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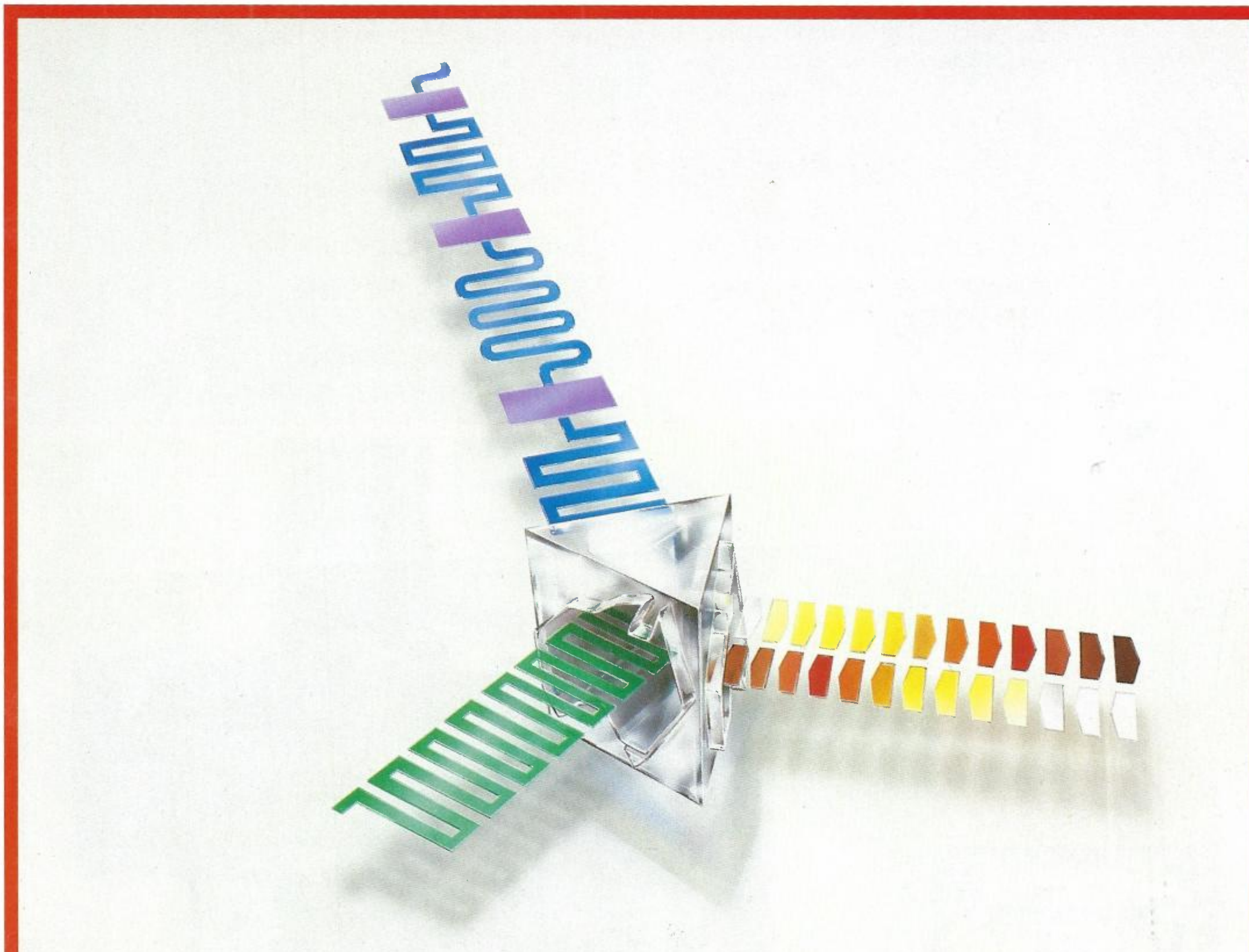

FEATURED IN THIS ISSUE

- DDN Development
- DDN Management & Control System
- DDN Time Division Cross Connect
- Electro-static Discharge
- Switching Laboratory
- Line Transmission Construction
- Tele-education
- Baseband Monitor

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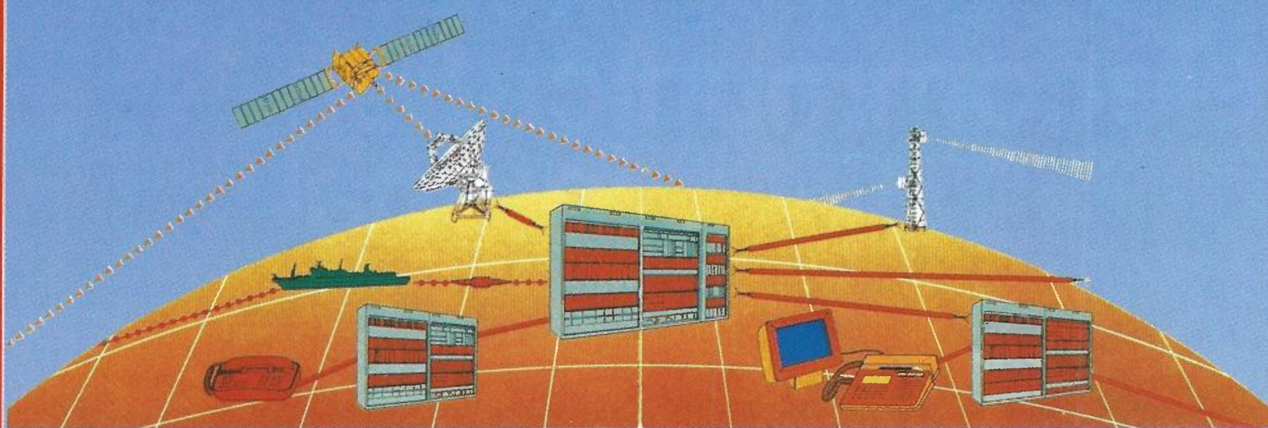
The world of Alcatel Thomson



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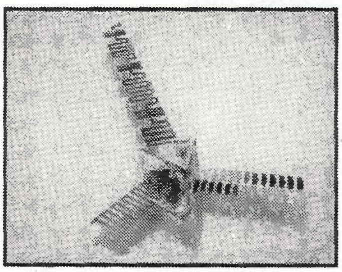

A symbolic representation of the digital data service.

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Editorial

Editor-in-Chief
Telecommunication Journal of Australia

Manager
Computer Assisted Planning Systems Section
M&OSS Branch

MUN CHIN

Mr. J. M. Crawford in launching this Journal in June 1935 had this to say, "For the true Scientist and Engineer is never selfish or exclusive. He is glad to bring his contribution into the common hive of knowledge and place his observed data at the disposal of his fellow-workers . . ." He also noted that in order for the Journal to achieve success, it must receive widespread and consistent support. It is worthwhile to reflect and note that those wise words are just as relevant now as fifty years ago.

The Journal has just celebrated its Golden Jubilee. By and large the Journal had fulfilled its role in providing the means for authors to share their knowledge with their fellow-workers. The question is, "Can the Journal continue to serve its readers and members of the Society in this age of computers and telecommunications?" The answer to this question must be "Yes!" However, we can only ensure this providing we work unselfishly to serve the Journal and in turn society.

The Board of Editors work hard at gathering quality articles for the Journal, but we are always looking for willing assistants.

As an individual, we can either passively sit back and allow the rest of the community to do all the work or actively take part in creating a Journal which is truly useful to our readers. As a reader, there are a variety of ways in which you can help. Identify topics which you would like to see in the Journal. More importantly, identify the potential authors. Then take steps to encourage potential authors to write that article. Maybe even write that article yourself.

My message is — we need you to make this Journal even more successful. Will you help?

Mun Chin
Editor-in-Chief

August 1986

Line Transmission Construction Practice

J. R. CAIRNS
Ing. R. A. J. REYNOLDS, B.E., M.Eng.Sc., MIEE

Telecom Australia has over the years adopted styles of transmission equipment construction practices which have been shaped by the combined influence of Telecom's history, associated equipment practices and manufacturing practices dominated in recent times by Australian industry. The recent dramatic change towards a digital transmission network has modified the equipment form and produced what is now known as the Type 84 transmission equipment practice. Associated with the change to digital working there has been a consolidation of attitude within Telecom to associated design matters such as equipment reliability and lifetime.

INTRODUCTION

In any Telecommunications network the transmission links are a vital part of the overall system. The links which connect the operating centres, exchanges, digital data centres, broadcast and television centres and a host of other users involve Telecom Australia in an annual expenditure on terminal, multiplex and repeater equipment of the order of $A100M. All this equipment is commmonly known as Long Line or Line Transmission equipment. Such large quantities are purchased that it has eventuated that Telecom in conjunction with manufacturing forces has evolved a physical form of the equipment with associated design concepts that differ to varying extents from similar equipment used by other telecommunications authorities.

Australia has always been in the forefront of the world's development of this equipment as evidenced by world "firsts" for changes in transmission technology. Quite often the development work is done overseas and this has a strong effect on the directions of the local development. Nevertheless there is now a large level of local development which has led from the technology of the 1920s quite traceably to the digital transmission technology of today as represented in the Type 84 Line Transmission Equipment practice.

Very broadly, the major milestones in developing the present form of equipment are:

1920s Introduction of British and U.S. designed equipment based on imperial 19¼ inch wide racks.

1950s Emergence of European Broadband equipment based on 600mm wide cabinets known as Type 52.

1960s The merging of these two concepts to produce the Australia Type 72 practice.

1970s The influence of digital techniques modifying the details of Type 72 practice.

1980s The major swing to digital transmission producing the distinct Type 84 practice.

As the practices have developed there have been more and more details included as standards. What started out in the 1920s as a purely mechanical technique of holding equipment is now a complex description of the mechanics, power supplies, alarm facilities, environment including heat and electromagnetic radiation, the cabling interfaces and some even more detailed design requirements.

The following description of the type 84 practice is a commentary on the current practices. The history to date has been a series of changes and there is no reason to believe that the practices will stand still. Nevertheless there has been a good deal of recent activity and it is likely that a period of stability will follow.

GENERAL EQUIPMENT DESIGN STRATEGY

Telecom Australia requires Line Transmission Equipment designed and manufactured so that in overall operation throughout its design life:

- It performs all the specified functions to a technical performance level as specified by Telecom Australia. This is often drawn from the most recent concepts as recorded by the various groups within the International Telecommunications Union; in particular the International Telegraph and Telephone Consultative Committee (CCITT). Australia's geography sometimes requires higher standards than are published by CCITT for given network conditions.
- It has a reliability which is high. The lifetime and required reliability figures are stated for each equipment item in the appropriate equipment schedule. The lifetime is defined as the field service life under the nominal operating conditions before the time when the reliability figures are expected to be inadequate. Reliability and lifetime are macro figures over a large population of equipment of the same type. In general, equipment is required to meet a 20 year life.
- It fits in with equipment and operates from standard power sources as generally summarised under "Type 84 rack practice" below.
- It must be able to be installed, commissioned and operated by Telecom staff. The equipment performance at installation is judged through a commissioning process performed on the transmission path through the whole system in the network. Likewise the performance of the overall network will reflect on the performance of the individual equipment items.
- It does not interfere with other equipment by way of electromagnetic radiation or heat beyond that specified. Conversely it must not have a degraded performance beyond the specified levels when subject to stated environments.

- It cooperates with other equipment when required to do so. This is covered by the issue of interface specifications.
- It must be maintainable. Telecom's requirements for alarm facilities supported by the Telecom staff and the practice of contractor repair when appropriate must be able to maintain the Telecom service provided by that equipment. It is important that components used must be available for maintenance throughout the equipment lifetime.

In summary, designs of high quality are sought. There is an implicit conservative attitude, tending towards mature concepts using well-established circuits and components rather than the experimental and often transitory designs and components that have been associated with periods of rapid technology change.

TYPE 84 RACK PRACTICE

One of the areas that has received considerable recent attention is the mechanical housing of transmission equipment that is mounted in exchanges and dedicated transmission equipment areas. The result is a series of modifications to existing practices. Some are minor, such as small dimensional changes, while others are quite significant, such as power supply arrangements.

Most of the underlying philosophy of equipment mounting remains unchanged. Equipment is assembled, generally as plug-in units, into subracks which are in turn mounted in racks.

Semi-enclosed racks without front doors, Type 84A 2750 mm high and Type 84B 2100 mm high, are 600 mm wide and 265 mm deep. These are fitted with mounting rails at the rear of the rack and offset to the right. The rails resemble the well-proven imperial 19¼ inch system.

The taller of the two rack types is intended for normal use while the shorter rack is for use in small-terminal exchanges and other restricted height applications. **Fig. 1** shows a typical rack layout.

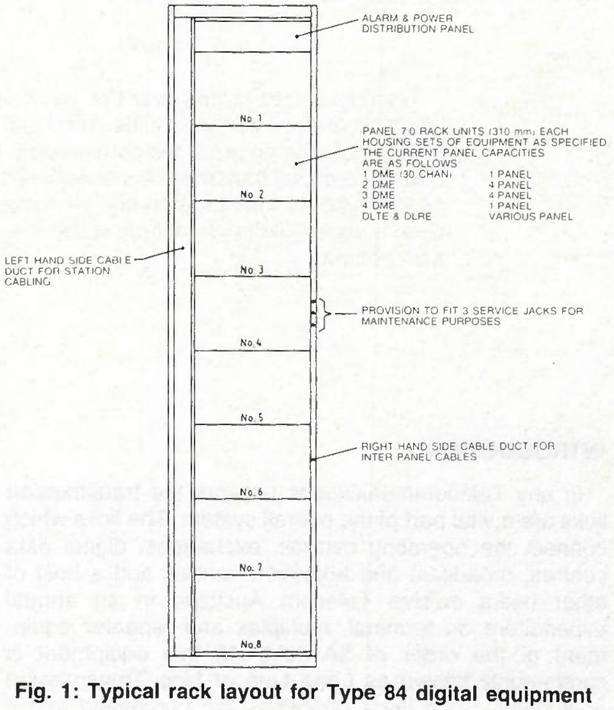

Fig. 1: Typical rack layout for Type 84 digital equipment

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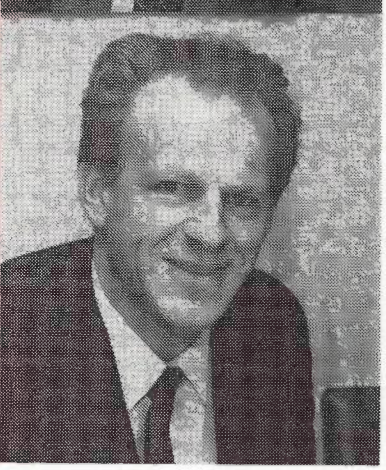
RODNEY REYNOLDS joined the APO in 1968 working as an engineer in Long Line and Radio Installation areas in Tasmania until 1973. He then transferred to Headquarters where he worked in the Line Transmission Branch in the areas of equipment provisioning and installation engineering. He is currently the Manager, Design Standards in the same Branch.

He received a B.E. degree from the University of Tasmania in 1968 and a M.Eng.Sc. degree from Monash University in 1980. He is a member of the Institute of Electrical Engineers (U.K.).



CABLING

As in the earlier Type 72 rack, signal and traffic cabling is on the left hand side of the rack while power, earth, alarms and supervisory wiring is on the right. However, small-dimension changes have achieved an effective increase of 30 per cent in cable capacity. This is at the expense of subrack width, but a small increase in subrack depth and an increase in equipment density associated with improved technology more than make up for the loss.

The greater part of digital transmission internal plant cabling in Telecom Australia uses coaxial cable. A special cable combining high flexibility, very good screening and well controlled electrical transmission parameters has been developed. Its design is a general compromise that ensure that all applications are covered up to 140 Mbit/s. This cable, designated S353/7 within Telecom, has been designed with minimum size as a primary concern and at 6mm overall diameter is smaller than comparable cables. All connectors used with this cable are in general accordance with DIN 47295 and are often known as 1.6/5.6 connectors.

Optical fibre cabling techniques are still developing and are expected to be standardised towards the end of 1986.

POWER

The primary power for all transmission equipment racks is either from secondary batteries at nominally — 52VDC or, in some cases, from buck/boost power supplies at the same voltage. The latter is usually associated with hi-ohmic power distribution as used in AXE exchanges.

The most critical of these is the secondary battery case and all equipment is designed to accept the transients and noise levels associated with the raw battery.

The racks are powered from feeds protected by 25 or 36 amp fuses. Distribution within the rack to each subrack is via a power and alarm distribution panel with each power feed being protected by a 4 amp thermal/magnetic circuit breaker. Occasionally, where high reliability is demanded, duplicated power feeds are used down to subrack level.

In general the specific power needs of the equipment are organised within the subracks. Regulation, inversion if required, filtering and alarm control are distribution at the equipment level rather than at the rack level which was the intention previously.

ALARMS

Alarm control is centered in the power and alarm panel mentioned already. This panel contains circuitry to concentrate the alarms from individual subracks, display the conditions and foward alarms to the row and, hence, station alarm system.

The power and alarm panel has been designed so that simply replacing a single plug in printed circuit board will permit any type of alarm scheme and technique to be accommodated.

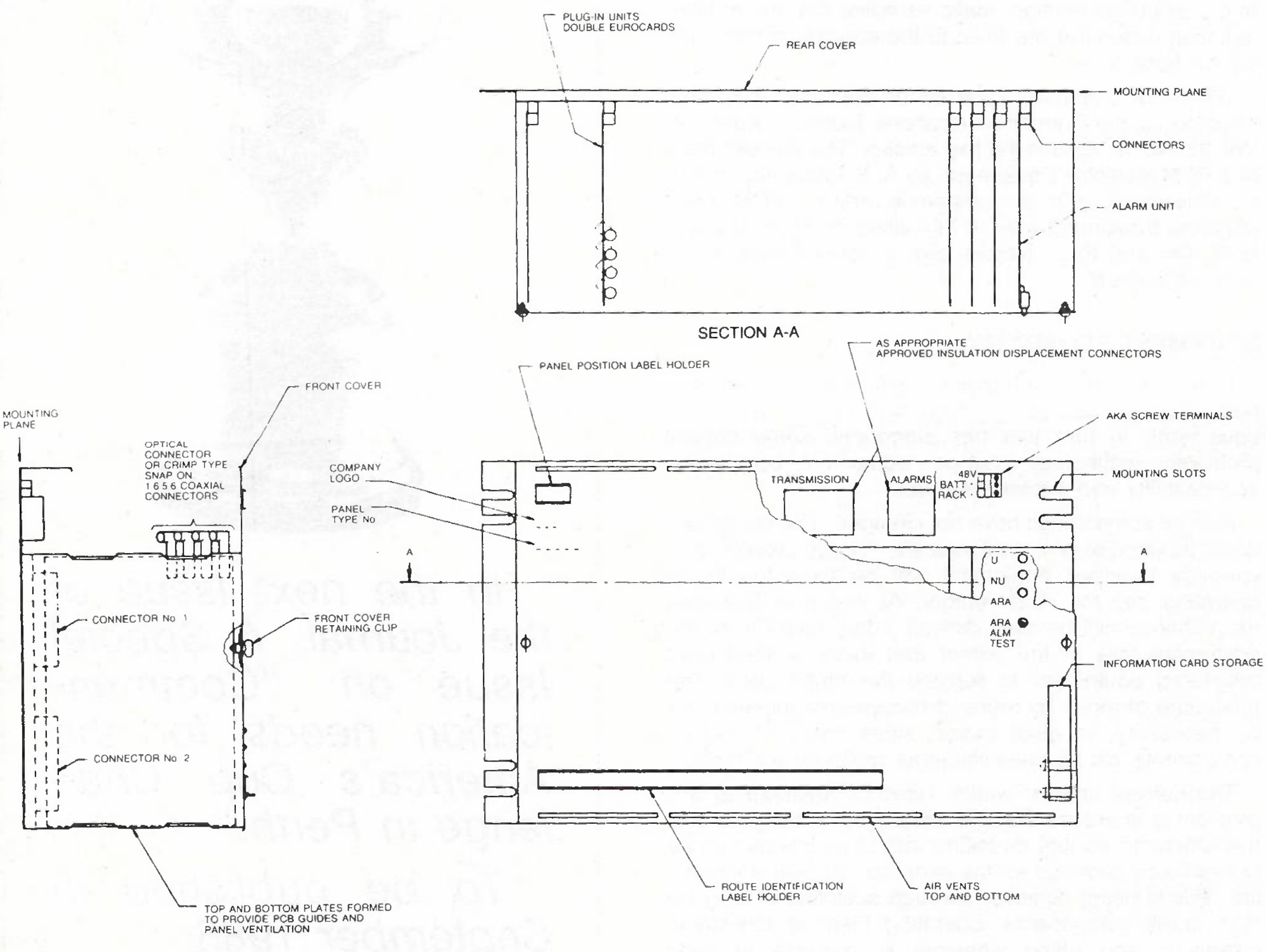


Fig. 2: Typical arrangement Type 84 panel

Whilst the current scheme uses D.C. signalling to indicate urgent, non-urgent and "alarm receiving attention" only, future systems will provided much more detail and the alarm PCB mentioned above has sufficient space for a microprocessor-based system.

SUBRACKS AND PLUG-IN UNITS

Subracks containing the equipment configured generally as plug-in units mount directly on the mounting rails at the rear of the Type 84 rack. While there is a degree of freedom for manufacturers to determine the detailed arrangements within the subracks, the outline shown in **Fig. 2** is typical of current manufacture.

The arrangement shown in **Fig. 2** has minimal ventilation. For applications requiring greater cooling the subracks are fitted with top and bottom plenum chambers admitting air at the bottom front and exhausting at the top front.

An overall front cover is provided which is painted grey on both sides and held in position with at least two quick-locking fasteners. The cover has facilities for air circulation and heat convection.

The external side of the front cover normally carry the company logo and panel type number and provide write-on identification labels. The required detail on the labels is recorded by Telecom staff. On the rear face of the front cover, or on a suitable plug-in insert accessible from the front of the panel without removing the front cover, information cards detailing the circuit diagram, terminal field disposition and route information details are provided. Where appropriate, warning or safety labels (e.g. hazardous voltage, static sensitive devices or laser radiation exposure) are fixed to the equipment units and on the front cover.

While not a mature Type 84 product the equipment described in the Telecommunications Journal of Australia, Vol. 33, No. 3, 1983 in the two articles "The Development of a PCM Multiplex Equipment" by A. Y. Gunzburg and D. P. Williamson and a companion article "PCM Loop Multiplex Equipment with T6 Signalling" by M. P. Quigley, B. F. Orr and P. L. Neville give a general idea of the subrack concept.

EQUIPMENT RELIABILITY

Associated with the change to digital transmission there has been a reliance on high technology within the equipment. In turn this has introduced some special problems: technology change, equipment complexity, serviceability and similar matters.

And yet some things have not changed. The equipment is still required to give a 20 year life. A large proportion of currently provided equipment will be expected to be operating into the next century. At that time however, maintenance will be very difficult if the reliability of the equipment falls to the extent that there is insufficient recovered equipment to replace the faulty units. The procedure of repair by reuse of recovered equipment will be necessary, in most cases, since many of today's components will be unavailable as replacement items.

The current answer within Telecom Australia to this problem is to ensure that the equipment is designed and manufactured so that its failure rate is as low as can be conveniently obtained for the expected 20 year operating life. This is being achieved through selection of long life high grade components, operating them at low-stress conditions and doing whatever is possible to keep operating temperatures low.

CONCLUSION

As Telecom Australia changes over to a digital network the transmission network is one of the first areas to make the change. The realisation is that the design and construction practice that has developed to make this change is now current and has been called the Type 84 practice. There is little doubt that "Type 84" and "Digital" are synonymous when considered in the environment of line transmission equipment.

NOTE: This article is an adaptation of material intended for specific purposes by Telecom Australia and is reproduced in the Telecommunications Journal of Australia for general interest. The original material is available to interested parties from the Line Transmission Branch, Telecom Headquarters.

