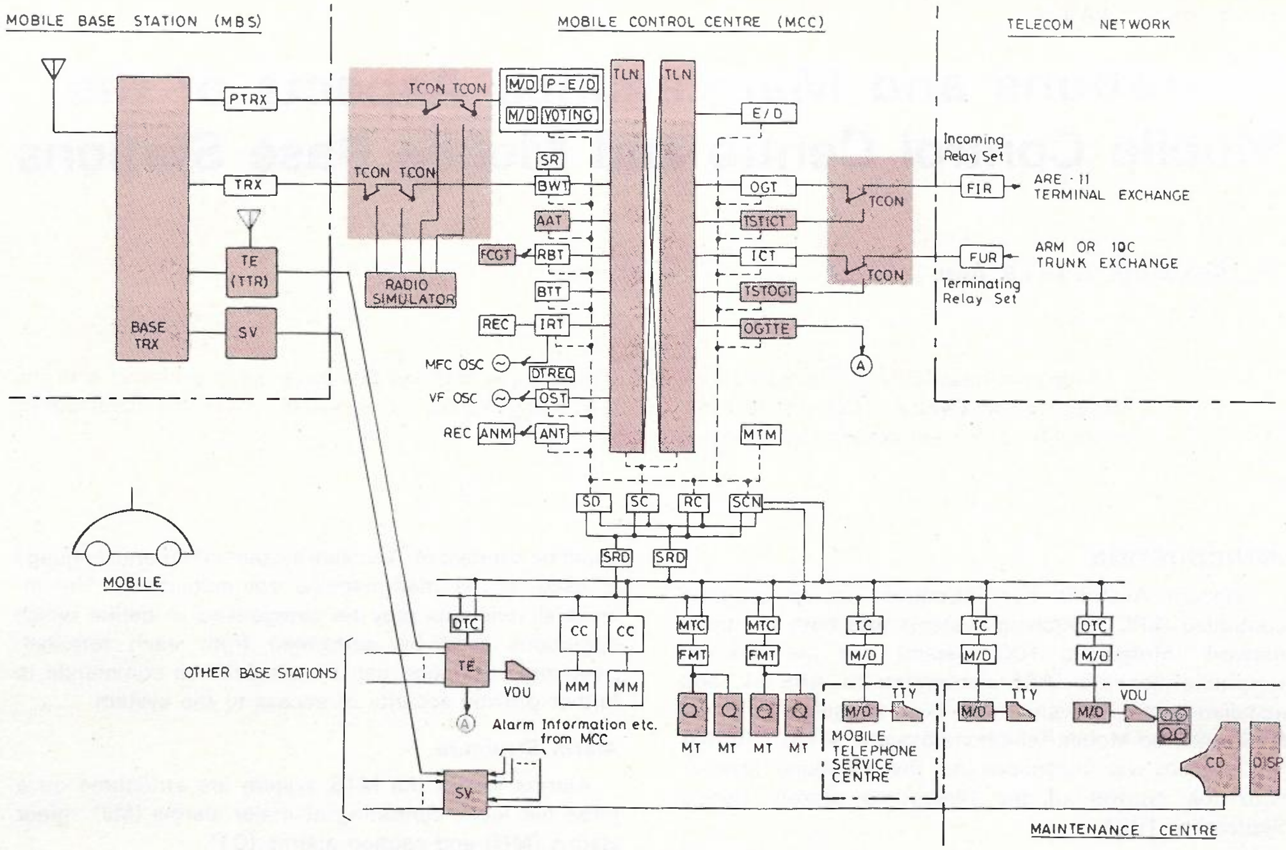


Fig. 1 — Block Diagram of Mobile Telephone System.

and a software minor alarm is generated to alert maintenance staff of the fault.

A further counter is provided to determine whether information of a faulty connection (switching path) is stored in the buffer after the first faulty test result, or up to the 255th faulty test result.

Once information about the connection is obtained from interrogating the alarm, it is then possible to set up a test of the network to manually check the switching path.

Switching System Supervision

The principal means of monitoring the MCC equipment performance is by the use of on-line supervisory and diagnostic functions. These functions are contained within the system software and continuously, automatically, monitor the performance of the various sub-systems, trunks and routes during the course of normal traffic handling.

For individual devices and routes, a software counter is decremented by one for each seizure, and is incremented by a certain amount for each disturbance (ie, a signal failure or time release), to provide disturbance supervision. The amount of incrementing depends on the percentage disturbance level required, which is specified in the registration command.

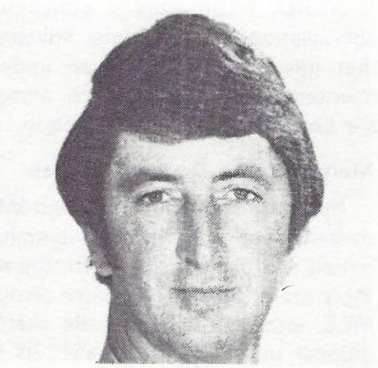
If the percentage limit of disturbances is reached or exceeded, an alarm is generated. The class of alarm generated is also specified in the registration command. If an acceptance limit is reached, the software counter is reset to it's initial value and any alarm previously generated is also reset.

Disturbance supervision is performed continuously after registration, until cancelled. As well as applying to signal failures and time releases on routes or individual devices, disturbance supervision of both the FCG and CON tests is also available, whereby an alarm may be generated at any time that a predetermined level of either test has been exceeded.

John Seamons joined the Post Master Generals Department in 1971 as an Engineer Class 1. Until 1978, he was engaged in operations and maintenance aspects of telephone switching and subscribers equipment as a field engineer in the Victorian Administration.

In 1978 he was promoted to a position of Senior Engineer working on ARE-11 operations and maintenance policies in the Network Performance and Operations Branch at Headquarters. It was during this period that John became involved in the MTS project due to its interface into the ARE-11 system.

His current position is Engineer Class 4, in the Exchange Switching Service Section of the Network Performance and Operations Sub-division.



Idle Trunks Audit

A continuous automatic audit of all trunks is carried out at a specified time interval. Any trunks that have been idle for all of the supervision period are written into an alarm buffer and a caution alarm is generated.

The specified time interval can be set at 15 mins., one hour, or 12 hours.

Busy Trunks Audit

A continuous automatic audit of all trunks is carried out at every 10 minute interval, and each trunk that is busy at the time of these audits, is recorded in software. Any trunks that have been continuously busy for a preset period of time, are written into an alarm buffer and a caution alarm is generated. The relevant details pertaining to the busy trunk(s) are then available by interrogation of the alarm buffer.

The preset time can be set anywhere between 10 minutes and 12 hours in 10 minute steps.

Radio Simulator

At each MCC, a radio simulator has been provided as a test mobile set for carrying out MCC internal (and external) connection tests. A front view of the radio simulator equipment is shown in **Fig. 2.** The radio simulator can be connected with any paging modem, and any both way trunk (BWT) via the test connector line by software control. The radio simulator has 2 test mobile sets, either one of which can provide hand-off (Ref. 2) call simulation.

The radio simulator has the following basic testing functions when configured with the testing system:

- outgoing connection from mobile to the telephone network;
- outgoing connection from telephone network to mobile;
- incoming connection from telephone network to mobile;
- Mobile to mobile connection through the telephone network;
- outgoing/incoming connection through test trunks in MCC, and
- hand-off connection between two simulated zones.

Speech Path Test Equipment

The speech path test equipment consists of a test incoming trunk (TSTICT), test outgoing trunk (TSTOGT), test connector (TCON) interface circuit, radio simulator interface circuit, and a test equipment (TE) interface trunk (OGTTE) circuit (Refer to Fig. 1).

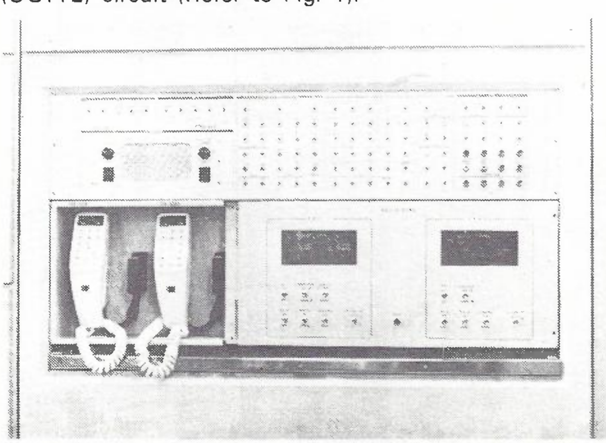


Fig. 2 — Radio Simulator, Windsor MCC.

The TSTICT/OGTs are associated with the switching network (TLN) and are used to connect an OGT or ICT via the test connector for internal connection tests, isolated from the normal switched telephone network.

The TE interface trunk is also associated with the switching network and connects the TE for any maintenance connection tests. (Refer to section on MCC and MBS facilities).

Automatic Answering Trunk

An automatic answering trunk (AAT) is provided at each MCC so that network testing from an automatic exchange tester (AET) or a traffic route tester (TRT) can be directed to a normal MTS number, which is allocated to the AAT.

The AAT functions in the same manner as a tone answer relay set, by applying an answer signal and then releasing. The answer condition and release of the AAT is compatible with that necessary for the automatic stepping of TRTs and AETs.

The AAT can be accessed by dialling either the normal AAT number, or the normal AAT number with a foreign service area code included, for testing of the roaming facility (Ref. 3).

Traffic Measurements

The MCC software has an extensive traffic package included, which allows for various traffic measurements to be made, following the inputting of registration commands. The commands are structured to allow the required traffic information to be collected over measurement cycles varying from 15 minutes to weekly. The traffic information may be output to a teletype, or onto a magnetic tape for sorting by a computer.

Recent Change Recording

The system software and data is recorded on a magnetic tape in a dedicated magnetic tape unit (MTU). This magnetic tape contains a dump of the main memory, and is used in the event of a fault corrupting the system memory in the extent that a reload, or recovery, is necessary. (Ref. 1).

Recent changes to the system data are recorded on a magnetic tape cartridge associated with a VDU. At regular intervals, a complete system reload dump is made to produce a new reload tape. Any subsequent changes to the system (customer validations, program patches, data changes, etc.) are made via input/output devices, which when successfully completed are echoed back to the VDU where they are stored on the magnetic tape cartridge. During a major recovery, after the reload tape has been loaded, the MCC automatically reads the magnetic tape cartridge to ensure that all changes to the memory have been recorded.

If for some reason this cartridge cannot be accessed by the MCC, an alarm is generated and further input commands which are required to be stored on the cartridge are inhibited.

Automatic Recoveries

Although the MTS is designed as a highly reliable system, a fault recovery system is incorporated in the design to ensure continuous system operation. This is carried out by checking the operation of both the hardware and the software on a call by call basis. If a fault occurs, the faulty unit is promptly disconnected from the system by the recovery program, and the switching operations are automatically restarted immediately from the point where the trouble occurred.

Built into this system of automatic recovery are three different phases of recovery; generally, a specified number of the lower phase recoveries lead to a higher phase recovery occurring, and so on. The counters related to this phased recovery approach are automatically reset every 24 hours.

The actual automatic phased recoveries are designated as phase 1, phase 2 and phase 2.5; there is one further phase of recovery (phase 3) which is not automatic but requires manual intervention to recover the system. Each of the automatic recovery processes have different effects on the customer, call charge record (C-CR) and MCC equipment.

MCC AND MBS FACILITIES

Due to the interworking of the radio system and the switching system, there is an interface area for which various operations and maintenance facilities have been introduced. These can provide maintenance staff with information related to either the MCC or the MBS, or both. The shaded areas of Fig. 1 indicate those items of equipment which provide or contain the facilities which are described within this section.

Test Connector

The TCON has been provided for connecting the radio interface lines, and the switched network interface lines, to the radio simulator and the TSTICT/OGTs respectively. It can also be used for monitoring the radio interface lines as instructed by software programs.

The TCON is basically composed of magnetic latching relays mounted on printed circuit boards (PCBs).

Supervisory System

The supervisory system (SV) has been provided to allow remote supervision of unattended MBSs at both the MCC and the maintenance centre (MC), and remote supervision of the MCC from the MC. The supervisory system consists of the following items of equipment.

- MCC Equipment

  This consists of one rack **(Fig. 3)** which when fully equipped can supervise 10 MBS sites. Signals from the respective MBS's are indicated locally on this equipment (as well as being sent to the MC and displayed on a console). Up to 16 items of MCC equipment can be supervised and are displayed locally as well as being sent to the MC. Two items among those supervised from each respective MBS are sent out from the SV equipment as emergency alarms.

- MBS Equipment

  At each MBS, the SV equipment consists of one rack **(Fig. 4)**, which when fully equipped can supervise 96 items. Local indication of the supervised items is performed.

  The MBS supervisory equipment arranges data which shows the status of all supervisory items, and data which shows the status change indication of the supervised items, and sends out this data repeatedly to the MCC and the MC. The MCC and MC equipment detects the presence or absence of any status change

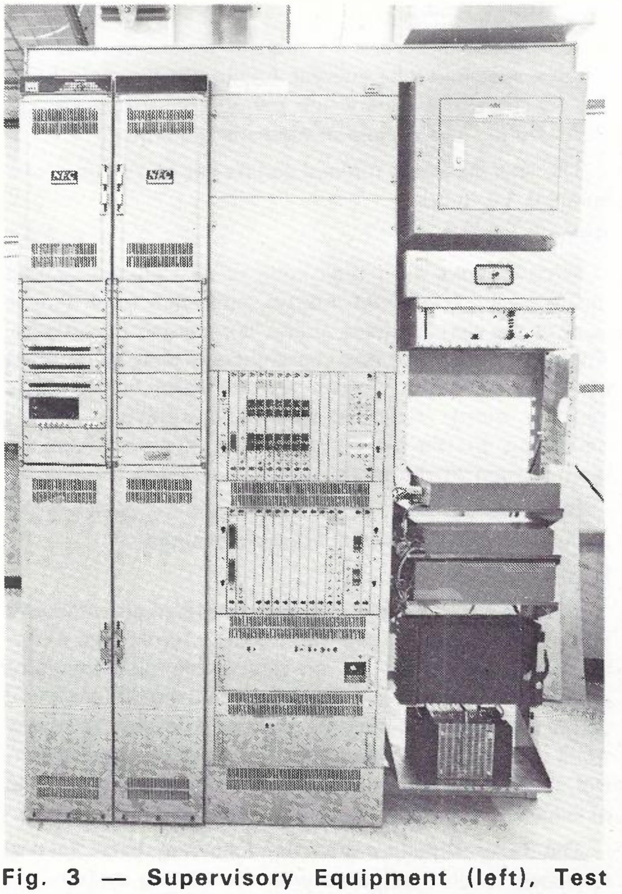


Fig. 3 — Supervisory Equipment (left), Test Equipment (Centre), and Miscellaneous/Modem (right), Racks at Windsor MCC.

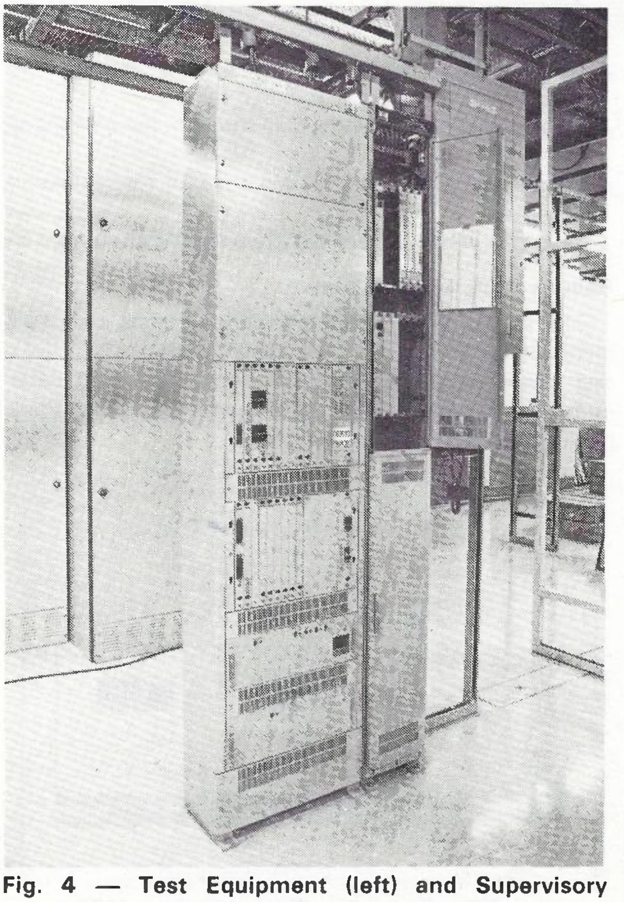


Fig. 4 — Test Equipment (left) and Supervisory Equipment Racks at Lonsdale MBS.

and when a change is detected, a visible and audible station alarm is given.