In the next Issue of the Journal, A Special Issue on: "Communication needs for the America's Cup Challenge in Perth."

To be published in September 1986.

Electro-Static Discharge (ESD) Control

KEITH NG
IAN CAMPBELL

The development of semi-conductor technology has resulted in low power, high density micro-circuits, which are extremely susceptible to damage by electro-static discharge. This article has been written to assist in understanding ESD and the means of controlling its effects.

Foreword

Static electricity is a naturally occuring phenomena and effects everyone in one form or another during our daily lives.

We have all been made aware of static electricity, even during school days when science teachers demonstrated its effects by rubbing an ebonite rod with fur to pick up pieces of paper and with the introduction of nylon in clothing, how it crackled and sparked when we undressed in the dark.

Lightning flashes are a very large and visible discharge of static electricity and can on occasions create a lethal hazard. Other forms of discharge are not so spectacular, but can also have disastrous results. The petroleum and chemical industries and users, have long been aware of the hazards associated with uncontrolled static discharge and spend much time and money ensuring that their facilities are adequately protected.

Modern technology has developed since the introduction of the transistor in 1958 to such an extent that equipment which once occupied a whole room, can now be effectively carried in a briefcase. This has brought about vast changes in business, communication and leisure but has not been without problems, one of which is the effects on the equipment of electrostatic discharge (ESD).

Like the petro-chemical industries, the electronics industries and users of electronic equipment must now take adequate measures to protect their investment in new technology against attacks by a formidable opponent to reliability and profitability — electrostatic discharge.

WHAT IS STATIC ELECTRICITY?

Static electricity is an electrical charge at rest. The electrical charge can be caused by polarization within a body or by conductive charging from one body to another. Several factors can effect the level of the charge including shape, size and the electrical "make-up" of the substances which form the body.

As with electric current flow, some substances have the ability to transfer or receive electrons more freely than others. When two substances are rubbed together or rapidly separated, one will gain electrons which the other has given up. If one or both of these substances are non-conductors, the equal, but opposite charges will remain in a localised area, i.e. the area subjected to the rubbing or separation.

A good example is the simple act of pulling a length of adhesive tape off the roll (Fig. 1). Here we have an adhesive substance bonded to one side of a backing strip and in contact with the other side of the backing strip.

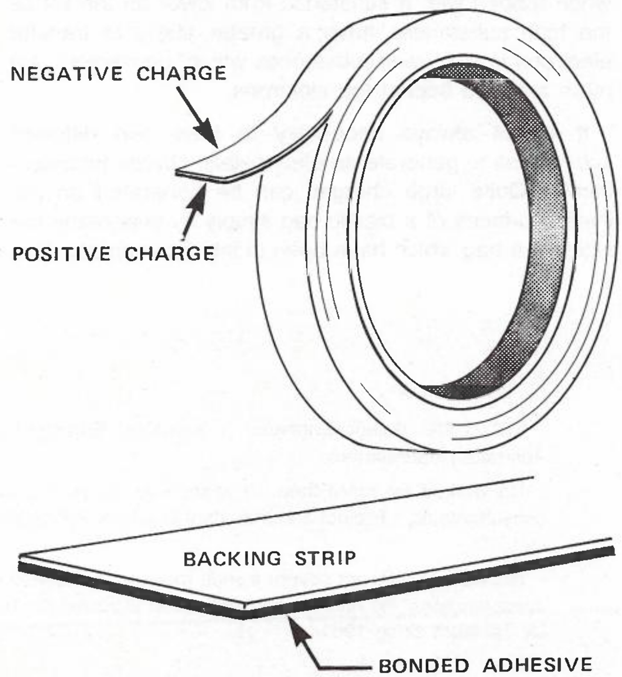


Fig. 1 — Example of Electrostatic Charge Generation

Both the backing strip and adhesive are non-conductors and by rapidly pulling a length of tape from the roll, an electric charge of up to 5000 volts can be generated with the adhesive side having a positive polarity and the backing a negative polarity.

Static charges can be induced from one body with a high charge to another body with a different potential without physical contact. Induced static can only affect conductive substances. However, non-conductors are equally at risk when changes occur in their physical size or shape. This is brought about by changes in the capacitance relative to a ground or another body. An inverse linear increase in voltage (V) will occur with a decrease in capacitance (C) for a given charge (Q) Thus

Q = CV. If the capacitance is sufficiently decreased, the voltage will increase until the point at which a discharge in the form of an arc will occur. Common plastic bags, usually polyethylene, will when handled or rubbed, develop an electrostatic charge of about 200 volts potential while laying on the bench. However, when picked up the decrease in capacitance may cause a ten to twenty fold increase in the voltage.

TRIBOELECTRIC SERIES

The generation of electrostatic charges caused by the rubbing together of two substances is called the triboelectric effect.

The magnitude in the generation of charges is dependent upon other factors, such as humidity, lubricity, surface condition, pressure of contact, surface area and speed of rubbing or separation will all affect the degree of charge generation.

Generally, these substances are non-conductors and a sample list of substances is shown in **Table 1** in order of positive down to negative charging.

A substance higher on the list is positively charged when rubbed with a substance from lower on the list as the high substances have a greater ability to transfer electrons to the lower substances which, conversely, are more ready to accept the electrons.

It is not always necessary to have two different substances to generate an electrostatic charge triboelectrically. Quite large charges can be generated on the inside surfaces of a plastic bag simply by separating the sides of a bag which have been in intimate contact. This

Positive +	Air
	Human Hands
	Asbestos
	Rabbit Fur
	Glass
	Mica
	Human Hair
	Nylon
	Wool
	Fur
	Lead
	Silk
	Aluminium
	Paper
	Cotton
	Steel
	Wood
	Amber
	Sealing Wax
	Hard Rubber
	Nickel, Copper
	Brass, Silver
	Gold, Platinum
	Sulphur
	Acetate Rayon
	Polyester
	Celluloid
	Orlon
	Polyurethane
	Polypropylene
	PVC (Vinyl)
	Silicon
Negative −	Teflon

Table 1. Triboelectric Series

KEITH NG Senior Engineer — Industrial Engineering Section at Telecom Australia Headquarters.

He worked for more than 10 years with private industries and management consultants as a Project and Industrial Engineer before joining Telecom Australia in 1979.

His work in telecom covers a wide range of disciplines often involving national considerations. He has been investigating Electrostatic Discharge (ESD) Control for Telecom since 1981.

IAN CAMPBELL Joined the PMG in 1957 as a technician in Training and was appointed to materials Inspection in Victoria.

In 1975 he joined Materials Quality Assurance at HQ and, in 1980, was appointed as Senior Technical Officer Grade 2 at Industrial Engineering, HQ, where he has been involved in various investigations and evaluations to improve the operating efficiency of products and management systems.

charge will remain on the inside surfaces, positive on one side and negative on the other until a means of discharge is provided, either through ambient conditions or by external contact with the inside surfaces, of a conductor connected to a lower potential.

PRIME SOURCES OF STATIC ELECTRICITY

Developments within the petro-chemical industry have provided many products which have enriched the quality of our lives. Unfortunately the majority of these products have one major disability. They are nearly all good static generators and because they are so common, they pose a potential hazard to all equipment that is susceptible to static discharge. Of course, it is not only synthetic products which produce static charges. Naturallu occurring materials can also produce electrostatic charges if conditions are right and **Table 2** shows the range of materials or activities which provide electrostatic charges during normal usage.

Object or Process	Material or Activity
Work Surfaces	
—	Waxed, painted or varnished surfaces
—	Common vinyl or plastics
Floors	
—	Sealed concrete
—	Waxed, finished wood
—	Common vinyl tile or sheeting
Clothes	
—	Common clean room smocks
—	Common synthetic personal garments
—	Non-conductive shoes
—	Virgin cotton
Chairs	
—	Finished wood
—	Vinyl
—	Fiberglass
Packaging and Handling	
—	Common plastic bags, wraps, envelopes
—	Common bubble pack, foam
—	Common plastic trays, plastic tote boxes, vials, parts bins
Assembly, Cleaning, Test and Repair Areas	
—	Spray cleaners
—	Common plastic solder suckers
—	Solder irons with ungrounded tips
—	Solvent brushes (synthetic bristles)
—	Cleaning or drying by fluid or evaporation
—	Temperature chambers
—	Cryogenic sprays
—	Heat guns and blowers
—	Sand blasting
—	Electrostatic copiers

Table 2. Typical Prime Charge Sources

Electrostatic voltages generated by insulative materials can be quite high since they are localised and not distributed over the entire surface area. However, under high humidity conditions, the surface conductivity of some materials can be increased by the absorption of moisture which changes the surface condition to allow a static charge to dissipate over the surface of the material. **Table 3** shows the effect that changes in the level of relative humidity can have on the level of static generation which occurs in normal, everyday activity.

Means of Static Charge Generation	Electrostatic Voltages (V)	
	10 to 20 Percent Relative Humidity	65 to 90 Percent Relative Humidity
Walking across carpet	35,000	1,500
Walking over vinyl floor	12,000	250
Worker at bench	6,000	100
Vinyl envelopes for work instructions	7,000	600
Common poly bag picked up from bench	20,000	1,200
Work chair padded with polyurethane foam	18,000	1,500

Table 3. Typical Electrostatic Voltages

From this table, it can easily be seen why we occasionally get "zapped" when we touch a filing cabinet **(Fig. 2).** The high voltage generated between the carpet and the soles of the shoes is transferred by means of perspiration from the feet to our bodies. Under low humidity conditions an extremely high charge is developed and when contact is made with another object at a much lower potential the rapid discharge arc can cause a visible, audible and tactile sensation.

It may seem that the solution to static generation is to cause a high humidity environment to be present, but this is not possible where people are involved as high humidity has a debilitating effect on performance with a consequent loss of productive capability.

Consequently it is necessary to achieve a balance between what is best for the equipment and what is acceptable to people.

WHY DOES ESD AFFECT ELECTRONIC COMPONENTS?

As stated earlier, developments in the design of electronic parts have dramatically reduced the size and as a consequence, reduced their operating power. Although there has been an increase in efficiency of dielectrics, the physical separation between active parts of circuits is now measured in nanometers.

It is the combination of minute separation small mass and low power which makes electronic equipment susceptible to electrostatic discharge damage. These devices include:— micro electronic devices (integrated

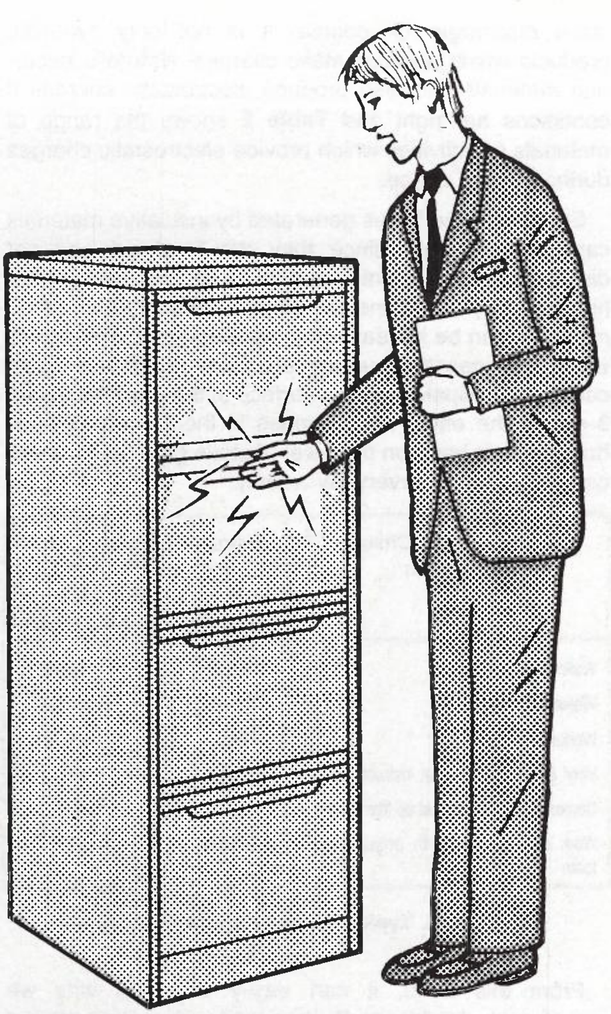


Fig. 2 — Discharge of an Electrostatic Charge from a Person

circuits, large scale integrated circuits), discrete semiconductors, film resistors, resistor chips, piezoelectric crystals and thick and thin film devices.

The microcircuits of these devices can be damaged by a static discharge onto one or more terminals of a device. The effect is that either the dielectric breaks down and/or the micro circuit conductor is "flashed" leaving a gap in the circuit path.

It is not necessary for the circuit to be connected to a "ground" for static discharging. MOS devices in hermetic packages for instance, can be damaged by spraying the cap with freon coolant.

Devices installed as assemblies on Printed Circuit Boards are susceptible to static discharge because the relatively greater mass of the printed wiring can carry the discharge, without damage to the wiring, direct to the sensitive electronic device. A good rule of thumb in static protection is to treat entire assemblies as you would the most sensitive part of the assembly.

TYPES OF ESD DAMAGE

Many electronic devices can be damaged or destroyed by ESD at potentials below the level of sensory perception. In some instances, a potential of 30 volts can be sufficient to so degrade the performance characteristics of a device, that it no longer performs its design function.

In the majority of cases, an ESD damaged part exhibits no physical signs of damage, not even when dissected and examined under a microscope. It is not until the part is examined under extreme magnification with an electron scanning microscope that the actual damage can be determined and a probable cause determined.

Both passive and active devices are equally susceptible to static discharge and the damage caused ranges from catastrophic failure, such as internal short circuits, down to a slight degradation of a parameter. The catastrophic failures are easy to detect; the device no longer operates and this results in a malfunction of the assembly. The faulty device can then be located, using normal test point inspection, and replaced. The degraded device however, is much more difficult to isolate and can be extremely expensive to detect. It can cause intermittant problems and depending upon the function of the circuitry it serves, could result in operating "hiccups" affecting data streams and operating programs.

We have referred to low power devices and high static voltages and their relationship to device damage. The type of failure mode that is caused can be determined as one of two types:

- Power Dependent Failure is the result of the dissipation of excess energy within the device and is characterised by:

— metallisation melt — of the conductor paths
— thermal secondary breakdown — melting of junctions
— bulk breakdown — impurity diffusion of junctions

- Voltage Dependent Failure occurs when excessive voltage is applied and the device construction is such that there is:

— dielectric breakdown — puncturing of dielectric
— gaseous arc discharge — metal globules form
— surface breakdown — leakage around the junction

Table 2 shows most of the recognised prime sources of static. One that is not shown is **the** prime source of ESD for damaging electronic components — **people**.

Electrostatic charges generated by rubbing or separating materials are readily transferred to a persons conductive perspiration layer causing the entire person to absorb that charge. Subsequently, when that person comes in contact with a static sensitive device, damage may be caused to the device from the resultant discharge. It is not necessary for direct contact to occur. As a magnet has lines of force known as a magnetic field, so does a charged body have an electrostatic field and causing the device to pass through that field can be sufficient to cause ESD.

A person can take extreme care not to come in contact with static generating materials but because of a phenomena known as body capacitance, he can cause hundreds of volts to be generated just by raising an arm or sitting down.

Human capacitance varies from individual to individual and can be as low as 30 picofarads (pF) or as high as several thousand pF. Typically though, it falls within the range of 50-250 pF but can be affected by factors such as the amount and type of clothing and shoes worn and differences in flooring materials.

The human resistance is nominally within the range of 100-100,000 ohms but is variable due to factors such as the amount of body salts, natural oils and moisture on the skin surface, and contact area and pressure. A finger-thumb grip has a typical resistance between 1000 and 5000 ohms.

Human capacitance and resistance have a large bearing upon static safeguarding techniques. A change in a person's capacitance could result in damage to a power sensitive device whereas a decrease in resistance will increase the charge voltage and power at discharge to a level capable of causing damage to devices which normally would not be sensitive to the charge potential.

It is possible to maintain body potential within limits by ensuring that ambient conditions do not cause a decrease in human resistance and by restricting the capacitance variations through a careful selection of clothing and footwear types.

ESD Control

As ESD is naturally occurring and cannot be entirely eliminated, it is necessary to introduce and maintain control techniques. This can best be achieved by recognising the causes of its generation and introducing procedures which minimise the situations in which an uncontrolled ESD can occur.

A very wide and diverse range of materials and products need to be considered when examining the work place initially to determine sources of ESD. Floors, floor polishes and cleaners, bench tops, trolleys, wheels, masking tape, freeze sprays, plastic folders, packing material, tools, chairs, shoes and protective clothing are all involved in the static protection examination.

The resolution of these problem areas is difficult to achieve completely when factors of cost, comfort and productivity are involved. Any solution which would lead to significant cost increases, comfort or safety concerns or significant loss of productivity would be simply replacing one problem with another. This then leads to a situation where compromises must be adopted to contain these three factors but also achieve an acceptable level of ESD control.

The 3M Company reports that one large semi-conductor manufacturer found that, in one seven month period, 28% of valid returns of CMOS devices were found to be electrostatic damage failures.

In mid-1980 a Hewlett-Packard Computer division implemented an aggressive ESD prevention program. Employees were trained on ESD and its prevention and static safe workstations were introduced. Over a three month period, failure rates dropped from 23% to less than 3%.

An experiment by another Hewlett-Packard division involved the handling of static sensitive integrated circuits. Eighty seven were tested and found good. Forty of these were placed in the standard plastic carry box and forty seven placed in anti-static foam.

The devices in the plastic box were handled by various people, returned to the box and retested. Of the forty, 31 failed and 9 passed the test. The forty seven devices in the anti static foam were retested and all passed. The subsequent introduction of ESD preventative measures and procedures resulted in a reduction of the standard time for board repairs from 13 hours to 5.47 hours per unit, and improved the yield of bi polar LSI parts from 22% to 100%.

This type of improvement has been reported by every large scale manufacturer and user of electronic devices who have recognised the ESD problem and taken the appropriate steps to overcome the problem.

ESD control is now a fundamental part of any manufacturing, assembly, installation or maintenance activity concerned with maintaining profitability and service whilst reducing the ESD related overheads.

Telecom Australia began to feel the effects of ESD in the late 1970s with the introduction of new generation communications equipment which had as the basis of its design "solid state" componentry. There was concern that the planned traffic management system allocated to the new exchanges could be affected if equipment failures through ESD reduced the availability of servicable equipment below an acceptable level.

A project team was formed to investigate potential sources of ESD and effective methods of control which would prevent widespread disruption to the Telecom network. It was determined that careful use of some commercially available products and staff education on static safe procedures would be instrumental in controlling ESD under a system utilising three levels of protection to suit the different operational requirements that exist.

Three Level Protection:

- **PRIMARY PROTECTION** — of the device itself, by enclosing it in a static-safe environment.
- **SECONDARY PROTECTION** — providing personnel handling static sensitive equipment with personal items to minimise static generation and provide a controlled method of discharging a static build up.
- **TERTIARY PROTECTION** — involves designing the general environment to limit static generation and to provide a safe discharging system.

In addition to these three levels of protection, guidelines for the establishment of ESD Control practices and procedures were developed which would ensure that materials handling and maintenance would be conducted in such a way that adequate protection would be available for ESD sensitive equipment in normal work situations.

APPLICATION OF PROTECTION LEVELS

The circumstances of each ESD protection requirement needs to be considered individually. It is neither necessary nor possible to always introduce the maximum levels of protection as this could result in excessive costs and applying measures in excess of what would be required to achieve adequate performance.

Variations of the intensity of protection can be made to suit the different work place situations; however, the basic requirements of the Primary and Secondary Levels of protection must be considered as the minimum to provide adequate protection for the majority of telecommunication equipment.

Primary Protection

This concerns directly protecting the static sensitive device or printed board assembly (PBA) and is achieved by designing into the construction, suitable inbuilt protection. In the majority of cases, this will be largely outside the control of the user, who can only use what is available. However more and more manufacturers of electronic components are taking care to provide inbuilt protection to their circuitry even though it may still be not fully effective or reliable.

The transport, packing and handling of devices and assemblies must not be allowed to affect the integrity of the unit and this can best be achieved by the use of anti-static foams, and anit-static and static dissipative plastic envelopes or bags.

Anti-static material is ESD protective and has a surface resistivity between 10^9 and 10^{14} ohms per square. Static dissipative materials are also ESD protective but the surface resistivity is usually between 10^5 and 10^9 ohms per square. They should not be considered as being conductive as the accepted measure for conductive material is one having a surface resistivity of less than 10^5 ohms per square.

Every care must be taken to prevent the common plastic products normally used in packaging from coming into direct contact with the sensitive items or even their specialised packing materials as high static charges can still be induced with the subsequent risk of damage. When anti-static packaging is not available, a level of protection can be provided by using stiff paper board or corrugated cardboard. Ordinary plastic bags, plastic wraps and aluminium foil should be avoided.

Secondary Protection

Personal grounding straps (wrist straps) are probably the most important item offering maximum protection. A strap fits around the wrist and is connected via an inbuilt 1 megohm resistor to a ground point. The 1 Megohm resistor limits the rate of discharge so that the wearer is not dis-comforted by a rapid discharge or put at risk by an inadvertant contact with mains power. A properly fitted and connected wrist strap guarantees that the wearer and his clothing are generally about the same potential as "ground" at all times.

In some work situations, it is not always possible to continually wear a wrist strap, therefore, alternative methods of minimising static buildup on the operator or his clothing are necessary.

These alternatives include:—

shoe ground straps — flexible link between shoe heel and sock to ensure good conductivity.
Anti-static lab. coat — short sleeved cotton or linen garment.
Anti-static Sleeve covers — fit over arm between wrist and elbow.
Anti-static Gloves — prevent direct skin contact.

It is not necessary to always provide each of these alternatives. Individual situations must be assessed on their merits.

Tertiary Protection

This involves treatment of the general environment in which ESD sensitive devices are handled, stored and transported. Where it is possible to directly influence the environment at a fixed location the term "controlled environment" is used.

Items which can be considered as forming part of this controlled environment include:—

workstation design	floor coverings
furniture	transit containers
instrumentation	atmospheric treatment

Equipment centres, maintenance centres and other areas where it is possible to nominate the conditions suitable for static-free work all fall within this category and offer the best opportunity to provide optimum levels of static safety.

It is not always possible to carry out work on static sensitive equipment in a controlled environment. Equipment installation and on-site customer servicing is normally carried out in situations where functional room design has included a large proportion of artificial fibres and materials in the general decor. It is this situation which puts the static sensitive equipment most at risk. However means are available to reduce this risk to acceptable levels. It involves the use of a table mat and floor mat (together with the use of a wrist strap) to prevent the build up of high static charges whilst work is being carried out on the equipment.

To be effective the floor mat must be capable of draining a static charge from a person as they approach the work position before they can reach out and touch or influence a component. The table mat has similar characteristics but is intended to drain the charge off any charged conductive object placed on the mat eg. a tote box, and to provide a static safe working surface.

Both the table and floor mats should be made from a static dissipative material and each should be connected to the same ground source, via a 1 megohm resistor and lead, as for the wrist strap.

Series connection of the mats and wrist strap to ground is preferred as parallel connection could reduce the protective resistance to an unsafe level.

STATIC AWARENESS

The provision of the materials mentioned above will not provide the maximum level of static safety if the vital ingredients in any ESD Control Programme — people — are not aware of correct procedures or their responsiblities. Staff education through seminars and publications together with proper supervision of practices and procedures is necessary to maintain static safe procedures.

Static awareness is essential on the part of management, technical and packing and cleaning staff. Without static awareness, failures will be incorrectly attributed to other causes.

ESD PROTECTION PROGRAMME

ESD damage is responsible for a significant percentage of electronic component failures. With the proliferation of ever smaller and lower powered components, the percentage is liable to increase unless effective ESD protection programmes are adopted and maintained.