When the maintenance personnel select a station to be supervised by the alarm indication, the status of the supervised items of the applicable station are indicated. Station alarm, indication, station selection etc, are all performed on the front panel of the rack at the MCC and on the console at the MC.

The supervisory equipment of the respective MBSs are connected to the SV equipment at the MCC through individual 2 wire VF lines employing 50 baud FSK signalling, and are combined by this SV equipment and relayed to the MC through frequency division arrangements via a 2 wire VF line.

Radio System Test Equipment

The purpose of the radio system test equipment (TE) is to check its own connecting operation from the MCC to the MBSs, and to check the performance characteristics and signalling sequences of the radio system. The radio system test can be performed from either the MCC or the MC. The VDU at either location can be used for commanding the start of the radio system test, and for outputting the test result. The control of the radio system test procedure is performed by the TE equipment at the MCC.

At the MCC, the TE equipment consists of one rack which when fully equipped allows testing of up to 10 MBS sites (Fig. 3). The equipment is connected to the MCC and the VDU. When a system test command is applied from the MCC or MC VDU, the test procedure is controlled by using the system test equipment of each MBS and the test result is summarised and outputted to the appropriate VDU.

At each MBS, the TE equipment consists of one rack (Fig. 4) incorporating a fixed test transceiver (TTR) and allows a radio system test in the MBS by using the test equipment at the MCC.

The TE can perform various modes of tests, combining individual tests as required. The tests may be either automatic, or manual. In the case of automatic tests, the procedure is such that the test is performed sequentially in the order of low to high channel numbers of each radio zone. If a channel is busy, it skips to the next channel; in the case of manual test calls, only the assigned radio zone and channel are tested.

A four wire voice line (FSK modulation, 1200 bits/s) is used for the control line between the MCC, and MBS, TE equipment.

The individual tests performed by the TE equipment are as follows:

Transmitter Output Power Check

The output power is detected by an output power monitor circuit mounted in each transmitter of the MBS. The outputs from these monitor circuits are connected to the TE rack at the MBS which selects the transmitter under test and reads the test result. This result is then forwarded to the MCC TE which determines whether the test result meets the specification or not; if not the test report is outputted to the VDU.

Transmitter Deviation Check

A test signal with the required level is sent from the MCC TE equipment, to the MCC, to the base station and finally to the MBS TE, and the level of the test signal is measured by the measuring section of the MBS TE. The test result is then sent to the MCC TE which determines whether the test result meets the specification or not, and sends the result of the determination to the VDU.

Limiter Current of Receiver

The MBS TE produces an output with the required level and the receiver limiter current is measured by a limiter current detector mounted in each receiver. The measured output of all receivers is separately connected to the MBS TE, which selects the receiver under test and reads the test results. These are then sent to the MCC TE which determines whether the test result meets the specification or not, and the result of the determination is sent to the VDU.

Demodulated Output of Receiver

A test circuit of MBS TE, to MBS receiver, to MCC TE is formed, and a test signal with the required level is sent from the MCC TE and the level of the test signal received by the MBS TE is measured. The test result is sent to the MCC TE which determines whether the test result meets the specification or not and sends the result of the determination to the VDU.

Off Air Monitor

Every time a mobile customer originates a call, the access channel (A-ch) is monitored for excessive signal deviation, which could affect adjacent channels. This is automatically detected by an off-air monitor, which is included as part of the MCC hardware. When detected, a caution alarm is generated and although the customer is not prevented from making the outgoing call, the customer's number is stored in the alarm buffer for interrogation and subsequent invalidation if interference is caused to other customers.

Speech and Paging Channel Supervision

The data channels used to connect the MCC to the various MBSs can be supervised automatically for any disturbances, particularly time-outs. This supervision is set by a command which indicates the alarm class, the route name and the preset disturbance value. If disturbances exceed the preset value for the particular route, then an alarm is generated. A further command is necessary to cancel the supervision on any route.

Access Channel Supervision

If the A-ch on a particular zone has not been in use for a period exceeding three minutes, the TE through its test transceiver originates a call and checks for receipt of the channel assign code (Ref. 2) to determine proper operation of the A-ch transmitter/receiver and approach lines. If the code is not received, the TE will ground the A-ch receiver m-wire to force the MCC to change the A-ch. If the A-ch is not changed, an "A-ch approach alarm" is issued by the TE to the SV; if it is changed, the TE originates another call on the new A-ch and this is tested for success.

MBS FACILITIES

In addition to the various facilities mentioned under the previous section, there are further operational facilities provided at the MBS sites to assist the personnel maintaining the equipment.

The equipment in use at the MBS employs plug-in panels and therefore its maintenance is generally carried out by panel replacement. The faulty panel would be located using the fault diagnosis flow charts provided, and repair of the faulty panel is then performed by using a separately provided repair manual.

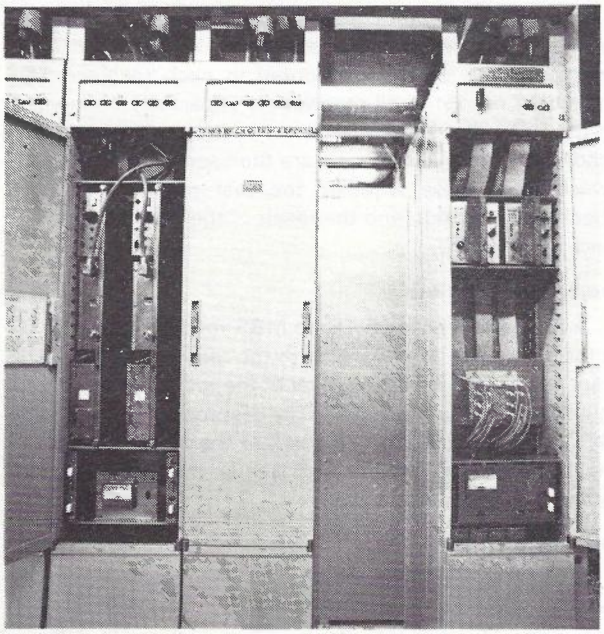


Fig. 5 — MBS Transmitter (left) and Receiver Racks.

Some of the various individual facilities provided at the MBSs are described in the following paragraphs:

Transmitter

The transmitter is of all solid-state construction employing transistors and integrated circuits in all units, including the power amplifier unit, thus ensuring high reliability. Protection is provided against the opening or shorting of the output terminals at the maximum transmitter output power of 25 Watts, and an alarm is indicated if the output of any unit falls below a specified preset level.

The operating conditions of each item of equipment (and its component units) can be monitored by the state of LEDs, corresponding to respective sections of the equipment. Similarly, alarms are indicated by lamps located on the front panel of the units, as well as on the top of the bay or rack. **(Fig. 5).**

The transmitters also have the following features:

- a TEST terminal on the front panel which can be used for checking of the transmitter frequency and modulation characteristics;
- a MAINT switch for use when maintenance work is being carried out. When this switch is depressed, the maintenance indicator lamp lights, and a loop signal is sent to a terminal at the top of the bay. All alarms of the equipment are then disabled, and are not forwarded to the SV;
- two further switches can also be used in the. event of testing, maintenance or repairs being carried out. A MANUAL switch when depressed, will disconnect the transmitter control wire from the MCC, and allows the transmitter to be manually controlled by using the transmitter (TX) switch;
- a built-in meter is provided for use in monitoring the output voltage of the power supply, and the transmitter output power and current.

Receiver

The receiver is of all solid state construction, again ensuring high reliability. When faults are encountered, the voltage and/or current at each point can be checked for normality by indicator LEDs, alarm signals and meters mounted on the METER UNIT to localise the faulty unit. Alarm lamp indications on the top of the bay, and on the faulty unit are given when the power supply, receiver or carrier detector units within the equipment, fail.

The METER UNIT (lower panel of receiver rack, Fig. 5) consists of a RESET switch for the resetting of alarms, a MAINT switch for informing the SV equipment that the unit is in a maintenance condition (therefore shutting down alarms to the SV) and meters for indicating the output voltage of the power supply, receiver input levels, etc.

MCC AND MBS MAINTENANCE ORGANISATION

To achieve efficiency in operation and maintenance of the MTS equipment, it was necessary that a maintenance organisation be developed to meet the characteristics of the SPC switching system, and to make full use of the various facilities that have been included with the system.

It was anticipated that the general maintenance workload required, especially for the MCC equipment, would be minimal. This was based on the characteristics of the SPC system, such as:

- a low number of faults per plant unit — the operation of the model MCC (Ref. 2) over a 12 month period indicated the high reliability of the MCC equipment;
- design features which minimised the service impact of faults and reduced the need for immediate attention to certain faults — the automatic recovery processes, and the self blocking of faulty equipment;
- the ability to perform a large proportion of operations and maintenance activities from an input/output terminal, which could be remotely located from the MCC;
- detailed flow chart type documentation to assist in fault investigations when error messages are outputted from the input/output device;
- a minimum of scheduled testing requirements, such as were developed for earlier electro-mechanical switching systems — certain routine functions however, such as removal of charging tapes, cleaning of tape drive heads etc, are still required.

The Maintenance Centre

Taking the above characteristics into account, the maintenance organisation for the MCC and the MBSs has been incorporated in a previously existing maintenance organisation that already had the maintenance responsibility for other SPC technology switching systems.

This maintenance centre approach was introduced into both the Windsor (Vic) and Haymarket (NSW) installations, by employing 10C trunk exchange maintenance personnel. In both installations, the MCC equipment is located in the same building as the 10C trunk exchange equipment, thereby providing convenient access to the MCC during those times when on-site activity is required.

It was also considered that the group maintaining the MCC should have the first-in maintenance responsibility for the associated MBSs. This first-in responsibility extends only as far as complete interrogation of the MBS alarms.

The benefits obtained from using this MC approach have been:

- efficient use of trained staff has been made;
- a disciplined approach to data changes has been more easily obtained from staff already applying such procedures;
- retention of SPC maintenance skills has not presented a problem as staff are continually working on other SPC systems;
- effective use of supervisory and test equipment, common to both the MCC and the MBS has been achieved.

Under this MC approach, the maintenance VDU and the supervisory console are located in the 10C exchange maintenance control room **(Fig. 6)**. Any alarms that are generated from either the MCC or the various MBSs are displayed on the supervisory console, and detailed analysis can then be performed using the console and the VDU.

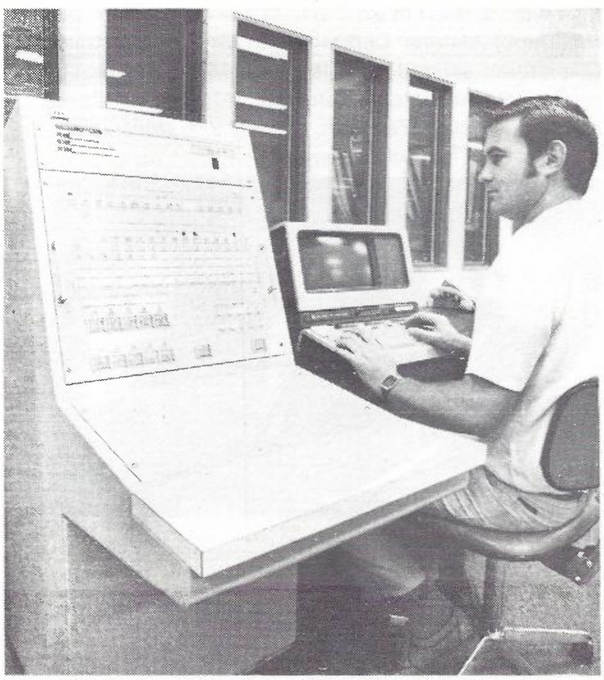


Fig. 6 — SV Console and Remote VDU at the Maintenance Centre.

The maintenance centre staff are therefore responsible for the performance, operation and maintenance of the fixed equipment. They perform the various tasks that are required at the MCC from the input/output terminal located in their maintenance control room. These tasks include fault analysis, performance assessment, equipment blocking and unblocking and general maintenance procedures.

In the case of the MBSs, the maintenance centre determines the actual alarm condition and this information is then passed to the relevant radiocommunications maintenance group who take any necessary action to clear the fault.

The National Support Centre

A national support centre (NSC) for the mobile telephone service has been established at Parramatta, NSW, with a model MCC installed in Parramatta exchange.

The model MCC is used to proved support facilities for testing software and hardware, and for verifying the interworking with other equipment. The model MCC has been provided with the same hardware and software as in the two field exchanges, although not to the same extent.

The major aims of the NSC are to provide sufficient and responsive detailed technical support for MCC installations throughout the network, and to provide a single point for co-ordination of the system software used by those MCC installations.

The main responsibilities of the NSC are:

- testing of new MCC hardware and software before their introduction into field exchanges;
- preparation of system software to maintain the program and data status of the MCC field exchanges;
- investigation of fault reports received from MCC field exchanges;
- provision of a 24 hour service for consultation with field exchange staff in cases of severe system failure.

CONCLUSION

Telecom's Mobile Telephone Service is a modern SPC system which has been developed with many operations and maintenance features, some of which were standard with the NEC design, and others which NEC developed specifically for Telecom Australia.

The introduction of these features, which have a direct bearing on the procedures employed in maintaining the system, has led to a maintenance organisation being established, utilising an existing maintenance centre experienced in SPC switching technology.

This has provided a disciplined approach to all operations and maintenance activities, which is necessary to ensure that the potential maintenance benefits available with this SPC system are fully realised, and that any disruptions to service are minimised.

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In Brief

INTERNATIONAL DATA STUDIES

In March 1982 Telecom Australia hosted a meeting of CCITT Study Group VII, Working Parties VII/3 and VII/5.

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

The CCITT Study Group VII on "Data Communication Networks" is responsible for the development of recommendations for data communication networks, with emphasis on networks employing digital rather than analogue technology.

The X-series recommendations promulgated by Study Group VII cover user facilities, interfaces for data terminal equipment and networking aspects of data networks. The standards have won international acceptance and, in particular, recommendation X.25 is the basis for connection of computer systems to the Australian public packet switched network 'AUSTPAC'.

Study Group VII comprises five Working Parties, two of which met in Melbourne.

Working Party VII/3 is concerned with network interworking, switching and signalling. It is responsible for the development of signalling schemes and protocols for the international interconnection of data networks.

Recommendations from Working Party 3 are primarily of interest to network administrations to increase the scope and flexibility of interworking between different networks.

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

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

A capacity attendance of 450 attested to the interest being shown in data communication standards in Australia.

The topics covered were wide ranging and of interest to users, suppliers, manufacturers and network providers alike.

Following the Seminar, Telecom's Commercial Services Department held a Telecom Data Forum which introduced some of Telecom's new data services.

The official opening of the Seminar was performed by the Chairman of the Australian Telecommunications Commission, Mr Robert Brack A.O. pictured second from left with Mr E. Sandbach, Director of Research, Telecom, Mr W. Pollock, Managing Director, Telecom, and Mr V. C. McDonald, Chairman CCITT Study Group VII.

INTERNATIONAL CO-OPERATION

The Australian Development Assistance Bureau and the Confederation of Australian Industry (CAI) have reached agreement on a new concept in Australian development assistance. The scheme, called the Australian Executive Service Overseas Program (AESOP) will be managed by CAI.

AESOP is designed to provide experienced Australian executives, managers and technicians to assist indigenous enterprises in developing nations of the South Pacific and ASEAN region.

AESOP experts will provide their services on a voluntary basis for short term assignments which will normally be completed within six months. Airfares for volunteers will be paid by AESOP. Accommodation and living expenses will be met by the enterprise receiving assistance.

The AESOP scheme is intended to provide practical assistance to developing countries to achieve economic growth by helping them to strengthen and improve the effectiveness of their own organisations and institutions.

The scheme provides opportunities for retired and active Australian executives, managers and technicians to make a voluntary contribution to development assistance by placing their expertise and experience at the service of enterprises in developing countries.

AESOP offers a unique means of increasing co-operation and understanding in relations between Australia and the peoples of developing countries.

Telephone Transmission Quality: Customers' Opinions. Part 2.

R. G. KITCHENN B.Sc (Eng)., C. Eng., M.I.E.E., R. P. KILLEY B.E.E.

Each of eight terminal-exchange areas in metropolitan networks was classified in terms of a 100% survey of customer line plant, (which yielded calculated distributions of send and receive reference equivalents) and a traffic-weighted distribution of inter-exchange loss to all other exchanges in the same metropolitan area.