There are no shortcuts to ESD prevention. Without staff awareness and proper use of suitable ESD products, the potential for causing ESD related damage could increase dramatically and negate the advantages of reliablility offered by electronic equipment.

Telecom Australia has instituted an ESD programme that incorporates the 3 levels of protection and conducts appropriate staff awareness courses. Just as importantly, suppliers of electronic components and equipment have been encouraged to set up their own programme so that the integrity of the product is assured, from manufacture to installation and through the service life of the equipment.

References:—

1. Australian Standard — AS1020
2. Department of Defense (USA) Military Handbook — DOD-HDBK-263
3. British Department of Defence Standard — 59-98 1852
4. British Standard Institute — BS 5783

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ARMY FINALISES PLAN FOR $575m COMMUNICATIONS OVERHAUL

The Australian telecommunications industry has negotiated contracts valued at $575 million with local defence forces to take their communications networks into the 21st century.

The main thrust of this programme is to replace analogue communications systems, some of which have been in service for almost 20 years, with state-of-the-art digital equipment. One of the many advantages of a digital network is that signals are much easier to encode, thus ensuring security.

There are three major projects in the Army programme — code named DISCON, RAVEN and PARAKEET — to cover three distinctly different levels of communication.

Local electronics companies are heavily involved in each of the three projects with most of the new equipment being Australian-made, said Mr G. (Bill) Page-Hanify, president of the Australian Electronics Industry Association (AEIA). In fact, Australian firms are managing all three projects on behalf of the Army.

Project DISCON (Defence Integrated Secure Communications Network) is the one closest to completion. Managed by Plessey Australia Pty. Ltd. which won the tender three years ago, DISCON is a $200m fully integrated digital secure telephone, telegraph, facsimile and data network linking Australia's permanent military bases.

It will provide secure, permanent communications links between the three armed services under the Department of Defence's umbrella — the Army, Airforce and Navy.

Due to be introduced next year, DISCON will eventually replace the existing Defence Communications Network (DEFCOMNET) currently used by all three armed services.

DEFCOMNET is a common user message switched telegraph network which uses both Defence-owned and Telecom bearers, although facsimile and telex services are also provided.

DISCON will interlink with RAVEN, a tactical system employing manpack radios (the portables worn into battle by infantry) and PARAKEET, a tactical defence communications network using vehicular transport.

The $150m project RAVEN, being managed by Plessey Australia Pty. Ltd., is scheduled to be completed by the early 1990s.

The RAVEN family consists of a manpack HF transceiver, a manpack VHF transceiver, RF power amplifiers, headsets, message entry devices, power cables and other ancillary equipment.

This micro-processor controlled system will provide a vastly improved performance and carry out more complex tasks than the existing single channel radio equipment, yet will be more reliable and easier to maintain.

Local sub-contractors on this project include Tubemakers of Australia, Antenna Engineering Australia, Hallmark International New Zealand, Scalar Industries, LJ Wallace and Computer Sciences Australia.

Project Raven, a tactical system employing manpack radios for use in battle by Army infantry in action.

As this project develops another 10 to 20 additional sub-contractors are expected to be signed up.

Project RAVEN also provides for the development of a frequency management facility (FMF), designed to ensure efficient use of radio systems in combat zones. This overcomes the problem of overcrowding the network, a problem compounded by the need to change radio frequency assignments at least daily for a number of electronic warfare reasons.

Project PARAKEET, being managed by Racal Electronics, is aimed at the communications system needed above the immediate combat level and is also due to be introduced in the early 1990s.

The existing network at this level consists of an array of terminal switching systems, control and transmission equipment, together with various short term stop-gap equipment. This will be totally replaced under project PARAKEET with an all-digital secure multimode (voice, data, facsimile, telegraph) system.

In fact PARAKEET will handle all forms of communication except video. Total cost of this project exceeds $225 million.

A major difference between project PARAKEET and similar systems overseas is the degree of integration of HF bearers into the otherwise wideband system. Although satellite links will play an important role in PARAKEET, the Australian Army believes that in Australia's unique terrain HF will be indispensible.

While work on project PARAKEET is still at the equipment design stage at least one local subcontractor — Software Sciences of Australia — has already been contracted and more are set to follow.

World Demand for Mobile Communications

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WHAT IS MOBILE COMMUNICATIONS?

Although mobile communications has often been described as a rich man's toy, it is clearly an unfair description as the term embraces far more technologies than the telephone in the chief executive's Mercedes Benz.

In the ITU Radio Regulations, the definition of a "Mobile service" is very broad: "A radiocommunication service between mobile and land stations, or between mobile stations."

A mobile station, under this definition, can be one used on land, across the seas or in the air. The service can be provided by terrestrial means or by satellite.

Mobile communications are used for a wide range of applications — much wider than just the company president rining up his secretary from his Mercedes. The following chart illustrates the range and types of radio communications services, including radio-determination, in use.

	Land	Maritime	Aero
Public communications services	mobile telephone paging cordless telephone	HF/MF telegraphy HF/MF telephony VHF telephony Satellite telephone/telex	Airfone
Distress/Safety	ambulance fire, police	navigational warnings distress alerts EPIRBs	air traffic control (ATC) ELTs
Operational	Dispatch taxis, trucking	ports, pilot, bridge-to-bridge	airline operations VHF, HF
Specialized		telemetry/tele-command tug-to-barge radar beacons Decca/Loran	NDB VOR DME ILS Secondary radar (SSR)

TYPES OF SERVICE IN DEMAND

The demand for mobile communications continues unabated. The market wants or is being offered mobile communications in varied forms as indicated by the following examples:

— Pagers can provide a tone alert, a numeric display or a full alpha-numeric display which can receive and store complex messages. Pagers were originally used locally, within a hospital for example; these pagers were often expensive, given the small number of users in the local environment, but now wide area and national systems are in use or being developed.

— Land mobile telephones were introduced decades ago, but their high cost and limited capabilities have kept them from becoming a popular consumer item. By contrast, the number of cellular phones is growing at a very rapid rate.

— Because they are controlled by electronic exchanges, cellular systems can offer services such as repeat call-out, scratchpad memory, call-barring, automatic call transfers and conference calls. They could offer value-added services, such as automatic telephone answering and electronic mailbox services. They could also be used for transmission of encrypted data, facsimile and telex in addition to telephony.

A huge consumer market is expected for highly portable telephones, which are so small they can be carried not only in a brief case, but in a pocket. In some countries, notably Scandinavia and Japan, the peripatetic user can or will be able to place a phone call from a bus or taxi.

— In the U.S., passengers on domestic flights can make telephone calls to their home or office by inserting their credit card in the wall-mounted console. When they complete the call, they return the phone to its cradle, which releases the credit card. NTT of Japan has announced its intent to develop a similar system for domestic flights which will be operational in 1986.

— INMARSAT provides satellite communications to ships and offshore oil rigs, which can use the service for telex, telephone and data communications up to 1.5 megabits per second, enough for compressed video transmissions. Leased circuits are also now on offer as well as a wide range of interactive services, including videotex, navigational and weather information services.

— In the next 10 years, there may be other mobile satellite systems in addition to that operated by INMARSAT. Canada and the United States are expected to take a decision to proceed with a domestic mobile satellite communications system, which could be used to send or receive signals to and from aircraft, boats and land vehicles. One MSS applicant says the system could act as a relay point for data sent automatically from sensors on board trucks or railway cars. The sensors would produce information about the contents, such as the temperature of frozen food. The Japanese Ministry of Posts and Telecommunications has signalled its intention to develop a Super CS communications satellite under a five year program to begin in 1987. The two-ton, multi-beam Super CS would meet the requirements of the large-scale value-added network services as well as those of the nationwide car telephone network. The European Space Agency is also studying the utility of a satellite system for personal mobile communications, with the emphasis on paging and alphanumeric message services.

No matter what type of system they are using, mobile communications subscribers share one intrinsic characteristic: they want to "roam," that is, to use the same equipment wherever they go, much in the way that cellular users of the Nordic Mobile Telephone System can in any Scandinavian country.

THE ECONOMIC RATIONALE FOR MOBILE COMMUNICATIONS

Few people regard efficient mobile communications as frivolous any more — and those who do, don't appreciate the sound economics which are stimulating the development of these technologies. An appreciation of the economics can be made by looking at the typical capital and operating costs of some of the vehicles in which these technologies can be found.

A 38-ton, five-axle articulated lorry costs about £40-45,000 in the UK. Assuming the lorry puts on 50,000 miles a year, its total operating costs, including fuel, oil, salaries, tyres, insurance, maintenance, overhead, profit margins, capital costs, depreciation, licences, etc., work out at about £140 a day or £20 an hour.

From a worldwide fleet of about 600, a wide-bodied, B747 aircraft can be purchased for about US$90 million and its operating costs are approximately $5,000 an hour. With 70 per cent of the seats filled on a typical London-New York flight in the off season, that aircraft would bring in about $60,000 in passenger revenue.

A 70,000 ton liquid natural gas carrier ship can cost about $150 million, with operating costs (not including capital costs) of about $250,000 a month, or about $7,000 a day. Daily bunker fuel consumption adds about $13,000 a day and port charges another $3,000 a day. Its cargo could be worth about $6.5 million.

Each of these mobiles needs communications for operations, safety, traffic control and public correspondence. If the UK-registered lorry breaks down somewhere in Spain as it carries a load of oranges from Morocco, the driver needs to get help fast. For every hour that vehicle is down, remember it is costing at least £20 just in operating expenses, not to mention the impact of the delay on the oranges or the customers who expect their timely delivery in London. Multiply the cost impact on a single lorry by the UK fleet of 63,000 lorries over 10 tons, and we begin to see some very large numbers.

If the LNG ship is not carrying an INMARSAT terminal and can not be contacted as a consequence by its owners who don't want it to steam into Algeria after all, but want to divert it to Tunisia instead, a day's delay will cost them more than $20,000 — perhaps a lot more, depending on the port charges. Two days delay will cost them more than an INMARSAT ship earth station.

In a report entitled "Oceanic Area System Improvement Study (OASIS)" prepared in 1981 for the US Federal Aviation Administration, various estimates were made of the total user and provider cost savings that would come under various configurations involving improved communications for air traffic control and more optimal aircraft separation distances. It was estimated that as much as $600 million could be saved in discounted 1979 dollars over the 1979 to 2005 time frame.

According to figures available to the ITU, the combined yearly revenues of the world's telecommunications administrations are currently some US$250 billion and their combined yearly investment programmes amount to about US$100 billion.

Yet the impact of telecommunications on the world's economies would be far greater than even these impressive figures. Admittedly, the impact of mobile telecommunications has a ripple effect difficult to measure, beyond investment in and revenues generated by the industry itself, but the true market demand is significantly greater than the actual investment or sales of equipment. The above-noted examples are cited to show that mobile communications are a tiny fraction of the capital and operating costs of the vehicles and the cargo they carry. Indeed, they are a tiny fraction of the cost of delays in going from point A to point B, when those vehicles don't have good communications. Hence, we can say with assurance that the cost/benefit of mobile communications is many times greater than the cost of the mobile equipment.

RAPID GROWTH IN MOBILE MARKETS

Recognition of these economies has led to an explosive demand for mobile communications in recent years, and system operators and suppliers consequently are witnessing exponential growth. As examples:

Land

— Sweden's first automatic mobile telephone service was offered in only three cities and had only 200 users from 1955 to 1963. Yet its cellular system, which began in 1981 and which provides national coverage, already has 50,000 subscribers. The Nordic Mobile Telephone (NMT) cellular system, still the world's largest, has more than 140,000 subscribers, and is predicting a growth rate of about 50,000 new subscribers per year.

— As recently as 1983, the mobile telephone subscribers in New York City totalled only 730, with a waiting list of 2,000. They shared 12 channels allotted to the city's five boroughs. By contrast, the metropolitan area's cellular system will be able to handle up to half a million subscribers.

— In 1979, Japan's cellular service started in Tokyo. Four years later, cellular transmitters had been installed in 329 cities.

— In the UK, the two cellular services, Cellnet and Vodafone, which began in January this year have been actively promoting their services with full page ads in the national daily newspapers and slick television commercials. The UK's cellular operators expect to go from zero subscribers at the start of 1985 to about 30-40,000 by year end and to about 500,000 by 1989.

— The FCC received 194 applications for cellular licences in the top 30 markets in the U.S., but it was flooded by 5,200 applicants for markets 91-120. In Chicago, which had the first cellular system in the United States, Ameritech is reported as having spent more than $1 million in advertising alone in the first year.

— The number of pagers in Singapore has tripled in two years, from just under 20,000 in December 1982 to more than 63,000 in December 1984 and the forecast is for 85,000 by the end of this year.

— In the UK, there are about 500,000 pagers of all types and the market is said to be growing about 20 per cent a year. Elsewhere in Europe the market is less substantial, although it too could grow rapidly with the introduction of the lower priced, more sophisticated pagers now coming on to the market.

— With 2.2 million paging subscribers in the US, the market is said to be growing at a rate of about 25-30 per cent a year, with a potential demand of 10 to 20 million subscribers.

Sea

The number of users of the INMARSAT system has tripled in three years, from 1,000 in February 1982 to more than 3,400 today. As this represents only four per cent of the potential market of vessels over 100 tons, INMARSAT expects a maritime population of at least 10,000 by 1990 and 15,000 by 1995.

Air

Several airlines in the US are equipping their domestic aircraft for the Airfone service, so that by the end of 1985 there could be nearly 1,000 aircraft with the service. It was reported that in the first 24 hours of service, more than 2,000 calls were placed. One airline reported more than 600 calls a day on its first seven equipped aircraft.

The domestic mobile satellite proposals in the US and Canada expect about 200,000 users in the two countries by the end of the century. They would be offered nationwide mobile radio telephone, voice and digital dispatch, interactive data, and perhaps surveillance and other services.

Forecasting is a hazardous art at the best of times, even with established technologies. With relatively new technologies, like cellular, there are as many forecasts as there are forecasters. In the US, for example, projections for cellular have shown that there may be anywhere from 1.5 million to several million users by the turn of the next decade. Arthur D. Little estimates a world market of 3 million cellular phones by 1989. Frost and Sullivan have estimated that there will be 1.6 million users in the US and 1.1 million in Europe by 1990. Some analysts expect that the US will account for about 60 per cent of the world market by 1990.

Globally, sales of all forms of mobile communications, including paging, will be in the billions of dollars — more precise numbers will depend upon which prediction one accepts.

While forecasting may be a hazardous art, it is necessary. INMARSAT for example has consistently underetimated the demand for its service. From a financial point of view, this does have its merits in presentations to our shareholders when those forecasts are exceeded, but from an operational point of view it is essential to have the system capacity available and ready for those additional users.

FACTORS AFFECTING MARKET GROWTH

A variety of factors can wreak havoc among the forecast numbers churned out by the computer. Among those that affect the growth in mobile communications are these:

1. Spectrum shortages

— The number of radiotelephone subscribers in New York City was restrained because of the high cost of the service, which was a function of the few available frequencies. The same story has been repeated elsewhere:

— The Nordic telecommunications administrations are coping with a demand far greater than had been anticipated for its 450 MHz NMT cellular system, which has only 180 channels available. Traffic on the system is some 300 per cent greater than had been estimated. The NMT system will introduce a higher-capacity successor in the 900 MHz band in 1986 which will have a capacity of 1,000 channels.

— Scarce frequencies were cited as one reason why the FCC has so far ruled against a permanent frequency allocation to the Airfone service in the U.S.

The problems posed by a shortage of spectrum for the mobile service are, however, being tackled by various means. Certainly one of them is frequency reuse, which is a feature of cellular. Another is narrow channel-spacing and yet another, the use of trunking. Private mobile radio systems of the variety used by taxis, police, public transport, and municipal services have been around a long time, but their growth has been hampered by the limited spectrum available and a limited coverage area. Instead of a number of private user groups each having its own frequencies, a better alternative is to allocate a number of channels to the area and have a computer to automatically assign a frequency to each user group as the need arises. Trunked systems are also being introduced on a wide area basis. When a subscriber is outside the coverage area of his system, he can still make a connection through another operator's base station which connects him to the switched telephone network for call completion.

2. Standardization

It has been said that national prestige is slowing down the development of communications in our societies. A lack of standardization has hampered and continues to hamper the growth of mobile communications. Worldwide, and notably in Europe, there is an alphabet soup of different and incompatible cellular systems — the Advanced Mobile Phone Service (AMPS) developed by AT&T and Motorola; the Mobile Automatic Telephone System, type E (MATS-E), developed by Philips and CIT-Alcatel; the Nordic Mobile Telephone System (NMT), developed by the Scandinavians; the Japanese Mobile Telephone System (MTS), developed by NEC; the Netz-C system, developed by the German Bundespost; the Total Access Communications System (TACS) system used in the UK.

The same situation prevails in paging, where for example the Benelux countries' Semaphon system is incompatible with the Franco-German Eurosignal system.

The demand for mobile communications will accelerate even more than today if greater efforts are made to swallow national prestige and to apply the same determination in regard to standards that countries are now making with respect to ISDN.

One can perhaps too easily adopt the posture that the market should decide what standards are to be adopted, but it is often the customer who suffers. He wants to be secure in the knowledge that his equipment has a reasonable life expectancy, that he can use it anywhere he goes. With agreed standardization comes a bigger international market than would otherwise be the case and, as a consequence, more, not less competition — real competition which is better and more meaningful than a de facto monopoly which has resulted from the so-called free market approach. A protected telecommunications industry, on the other hand, is a sub-optimal industry — it may protect some jobs and profits, but it also usually increases costs elsewhere in the economy. Microcomputer users in some countries regard their confreres in the United States with envy, where the prices of modems are much cheaper than those sanctioned by PTTs in many other countries. Hence, protectionism restrains improvements to the economy and society as a whole.

3. Equipment costs/tariffs

Using the UK cellular systems as an example, the equipment currently costs from about 1500 pounds for a mobile station in the car to about 3000 pounds for a portable. The subscription fee is about 300 pounds a year and user charges are 25 pence a minute in the peak hours from 8 a.m. to 8 p.m. A typical user is expected to spend about 1500 pounds a year. These figures are roughly comparable to those in the United States and in the Nordic countries.

Although the Cellnet and Vodafone systems commenced service in January and as a consequence have only a few thousand subscribers, both expect a total UK market of about 500,000 subscribers by 1989. To reach that target, they recognize that user costs will have to drop dramatically. Cellular system operators around the world share that recognition. In the US, equipment suppliers foresee the cellular phones dropping to less than $1,000 in the next two years. In Japan, $500 is the target wholesale price for a cellular phone in 1987.

Price elasticity of demand is high for mobile services that are aimed at the general public. While lower equipment costs will greatly expand it, the market is also very sensitive to user charges. One equipment dealer in Chicago was recorded as saying that the demand flattened out a few months after the cellular service went commercial, just about the time that people were getting their first bills of $700 or $800 a month. The average bill was $260 a month for calls alone. Ameritech subsequently applied for and received permission to drop the basic charge for its cellular service in June 1984 from $50 to $22 a month. Call charges are now between 22 and 38 cents a minute for a local call depending on the time of day. Stiff competition in other markets has also produced lower service charges.

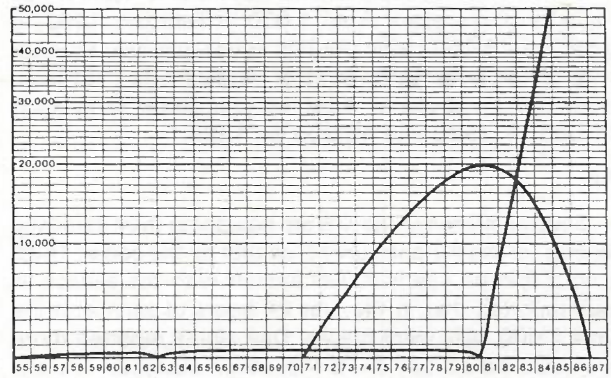
A similar phenomenon is being witnessed in the paging business. Once a service for businessmen and doctors paging is now being popularized. In the U.S., pagers are being promoted as a fun consumer item, with names like Li'l Bugger and Hippobeepamus. Radio Shack sells a Tandy pager for $99, a cheap mass product.

The costs of mobile communications in general will drop. The costs of integrated circuitry and storage are dropping, and as the number of units and maturity of the technology increase, so will the economies of scale. The large markets that come with standardization will make it possible to develop LSI and VLSI logic which will have the same favourable impact on end user costs witnessed in the microcomputer market.

4. Migration

The migration of subscribers from conventional mobile radiotelephone services to cellular is not only likely, but is being encouraged:

Televerket of Sweden plans to phase out its 11,000 remaining manual mobile subscriptions, following introduction of the 900 MHz NMT system. In fact, Sweden provides a dramatic illustration of the migration phenomenon.



1955-1963, System Lauren, automatic mobile telephone, 200 users
1963-1981, Syste Berglund automatic mobile, 650 users in three cities
1971-1987, MTD operator assisted mobile telephone, 20,000 nationwide.
1981- NMT cellular radio, 50,000 users by Feb 1985, four countries

British Telecom is offering financial incentives to its current radiotelephone subscribers to transfer to cellular. This is a trade-in deal which slices 500 pounds off the price of a new cellular model. In its advertising for the Cellnet service, it announces "Now Cellnet is here, all old car telephones are dead." If this is true, there will need to be an electronic graveyard for a large number of the 320,000 licensed mobile radios and telephones in the UK, whose users are expected to migrate.

A similar migration is being witnessed within the maritime market, as more ships are installing and using INMARSAT ship earth stations in preference to the older technologies of MF, HF and VHF. While the Safety of Life at Sea (SOLAS) Convention still requires the carriage of the latter by ocean-going vessels, several countries have introduced equivalency rules to exempt such carriage of the main transmitter if the ship has an INMARSAT terminal, and the International Maritime Organization, as the SOLAS custodian, will be overhauling the Convention with the introduction of its Future Global Maritime Distress and Safety System (FGMDSS) in the early 1990s. The FGMDSS will rely heavily on satellite communications.

5. Size and weight

Tied closely to cost as a factor in the demand for and growth in mobile communications are the size and weight of user equipment. The manufacturers of INMARSAT ship earth stations have steadily been reducing the size and weight of the terminals. Antenna diameters, once 1.2 m, are now 85 cm. One manufacturer's early advertisement showing two men lugging a radome, which houses the antenna, has been superseded by another manufacturer's ad showing two women easily lifting a newer, smaller radome. The drop in size and weight of the ship earth stations are crucial to expanding the potential maritime market from oil tankers and liquid natural gas carriers to fishing boats and yachts.

Similarly, in cellular systems, manufacturers have begun to announce portable equipment. At a trade show in the U.S. last year, Motorola exhibited a cellular phone weighing about three pounds. Ericsson has announced a second generation of mobile units, initially available for the NMT cellular system. One handheld unit weighs only 340 g, just under one pound. And in the UK, Excell Communications of Manchester claims it has the only truly pocket telephone yet announced. Designed to work with the UK TACS cellular system, the unit weighs less than one pound and measures about seven inches by three inches by one and a quarter inches. It is called, appropriately enough, the Futurephone.

Such small mobile phones may indeed revolutionize the future of the cellular markets — or, at least, the forecast markets. While a number of manufacturers have come out with portable phones or have signalled their intention to do so, there are difficulties to overcome, notably in the lower power levels associated with battery operation. How quickly technical obstacles can be overcome will have a decided bearing on how fast the mobile communications market grows. Among other obstacles are these:

— Current air-to-ground telephony technology has not achieved a relay system that hands off calls from one cell to another, as terrestrial cellular telephone systems do.

— INMARSAT has carried out long and detailed studies with respect to new ship earth station standards. One new standard, which will come into force in the early 1990s, will be a high gain, digital version of the existing, analogue Standard A ship earth station. We have also begun detailed studies for an aircraft earth station standard, but there are real technical challenges, notably in the trade-offs between the cost and complexity of aircraft equipment and the satellite power required to give an acceptable telephony link. A feasible AES must also of course minimize aerodynamic drag.

— Sweden has introduced a new mobile service called Mobitex, which combines trunked voice channels with a common data channel and which allows access to the public switched telephone and data networks. A single mobile unit will enable transmission or reception of telex, telefax, data, videotex and other information as telephone calls. Results from the Mobitex service so far indicate that users gradually develop a preference for text instead of speech. In cellular systems, voice is the primary mode of operation, but data transmission will probably be of growing importance. However, frequency switching from cell to cell may not be fast enough to capture information transmitted by a computer, although some system operators say data transmission and digital information will be included in cellular services in the near future.

— One challenge on the road to a system that is fully digital, end-to-end, is the development of a digital transmission system to link the cell's transmitter/receiver with the mobile telephones. In the present cellular systems, the radio link is analogue.

— Although speech coding technology is developing rapidly, it has not yet matured enough for the low bit rates needed to achieve frequency economy in terrestrial systems and power economy in satellite systems. Another challenge which is becoming more prominent as demand increases is development of efficient multiplexing techniques for the base station to handle many narrow band radio signals to common antennas. Digital radio would, however, permit use of wideband, time-divided channels which simplify the multiplexers at the base station.

6. Liberalization

The winds of liberalization are blowing across the communications business. While some may feel these winds don't amount to much more than a gentle breeze, a sign of the times came with the AT&T divesture. In the UK, British Telecom has been privatized and a competitor, Mercury Communications, has been licensed. In the Federal Republic of Germany, an expert committee is to examine, among other things, the liberalization of the market for end user equipment. In Japan, NTT is going through the throes of partial privatization, as Daini-Denden, the number two telephone company, gathers its forces from some 25 companies.

All of these moves spring from a growing recognition that technology is rapidly outstripping existing institutional structures. The monopolies which have existed until now are seeing their power bases eroded as the technologies of micro-circuitry, computers and communications converge, as all industries, old and new, scan the horizons for ways to increase their operational efficiency, and as the consumer looks for cheaper alternatives. Governments are now beginning to pay more heed to the arguments put forth by the newcomers, especially in the field of terminal equipment.

COMPETITION

In the US, the FCC ruled that each cellular market should be served by two franchises, one "wireline", typically the local telephone company, the other "non-wireline", represented by companies other than the local telephone company. The competitors would share equally in the 40 MHz of spectrum assigned for cellular services.

This model has been followed in other countries, such as Canada, where Bell Canada, the telephone company, and Cantel, a radio common carrier, will be competitors. In the UK, British Telecom and Securicor have formed a joint venture to compete with the Racal Vodafone system. Despite this competition, the UK TACS system has been conceived so as to permit roaming between the two system operators. Hence a subscriber of one system could make a call in an area served only by the other system.

Generally, it is fair to say that we will see more competition in mobile communications, which should benefit the end user, particularly as that competition drives down the cost of equipment and tariff charges. In most cases, although system operators may be loathe to admit it, that competition will also create faster growing markets. It must, however, be recognized that most countries have smaller markets and different economies compared to the U.S., U.K. and Japan. Policies that may make sense in some countries are not necessarily applicable or helpful in other countries.

"Generally" is the key word in that proposition. In some areas, at least for the time being, competition would seem to make little sense. In its Notice of Proposed Rulemaking with regard to the mobile satellite service (MSS) in the US, the FCC said it believes only one entity can be authorized to operate on the frequencies allocated to the mobile satellite service, in part because of the shortage of available spectrum and because of the high cost of an MSS system.

This same situation prevails with regard to international mobile satellite communications. The member countries which signed the INMARSAT Convention agreed that there should be only one system, in part for reasons of frequency economy. The Parties to the Convention agreed that there should be international standards for ship earth stations, so that users from any country could use the system. They were also doubtful that there would be a sufficiently big market to justify a second system. As it was, INMARSAT was established as a revenue-generating, but not-for-profit organization. Surplus revenues are to be ploughed back into the system to stabilize or lower space segment charges. Nevertheless, a certain amount of competition has been built into the system. The user can choose his hardware from about a dozen different manufacturers competing for the maritime market and can choose through which coast earth station to route his call.

In the INMARSAT system, provision of services to end users is the responsibility of INMARSAT Signatories. National policy determines access regulations in the various countries. Thus, INMARSAT is transparent and pluralistic — some countries can provide INMARSAT services through the national PTT while other countries can apply a "deregulated" or liberalized" approach and allow several or any number of service providers/users direct access to INMARSAT. These different national approaches can coexist side by side in INMARSAT while we safeguard the ultimate aims of achieving economy of scale for the benefit of the users through international co-operation, international standards and interconnectivity as well as frequency economy.

WHO PROVIDES WHICH SERVICES

Until recently, the mobile communications market could be characterized as a pie with discrete segments. Such is no longer the case. Reference has been made to a migration of users from one service to another, but as the end users demand more capabilities from their equipment — as some are no longer satisfied with a simple tone from their pager, wanting alphanumeric displays — as some are no longer content with just voice from their land mobile telephone system, wanting text as well — we are witnessing a blurring of those segments.

Until a very few years ago, the maritime user could use only MF radio of VHF radio telephone in coastal waters. Now he can use INMARSAT. With the advent of cellular, he can also use that. One of the leading US maritime magazines recently carried an article promoting the use of cellular on the inland waterways. The FCC has gone further, as it has licensed two cellular operators to provide service in the Gulf of Mexico. The nordic Mobile Telephone system is also being used on ships and ferries, which thus relieves some pressure on the maritime VHF band. As the UK and Japanese cellular operators will provide national coverage within the next two years or so, the same possibility opens up there. Similarly, the Canadian MSAT system could provide service to the 200-mile offshore limit.

Similarly, aircraft a decade from now conceivably could face a multiplicity of different mobile communications systems. In addition to the Airfone service in the U.S., there may be similar terrestrial services in many parts of the world. In addition to a global INMARSAT service, there may well be national and regional, often subsidized, mobile satellite systems. This scenario could be very unattractive to the world's airlines which would probably prefer a universal approach, minimizing investments in both ground facilities, satellites as well as airborne equipment.

It is unlikely that satellites will ever become cheaper than terrestrial solutions in heavily populated areas. The need for high power in the satellite to serve small, low power terminals on the ground makes satellites much more costly than terrestrial systems in populated areas. While frequency channels can be reused many times over even in a single metropolitan area in a terrestrial cellular system, frequency reuse in mobile satellite systems is technologically difficult, expensive and not likely to be seen in the near future. Any consideration of efficient spectrum utilization would make the satellite solution look dramatically less attractive compared to terrestrial systems in any area where there is a choice. As INMARSAT and the proponents of the domestic MSAT service have indicated, where satellites may make sense is in providing coverage over thinly populated areas, whether in Canada's North or the world's oceans or for that matter across Africa.

The first halting steps towards a thin-route mobile communications system have been taken. A U.S. entity and Telesat in Canada are likely to co-operate in the MSS. This North American approach appears, however, to be founded on considerable taxpayer subsidies. NASA is offering a free launch. Governmental customers are likely to be required to support the system, thus providing further indirect subsidies. Communications to the sparsely populated regions in northern Canada can hardly by itself support a mobile satellite system commercially.

THE FUTURE OF MOBILE

As for the fixed communications services, the future of mobile communications is digital. INMARSAT is well advanced in the development of digital ship earth station standards. Our progress towards a digital future is hardly unique in the mobile communications world, but our standards-setting makes it easier for us than some others.

The next window of opportunity for an international cellular standard lies with the introduction of digital techniques. The Nordic PTTs have a working group studying a digital system, as does the Confederation of European posts and telecomunications administrations (CEPT). The Franco-German cellular system was postponed, perhaps forever, while a digital equivalent is considered. A pan-European digital cellular standard is possible, but unlikely before the early 1990s.

As in ISDN, the application of digital techniques to mobile communications could considerably reduce the cost of services and, perhaps, make more economic use of the spectrum than today's analogue systems. It would greatly increase system flexibility with a common transmission format for speech and data transmission and system signalling. It could also lead to further migration of users and to the development of new market segments. ISDN techniques could minimize the long lead times and heavy investment costs by system operators in large systems that are not flexible enough to accommodate new and varying user requirements.

While the end user will not be able to see the digital path the communications takes, he or she will at the least unconsciously appreciate its implications and benefits. Undoubtedly, the future of mobile communications promises him an "intelligent" system en route which mirrors that in his home or office, a system capable of transmitting and receiving text and voice over the same invisible path, and perhaps a path of his choice. The secretary in Geneva will be able to page her boss touring the exhibition site in Singapore, leaving him a short message and telephone number, which he can store or print out. The journalist covering a conference such as this will be able to take his portable computer out of his brief case, type up the story in the airport lounge and transmit the article from the aircraft that takes him back home. And if they wanted, the passengers on the cruise liner sailing away from Singapore will be able to have a compressed video transmission of the proceedings.

With the advent of automated, digital mobile communications, we will see mobile spreading not only through the transport industries, down to and including, cars, but also to the mainstream of everyday life, to the truly personal, pocket phone — it is difficult to avoid the Dick Tracy cliche. Hence, wherever you roam, across town, across the country or across continents, you should be no farther from your home or office than the mobile, multifunctional telephone terminal you carry in your pocket.

Or at least, **amost** wherever you roam.

While a roaming capability should be built in as a design objective for all mobile communications systems, as it was in the Nordic Mobile Telephone system, there still remain the awesome disparities between the industrialized and developing countries, which were so succinctly described in the Report of the Independent Commission for Worldwide Telecommunications Development, otherwise known as the Maitland Commission. The report noted that there are some 600 million telephones in the world, of which 75 per cent were concentrated in nine advanced industrialized countries. It noted that Tokyo has more telephones than the whole of Africa with its population of 500 million people.

Yet their needs are great. The B747 operated by Air Afrique has the same need and demand for communications as does Singapore Airlines or British Airways or Pam Am. The Gabonese cargo ship has the same needs as the P&O vessel, which may be docked next to it in Rotterdam. The lorry crossing Ethiopia has the same needs as the one crossing Europe. The modern oil rig operated by the Indian Oil and Natural Gas Commission has the same communications needs as one operated in the Gulf of Mexico. Telecommunications are not an end in itself, they are basic to the economic infrastructure of every country. The less prevalent and sophisticated they are, the less that economy can be expected to grow.

While the proliferation of mobile communications systems will occur in the developed countries in the same way the fixed services have, mobile telecommunications could offer an inexpensive alternative for developing countries.

As an example, a mobile telephone system is being put into operation in Malaysia. With a cellular system in remote or rural areas of the country, it may avoid the need to string wires into the distant countryside, thereby saving large sums of money. With an interface between a coinbox and the mobile telephone, public telephone service can be established in villages and small towns. In some instances, the mobile system is providing an alternative to the wireline, in other cases, it will supplement the normal service.

Similarly, Matra believes its new Radiocom 2000 mobile system now being installed in France could be a viable alternative to conventional systems for developing countries. As Radiocom 2000 has been designed for both direct dial public mobile radiotelephone as well as private radio network users, the system could be attractive to countries where the demand from one type of user is not sufficient to justify a separate system. This claim would probably be true of other systems as well.

It is unfortunately ironic that in the developing countries where the demand or at least the need for both mobile and fixed communications is greatest, the difficulty in alleviating that demand has so far proved most intractable.

ISDN and mobile communications do, however, present developing countries with technologies which can be used to leap-frog the earlier stages of development which took place in the industrialized countries.

There are no easy solutions, given the other pressing needs in those countries, but the Maitland report and some other studies have eloquently expressed the cost/benefit of communications. Hence, it is in the interests of both developed and developing countries to tackle the problem — for the developing countries to benefit from the favourable economies which communications can introduce and for the developed countries to open up new markets.

A multinational approach may offer a much more cost-effective and more technologically advanced solution. Such a solution to thin-route requirements would seem difficult to achieve by virtue of the fact that present institutional arrangements revolve around national pride, which is not only a barrier to true international co-operation, but also works against actual national economic development.

Nevertheless, the ultimate goal in mobile communications systems should be to enable the user to make or receive a call no matter where he or she is — in the air, on the oceans or on land. While mobile needs can be met by either terrestrial or satellite means, it is unlikely that mobile satellite systems will ever be able to compete with terrestrial systems. As stated elsewhere in this paper, a mobile satellite system simply cannot re-use frequencies anywhere near the extent which terrestrial systems can. However, in order to provide a universal mobile communications environment, terrestrial and satellite systems will need to complement each other. Thus, I would suggest that governments and industry should take a longer term view of the evolution of the mobile market and begin thinking about ways in which we can arrive at the ultimate goal, which is to allow roaming across national borders and to allow the mobile user the same services as in the fixed telecommunications system.

Information Transfer News

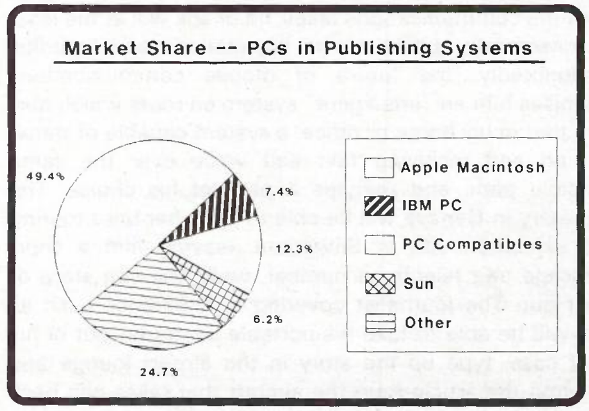
BEETHOVEN'S MISSING FIFTY SYMPHONIES . . .

Stone deaf, almost blind, Beethoven struggled to complete his Ninth, and last, symphony. Painstakingly, one note at a time, he handwrote the score. Soon after finishing his most famous, and most profound, symphony, he died in poverty. But according to Steven Newman, project manager for a new 243-page research study on computer-aided publishing, Beethoven would have been "five or six times more prolific" if he had, by some miracle, access to a personal computer with one of today's music composition and printing programs. Newman maintains, "There'd have been fifty more Beethoven symphonies if only Beethoven had been able to use this stuff to help him write the scores faster."

Whether the world of music wants, or can handle, the output from composers who are now five times more prolific remains to be seen, according to Newman. He suspects that "now machines make it easier to write music, easier to reproduce or publish it, and easier to play it, the real difficulty may lie in finding people willing to listen to it." The study singles out the Professional Composer (Mark of the Unicorn, Cambridge, MA) as the software which Beethoven would most likely have used if he'd had a Macintosh personal computer. If Beethoven were using an IBM PC he would probably have picked the Personal Composer software from Passport Designs (Half Moon Bay, CA).

At Least $700 Million Sucked Out of Typesetting Services, Printshops

Only a comparatively small amount of the total market for desktop/personal publishing is concerned with music, although among all users the musician is probably the person who benefits most from the new technology. According to the IRD report the market in 1986 for personal publishing hardware and software will be in excess of $1.3 billion. IRD's Newman believes that at least $700 million of this total represents money which would otherwise have been spent for commercial typesetting services, at instant-printing establishments, and in-plant printshops. Particularly popular uses of desktop publishing include in-house company newsletters, price lists and memos/announcements for internal distribution. But increasing quality of output, connected with software improvements and snazzier laser printers, is extending the scope of desktop publishing. "Although the commercial printing industry in general isn't really feeling much impact yet there are already some areas of the country where small typesetting services and instant printers are feeling the pinch," says Newman. Ironically, the



(SOURCE: INTERNATIONAL RESOURCE DEVELOPMENT INC.) (#685)

response in many cases is for the typesetting services to purchase their own personal computer-based publishing setup, so as to be able to compete with in-house units on the basis of speed and price. "Not every white collar worker wants, or can be bothered, to be his own typesetter," Newman points out.

Turf Battles Intensify

While the actual user of the desktop system is intrigued and gratified by the speed with which he can compose and print an almost-professional-looking document, not everyone in the organization shares his enthusiasm. The new technology is already triggering some royal turf battles in large corporations, according to the IRD report. The MIS department, the word processing department, the art department and the in-plant printshop feel that their prerogatives are somehow being trampled upon by the new personal publishing systems; the in-plant printing department probably has the most to lose. "At the lower end of the electronic publishing market the in-plant guys are getting creamed by PCs, and at the high end they're getting shunted aside by Xerox and Kodak," asserts Newman, who sees only about 40% of in-plant printing managers as being "sufficiently on the ball to deal with all this."

International Resource Development Inc. is an independent research and publishing firm which, since 1971, has produced more than four hundred in-depth analyses of high-technology business opportunities. IRD also does custom consulting work, for clients which have included AT&T, IBM, Nippon Electric and Fujitsu. A free table of contents and description of the new $1,850.00 report (No. 685), entitled DESKTOP/PERSONAL PUBLISHING EQUIPMENT & SOFTWARE MARKETS is available from IRD, 6 Prowitt Street, Norwalk, CT 06855 USA.

The Automated Baseband Monitor

Dennis Dorman
Martin Bastock

An Automated Baseband Monitor (ABM) has been developed and introduced into the Australian Telecommunication Network to specifically meet Telecom Australia's need for automated transmission performance surveillance and demand measurements on the broadband analogue network.

This article describes those specific needs and gives an insight into the hardware and software configuration of the ABM highlighting the tests that it performs.

BACKGROUND

In 1981 Telecom Australia issued its strategy plan for the service supervision and maintenance of the transmission network within Australia. This publication known as the Transmission Network Service Operations Plan called for the use of modern supervisory techniques such as the Transmission Performance Tester (TPT) and the Automated Baseband Monitor (ABM). The TPT and ABM would complement each other and provide a comprehensive performance coverage of the broadband analogue network.

The TPT which monitors interruptions, outages, level variation and noise on a selected voice frequency circuit of each bearer under test was described in the Telecommunication Journal of Australia Volume 33, No. 2, 1983. This complementary article gives a general description of the ABM, including an insight into the capabilities and facilities that were specifically required to meet Australia's needs.

WHAT IS AN ABM?

The Automated Baseband Monitor is a computer controlled system which continually oversights the transmission performance of broadband analogue bearers. It gains access to the end points of the links via special access switches and continually scans the system basebands (4, 6, 12 and 18 MHz) to check for the following conditions:

- Excessive traffic loading
- High level signals
- Incorrect pilot levels
- Noise

In addition to this surveillance mode the ABM is available to conduct measurements on demand, initiated by technical staff. The basis of an ABM in terms of hardware is a Programmable Selective Level Meter (PSLM), an instrument controller with printer facilities and an access switch.

BENEFITS OF AN ABM

Telecom Australia's operational practices and maintenance aids have been adequate to deal with the more straighforward faults such as complete or partial failures, but they were inefficient for the more obscure and intermittent fault conditions such as high level noise, excessive system loading and spurious high level tones which marred overall system performance. Such faults required laborious use of selective level measuring equipment and there was no means by which continuous monitoring of a system could be conducted when such a fault was suspected.

Because of the laborious and time consuming procedures involved, important routine system checks for loading, noise and pilot levels were not carried out by Telecom Australia. With ABM equipment, such manual measurements are not required; instead, maintenance staff have detailed performance data of each system and any deterioration in the transmission performance of the system is reported in real time. Eliminating problems at their source has a major impact on the overall quality of transmission and the incidence of reported sub-standard transmission performance. With the performance data available from the ABM providing good reference data, which was previously lacking, maintenance effort can be more precisely and gainfully directed.

Thus it can be demonstrated that the introduction of the ABM would give as its prime benefit a significant improvement in the performance of the broadband analogue network without incurring additional maintenance effort.

EVOLUTION OF THE ABM

During the years which Telecom has been considering the introduction of an ABM and evaluating commercially available systems, the approach taken has evolved through a number of stages, culminating in the system purchased from Hewlett Packard in 1985.

It was not until the early 1980s that commercial systems even came close to meeting the requirements of the Australian network. Evaluation of earlier available systems showed them to be far short of these requirements without extensive redevelopment.

Initial proposals for the introduction of an ABM in Australia were for a large scale National system with full networking of all equipped locations, allowing fully automated surveillance of end to end transmission performance of broadband analogue links. The facility for user specified measurement tasks on demand, locally and remotely, would allow the verification and sectionalisation of faults and ensure full flexibility in the application of the system. An existing commercially available system was sought, rather than seeking development of a new system.

As an interim stage in the introduction of an ABM, ten Hewlett Packard (HP) FDM Surveillance Systems were purchased in 1982/83; two sets each for New South Wales, Victoria, South Australia and Western Australia, and one set each for Queensland and Tasmania. This system, comprising an HP3746, PSLM, HP3754 Access Switch, HP85F Controller an HP5061A-Z01 Software Package, was developed by HP Australia for, and in close consultation with, Telecom Australia **(Fig. 1).** This equipment, used in conjunction with the software package enabled up to 14 different measurement tasks to be performed automatically on up to 10 different FDM basebands, either continuously or intermittently, at predetermined intervals as selected by the operator. Measurements available included pilot levels, traffic loading, carrier leaks and inter-supergroup noise. It was purely a transmission performance surveillance tool on a stand alone basis with no networking, remote control or demand measurement facilities. This purchase was seen as a means of gaining operational experience in automated FDM surveillance systems and to better gauge the requirement and application of such

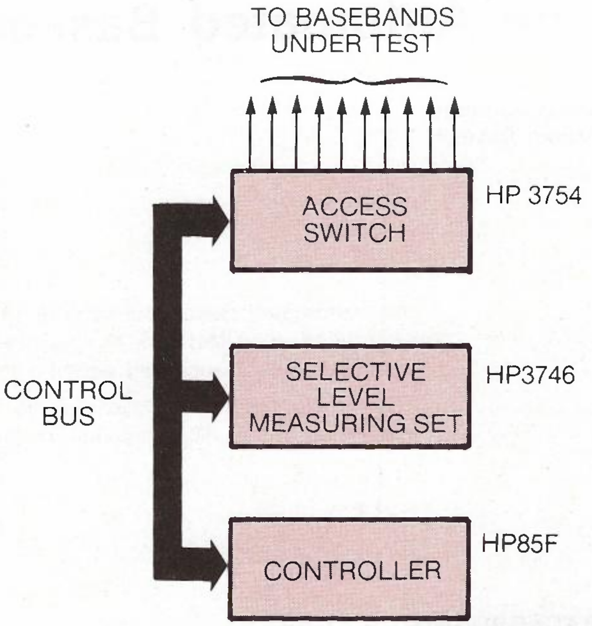


Fig. 1 — Basic Automated Baseband Monitor

equipment, while at the same time meeting the immediate and pressing need for FDM surveillance equipment in Australia.

The decision was made in June 1983 to abandon the large scale ABM in the originally proposed form in favour of a simplified, cheaper system similar to the 10 HP FDM Surveillance Systems purchased in 1982/83. This

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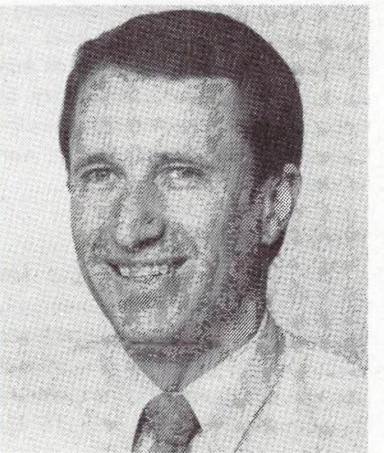
In 1974 he joined Telecom (then the PMG) as an Engineer Class 1 in Trunk Network Service, Victoria.

Dennis was promoted to Engineer Class 2 and subsequently to Engineer Class 3 in Transmission Operations Section, Network Operations Branch, Headquarters where his principal involvement has been with operations and maintenance aspects of 2 Mbit/s digital transmission and, in more recent time, responsibility for introduction of transmission performance monitoring systems including the TPT and ABM.