By convolving the various distributions into a distribution of overall reference equivalents associated with each exchange, assuming likely distributions of noise levels, and applying the results of part 1 of this paper, it was possible to estimate percentages of customers' adverse opinions for such distributions. For a given exchange, the opinion levels so derived are those of the composite of the customers throughout the rest of the network who converse on calls made by all customers at the given exchange.

The techniques in this article cannot usefully be extended to give a measure of the adverse opinions of customers at the given exchange.

Results are given in terms of %D and %(P+I) for the respondents on calls from each of the eight sample exchanges. They are indicators of network transmission performance under present transmission plans.

APPLYING THE SURVEY 'LAWS'

Part 1 of this paper described a survey in which the opinions of 3148 telephone customers were obtained about the transmission quality of test calls made to their homes or work-places. Each customer's opinion concerned one randomly selected combination of overall reference equivalent (ORE) and normalised line noise (LN(O)). The composite of these 3148 opinions yielded statistical 'laws' relating customers' subjective opinions to the objectively measurable (or calculable) characteristics of telephone connections.

This part of the paper describes the application of these 'laws' to actual network situations to obtain assessments of customers' views of the transmission performance that is currently being achieved in practice. Assessments are made for the busy-hour calls originating at eight selected metropolitan exchanges. As described below the method of calculation adopted allows a reasonable estimate to be made of the conditions applying for the transmission of speech from the originators ('A' parties) of these calls to their respondents ('B' parties) at the other exchanges within their metropolitan networks. The opinions assessed are accordingly those of the recipients of the busy-hour calls generated at the selected exchanges; own-exchange calls are included in the assessments.

THE EXCHANGES

The particular assessments made in this paper are concerned with the current performance of junction and own-exchange calls originated at suburban exchanges.

(NOTE: Alternative data could be used to make assessments for other types of calls. These could include, for example, calls from inner city, provincial or rural exchanges and might relate to calls within a closed numbering area or to calls using various parts of the national trunk network. The method could also be used to study the effects of projected network developments on the customers' perception of transmission quality. Appropriate data could be used, for example, to forecast customer-transmission opinion at significant points during the transition to an integrated digital network. In view of space constraints the assessment of these alternatives has not been undertaken in this paper).

The eight selected exchanges represent both older and newer technology. The classification was broadly based on establishment during the step-by-step or the crossbar eras of network development. This point in time also coincided with significant changes in external plant practices including the change to lighter-gauge customer cables. One older and one newer exchange were chosen in each of the Adelaide, Melbourne, Sydney and Brisbane networks. The selected exchanges are listed with pertinent details in **Table 1**.

NETWORK DATA

In order to apply the 'laws' relating customers' opinions to transmission characteristics it was firstly necessary to determine, for each exchange, statistical frequency distributions of ORE ('A' party to 'B' party) and LN(O) ('B' party). Data for the determination of these frequency distributions were obtained by the State Planning and Programming Branches.

As ORE is obtained by summing send reference equivalent (SRE), receive reference equivalent (RRE) and junction loss it was necessary to collect detail about both customer lines and junction losses. Line make-up details (cable gauges, route distances, teed multiples etc) were obtained to the distribution point (usually a distribution pillar) in each of the distribution areas (DAs) in each of the exchanges. These were recorded together with details of the number of customers served in the DA, its

Network	Exchange	Date of establishment	No. of subscribers (mid 1979)	Exchange area (ha)	Radial Distance from GPO (km.)	Type of Switching Equipment
Adelaide	Norwood	1922	17 679	3885	4.5	Mixed
	Modbury	1964	15 918	4921	13.3	Crossbar
Melbourne	East Kew	1941	7 509	977	9.1	Step by step
	Blackburn	1964	15 076	1640	17.2	Crossbar
Sydney	Maroubra	1946	12 265	920	8.0	Crossbar (1970)
	Carlingford	1966	10 144	1940	19.3	Crossbar
Brisbane	Nundah	New site 1961	6 804	1174	9.0	Crossbar (1964)
	Aspley	1964	5 002	2277	12.4	Crossbar

Table 1. Terminal Exchanges Selected for Study

predominant distribution-cable-gauge and an estimate of the mean distance from the distribution point to the customers' premises. These data provided a reasonably complete overview of the total line plant in each of the eight customer networks.

Busy-hour traffic dispersions were studied together with details of alternative routing choices and junction plant records to establish frequency distribution tables of the inter-exchange loss applying to the calls originating at each of the exchanges.

The LN(0) also required the determination of RRE and an estimate of the noise level occurring in the junction network.

ORE AND NOISE

The processing of the collected data to obtain the necessary frequency distributions led progressively through frequency distributions of customer-line length, resistance, current and loudness-loss to frequency distributions of customer-circuit SRE and RRE. In calculating SRE and RRE an assumption was made that all of the services used the standard, 800 type, telephone instrument. The interview-survey described in part 1 of this paper had previously indicated that this instrument is in fact used on at least 90% of suburban services.

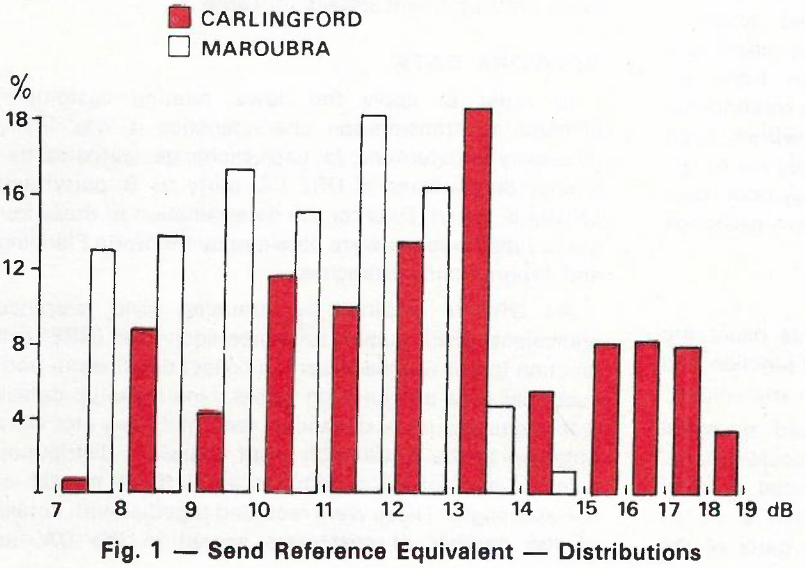

Fig. 1 — Send Reference Equivalent — Distributions

The frequency distributions of SRE and RRE for two of the exchanges are shown in **Figures 1 and 2.**

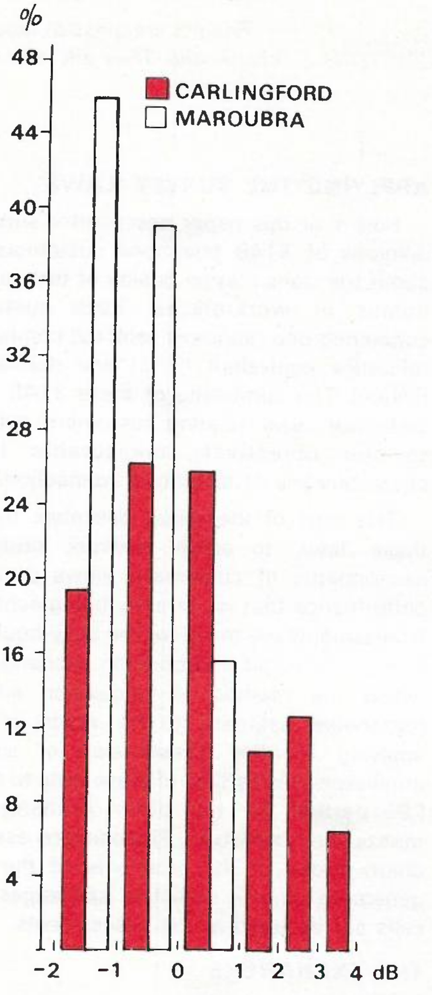

Fig. 2 — Receive Reference Equivalent — Distributions

In the receiving direction the regulating device in the telephone instrument partly offsets the effect of varying line-loss and restricts the range of RRE. In contrast the resultant effect of the regulating device and the line-current-sensitive carbon transmitter adds to the line loss in the sending direction and causes a much wider range of SRE. Accordingly while the adoption of a standard frequency distribution of RRE for the destination exchanges would introduce little error in the assessment of ORE the adoption of a standard frequency distribution of SRE would not be acceptable. For this reason it was necessary to confine the ORE assessment to the 'A'-party-to-'B'-party direction with the result that the customer opinions finally assessed had to be those of the recipients of the calls generated from the exchanges being examined. The 'standard-destination' RRE frequency distribution which was obtained by averaging those of the eight exchanges and which was used for all terminating exchanges is shown in **Figure 3.**