MARTIN BASTOCK joined the APO in 1967 and spent eight years in Construction Branch specialising in the installation of broadband equipment throughout South Australia. In 1977 he joined a Telecom Headquarters project team and was involved in the design, development and implementation of a computer based system for the national dissemination of technical information concerning the trunk and country junction network. His appointment as a Senior Technical Officer in the Network Operations Branch commenced in 1983 and he has been primarily involved in specification, development and testing of the ABM. Martin has recently completed an assignment to the International Telecommunications Union as a consultant to Jabatan Telekom Malaysia on the subject of automated transmission surveillance systems.

decision was made in the light of planning information indicating considerably more rapid introduction of digital transmission in the trunk network than was previously expected, together with an unexpected early decline in the number of analogue telephony bearers, particularly on interstate routes. As analogue bearers are replaced by digital bearers it is also likely that, as time progresses, it will be the more modern reliable analogue bearers that remain, which will not need the sophistication and periodicity of surveillance that would have been offered by the original ABM proposal. The decision was further justified by the results of an investigation into FDM surveillance practices of a number of European telecommunication administrations and by local field experience with the existing HP systems.

With the envisaged size of the analogue broadband network over the next 10 years, there is still ample justification for automation in FDM surveillance. The final phase in this project, after extensive evaluation of available systems and drawing heavily on experience gained with the existing HP systems, was the preparation of a system specification for a simplified ABM to meet Australian requirements, and the issue of a Tender Schedule in January 1984. Hewlett Packard Australia received the Contract in October 1984 for delivery in early 1985.

SYSTEM OVERVIEW

Hardware

The ABM comprises a programmable selective level meter (PSLM) (HP3746), an access switch (HP3754), a desktop computer with visual display and printing facilities (HP85B) and an appropriate software package (HP50601A-Z02) for control of the system. As some ABMs are to be used on a semi-portable basis, being moved around each State to a number of locations as required, the equipment is therefore, by necessity, reasonably portable and sufficiently rugged to withstand regular transportation.

Provision is made for remote operation of the system by use of bus extenders (HP37201). The software provides for the application of a tracking generator (HP3-335) for frequency response testing but generators are not being provided in the initial purchase **(Fig. 2)**.

Operation

Under computer control, the ABM automatically carries out predetermined sets of measurements in a cyclic manner on each broadband bearer connected to the access switch. Single tasks or combinations of the available measurement tasks may be selected independently for each test point. Nominal levels where applicable and limits for each measurement task may also be specified individually per test point.

The ABM system software provides, as its prime function, a "Surveillance Mode", with the additional facility for operator selected interruptions to perform "Demand Measurements". The surveillance mode permits operator programmed sequences of measurement tasks to be performed on preselected test points with the option of a single run, continuous run or time delayed run. Measurement results are compared with operator preset limits, with only those results outside limits, together with a status level indicator,

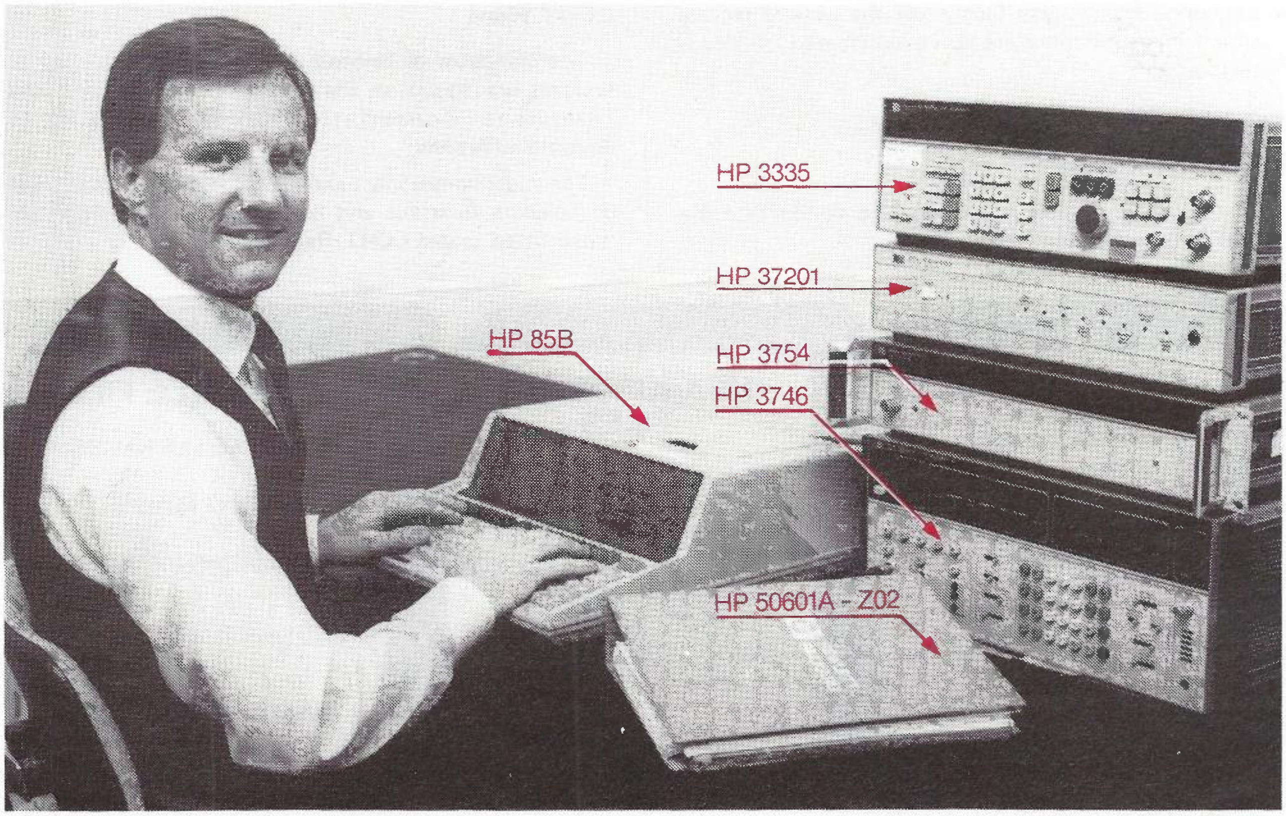


Fig. 2 — ABM Workstation

being output to the printer. The operator has the option of inhibiting any further print after the first occurrence of a particular out of limit condition or of printing the results of each occurrence. Alternatively, the operator may choose to have all measurement results with appropriate status indicators output to the printer.

System design is such that, at the discretion of the user, the full facilities of the ABM may be controlled remotely.

The software is interactive, supplying prompts in clear English or commonly recognisable abbreviations. It is also capable of translating an FDM statement (15 SGA/SG/G/Channel) or a frequency statement to an instruction for the PSLM. The relevant modulation plan, in accordance with CCITT recommendations, is operator selected from the specified range to suit each test point.

The access switch configuration is such that the number of test points is in the range of 10 to 50 in increments of 10. Testpoints are addressed using the testpoint number. The Telecom standard multiplex link identification code of the link connected to it, with an additional character to differentiate the direction of transmission is input by the user. A typical code is:

M LONC BENC C21 S

Multiplex link identification Direction of Transmission

Software Architecture

The software comprises three files into which data is stored **(Fig. 3)**. These files are:

- Testpoint Files: containing information about the 50 testpoints.
- Measurement Files: containing information about the various measurements available.
- Sequence Files: these files allow the user to dictate which measurements are to be conducted on which testpoints.

SYSTEM FACILITIES

Measurement Tasks

The software is able to control the conduct of the following measurement tasks:

Pilot measurements for 15 SGA, SG, G and ISGRP.

- Nominal level input in dBmO
- Upper and lower limits input in dB relative to the nominal level
- Measurements result in ± dB around nominal level

Power measurements for wideband power, supergroup power, group power and channel power.

- Upper limit is input in dBmO
- Measurement result in dBmO

Carrier leak measurements for SG, G and Channel.

- Upper limit is input in dBmO
- Measurement result in dBmO

Inter-supergroup Noise

- Upper limit is input in dBmOp
- Measurement result in dBmOp

Specified Frequencies

- Up to 40 frequencies may be specified.
- Measurement result in either dB, dBmO or dBmOp depending on actual measurements being taken (eg, Pilot, Noise, etc.)

Spectrum Scan

- For any specified frequency band.
- Result in dBmO.

FDM Scan

- For any specified part of the DM plan.
- Result in dBmO.

Hot Tone Search

- Counted frequency description is given in result.
- To overcome unnecessary attention being drawn to fleeting Hot Tones there is an option for suppression of the printout of these occurrences.
- Measurement result in dBmO.

CCITT Plans

The standards of Telecom Australia's analogue carrier systems are based on the International Telegraph and Telephone Consultative Committee (CCITT) Recommendations.

The most commonly used FDM hierarchial plans used by Telecom Australia and provided for in the ABM are those listed under CCITT Recommendation:

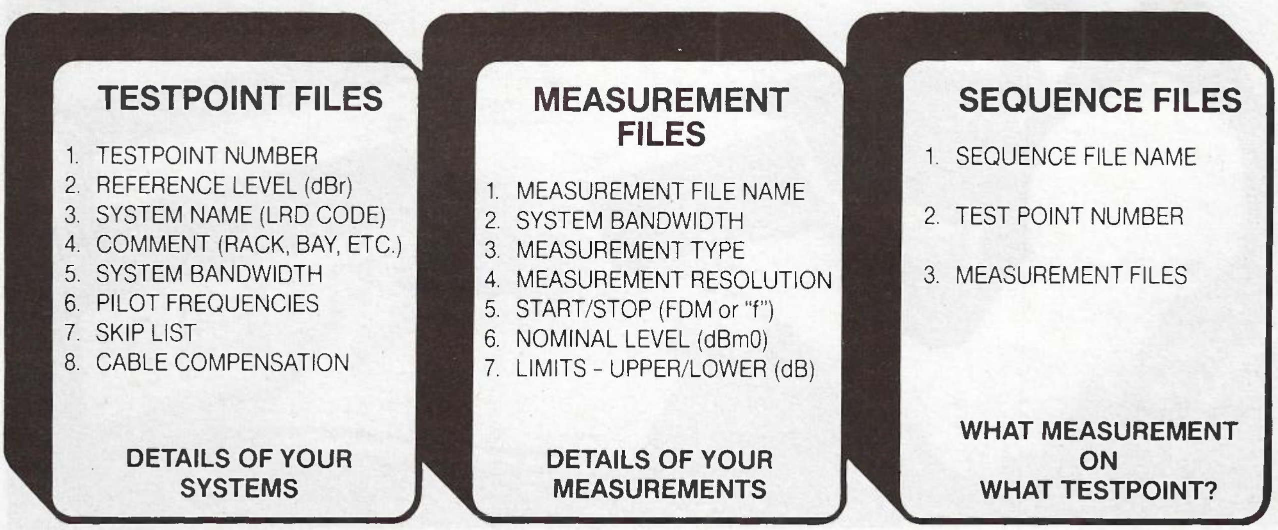


Fig. 3 — Software Architecture

- G343 — Plan 1 for 4 MHz systems
- G344 — Plan 1 for 6 MHz systems
- G332 — Plan 2 for 12 MHz systems
- G334 — Plan 2 for 18 MHz systems

SOFTWARE FACILITIES

The system software provides for:

Automatic Start. Once the hardware components have been interconnected and power applied, the software automatically loads the required programs to bring up an operator controlled "menu" on the screen.

Menu Operation. The software is menu orientated with maximum use of default values.

Hardware Test. A hardware test under software control is able to be conducted via the menu. It checks interconnection and correct operation of all peripherals.

Software Copy. A software copy capability is incorporated for back-up use.

Identifying CCITT plans. The software enables selection of the CCITT plans used by Telecom Australia by the specification of their respective bandwidths (eg. 4, 6, 12 and 18 MHz).

Skip List. Having selected one of the CCITT plans, the software allows the user to enter up to 30 skips. A skip causes the software to ignore an area of the plan that the user does not want to monitor (ie. the area may be unequipped or known to be faulty). Skips are in 15SGA or SG increments.

Identifying Individual Testpoints. Up to 50 testpoints can be accessed by the software and are able to be identified by the numeric values 1 to 50 inclusive.

Control of System Clock. The software controls a system clock that is not mains power dependant.

Output. The software controls the output and directs it to either the VDU or printer or both. The following types of output are available:

- Print all
- Print all out of limits
- Print all out of limits with reprint inhibit.

(**Fig. 4** for example of printout).

Power Failure Indication. Subsequent to a mains power failure the software causes the printer to print a timed record of the occurrence and then continue with any instructions it had previously been given.

Remote Control. The software is capable of controlling or being controlled by an identical system from a remote location with full facilities at both locations and control via dial-up link or dedicated 4-wire circuit.

Demand Measurement. The software is able to conduct each of the measurement tasks as a "Demand Measurement". It is a quick and simple operation which interrupts the surveillance mode and allows automatic return to surveillance mode on completion of operation.

Compensation for Input lead loss. The loss incurred by the connection to the PSLM, via the access switch, is compensated for by the software taking the frequency loss characteristics into consideration.

Working with a tracking generator. The software is able to control the system whilst working in conjunction with a level generator, locking into identical frequences. The generator is effectively open circuit whilst changing frequencies.

Create/Edit Facilities. The software is capable of creating and editing files to conduct a number of measurement tasks. This facility is menu orientated with default values offered. Edit is by destructive overwrite.

Automatic Skips. The software automatically skips Supergroup 2 of 15SGA number 1 when conducting supergroup carrier leak tests as there is no carrier used on this part of the FMD plan.

Update Sequence File. The software updates the sequence files with a "time" and "date" each time the file is modified.

Status File. The software maintains a status file of 2000 "out of limits" results. The current measurement is then compared to the limits parameters and the status file, possibly resulting in the printing of a status indicator as shown in the sample output, figure 4.

Run Options. The software makes available the following run options:

- Single run — Only one run of a sequence file
- Continuous run — Continuously run a sequence file
- Time delayed run — A sequence file is run for a user specified number of runs commencing at a user specified time with a user specified period of time between runs.

Default Values. Upon delivery the software contains the following default values. It is noted that these values may be altered by destructive overwrite as required by the user.

• Testpoints:	
Reference Level	-50.0dBr
• Pilots:	
Nominal Level	-20.0 dBmO
Upper Limit	+ 2.0 dB
Lower Limit	- 2.0 dB
• Power:	
Wideband, Upper Limit	+10.0 dBmO
Supergroup, Upper limit	+10.0 dBmO
Group, Upper Limit	0.0 dBmO
Channel, Upper Limit	0.0 dBmO
• Intersupergroup Noise:	
Upper Limit	-40.0 dBmOp

SYSTEM APPLICATION AND CONFIGURATION

Where justified, ABMs are permanently installed in major carrier terminals. Other sets are used on a portable basis being moved around the State as directed by the State Line Transmission Support Section/Group. They provide performance statistics facilitating a better informed, more economic approach to the maintenance of the transmission network, particularly in respect to performance degradation correction and bearer overhauls.

The equipment is also available for direct access by on site staff to perform individual measurements or more involved measurement tasks to assist them in the management of that part of the network for which they are directly responsible.

In the initial stage of monitoring with the ABM, effort is being concentrated on ensuring that all send pilot levels are correct, then the receive pilot levels. Once

SEQUENCE FILE NAME: TEST 1

LOCATION: LONSDALE

TIME: 02:59:50 DATE: 12/08/83

TIME 02:59:52 DATE 12/08/83

TESTPOINT 3 - M LONC BENC C21 R

GROUP PILOTS

HIERARCHY FDM	FREQUENCY KHz	LEVEL dB
1 02 1	335.920	-1.10
1 02 2	383.920	+2.20
1 02 3	431.920	+3.20 H
1 02 4	479.920	-1.20
1 02 5	527.920	-1.40
1 03 1	780.080	-2.60
1 03 2	732.080	-1.50
1 03 3	684.080	+1.30
1 03 4	636.080	+1.80
1 03 5	488.080	+0.10 R
1 04 1	1028.080	-1.10
1 04 2	980.080	-1.40
1 04 3	932.080	-4.60 L
1 04 4	884.080	+1.80
1 04 5	836.080	-56.6 M

RUN 3 STOPPED AT

TIME 02:59:58 DATE 12/08/83

- AT START OF EACH SEQUENCE FILE
- AT START OF EACH MEASUREMENT
- HIGH LEVEL INDICATOR
- SPACE LINE BETWEEN HIERARCHICAL GROUPS
- RETURNED WITHIN LIMITS INDICATOR
- LOW LEVEL INDICATOR
- MISSING PILOT INDICATOR
- END OF EACH SEQUENCE FILE
- INCREMENTED FOR EACH RUN

Fig. 4 — Output Format

correct pilot levels are established the condition of links can be checked by regular surveillance without the need for continuous long term monitoring.

CONCLUSION

The prime benefit from introducing the ABM will be a significant improvement in performance of the analogue broadband network, without incurring additional maintenance effort. Laborious use of manual selective measuring equipment will no longer be required for obscure or intermittent fault conditions and performance degradation evaluation. The ABM provides an economic and practical means of obtaining the network performance data required to accurately determine when performance degradation correction work is required and will significantly reduce fault location times. Gradual degradation in plant performance will be detected before complaints are received from customers.

The benefits of the ABM should be seen in terms of improved network performance against what this improvement would cost in manhours without the ABM.

Time Division Cross Connect and the Development of the Digital Data Network

S. MARK ELDREDGE B.E.(Hons), M. Eng.Sc., M.Admin

This paper provides an overview of the Australian Digital Data Network (DDN) and the proposed strategy for the introduction of the Time Division Cross Connect system (TDCC) and associated Management And Control System (MACS) into the network.

The Time Division Cross Connect (TDCC) is a digital crossconnection system that enables data services to be automatically crossconnected under operator control and the Management And Control System (MACS) is a minicomputer network to control the TDCCs and to provide advanced operations and maintenance functions.

The TDCC and associated Management And Control System (MACS) will provide the infrastructure for the ongoing expansion of DDN and will support a new range of dedicated digital services including data, voice and wideband services.

1. INTRODUCTION

In 1981, plans were prepared for the introduction and development of the Digital Data Service (DDS) which provides dedicated leased data communication services on the Digital Data Network (DDN). (1)

The DDS is a premium leased synchronous service that provides the following characteristics:

- Rapid Service Provision
- High standard of error performance (99.5% error free seconds)
- High availability (99.9%)
- Rapid Service Restoration

The services to be initially offered were at the data rates of 2400, 4800, 9600 bit/s and 48 kbit/s, and needs were identified that would require the future development of the following systems:

i. A Time Division Cross Connect system (TDCC) to carry out the cross connection of user rate data services between different timeslots in multiplex streams without physically demultiplexing.

ii. A Management and Control System (MACS) to achieve large scale network surveillance incorporating alarm and test access facilities.

iii. Customer Distribution System for higher speed data rates of 48 kbit/s and above including a range of services at 64 kbit/s and N x 64 kbit/s where N = 2 to 31.

These systems are now being developed and the following sections provide an overview of DDS marketing aspects, DDN network development, network architecture and the strategy for the integration of TDCC and MACS into the network.

2. BACKGROUND

The DDN has been implemented in three stages as follows:

Stage 1 — A **Pilot Network** linking Melbourne, Sydney and Canberra. This was commissioned in September 1981.

Stage 2 — The **Intercapital Network** expanded coverage to include Adelaide, Perth, Brisbane and Hobart, and the DDS Intercapital Service commenced in December 1982.

Stage 3 — The **National Network** progressively expanded the geographic coverage to regional centres with an increased number of metropolitan centres and provided full national service from December 1983.

This covers the period to June 1986 at which time there are planned to be about 400 DDN centres, supporting 24,000 Network Terminating Units (NTUs). The geographic coverage is shown in Fig. 1.

To cater for future network expansion and new digital service offerings, a range of enhanced customer and network facilities based on TDCC/MACS are proposed to be implemented in two additional stages.

Stage 4 — **TDCC/MACS Introduction** to reduce crossconnection costs and to provide advanced operations and maintenance facilities in 1986/87.

Stage 5 — **New Customer Interfaces** to support high speed data, voice and wideband services in 1987/88.

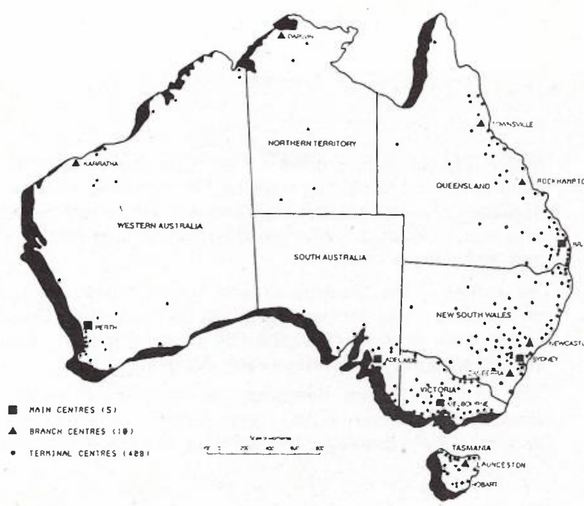


FIG. 1 DDN Geographic Coverage 1986

3. MARKETING ASPECTS

3.1 Market Demand

There has been a high demand for DDS facilities since the launch of the public service in December 1982. The forecast number of NTUs in operation on the network is as follows:

MAY 1986 FORECAST
NTUs IN OPERATION

June 85 (actual)	11.959
June 86	24,032
June 87	43,051
June 90	144,000
June 95	485,000

With this level of growth in the network it is necessary to provide advanced network management facilities to operate and maintain the DDS as a premium service.

3.2 Data Services

The services offered by DDS are synchronous leased services operating at 2400, 4800, 9600 bit/s and 48 kbit/s. The customer's data terminal equipment (DTE) connects into the DDN via an interface on a Network Terminating Unit (NTU) which is installed on the customer's premises. The customer interfaces supported by DDS are specified by CCITT for public data networks and are as follows:

Data Rate (bit/s)	Customer Interface (CCITT Rec.)
2400) 4800) 9600)	X.21bis (V24), X21
48K	X.21bis (V35), X.21, X.22

The range of data services supported on the network includes:

- Point-to-Point: Providing a dedicated synchronous leased line between two DTEs operating in full and half duplex mode at 2400, 4800, 9600 and 48 kbit/s.
- Multipoint: Enables three or more DTEs to be connected to a single line with operating speeds at 2400, 4800 or 9600 bit/s.
- Netplex: Enables data from a number of different low speed terminals at 2400, 4800 and 9600 bit/s to be multiplexed into a single high speed stream at 48 kbit/s to connect with a control terminal.

In addition a number of enhanced facilities are provided and these include:

- Redirection — Provides redirection of 48 kbit/s services under customer control for security or load sharing arrangements between two computer sites.
- Austplex — This facility is treated as a DDN private terminal centre and provides multiplex equipment on the customer's premises with 2 Mbit/s access to the network.
- Vitalink — Provides a second 2 Mbit/s access link to the customer's premises for backup and is used in association with the Austplex facility.
- Customer Test System — Provides the customer with local testing and diagnostic facilities for large networks.

3.3 Customer Requirements

Since the introduction of the DDS, customer requirements have changed and special facilities are now seen as necessary for the major business customers. These facilities include:

- Customer controlled alarm and diagnostic facilities to monitor the performance of their network.
- Customer controlled network reconfiguration to allow services to be redirected at different times to different locations.
- Disaster backup facilities to provide diverse routing of services.
- Higher speed data rates from 64 kbit/s to 2 Mbit/s to cater for existing and emerging equipment requirements.
- Integration of voice and data to allow transmission capacity management at different periods of the day.

To cater for these changing customer requirements the Digital Data Network will evolve into a Dedicated Digital Network that supports a range of digital services including data, voice, and wideband services.

3.4 New Data Services

With the introduction of TDCC/MACS and associated customer distribution equipment the capability will be available to provide a range of new data services.

The range and extent to which these services are offered, however, will be dependent upon customer requirements.

These services include:

- Point-to-Point — Speeds of 48 kbit/s (X.22), 64 kbit/s (X21) and N x 64 kbit/s where N = 2 to 31 (G.732 or I.431).