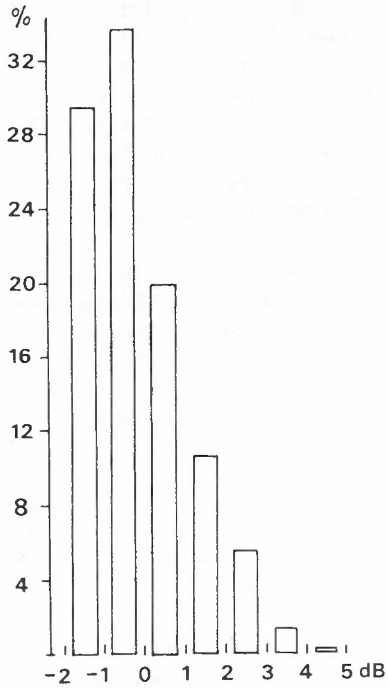

Fig. 3 — 'Standard-destination' Distribution of Receive Reference Equivalent

Provided we can accept that the call dispersion at an exchange is reasonably independent of customers' SRE (which might not be the case, for example, at a country exchange with clearly identifiable 'town' and 'rural' components) we can progressively convolve the frequency distributions of SRE, junction loss and 'standard-destination' RRE to obtain a frequency distribution for the ORE ('A' party to 'B' party) for the calls from that exchange. Such ORE frequency distributions were accordingly obtained for the calls from each of the eight exchanges. The resultant frequency distributions of ORE for the Maroubra and Carlingford cases are shown in **Figure 4.**

As mentioned in part 1 of this paper, the line noise levels of the test connections used in the interview-survey were normalised to equivalent values at the terminals of a telephone circuit having an RRE of 0 dB. The unit of normalised line noise is dBmp(0) and the relationship between LN(0) and the line noise, LN at the exchange reference point of the terminating exchange is:

$$LN(0) = LN - RRE.$$

Data about line noise values at metropolitan terminal exchanges are rather limited and for the purposes of this assessment two representative values, common to all connections, were assigned to LN. A common frequency distribution of LN(0) was then obtained by subtracting the 'standard-destination' frequency distribution of RRE from each of these values.

CUSTOMER OPINIONS

A computer program, CUSOP 5.0, was devised at Headquarters to produce a single-valued indicator of adverse opinions (% (P+I) or %D) for a statistical model of a telephone network characterized by a distribution of ORE, and LN(0). The latter may take one of three forms:

- constant noise on all connections;
- a specified probability density distribution of noise level in 1 dB 'slots' over the range -70 to -45 dBmp (0);
- a Gaussian distribution described in terms of a mean noise level and standard deviation.

For each 1 dB 'slot' of ORE, its probability of occurrence is multiplied in turn by the probability of encountering each 1 dB 'slot' of LN(0). Each 1 x 1 dB ORE/LN(0) cell is assigned a characteristic percentage of adverse opinions, (effective at the cell-centre) using data derived from part 1 of this paper.

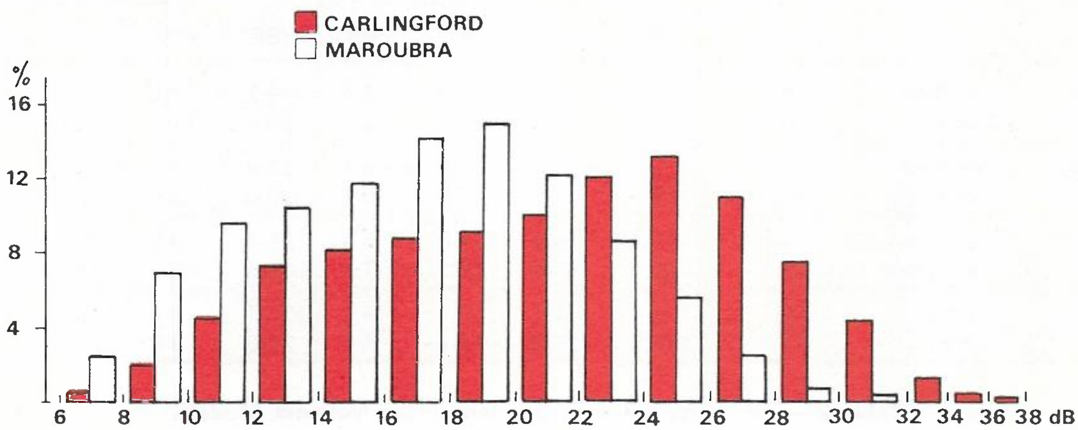

Fig. 4 — Overall Reference Equivalent — Distributions

The percentage of adverse opinions is summed over all 1 x 1 dB cells for the lowest 1-dB-wide ORE slot, and the procedure repeated for the next higher ORE slot, the total adverse opinions for which are added to those of the previous ORE 'slot(s)'. The process is complete and print-out occurs when every 1 x 1 dB ORE/noise cell has been explored in the area contained in the ranges:

ORE : 0 to 40 dB (41 slots)
LN(0) : -70 to -45 dBmp(0) (26 slots)
Total cells : 1066

A feature of this approach is that the same noise distribution is assumed in each 1 dB ORE slot; an assumed attribute which is unlikely to occur in practice. On real connections there is likely to be a correlation of noise level with:

- length of connection (in long-distance connections the noise increases with length) and with;
- ORE (in mainly-passive connections, the noise is likely to decrease with increasing inter-exchange loss).

To the extent that this correlation occurs, the predicted adverse opinions will be in error. A more flexible version of CUSOP 5.0 would provide for a rationally variable application of the noise distribution. Nevertheless, the imperfect model (or combinations of imperfect models) provides a valuable interim tool for the assessment of different transmission plans.

Particular attention has to be given when it is desired to express the noise distribution in Gaussian form. Such a distribution (of noise level) may extend below -70 and above -45 dBmp(0), but our data matrixes can supply opinion data only for noise levels between those values.

In the results described below, only specified probability density distributions of LN(0) are considered.

The program CUSOP 5.0 was applied to the previously-described ORE and noise distributions for each of the sample exchanges when LN was set in turn at -55 dBmp, and -65 dBmp, representing moderately high and moderately low levels of noise respectively.

Results are shown in **Table 2.**

[NOTE: The 'laws' of part 1 of this paper are based on the assumption of steady-state psophometric noise. Noise in real — particularly metropolitan — networks is likely to be overwhelmingly impulsive and intermittent. Such noise cannot satisfactorily be accounted for by modelling or by experiment, and to the extent that such noise is actually present, the predicted adverse opinions will be optimistic by an uncertain amount. Such noise is expected to reach negligible levels with the continuing retirement of obsolete switching equipment.]

It is also of interest to note the adverse opinions corresponding to the 'worst' connection from each of the exchanges; ie those corresponding to the combination of a maximum SRE at the 'A' party exchange, the maximum of the inter-exchange loss distribution from that exchange, and the maximum of the composite RRE distribution. These values are given in **Table 3.**

DISCUSSION

Tables 2 and 3 are assembled in pairs of 'old' and 'new' exchanges to facilitate comparisons of performance between these classes. Both the 'network' and the 'worst-connection' cases show an increase of adverse opinions from 'old' to 'new' exchange areas. One aspect of this is exemplified in Fig. 1, which shows a significantly higher proportion of high SREs for the 'new' exchange, Carlingford, than for the 'old' exchange, Maroubra.

The customer cable plant of older exchange areas was designed to provide limiting SRE when used with 300-type (or earlier) telephones. When the more efficient 400-type telephone was introduced and superseded the 300-type, the SRE of customer circuits using existing cable plant and the new telephone was substantitally reduced below the permitted limit. New cable plant would permit the SRE limit to be reached, with saving in copper costs, but the proportion of circuits approaching this limit would always be smaller than in exchange areas designed initially to absorb the higher efficiency of the more modern telephone.