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He worked in the South Australian Administration in the construction, operations and service areas and was awarded the 1978 GEC Overseas Fellowship for two years' work experience in the UK in the research, design and manufacture of digital switching and transmission equipment.

After returning from overseas he transferred in 1981 to the DDN Group Headquarters where he was responsible for network planning and design aspects and since 1984 managed the development of the Time Division Connect System.

- Multipoint — Centralized multipoint at 48 kbit/s (X21 or X21 bis). Broadcast multipoint at 64 kbit/s and N x 64 kbit/s PCM Conference Bridge at 64 kbit/s.
- Netplex — Multiple high speed outstations operating at 48 kbit/s (X.22) and N x 64 kbit/s (G.732 or I.431).
- Redirection — All speeds including time of day and alarm initiated.
- Subrate — 8,16 and 32 kbit/s for low bit rate encoded voice or data applications.
- MACS Access — Customer Control of closed user group TDCCs and database enquiry facilities.

4. NETWORK ARCHITECTURE

The DDN incorporates four separate functions of data crossconnection, transmission, synchronisation and network management and the overall network has been divided into two functional entities as shown in Fig. 2.

- **The Transmission Network** — consists of the transmission and multiplex equipment, data crossconnection equipment (TDCC) and synchronisation equipment to support leased line data services.
- **The Management and Control Network** — consists of the network management and support system including the MACS for the supervision and control of the transmission network.

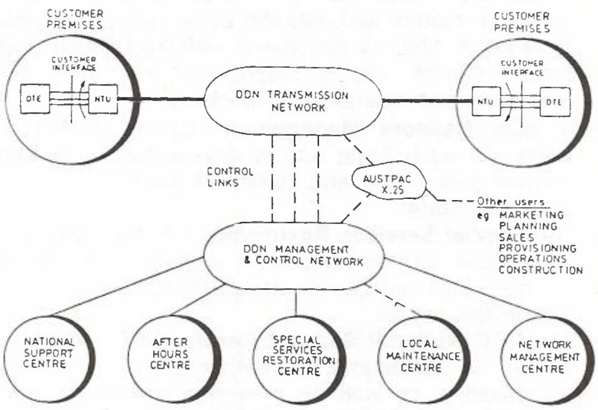

Fig. 2 DDN Functional Entities

4.1 Data Crossconnection

The Data Crossconnection function allows data circuits to be connected together to form an end-to-end digital data service. DDN centres are classified in a manner so that services can be efficiently routed through the network and crossconnections made in a systematic way. The hierarchy of centres and routes between them is shown in **Fig. 3.**

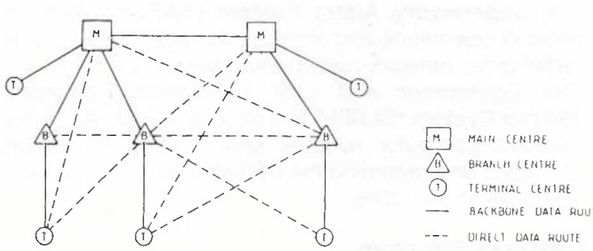

Fig. 3 DDN Crossconnection Hierarchy

The NTU in the customer premises connects via local and junction cable pairs to a **Terminal Centre** that contains transmission and multiplex equipment for connection to a crossconnection centre.

There are four types of terminal centres in DDN.

— An **End Terminal Centre** provides a multiplexing function for connection of the NTUs to the crossconnection centre.

— A **Transit Terminal Centre** provides multiplexing for local NTUs as well as providing a transit facility for the throughconnection of 64 kbit/s links from other terminal centres onto a 2048 kbit/s link.

— A **Co-located Terminal Centre** exists with each crossconnection centre and connects local NTUs into the network.

— A **Private Terminal Centre** is installed on the customer's premises and is functionally similar to the other terminal centres.

The **crossconnection centre** provides a means for crossconnecting data circuits to form an end-to-end data service and contains transmission and multiplex equipment, test access equipment, synchronisation equipment and supervisory alarm equipment.

There are two functional types of crossconnection centres.

— A **Branch Centre** performs the crossconnection of data circuits between terminal centres connected to it and transit crossconnections to other crossconnection centres.

— A **Main Centre** performs the crossconnection of data circuits between Branch Centres connected to it and to other Main Centres, all of which are fully meshed. A Main Centre also incorporates the Branch Centre function for terminal centres connected to it.

4.2 Transmission

The DDN centres are connected together via a range of digital transmission facilities and the digital network interfaces are in accordance with the CCITT digital hierarchy based on 2048 kbit/s.

Digital Multiplex equipment is used for translating between the various ditigal levels and group band data modems (GBDM) are used to convert from digital levels to analogue levels for transmission over analogue FDM systems.

Digital transmission facilities are provided over cable pairs, coaxial cable, optical fibre, digital radio and satellite systems whereas analogue FDM transmission is generally provided over coaxial cable and radio systems using a variety of techniques. (1).

The interface from DDN into the Main Transmission network or carrier terminal occurs at the 2048 kbit/s digital level and 48 kHz FDM Group level. In addition protection switching equipment (PSE) operating at 2 Mbit/s or 64 kbit/s is used on all transmission routes to achieve availability objectives, with route diversity provided where possible.

The equipment associated with the transmission hierarchy is show in **Fig. 4.**

4.3 Synchronisation

Network synchronisation is required in order to reduce the amount of slip that occurs in the network for end-to-end synchronous data services.

The slip performance is particularly relevant to data transmission throughput and is achieved by using high-accuracy clocks within the network that are phase-locked to a reference frequency source.

The network synchronisation system chosen for the DDN is based on the **Master-Slave synchronisation**

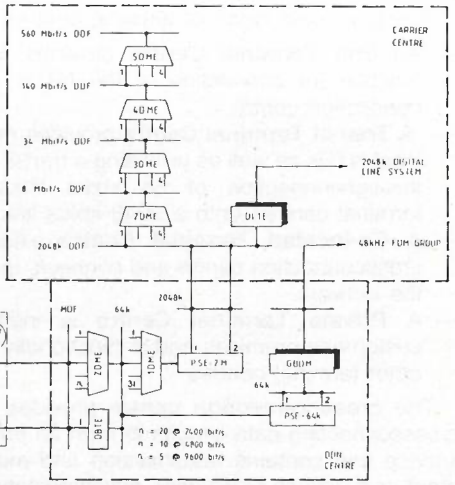

Fig. 4 Digital Transmission Hierarchy

technique and provides slipless data transmission under normal operations with backup for network failures. The system is also compatible and may be integrated with the planned National Synchronisation Network which will meet the standards for interconnection to international digital networks.

The Master-Slave system is a method of distributing the timing information from a singe reference or master clock to the other clocks in the network via a tree type configuration. The timing information is included as part of the digital transmission signal and is derived using clock extraction circuitry which is part of equipment terminating the transmission link.

To cater for transmission link failures, alternate timing routes are used to provide a backup for the main route. These alternate routes are predetermined and allocated a priority for input to the clock selection circuitry. The Master-Slave system is shown in **Fig. 5**.

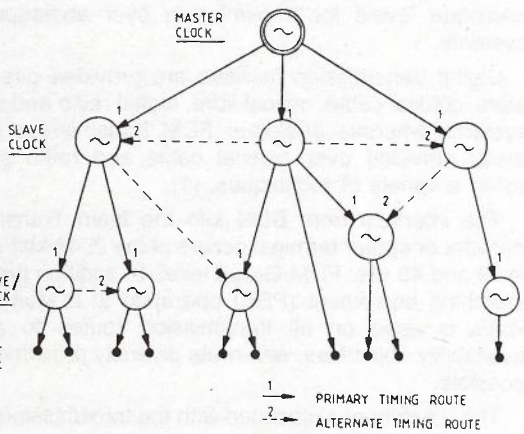

Fig. 5 Master-Slave System

4.4 Network Management

The network management functions associated with DDN are separated into customer-related responsibilities and network-related responsibilities. The distinction between the responsibilities is that customer refers to the equipment required to provide an individual digital data service at 2400, 4800, 9600 and 48 kbit/s and that network refers to the equipment that provides the network infrastructure at 64 kbit/s and above to support the services.

4.4.1 Centre Classification

There are four main types of centres associated with the management and supervision of the network, each performing a separate operational function. The control links between the centres are shown in **Fig. 6**.

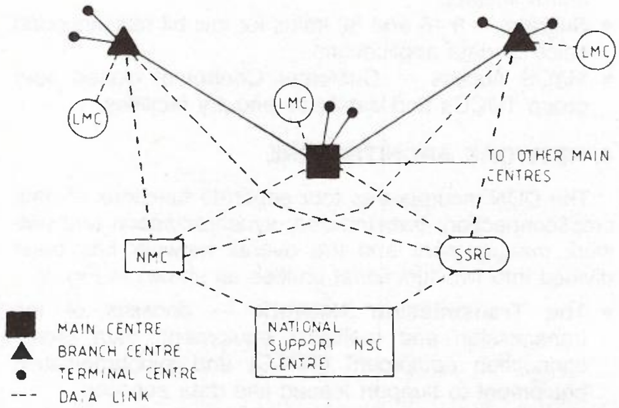

Fig. 6 Network Management Centres

- The DDN **Local Maintenance Centre (LMC)** provides on-site alarm and test facilities for access to both customer- related and network-related equipment and systems. A LMC is co-located with each Main and Branch Centre and is responsible for day-to-day operations and maintenance functions.
- A DDN **Network Management Centre (NMC)** is located in each State and is responsible for overall network supervision and control of the DDN centres within the State.
- The **Special Services Restoration Centre (SSRC)** is responsible for the restoration and maintenance of customer data services including DDS and is located in each major region.
- The DDN **National Support Centre (NSC),** which is located in Melbourne, is responsible for national co-ordination as well as providing support for the development and maintenance of the hardware and software systems used in DDN.

4.4.2 Support Systems

There are three main support systems that are currently used within DDN.

- The **Subscriber Test System (STS)** is a microcomputer-based system with VDU access and is used for customer-level operations to test data services by establishing loops and to measure inservice error performance and availability. (2).
- The **Supervisory Alarm System (SAS)** is used for network operations and provides monitoring and alarm facilities for network-based equipment. (3)
- The **Equipment and Link Utilisation Inventory Record System (ELIXIR)** is a national database on the Telecom computer network and is used for circuit allocation and recording the utilisation of all equipment and links in the DDN.

4.5 Network Structure

The existing network structure was planned for the initial growth of DDN and the systems that were developed had a number of limitations in terms of capacity, cost and floorspace. Crossconnections required physical demultiplexing and hardware jumpering on a distribution frame, separate multipoint equipment was required and the network support systems were separate entities requiring separate VDUs for access. The general structure is shown in **Fig 7**.

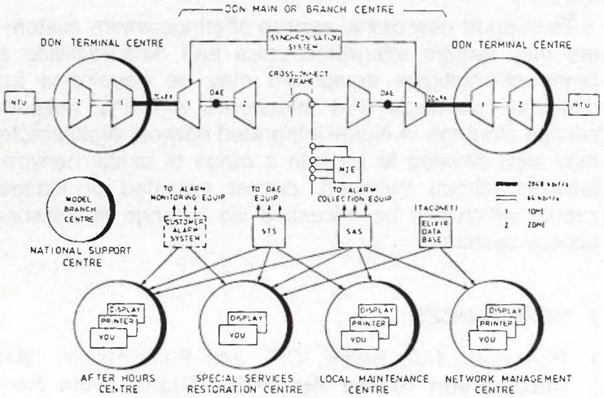

Fig. 7 Existing DDN Structure

To overcome the limitations with the existing systems, the TDCC is being developed to replace the multiplex equipment with an operator-controlled digital crossconnection system with alarm and test facilities, while the MACS will replace the existing support systems, incorporate the ELIXIR database and provide an integrated management and control facility. The proposed network structure with TDCC and MACS is shown in **Fig. 8.**

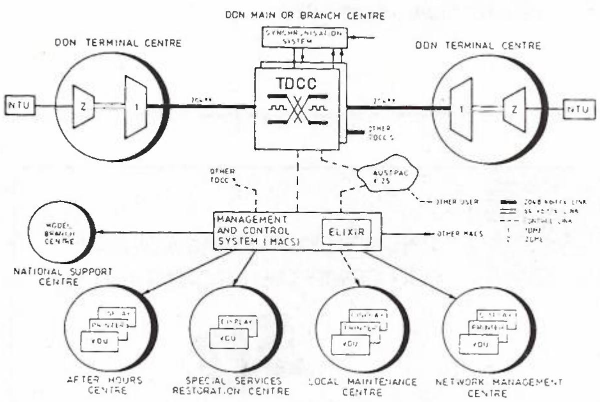

Fig. 8 DDN Structure with TDCC/MACS

5. TDCC/MACS NETWORK STRATEGY

5.1 System Integration

The introduction of TDCC and MACS into the DDN will provide improved service to customers through a more cost-effective and flexible network infrastructure and will provide the network management capability for a range of service provisioning and maintenance functions for end-to-end data services. **Fig. 9** shows a network of TDCCs that are controlled by the MACS network.

5.2 Benefits

The major thrusts associated with the introduction of TDCC and MACS into DDN are:

- Reduction in crossconnection costs
- New digital product opportunities
- Replacement for existing support systems with an integrated system

In addition there are a number of benefits that will be gained and some of these include:

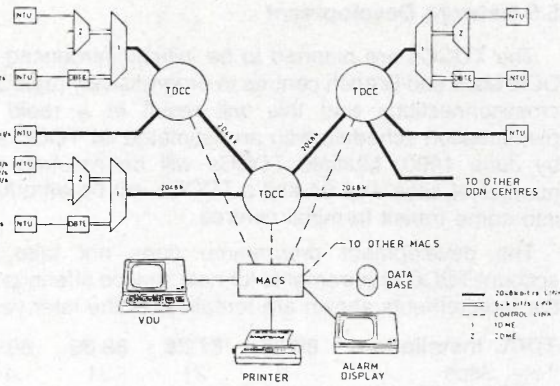

Fig. 9 TDCC/MACS NETWORKING

- advanced operations and maintenance facilities
- improved service provision and restoration
- efficient capacity utilisation
- reduction in floorspace
- rapid network rearrangement
- network performance monitoring
- comprehensive management information

5.3 System Development

The TDCC and MACS systems are being developed by GEC-Marconi Australia Pty Ltd in association with Marconi Communication Systems Limited in the UK.

The TDCC is based on the design of the Automatic Crossconnect Equipment (ACE) that performs 64 kbit/s crossconnections and is used in a number of overseas networks including the British Telecom Kilostream network. System development is being undertaken in the UK as well as Australia to develop X.50 user rate crossconnection capability to interwork with the DDN.

The MACS network is based on a range of minicomputers supplied by Digital Equipment Corporation (DEC) of the US and the application software is being developed in Australia to satisfy the specific operations and maintenance requirements of DDN.

5.4 Implementation Schedule

The TDCC/MACS systems are to be introduced in a phased manner. Initially they will support the existing data services on the DDN **(Phase 1)** and then enhanced to support new digital services and customer control facilities **(Phase 2).** The ongoing development and future enhancement of the systems **(Phase 3)** will be dependent upon the network and customer requirements.

The proposed timetable for the initial development and introduction of the TDCC and MACS is as follows:

Aug 86	Model TDCC and MACS Installation (National Support Centre)
Sept 86	First-In TDCC and MACS Installation (Melbourne & Sydney)
Feb 87	Model Systems Acceptance
May 87	First-In TDCC and MACS Commissioning (Melbourne & Sydney)
June 87	Bulk TDCC Deliveries Commence with progressive commissioning
Dec 87	Regional MACS Commissioning (Brisbane, Adelaide, Perth, Hobart, Darwin) and Phase 2 facility introduction.

5.5 Network Development

The TDCCs are planned to be initially introduced into DDN Main and Branch centres to progressively replace all crossconnections and this will result in a rapid implementation schedule with an estimated 44 TDCC sites by June 1990. Multiple TDCCs will be required in a number of sites and 64 kbit/s TDCCs will be introduced into some transit terminal centres.

The development programme does not take into account TDCC requirements for new service offerings and the requirements shown are tentative for the later years.

TDCC Installation	**86/87**	**87/88**	**88/89**	**89/90**
Total Sites	9	21	31	44
Total Switches	14	41	64	91

MACS Installation	**Model**
National	Melbourne Sydney
Regional	Brisbane, Darwin Adelaide, Hobart Perth

6. FUTURE DEVELOPMENTS

There are a number of future developments envisaged for DDN. The TDCC may be extended to perform higher levels of crossconnection at 2, 8 and 34 Mbit/s as well as voice testing facilities for 64 kbit/s voice services. Interworking with ISDN is also proposed to allow access to switched capability and to extend the ISDN coverage.

The MACS may be developed to provide enhanced customer access facilities depending upon customer requirements and database interworking with other management systems may be required.

To support new digital service offerings where customers may require integrated voice and data facilities a range of multiplex equipment may be developed for customer premises that interworks with the network service offerings. A digital integrated network architecture may also develop to provide a range of digital network facilities (circuit switched, packet switched or leased circuit) which can be accessed via a range of network access systems.

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BOOK REVIEW

North-Holland recently published "SO THIS IS 1984," some personal views by governors of the international Council for Computer Communication," edited by D. Parkhill and P. Enslow, Jr.

"So this is 1984" is a reprint from Volume 9, issue no. 1 of COMPUTER NETWORKS AND ISDN SYSTEM, the official journal of the ICCC. This organization is concerned with the problems and opportunities presented by the precocious development of the new electronic information technologies that are now transforming our world. Our arrival in the real 1984 triggered the world-wide discussion of 1984-reality versus Orwell's predictions. In this book a number of governors of ICCC present a analysis of the degree to which the world today exhibits Orwellian characteristics, and discuss both dangers and opportunities for good that are intrinsic to the application of modern information technology. Finally they bring to bear actions to avoid the creation of a "nineteen-eighty-four-like" society. Actions which at the same time expand horizons of human freedom.

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The DDN Time Division Cross Connect System (TDCC)

S. MARK ELDREDGE B.E.(Hons), M.Eng.Sc., M.Admin.

This paper provides a system description of the Time Division Cross Connect (TDCC) that is to be incorporated into the Australian Digital Data Network (DDN). The TDCC is an operator controlled digital crossconnection system that provides semi-permanent connections between data channels that are multiplexed into digital streams that terminate on the TDCC.

The TDCC and associated Management And Control System (MACS) will provide the infrastructure for the ongoing expansion of DDN and will support a new range of dedicated digital services including data, voice and wideband services.

1. INTRODUCTION

The Digital Data Service was launched in December 1982 and since that time data services have been crossconnected on physical distribution frames in DDN Centres.(1) As the level of new demand and the number of rearrangements increases the level of activity on the distribution frame also increases and the services will become increasingly more difficult to maintain.

To cater for this increasing growth in new services and network rearrangements the Time Division Cross Connect (TDCC), which is a computer controlled digital crossconnection system, was seen as the solution to providing rapid service provision and restoration where data circuits could be rearranged and tested electronically.(2) This system would also simplify the procedures for the provision of interstate services where co-ordination across a number of crossconnection centres is required.

The development of the TDCC provides a number of other benefits including a substantial reduction in crossconnection costs, a dramatic reduction in the floor space requirements and the opportunity to develop new product and service offerings for customers.

The TDCC is being developed by GEC-Marconi Australia Pty. Ltd. in association with Marconi Communication Systems Limited of the UK and the following description outlines the overall functions of the system and how it is planned to be integrated into the DDN.

2. DESIGN ASPECTS

2.1 Functions

The TDCC is a digital crossconnection system that uses time division switching techniques to provide operator controlled semi-permanent connections between data channels within the 2 Mbit/s streams that terminate on the TDCC.

The TDCC in effect provides a double level of multiplexing and replaces the existing Zero Order Digital Multiplex Equipment (ZDME) and First Order Digital Multiplex Equipment (1DME) used for crossconnections as well as the Multipoint Junction Equipment (MJE). Since the only physical interface is at the 2 Mbit/s level there is a substantial saving over existing multiplex equipment which requires physical interfaces at the user level. The functional diagram of the the TDCC is shown in **Fig. 1.**

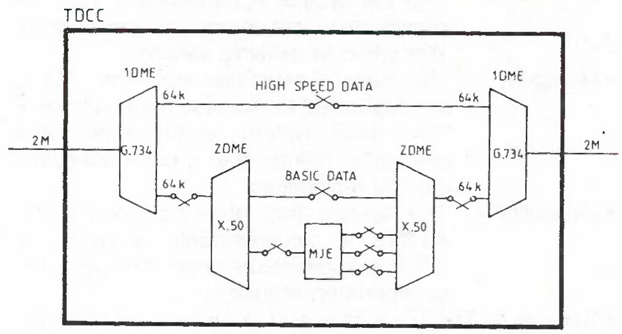

Fig. 1. TDCC Functional Diagram

The TDCC is capable of connections between channels within the 2M streams operating at the following speeds:—

- Basic Data Channels — 2400, 4800, 9600 bit/s and 48 kbit/s multiplexed according to CCITT Rec. X.50 Div. 3.
- High Speed Data Channels — 64 kbit/s and N x 64 kbit/s (where N = 2 to 31)
- Subrate Data Channels — 8, 16 and 32 kbit/s.
- Signalling Channels — Channel-associated customer signalling in timeslot 16.

Although the TDCC can support all these connections, the main requirement is for the crossconnection of the basic data channels.

2.2 Facilities

The TDCC is normally connected to the associated Management and Control System (MACS) (3); however it can also operate in a standalone mode although the level of diagnostics and user facilities provided by the system is reduced.

A range of hardware and software facilities are included in the TDCC as follows:

Hardware

- Multipoint facility for X.50 data up to 48 kbit/s.
- Broadcast multipoint for 64k and N x 64k.
- PCM Conference bridge to enable multiple voice conversations or for voiceband data multipoint.

- Test Access for remote control of monitoring and break access functions including in-service performance measurement.
- Continuous alarm monitoring on each 2 Mbit/s and 64 kbit/s stream.
- Synchronisation system with multiple choice input for reliability.

Software

- Netplex functions to provide a logical association between low speed channels and the aggregate high speed multiplexed channel.
- Redirection function to allow a main channel to be switched to up to 8 tributary channels on demand or under time of day.
- Multi-user access to operations and maintenance functions.
- User friendly operating system.

2.3 Features

The TDCC has been designed with four main features.

- Modularity — Each subsystem is designed separately and the system is expandable from the minimum to maximum capacity without disruption to existing services.
- Reliability — The major subsystems within the TDCC are duplicated to increase the reliability of the overall system. In the event of a processor failure the crossconnections are still maintained.
- Flexibility — The system has been designed to be flexible to accommodate a range of different subsystems depending upon the configuration required.
- Security — The TDCC processing system has hardware and software security checks to provide a high integrity system as well as preventing unauthorized access to the system.

3. SYSTEM CONFIGURATION

A TDCC system is divided into the two main subsystems that are shown in **Fig. 2.**

i TDCC Switch Sub-System

The TDCC Switch provides the main hardware facilities and terminates the 2 Mbit/s streams, performs the digital crossconnections and provides test access, alarm and synchronisation facilities. A TDCC system can incorporate up to four TDCC Switch Sub-Systems.

ii TDCC Local Controller Sub-System

The TDCC Local Controller provides the main software facilities and provides the communication with MACS (via Datel and Austpac), the non-volatile backup memory and the interface to the local control console and alarm display. Each TDCC system incorporates one TDCC Local Controller Sub-System.

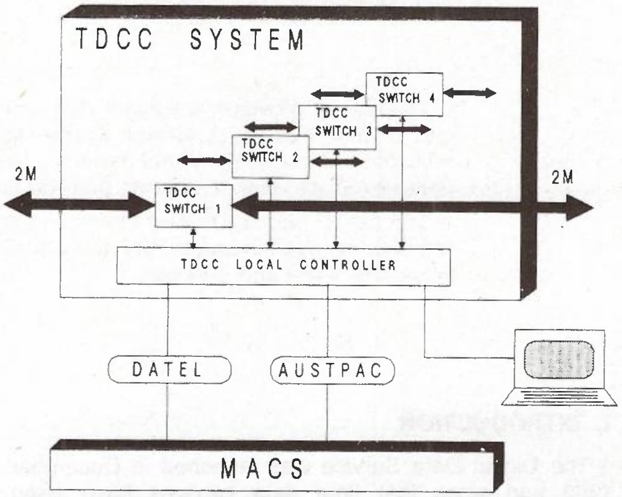

Fig. 2. TDCC System Configuration

3.1 TDCC Switch Configuration

The TDCC Switch is made up of a number of individual functional blocks that may be configured in different ways (e.g. 64k only or X.50 with multipoint). These functional blocks are shown in **Fig. 3.**

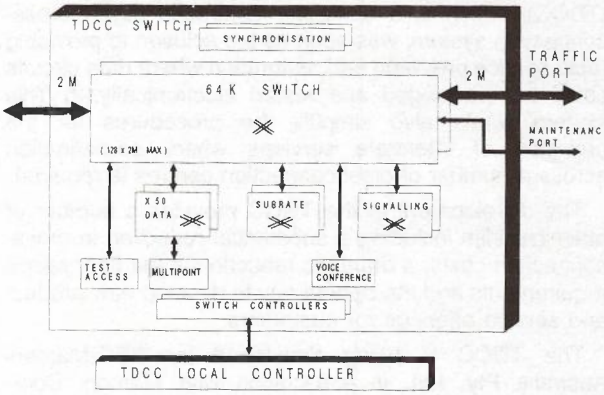

Fig. 3. TDCC Switch Configuration

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He worked in the South Australian Administration in the construction, operations and service areas and was awarded the 1978 GEC Overseas Fellowship for two years' work experience in the UK in the research, design and manufacture of digital switching and transmission equipment.

After returning from overseas he transferred in 1981 to the DDN Group Headquarters where he was responsible for network planning and design aspects and since 1984 managed the development of the Time Division Connect System.

• 64k Switch

This block is a single stage time switch consisting of duplicated switch planes that provide 64k crossconnections between channels in the 2 Mbit/s streams. The switch accommodates up to 128 x 2 Mbit/s streams and is non-blocking with full availability. Different line interfaces are provided between the different blocks with V.11 used internally to the X.50 Data and Subrate switches and HDB3 (G.703) to the external ports and other functional blocks.

• X.50 Switch

This block performs the user rate crossconnection of data channels multiplexed within a 64 kbit/s stream in accordance with X.50 Division 3. The block performs in-service monitoring of each X.50 stream and up to 2048 X.50 streams can be terminated on the switch in two groups of 1024 streams, each of which are non-blocking.

• Multipoint

The multipoint function refers to X.50 multipoint services and the function block connects to the X.50 switch. The function provides for one main channel to connect with up to four or eight tributaries and allows data speeds from 2400 to 48 kbit/s.

• Signalling Switch

This block switches channel-associated signalling information in the timeslot 16 format and can be applied to user signalling in timeslot 16 or network signalling in timeslot 31. The signalling information is associated with an individual 64k channel.

• Test Access

This block enables all crossconnections to be accessed for test purposes in either monitor or break access mode. In the monitor mode, in-service performance can be measured and in the break access mode loop commands can be injected into the stream as well as test patterns for error analysis.

• Voice Conference

This block provides an A-law PCM Conference Bridge function for 64k services. This may be used for voice conference or voiceband data multipoint services.

• Synchronisation

This block extracts timing information from a choice of different input sources including two incoming 2M streams and two external clocks and provides timing to the TDCC switch hardware.

• Switch Controllers

This block consists of a number of duplicated microcomputers that provide the interface between the TDCC switch and the TDCC Local Controller and contains software to operate the other function blocks.

• Traffic and Maintenance Ports

These are external 2 Mbit/s ports that have an HDB3 interface (G703) and can be used for connecting to line systems or external test equipment.

3.2 TDCC Local Controller Configuration

The TDCC Local Controller is made up of a number of functional blocks shown in **Fig. 4.**

• Processor

This function block consists of a duplicated microcomputer system based on the Intel range of single board computer products using the Intel 8086 16-bit microprocessor. It includes 2 Mbytes of non-volatile bubble

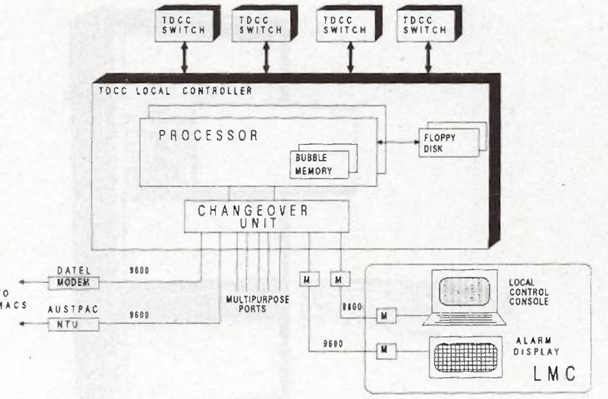

Fig. 4. TDCC Local Controller Configuration

memory, interworks with a floppy disk drive and provides serial interfaces to the TDCC Switches.

• Changeover Unit

This unit provides a single interface to the serial communications ports and directs the data to the active processor. The communications ports allow connection with a local control console, alarm display, MACS and with four multipurpose terminals to allow multiuser access.

• MACS Communications Ports

The communication with MACS is provided using synchronous data links operating at 9600 bit/s. A primary link is provided via a leased Datel service (V.24) for independence from the DDN. A secondary link is provided via a dedicated AUSTPAC service (X.25) within a closed user group using DDN access.

• Terminals

The local control console (VDU) consists of a DEC VT220 terminal which can be connected with a printer. The alarm display consists of an NEC APC III microcomputer which has a keyboard and a colour graphics monitor. This equipment is located in the Local Maintenance Centre and connects to the TDCC Local Controller via a Datel modem.

3.3 Equipment Practice

The TDCC switch is housed in TEP-1E equipment practice which is a British Telecom standard for transmission equipment and of similar dimensions to the Telecom Australia Type 84 practice. TEP-1E allows natural convection cooling and consists of racks and shelves that provide front access for cabling as shown in **Fig. 5.**

The TDCC Local Controller is housed in a separate freestanding rack using a 19" practice and is double the depth of TEP-1E. The total system can be installed in a normal exchange environment with overhead cable entry and standard air conditioning. Standard exchange power of -48V DC is used to power the complete TDCC system. The VDUs and alarm displays require 240 Volts AC.

3.4 Capacity

The capacity of the TDCC is dependent upon the functions required; however the following maximum limits apply to a single TDCC switch.

	Maximum
2 Mbit/s Ports	128
64 kbit/s X.50 Logical Terminations	2048
Multipoint Functions	1000
Redirection Functions	512

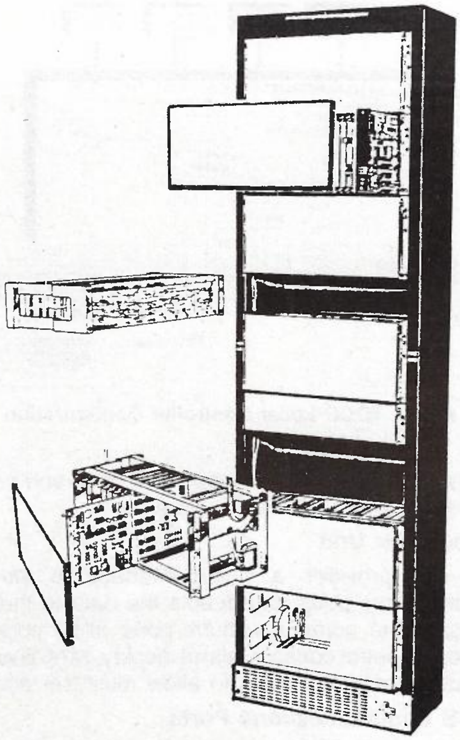

Fig. 5 TEP-1E Equipment Practice

4. SYSTEM INTEGRATION

The TDCC systems are initially planned to be installed in Main and Branch Centres where user rate crossconnections are used. A full cutover approach will generally be adopted where a complete crossconnection centre is cutover from the existing multiplex equipment to the TDCC. In the larger Main centres where multiple TDCC switches are required it is planned to first logically separate the centre into functional Branch and Main Centres and then to cutover each functional centre independently.

The TDCC will also perform 64k-only crossconnections and a number of small systems may be installed in transit terminal centres to provide concentration of 64k streams into 2 Mbit/s streams.

When installed and commissioned the TDCC switch will interface with the 2 Mbit/s protection switching equipment (PSE-2M) which connects to terminal centres and other crossconnection centres. Data communication links will connect with the MACS via Datel with Austpac as a backup and local modems will be used to connect with the local control console and alarm display in the co-located Local Maintenance Centre. The equipment configuration for integrating TDCC into network is shown in **Fig. 6.**

5. TDCC networking

The networking of TDCC Switches occurs at the 2 Mbit/s physical level although there are two different logical network layers for crossconnection at the X.50 Data level and the 64 kbit/s level. The networking at the X.50 Data level is more important in terms of the network architecture since crossconnections at the data rates from 2400 bit/s to 48 kbit/s experience the greatest equipment delay and this provides the main constraint on network design. The networking at different layers is shown in **Fig. 7.**

When multiple TDCC Switches are installed at a crossconnection centre they are fully meshed at the 64k logical level (and possibly the 2M physical level) and treated as a single TDCC with increased capacity. The 64k logical routes from other centres are distributed across the TDCC switches where possible, depending upon the dispersion of services and route diversity available.

Within the metropolitan area of major cities multiple Branch Centres are being established for centre diversity so that end-to-end services can be routed over two independent paths. The branch centres are generally fully meshed at the 64k logical level (2M where possible) within the metropolitan area and provide alternate diverse routes to other crossconnection centres. The routes between metropolitan areas are distributed across crossconnection centres where possible to satisfy dispersion and diversity requirements.

Finally, the major cities are connected together via a

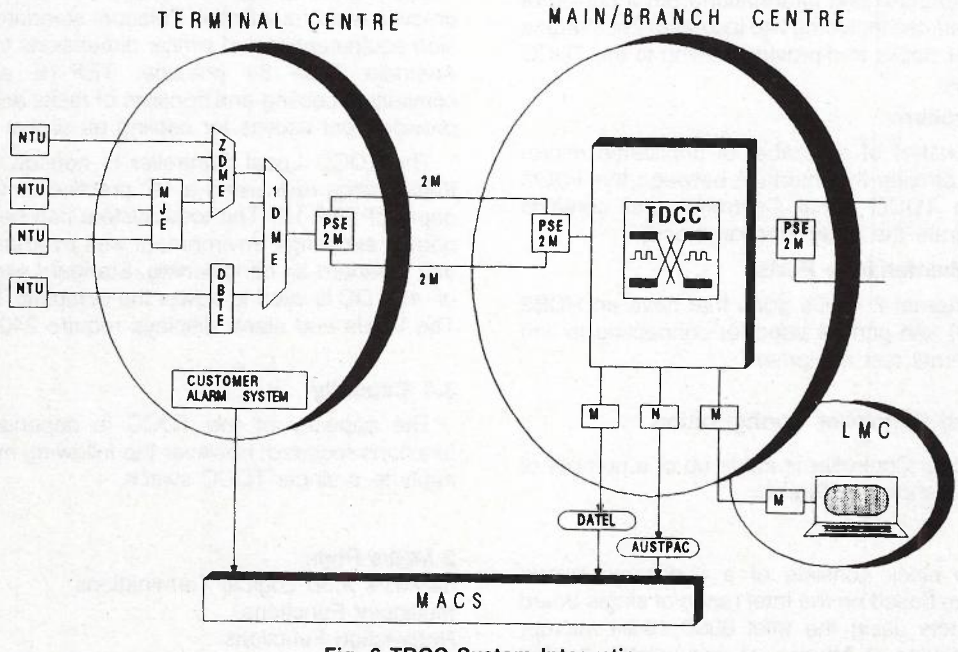

Fig. 6 TDCC System Integration

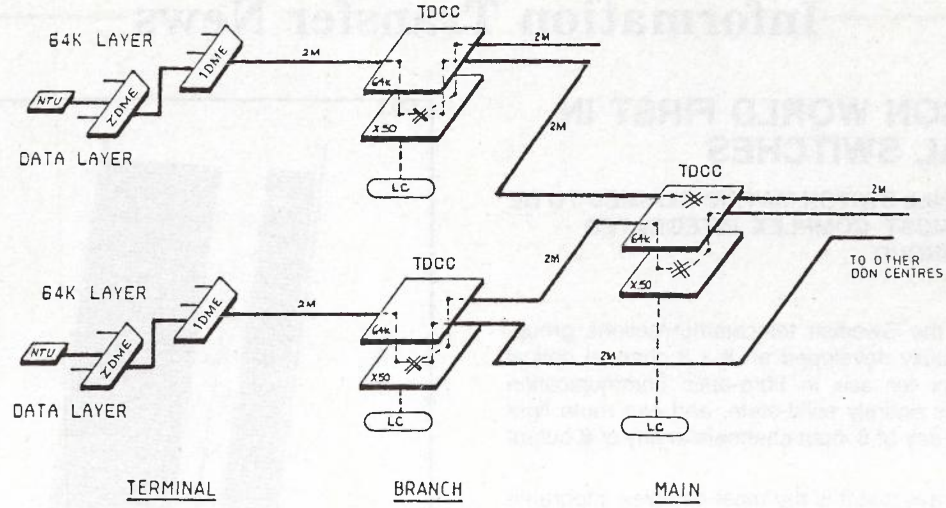

Fig. 7. TDCC Logical Network Layers

range of transmission facilities where the Main Centres are fully meshed at the 64 kbit/s level (and progressively 2 Mbit/s) and the Branch Centres are partially meshed to form the national network. This systematic approach to network design enables automatic algorithms to be developed for route allocation on a national basis. The different aspects of networking are shown in **Fig. 8.**

6. FUTURE DEVELOPMENTS

The TDCC may evolve into a general purpose digital crossconnection system that may be used in a number of other network applications. These may include the crossconnection of leased special services, electronic distribution frames and integrated access to a number of different networks including ISDN. The TDCC may be enhanced to perform higher level crossconnections at 2, 8 and 34 Mbit/s and with the associated MACS will provide a flexible network supporting a wide range of dedicated network services.

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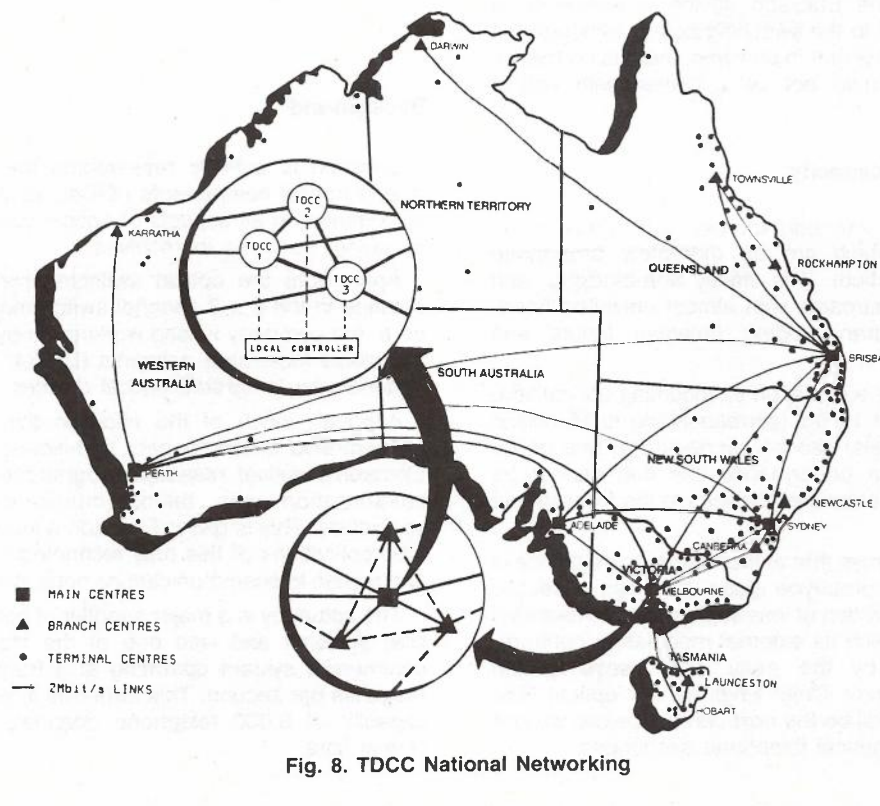


Fig. 8. TDCC National Networking

ERICSSON WORLD FIRST IN OPTICAL SWITCHES

8 x 8 CHANNEL SWITCH MATRIC CLAIMED TO BE WORLD'S MOST COMPLEX INTEGRATED OPTICAL CIRCUIT

Ericsson, the Swedish telecommunications group, has successfully developed an 8 x 8 channel optical switch matrix for use in fibre-optic communication systems. It is entirely solid-state, and can route light signals from any of 8 input channels to any of 8 output channels.

Ericsson says that it is the most complex integrated optical circuit so far developed, anywhere in the world. It has been developed jointly by Ericsson's Public Telecommunications division in Stockholm, and RIFA, the group's component subsidiary.

The device, which has been demonstrated in a laboratory version, has been implemented on a single chip of lithium niobate. It is built up from 64 switching elements — each referred to as an 'optical directional coupler'.

"Points the way to all-optical telephone exchanges"

Switching is carried out with the switched signal staying in the optical domain. It brings one step nearer the possibility of building 'optical exchanges' to route signals in optical fibre communications networks, without the need to first convert the optical data stream into electronic signals (as at present).

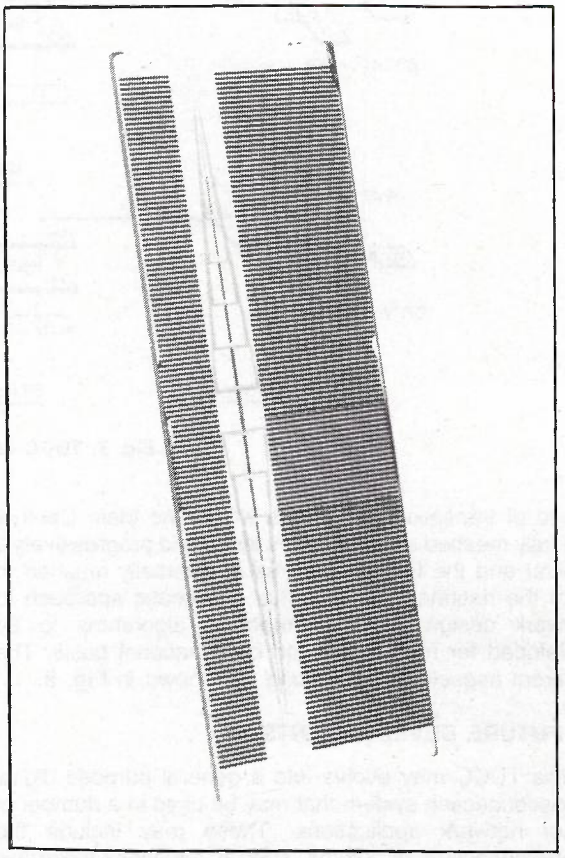
Switching in the Ericsson device is achieved by applying voltages to the switching points, although the company points out that in principle, there is no reason why this, too, could not be achieved with optical signals.

Very high data capacity

The device is intended for use with single-mode optical fibres, which are an extremely broadband transmission medium. It is strictly non-blocking, and can switch data streams with almost unlimited bandwidth, and arbitrary coding between inputs and outputs.

As an example, a signal on an incoming optical fibre with a capacity of 1 Tb/s (corresponding to 15 million telephone channels) can be connected to one of the optical outputs, a performance like that cannot be achieved with electronic exchanges in the foreseeable future.

The company says that at the moment, the device is at the laboratory prototype stage. "We can expect to see the first generation of less sophisticated integrated optical devices such as external modulators commercially available by the early '90s," says Oerjan Mattsson, Ericsson's Chief Engineer for optical fibre activities. "But it will be the next century before we see the arrival of all-optical telephone exchanges."



The 8 x 8 channel optical switch matrix for use in fibre-optic communications systems. Developed by L. M. Ericsson, Stockholm (length 60 mm, width 5,4 mm).

Background

Ericsson is actively researching the field of integrated optical components (IOCs), as part of a wide involvement in all aspects of optical communucations including the fibres themselves.

Apart from the optical switching programme that resulted in the 8 x 8 channel switch matrix described here, the company is also working on bypass devices for optical local area networks (LANs), and on basic materials for integrated optical devices.

Although much of the effort in this new field is concentrated on component techniques, a feature of Ericsson's optical research programme is the close collaboration with telecommunications systems specialists. This is giving Ericsson a lead in assessing the implications of this new technology for the public and private telecommunications networks of the future.

The company is a major supplier of optical transmission systems and was one of the first to install a commercial system operating at a frequency of 565 Megabits per second. This data rate is equivalent to a capacity of 8,000 telephone channels on a single optical fibre.

The DDN Management and Control System (MACS)

KANWAL KUMAR, B.Sc. (Eng.), M.Sc.

This paper provides a brief description of the Management and Control System (MACS) which is a major new development in the evolution of the Australian Digital Data Network (DDN). It is a distributed minicomputer network designed to provide centralised control of the Time Division Cross Connect (TDCC) systems as well as advanced operations and maintenance functions for the DDN.

In conjunction with the TDCC, MACS will provide the appropriate infrastructure for the ongoing expansion and management of the DDN into the 1990s and support a range of new dedicated digital services including data, voice and wideband services.

1. INTRODUCTION

The Digital Data Network (DDN) has been established since December 1982 to enable rapid provision and restoration of dedicated data communications services and allow a high standard of error performance and availability (1). To assist in achieving these objectives, a number of operations support systems have been developed. These include a test system, known as the Subscriber Test System (STS), an alarm handling and performance analysis system, known as the Supervisory Alarm System (SAS), and a database system, known as ELIXIR (Equipment and Link Utilisation Inventory Record) System (2, 3).

In addition, a tiered maintenance structure has been established which corresponds with the DDN centre hierarchy (4). This structure involves three specific network maintenance centres:

i. the "Local Maintenance Centre (LMC)", which is co-located with every DDN Branch and Main Centre and provides day to day operation and maintenance function for that centre as well as assistance to the Terminal centres within it serving area;

ii. the "Network Management Centre (NMC)", which is located in each State and provides overall network supervision and control for the State; and finally,

iii. the "National Support Centre (NSC)", which is located at HQ in Melbourne and provides national co-ordination and support for DDN.

The Special Services Restoration Centre (SSRC) and After-Hours Centres (AHC) also play an important role in supporting services on DDN in the same manner as other leased services.

The existing operations support systems mentioned earlier have been developed more for expediency than for the purpose of meeting the long term operational requirements of the DDN. While these systems have fulfilled their role very well, they are basically separate systems and relatively unsophisticated, limited in capacity and expensive on floor space. With the rapid expansion of the network, there is a strong need to integrate and substantially enhance these systems in order to provide greater capacity and operational flexibility, with reduced hardware requirement and data duplication.

The decision to introduce the Time Division Cross Connect (TDCC) System into the DDN has provided an opportunity to develop a multi-minicomputer based operations support system to provide not only centralised control of the TDCCs but also integrated network operations and management facilities for the DDN (5). Called the Management and Control System (MACS), it will incorporate the ELIXIR database and replace the existing operations support system SAS and STS. It will provide enhanced customer access facilities to enable greater customer control of his network, as well as advanced reporting facilities to assist in a better management of DDN.