Network	'A'-party exchange	(Note)	'Law' Based On 'Customer' Opinions				'Law' Based On 'Interviewer' Opinions			
			%D		%(P+I)		%D		%(P+I)	
			−55*	−65*	−55*	−65*	−55*	−65*	−55*	−65*
Adelaide	Norwood	(o)	6.4	3.4	10.8	3.6	19.2	6.2	24.5	6.1
	Modbury	(n)	14.7	7.6	18.1	5.9	29.6	12.3	32.0	9.7
Melbourne	East Kew	(o)	8.5	4.4	12.6	4.1	21.8	7.7	26.3	6.9
	Blackburn	(n)	15.3	7.9	18.3	6.1	30.0	12.8	32.4	10.0
Sydney	Maroubra	(o)	11.4	5.9	15.0	5.0	25.3	9.9	29.0	8.2.
	Carlingford	(n)	20.3	10.8	22.1	7.4	35.5	16.6	36.8	12.4
Brisbane	Nundah	(o)	8.1	4.2	12.4	4.1	21.4	7.5	26.0	6.8
	Aspley	(n)	10.2	5.3	14.2	4.7	24.0	9.0	27.9	7.7

Table 2 — 'B' Party Adverse Opinions From Network Models.

*Noise level received at 'B' — party's terminal exchange (dBmp)
Note: (o) = 'older' exchange; (n) = 'newer' exchange.

Network	'A' -party Exchange	(Note)	Max ORE (dB)	'Law' Based On 'Customer' Opinions				'Law' Based On 'Interviewer' Opinions			
				%D		%(P+I)		%D		%(P+I)	
				−55*	−65*	−55*	−65*	−55*	−65*	−55*	−65*
Adelaide	Norwood	(o)	34	54.5	31.7	45.0	15.4	67.4	41.1	63.8	29.3
	Modbury	(n)	38	67.4	42.2	53.3	19.2	75.4	50.0	72.8	37.9
Melbourne	East Kew	(o)	35	57.7	34.2	47.0	16.3	69.6	43.3	66.1	31.3
	Blackburn	(n)	40	73.9	48.1	57.6	21.3	78.3	54.2	76.9	42.6
Sydney	Maroubra	(o)	36	60.9	36.7	49.1	17.3	71.7	45.6	68.4	33.4
	Carlingford	(n)	40	73.9	48.1	57.6	21.3	78.3	54.2	76.9	42.6
Brisbane	Nundah	(o)	34	54.5	31.7	45.0	15.4	67.4	41.1	63.8	29.3
	Aspley	(n)	35	57.7	34.2	47.0	16.3	69.6	43.3	66.1	31.3

Table 3 — 'B' Party Adverse Opinions For 'Worst' Connections

* Noise level received at 'B' — party's terminal exchange (dBmp)

Note: (o) = 'older' exchange; (n) = 'newer' exchange.

Tables 2 and 3 show the large influence of noise level, particularly when the adverse opinions are high, due to high ORE; a doubling (and more) of adverse opinions is commonly encountered as the noise level changes from −65 to −55 dBmp.

Table 2 represents what might be called the 'average experience' of metropolitan-network customers talking with customers on the named exchanges. The levels of %(P+I) at the 'optimistic' noise level of −65 dBmp range from 3.6% to 7.4% 'customer' opinions, and from 6.1% to 12.4% using 'interviewer' opinions.

It is of interest to note that AT & T (USA) estimates of short-distance network performance five years ago yielded values for 'average' telephone services of about 5% 'poor or worse' customer opinions (Refs. 2, 3).

Each distribution of junction loss incorporated in Table 2 includes own-exchange traffic, in the category 0 to 1 dB junction loss. This traffic incurs ORE values in the 'preferred' range of volume (part 1, Fig. 10) and is responsible for quite low values of %D and %(P+I).

The magnitude of this traffic, relative to the total traffic, therefore has an effect on the adverse opinions listed in Table 2; the larger the proportion of own-exchange traffic, the lower will be the overall adverse-opinion scores.

The proportion of own-exchange traffic was quite significant in the sample exchanges, ranging from 8.2% at East Kew to 21.8% at Norwood (see **Table 4**)

Exchange	% of Own-exchange Traffic
Norwood	21.8
Modbury	21.2
East Kew	8.2
Blackburn	18.9
Maroubra	17.2
Carlingford	16.1
Nundah	12.3
Aspley	11.1

Table 4 — Percentage of Own Traffic Per Sample Exchange.

The average proportion of own-exchange traffic for the eight exchanges, weighted according to the number of customers at each is 17.9%; unweighted, it is 15.8%. Further models of inter-exchange networks which exclude own-exchange traffic can easily be devised; for such models the %D and %(P+I) values are higher than those of Table 2.

It is not sufficient, of course, merely to ensure that 'average' traffic has acceptably low adverse opinions; a 'worst' connection with high values of adverse opinions can be very frustrating to a customer if encountered frequently.

The 'worst-case' values of Table 3 are unacceptably high, and it is evident that performance objectives and planning rules should be modified, not only to reduce the 'network' values of Table 2, but also to ensure that even improved 'worst' connections should be encountered only infrequently by any customer.

Planning rules have already been promulgated (Ref. 1) for the provision of reduced maximum send and receive reference equivalents for customer services, although achievement of these lower maxima depends on the introduction of active microphones into telephone instruments.

A modest reduction of maximum transmission loss in inter-exchange connections is under consideration at the time of writing (end 1981), as a transitional stage towards the achievement of an integrated digital network.

The above two measures, when complete, would result in a maximum ORE of 28 dB in a metropolitan network and the opinions of **Table 5**.

Noise level LN dBmp	'Law' Based On 'Customer' Opinions		'Law' Based On 'Interviewer' Opinions	
	%D	%(P+I)	%D	%(P+I)
−65	19.1	10.5	27.6	18.6
−55	36.1	33.0	52.2	49.4

Table 5 — Adverse Opinions for 'Worst' Connections, After Proposed Improvements.

A performance corresponding to even the better of the two conditions above could hardly be classed as good, but is probably acceptable if allowed to occur only infrequently for any customer. Planning rules under consideration set a maximum of 5% on the traffic from any customer which will incur this 'worst' connection.

Finally, it may be noted that connections entirely within the future integrated digital network will incur a constant 'inter-exchange' loss of 6 dB (including own-exchange traffic, and regardless of distance) and that noise levels will also be lower than with analogue plant, and independent of distance. For such connections, 'customer' opinions would be about 5%D for 'average' customer lines and 9%D for 'limit' customer lines. The corresponding 'interviewer' opinions would be about 11%D and 14%D respectively.

CONCLUSION

The transmission survey described in part 1 of this paper has yielded 'laws' connecting Australian customers' opinions of telephone transmission quality with the two principal impediments to easy conversation: transmission loss (ORE) and steady line noise.

By applying these 'laws' to various models of telephone networks, of which some examples are given in part 2, it is possible to predict the effects on customer opinions of possible changes to transmission planning rules, and to declare network aims in terms which are relevant to users of the telephone network.

Subsequent sample customer surveys can be used, as a supplement to transmission measurement and audits, to ensure that the network objectives are being achieved.

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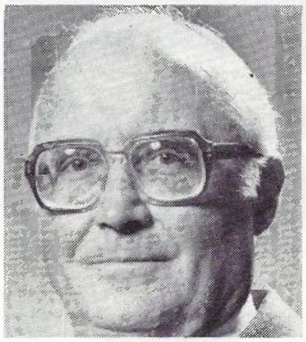
3. Abate, J. E., Brandenburg, L. H., Lawson, J. C., Ross, W. L. 'The Switched Digital Network Plan', Telephony, 24 October 1977 p. 39 (Fig. 10).

PERSONALITIES



APPOINTMENT OF NEW CHIEF GENERAL MANAGER — TELECOM

It is always with pleasure that the journal records promotion to senior appointments by active members of the society. Mr Gordon Martin, B.Sc, FIE (Aust.), has been appointed Chief General Manager of Telecom Australia, coming from the position of General Manager, Engineering.

Mr Martin started with Telecom (PMG) as a clerk and after qualifying as an engineer, advanced through various engineering positions in Queensland, Victoria and at HQ.

Mr Martin has held the positions of Chief State Engineer (Victoria) and Chief Services Engineer (HQ). Mr Martin is a keen golfer, swimmer and musician.

EDITOR IN CHIEF CHANGE FOR ATR

After 15 years as Editor in Chief of ATR, (Australian Telecommunication Research), Mr H. (Harry) S. Wragge (left) has resigned from the position and consequently steps down from the Council of Control. Harry Wragge has had an association with the Society's publications since 1956, when he became an Associate Editor for TJA covering the Research and Radio areas. He was actively involved in the launching of ATR and became its foundation Editor in Chief in 1967. Since then, he has taken a keen interest in promoting ATR as a Journal of international standard, covering the whole field of telecommunications research in Australia.

Harry, an Assistant Director in the Telecom Research Laboratories, is presently seconded to Telecom's task force which is concerned with the Davidson Inquiry into telecommunications services in Australia.

The Council records its appreciation to Harry Wragge for his energetic leadership and members will be pleased to note that Harry will remain on the Board of Editors of ATR. His considerable experience will therefore continue to be available to the Society.

ATR's new Editor in Chief is Garth Jenkinson, (right). He has been the Executive Editor from 1975 to 1981 but his association with ATR, as an editor, dates back to the first issue, in 1967. Garth joined the Telecom Research Laboratories in 1960, working in microwave radio propagation investigations, and then satellite communications. He now heads the Satellite Technology and Electromagnetic Environment Section.

LIFE MEMBERSHIP TO BOB LANGEVAD

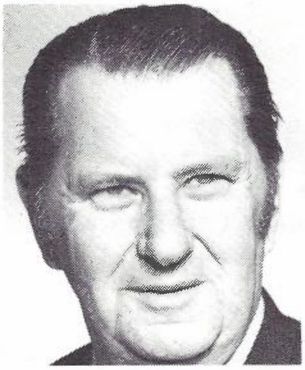
A member of the Society since joining the PMG's Department in 1948 and a member of the NSW Committee since 1968, Bob occupied the positions of Treasurer and Secretary from 1968 to 1970 inclusive and in 1971 he took over the position of State Chairman, and continued in this position until the end of 1980.

During the period 1969-1980, the Society introduced a number of changes in an effort to meet the needs of its members in a rapidly changing technological and organisational environment and many of these changes, had resulted from an initial impetus from the N.S.W. Division Committee.

Within the State, changes in the system of society awards, the introduction of major seminars, the establishment of geographical and functional branches and the publication of numerous N.S.W. monographs were important examples of the work of the Committee under Bob's enthusiastic leadership.

Bob was the author of an article entitled "Quality Assurance of Crossbar Equipment Manufactured in Australia", published in Vol. 14 No. 4. He also made a major contribution to the publication of Monograph No. 4. "The Development of Automatic Telephony in Australia."

Bob Langevad has made an outstanding contribution to the Telecommunication Society of Australia, and has more than fulfilled all of the conditions required for life membership.



DOUG WHITESIDE RETIRES

Doug Whiteside, has retired from Telecom, in the position of Manager, Course Development and Control, Training Group, H.Q. Doug, who joined the Society as a Technician in Training in 1939 has been part of the production team of the Journal since 1964 and has supported the past four Editors in Chief (Vern White, George Moot, Lindsay Mitton and Ron Keighley). In more recent years, Doug has been helped by Adrian King and together they have brought all the production activities together to ensure that journal papers have been published with a minimum of fuss and error.

The Board of Editors joins with Doug's many friends in saying "thank you" for a very valuable contribution and good wishes for a well earned retirement.


The latest cable conduit installation system
Neat, economical and versatile
This is an extremely economical and neat method of installing electric cables and conduits of various diameters, especially in rows. The system comprises three parts — a clip base, clip top and a track — which make many different applications possible.
For single cables or conduits the clip base is fastened by drilling and anchoring. Cables are laid in place and clamped with the clip top.
Conduits are held firmly in place by pressing them into the base where they are held by reason of the elasticity of the conduit. Another advantage is that all sizes of clips can be joined together in a row without using track.
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The Telecommunication Journal of Australia

ABSTRACTS: Vol. 32, No. 2

THE NATIONAL COMPUTERISED DIRECTORY ASSISTANCE SERVICE — DAS/C; I. Baxter and H. Lyon; Telecom Journal of Aust., Vol. 32, No. 2, 1982, page 95.

National DAS/C consists of a standard IBM data retrieval system, a data base update network which has been designed specifically for Australian conditions and a series of automatic call distributors, which link the retrieval system to the telephone network.

This paper describes, in general terms, the features of the overall system together with some of the operating procedures.

INTEGRATED CIRCUIT TECHNOLOGY — A TELECOMMUNICATIONS VIEW; Carol J. Scott; Telecom Journal of Aust., Vol. 32, No. 2, 1982, page 101.

Semiconductor integrated circuit (IC) technology is assuming growing importance in the design and application of all kinds of telecommunications equipment. This paper provides an introduction to the key features of the technologies which dominate present integrated circuit development. The special requirements of telecommunications ICs are described and relevant IC technologies identified. Examples of new telecommunications ICs are given and their likely impact assessed.

VIDEOTEX — AN EMERGING PUBLIC INFORMATION SERVICE; R. I. Davidson and A. R. Jenkins; Telecom Journal of Aust., Vol. 32, No. 2, 1982, page 109.

One aspect of image processing that is often not fully appreciated is the need for transmission and presentation of images in conjunction with an information data base. This paper discusses videotex, an emerging service for the transmission and display of textual and graphical information. The point is made that technological development on its own is of limited value unless the end result is one that the user will accept and is prepared to pay for.

COMPUTERS, COMMUNICATIONS AND MAN; Koji Kobayashi; Telecom Journal of Aust., Vol. 32, No. 2, 1982, page 115.

The convergence of computers and communications has been evident for some time. This paper expressed a formulated concept of the convergence and predicts the integration by the end of the century. The paper adds to this concept, the thought that integration will not only be through a series of technological developments but also in order to meet the needs of mankind. A third variable, the human (M) variable is therefore introduced to the process of integration.

SYDNEY STOCK EXCHANGE ANNUNCIATOR LIGHTS; D. A. B. Sangster; Telecom Journal of Aust., Vol. 32, No. 2, 1982, page 125.

The Sydney Stock Exchange required annunciator lights for a new trading floor. Suitable equipment was not available commercially and Telecom custom designed and provided the facility described in this article.

TELECOMMUNICATIONS IN AUSTRALIA; W. H. Thurman; Telecom Journal of Aust., Vol. 32, No. 2, 1982, page 131.

A broadly descriptive review of the Australian National Telecommunications Network in the 1980s and an examination of the interaction between technology and service in some of the new services which Telecom intends to offer.

DIGITAL FACSIMILE; R. I. Davidson; Telecom Journal of Aust., Vol. 32, No. 2, 1982, page 141.

This paper outlines the importance of high speed document facsimile to the business user and discusses the relevant factors in ensuring compatibility of equipment. Image coding and transmission techniques recommended by the CCITT for use with document facsimile equipment are described.

The author concludes by observing that the high speed facsimile printer, because of its capability of printing almost any type of image, may be one of the key elements supporting the integration of services in the office of the future.

TELECOM'S MTS: OPERATIONS AND MAINTENANCE ASPECTS OF THE MOBILE CONTROL CENTRE AND MOBILE BASE STATIONS; J. L. Seamons; Telecom Journal of Aust., Vol. 32, No. 2, 1982, page 149.

A general description of the operations and maintenance facilities that have been provided with the Mobile Control Centre (MCC) and the Mobile Base Stations (MBS), and an outline of how the maintenance approach to this equipment has been organised.

TELEPHONE TRANSMISSION QUALITY: CUSTOMERS' OPINIONS. PART 2; R. G. Kitchenn and R. P. Killey; Telecom Journal of Aust., Vo. 32, No. 2, 1982, page 157.

Each of eight terminal-exchange areas in metropolitan networks was classified in terms of a 100% survey of customer line plant, (which yielded calculated distributions of send and receive reference equivalents) and a traffic-weighted distribution of inter-exchange loss to all other exchanges in the same metropolitan area.

By convolving the various distributions into a distribution of overall reference equivalents associated with each exchange, assuming likely distributions of noise levels, and applying the results of part 1 of this paper, it was possible to estimate percentages of customers' adverse opinions for such distributions. For a given exchange, the opinion levels so derived are those of the composite of the customers throughout the rest of the network who converse on calls made by all customers at the given exchange.

The techniques in this article cannot usefully be extended to give a measure of the adverse opinions of customers at the given exchange.

Results are given in terms of %D and %(P+1) for the respondents on calls from each of the eight sample exchanges. They are indicators of network transmission performance under present transmission plans.

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