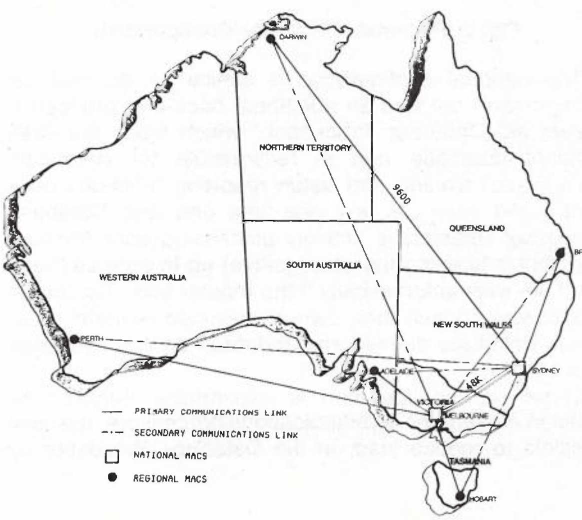


Fig. 1 — MACS Network

2. SYSTEM DESIGN AND CONFIGURATION

The MACS basic design concept represents a compromise between the capacity limitations of the computer hardware tendered and the Telecom requirements for high system availability, flexibility and fast response times. Accordingly, the system development has been on the basis that the database, service provisioning and batch reporting functions will be centralised nationally, and the network maintenance functions, including alarms handling, test access and user interaction, will be regionalised on a state basis. This has led to the establishment of MACS as a distributed minicomputer network consisting of interconnected computer sites of two possible configurations — "national" or "regional", with the former being located at Sydney and Melbourne and the latter at all the remaining capital cities and Darwin in the Northern Territory **(Fig. 1).** Each regional site is connected to both the national sites via 9.6 kbit/s data links, one of which is designated as the primary link, and the national sites are linked together via 48 kbit/s links.

Hardware Configuration

The regional configuration typically comprises a back-end processor (VAX 11/750) called the "Alarm Processor", with the associated disk drives, magnetic tape unit and system printer, connected with a number of front-end communications processors (PDP 11/73s) via an Ethernet local area network (DECNET) **(Fig. 2).** Together, these computers are responsible for alarm handling, test access and customer access for an entire region (usually the State).

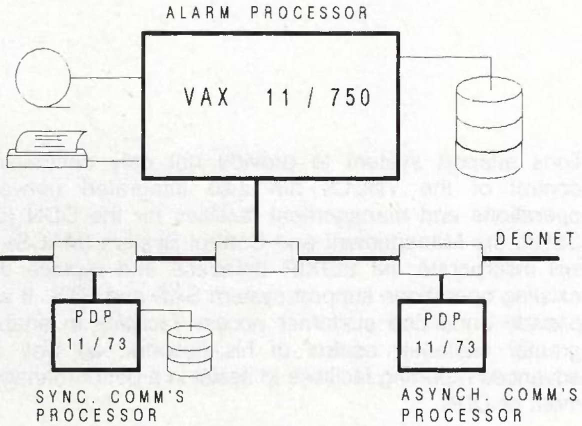


Fig. 2: Regional MACS Site Configuration

The national configuration is similar to the regional configuration but has an additional back-end processor, known as "Database Processor," which holds the DDN national database and is responsible for database, service provisioning and batch reporting functions on a centralised basis. At any one time only one Database Processor (master) is actively processing user transactions but is keeping the other (slave) up to date so that it can take over automatically if the master fails. The Alarm Processors contain their own abbreviated regional databases which are derived and updated from the Database Processor.

Either site configuration is expandable through the addition of alarm or communications processors. It is also possible to reduce load on the Database Processor by hiving off the batch processing function to a separate back-end processor.

3. SYSTEM OPERATION AND USER ACCESS

All the TDCCs and terminals (VDUs, Printers, etc) in a region (normally, the State) are connected to the MACS site via its front end processors which control all communications with the System **(Fig. 3).**

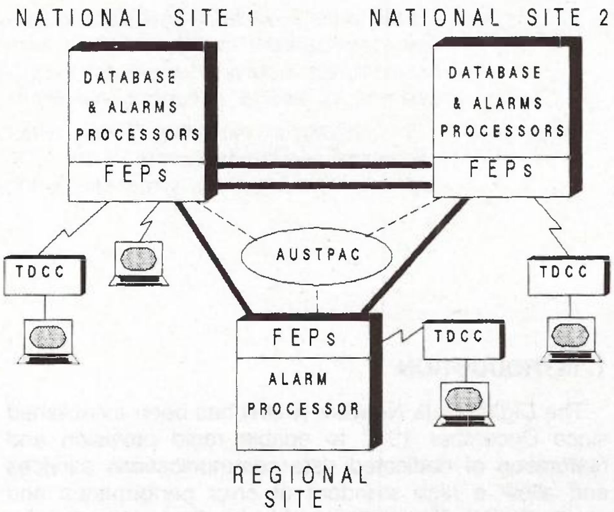


Fig. 3: Inter — MACS Communications

The alarm information emanating from the TDCCs, as well as the Alarm Monitoring Equipment (which concentrates alarms from the non-TDCC equipment installed at the cross-connection centres), is gathered by the alarm processors at the MACS site, processed, and made available to the alarm display consoles. The alarm processors also drive a wall display located in the respective State NMC, which provides a broad overview of the network status at anytime. Further, the test access and customer access functions are also handled by the alarm processors.

Fallback and Recovery

The overall network configuration provides high availability of MACS functions, particularly the service provisioning functions, by providing alternative paths from each regional MACS site to the two national sites, including access via Austpac. Should any element of the MACS configuration fail, it would be possible to keep most

KANWAL KUMAR (Kon) is currently Manager of TDCC/MACS Project Group at Telecom headquarters, where he is responsible for the development and introduction into network of the DDN Time Division Cross Connect (TDCC) and Management and Control System (MACS).

Kon joined Telecom from London in early 1973 to work as an engineer in Planning and Programming Branch, New South Wales. In 1976 he moved to Planning Services Branch HQ, where he was involved in the development and implementation of computer based Data Management Systems. His subsequent promotion into the Transmission Planning Branch involved him in the planning of the Australian Intercapital Trunk Network until, in 1981, he moved to the Digital Data Network Product Group. Here he has been responsible for DDN equipment design, construction and operations aspects, including the development of MACS since 1984.

Kon holds a Bachelor's degree in Engineering from Delhi University and a Master of Science degree from London University, and expects to complete the Master of Administration degree course at Monash University this year.

of the system operating. The most serious failure that could occur would be of the alarm processor at a regional or national MACS site as the centralised alarm processing capability for the region will be lost. However, limited alarm information would still be available remotely from the TDCCs which would be operating in the stand alone mode during the outage and it would still be possible to locate equipment faults.

The system recovery procedures are carefully designed so as to ensure high database integrity and efficient system recovery from a failure situation.

MACS-TDCC Control

Each TDCC has two alternative access paths to MACS **(Fig. 4).** The primary path is provided via a dedicated datel link, and the secondary path is available via Austpac. When the primary path fails, the TDCC automatically attempts communication via its secondary path.

The local control console and the alarm display associated with the TDCC have logical paths to MACS via the cross connect system. In the event of the TDCC-MACS communications being completely lost, the TDCC reverts to its standalone mode and can still communicate with the console and alarm display monitor.

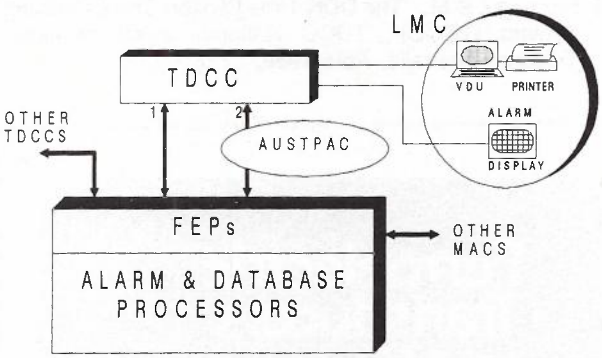


Fig. 4: MACS — TDCC Control

User Access to MACS

A range of functional areas will be provided access to the MACS **(Fig. 5).** The NMC, SSRC and LMCs in each State will be all provided with a VDU console, an alarm display monitor and a printer. The NMC will in addition be provided with a system printer and a wall display. The alarm information can also be extended to the After Hours Centre where it is located separately from the SSRC.

Access for database enquiries, update and service

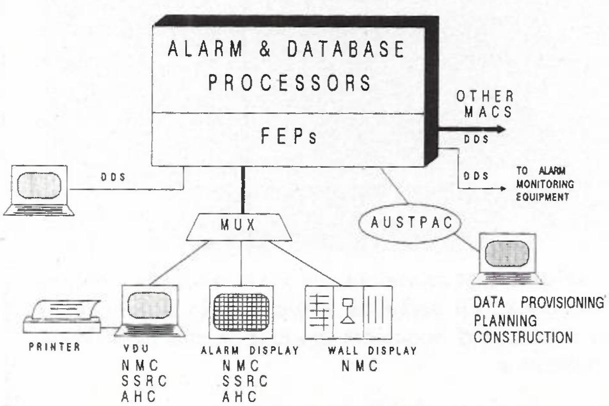


Fig. 5: MACS User Access

provisioning functions will be provided to the planning, construction, plant layout and sales/marketing personnel via either dedicated DDS links or Austpac depending upon the amount of activity generated.

Designated customers will be provided with a customer access facility which would enable them to test their networks or links, obtain alarm information, carry out redirection switching, etc., from their own premises.

4. SYSTEM SOFTWARE

THe MACS software is based on Digital Electric Corporation's proprietary VAX/VMS operating system and written primarily in "C" language. A custom-designed database management system using random access file structure has been developed in order to achieve fast transaction response times. Likewise, the report generator has been specially designed for this application.

The software specially developed for MACS can be broadly divided into two categories:

i. software to provide appropriate system infrastructure and housekeeping functions.
ii. application packages to provide the specified system facilities.

The first category covers such functions as data entry, VDU handling, menu management, task queue management, database management system, communication control (for the front end processors), memory management, security, fallback and recovery, etc.

The second category includes several application subsystems, of which five are major and a few relatively minor. The major sub-systems are:

i. DATABASE:
This is to load, process and maintain data relating to the DDN Centres, Links and Equipment. The subsystem allows details of DDN link and equipment utilisation, link and service performance, and product prices to be held on the database and available on request.

ii. SERVICE PROVISIONING:
This provides a number of functions relating to the customer service provisioning, including automatic route allocation, reservation and cross-connection, service rearrangements and pricing.

iii. ALARMS:
The basic functions of this sub-system is to gather alarm information from the TDCCs and AMEs, process it and provide appropriate displays and reports. The alarm information is further analysed to provide performance reports. The system will also handle both the network alarms and the alarm associated with the customer service.

iv. TEST ACCESS:
This is to provide access to individual links and customer services for testing purposes. Various test options are available which can be exercised in conjunction with the TDCC functions.

v. REPORTING:
A comprehensive report generation system is being developed to provide a large range of on-line as well as batch reports on the various aspects of the network.

The other application packages include:

— system management
— ELIXIR to MACS database conversion
— man machine interface
— customer alarm facility, and
— customer access facility.

5. MACS CAPACITY

The MACS hardware and software are so designed that the system can be expanded in capacity by the addition of appropriate processors, peripherals and terminals. However, after a certain point, the system performance and response times will begin to deteriorate. On the basis of the current specifications, the minimum system design capacity is as shown in Table A, which is expected to meet DDN requirements well into the mid-1990s.

TABLE A: MACS Capacity

	National MACS	Regional MACS
* TDCC Sites	48	24
* Control Consoles	128	64
* Alarm Displays	80	40
* Printers	4	4
* Customer Access Lines	40	30

6. INTERWORKING WITH OTHER SYSTEMS

As MACS is being developed as a minicomputer network independent of the TELECOM computer network, there are difficulties in providing automatic transfer of data between MACS and other Telecom systems. Fortunately, there will be little duplication of information between MACS and other systems used by the staff associated with the operation and maintenance of DDN. A significant exception, however, is the Record Automation of Special Services (RASS) system, where some duplication in terms of customer service details will occur. At the time of the release of MACS schedule, a number of issues required resolution and, therefore, a conscious decision was made not to include the MACS-RACS interworking in the schedule. However, an examination of the data transfer requirements between the two systems will be made in the near future and, depending on its outcome, a decision may be made to provide an enhancement to either MACS or RASS to fulfill this requirement.

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3. Tsoucalas, J. and Kumar, K. "Supervisory Alarm System for the Australian Digital Data Network," Proc. ICCC, Oct-Nov 1984
4. Eldredge, S.M., "Time Division Cross Connect and the Development of the Digital Data Network", TDCC National Video Seminar, Telecom Australia, April 1986.
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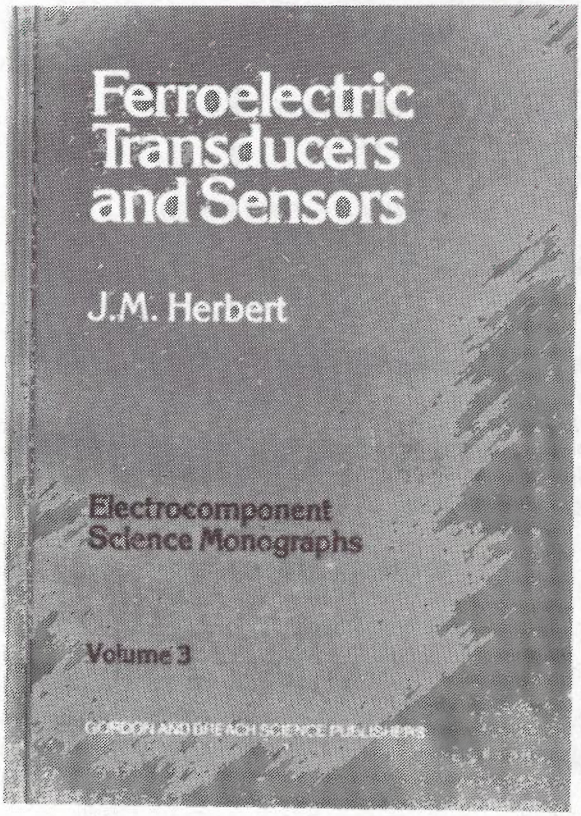
Book Review

FERROELECTRIC TRANSDUCERS and SENSORS.

Author: J. M. Herbert

Publisher: Gordon and Breach Science Publishers, 1982.

A$60.25 xxv + 437pp.



This volume is one of four currently available in a series of Electrocomponent Science Monographs. The series is directed towards final year graduate and graduate students written in engineering terms effectively bridging the gap between detailed scientific discussion and practicle engineering. The volumes already available are titled:

Instabilities in MOS Devices; J. R. Davis.
Dielectric Films on Gallium Arsenide; W. F. Croydon and E. C. H. Parker.
Ferroelectric Transducers and Sensors; J. M. Herbert.
Hybrid Microelectronic Technology.

In the third volume, for example, ferroelectrics are discussed in general terms. The principles of ferroelectric compounds used in devices, the preparation of ferroelectrics, the various types of ferroelectrics, positive temperature coefficient resistors, piezoelectric materials, medium and far infrared detection and imaging and transducers involving visible and near infrared radiation are all discussed in considerable detail. Two appendices give piezoelectric coefficients and relations for poled ceramics and for a selection ceramics and single crystals. A list of 249 references is given, and excellent author and subject indices. The whole book has a reference feel about it. Although the typesetting is unjustified, it has a high quality appearance and is very easy to read. My opinion is that as well as the student target audience, this book will serve as a worthwhile reference for scientists and engineers working in the field of ferroelectrics.

Reviewed by: Rodney A. J. Reynolds

The Headquarters Melbourne Switching Laboratory

I. McKAY
P. WELLARD

INTRODUCTION

The Switching Laboratory of Network Engineering's Switching Division, Headquarters, is located in the Exhibition Exchange Building, Melbourne. The Laboratory occupies all of the 15th and 16th floors of this new exchange equipment building and shares the 14th floor with the PABX and TELEX Test Centres of Commercial Services Department, Headquarters.

The main functions of the Laboratory are to:-

- test new types of equipment, hardware and software, prior to its general application in the Public Switched Telephone Network.
- provide software production facilities for programs and data.

To support the above functions the Switching Laboratory has a Simulated National Telephone Network which contains all equipment types used in the Public Switched Telephone Network, a range of sophisticated analogue and digital test instruments and a staff of 23 Technical Officers.

BRIEF HISTORY OF THE LABORATORY

The Laboratory has had a number of changes to its duties and physical locations since its beginnings in the early 1930s when it was first established at Spring Street, Melbourne. In those days its main function was to test the quality of tools and mechanical devices used by the then Postmaster-General's Department. It was more concerned with external plant than switching equipment and the job skills were manipulative rather than analytical.

In the early 1940s the Laboratory was moved to Flinders Street, Melbourne, and its responsibilities were expanded to include switching and telephone equipment. Some of the special projects of that period included the development of a variable rate coin telephone, the evaluation of the SE 50 type bi-motional selector, a working model bi-motional line finder exchange and the development of a valve-type car radio-telephone.

In 1955 the Laboratory was moved to 9 Spring Street, Melbourne, where a step-by-step Model Exchange was installed. Activities during this period included the development of party line equipment for automatic exchange subscribers, development of the Discriminating Selector Repeater and initial testing of the LM Ericsson crossbar switch.

By 1961 a separate Subscribers' Equipment Laboratory had been established and the Telephone Switching Laboratory was now sited at 10 Lonsdale Street, Melbourne. It had a full range of step-by-step equipment including Strowger, 2000 and SE 50 type, to which a Model ARF Crossbar Exchange was added. The initial problems of interworking crossbar with the existing step-by-step network were investigated and mainly resolved. During the 1960s, STD facilities were developed and, in 1968, Multi-Frequency Code information signalling was tested over a satellite call.

The Laboratory was moved in August 1972 to the Third Floor, Argus Building, 290 LaTrobe Street, Melbourne. It was then a sophisticated and efficient testbed for the development and support of the national telephone switching network, with a model of every main type of exchange in the network — 13 in all. In order to adequately test network facilities and evaluate interworking problems these Model Exchanges were permanently interconnected to form a fully operational Simulated National Network.

The type of services provided by the Laboratory expanded during the Argus years with the introduction of models of five SPC systems (10C, ARE, AXE, AOM and SULTAN). The concept of the National Support Centre and its role in the operational support of SPC field exchanges through the states exchange maintenance organization, was implemented during this period.

With the introduction of Stored Program Controlled (SPC) exchanges, the SPC models assumed a dual role, having a software production requirement added to their test function in the Simulated Network. Software production has a vital part in the achievement of State Exchange Construction Programmes for the expansion of the national telephone network and the physical security of the Laboratory became an important consideration in its ongoing opertions. As the Argus building was privately owned and the Laboratory shared the premises with a number of commercial enterprises it became increasingly difficult to achieve the high level of security deemed necessary. In 1981 it was decided to transfer the Laboratory to a Telecom-owned permanent home in the Exhibition Exchange Building, then under construction.

The move to these new premises commenced in July 1982 and was completed by staff of the Victorian Construction Branch in March, 1984.

THE SIMULATED NATIONAL NETWORK

The Simulated National Network is the major equipment facility of the Switching Laboratory. As installed at Exhibition, it consists of 16 exchange models permanently interconnected to form two Closed Numbering Areas with a fixed network numbering, routing and charging configuration. This test network is available only to traffic originating in the Laboratory. Outgoing access to the Public Switched Telephone Network (PSTN) is provided at appropriate levels of the Simulated National Network's standard switching hierarchical network.

Equipment is 'model' only in the sense that the total subscriber, junction or switchblock capacity is limited for economic reasons. All exchange hardware is standard and installed to normal construction standards. Care has been taken to ensure that the 'model' exchanges are a true replica of field installations in all their facets except capacity.

Advantage was taken of the transfer from the Argus building to reassess the performance of the Simulated National Network, designed in 1973, (a previous Journal, Ref. 1, refers) and to forecast the demand for ongoing requirements. Allowance has now been made for the future development of the Simulated National Network to include the Integrated Digital Network and the Integrated Services Digital Network concepts.

MINOR AND TRUNK SWITCHING NETWORK ←

OA B C D F FGH

DIGIT	TERM EXCH TYPE SELECTION 'B' DIGIT STAGE 1	NETWORK ROUTING SELECTION CODES					TERMINATING EXCHANGE TYPE SELECTION				
		'C' DIGIT STAGE 1	'D' DIGIT STAGE 2				'E' DIGIT STAGE 2				
			'C' DIGIT = 1	'C' DIGIT = 2	'C' DIGIT =5	'C' DIGIT = 3,4,6-0	'B' DIGIT = 2	'B' DIGIT = 3,7	'B' DIGIT = 2	'B' DIGIT = 5,6	'BCD' = 2X0
1	SERVICE	DIRECT	DIRECT	DIRECT	DIRECT	DIRECT	ARF - LP -MSC	AXE - 2D,1	SXS	ARE - N,C	
2	ARF/ ARK	Tx (y) (NOTE 1)		Tx - ARM	T1 - ARM		ARK521M	AXE - 2A			INDIAL PABX MFC (4 DIGITS)
3	AXE - 2	ARM		Tx - 10 C	T1 - 10C		ARK511M				
4	SXS	10 C		Tx - OTT	T1 - OTT		ARK521D				
5	ARE - N	T1 (2) (NOTE 2)	NETWORK SIMULATOR	Tx - Ty	T1 - T2		ARK511D				
6	ARE - C	OTT		Tx - T2	T1 - Ty		RAX - B				
7	AXE - 1/3 (NOTE 5)	ARF – MSC		Tx- ARM-10C Tx-ARM-10C			RAX - C				
8	RESEARCH ISDN (NOTE 3)	SXS (DSR EXCH)	ENTRAIDE				AXE 104 - 1	RSS			
9		RESEARCH ⋇2 DIRECT					AXE 104 - 2		INDIAL PABX DEC	INDIAL PABX DEC	INDIAL PABX DEC
0			PABX (NOTE 4)							INDIAL PABX MFC (3 DIGITS)	INDIAL PABX MFC (3 DIGITS)

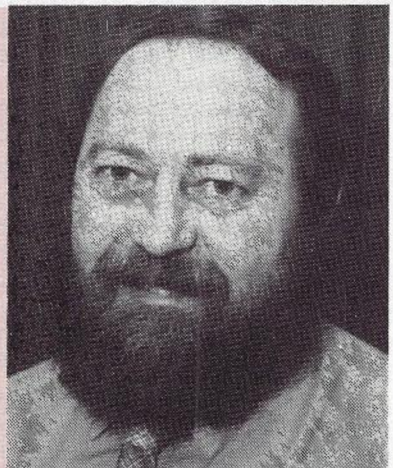
NUMBER RANGES – DIRECT ROUTE CALLS

ARF - LP	211 1000 - 1199
ARF - MSC	211 1200 - 1399
ARK521M	211 2100 - 2299
ARK521D	211 310 - 339
ARK511D	211 4100 - 4199
RAX - B	211 5200 - 5239
RAX - C	211 620 - 659
AXE - 2D	211 7200 - 7249
AXE - 2A	311 1000 - 1127
AXE - 2/RSS	311 2000 - 2127
SXS	311 800 - 8255
SXS DSR	411 1400 - 1474
SXS SR - B(AB1D)	411 1475 - 1499
SXS SR - B(ARF)	411 1500 - 1549
ARE - N	411 1550 - 1599
ARE - C	511 1200 - 1399
AXE - 1/3	611 1000 - 1199
AXE - 1/RSS	711 1000 - 1127
(TEMP. '86) ISDN	711 8000 - 8255
RESEARCH CCS 7, ⋇1	
(TEMP. '86) ISDN	811 0000 - 0100
RESEARCH CCS 7, ⋇1 2	881 0000 - 0100
AXE104 - 1	211 8000 - 8023
AXE104 - 2	211 9000 - 9015

RULES:
THE ORIGINATING PATH IS THE SAME AS THE TERMINATING PATH, e.g., A CALL TO A DIGITAL EXCHANGE FROM AN ANALOGUE WHICH SWITCHES VIA Tx-10C WILL TERMINATE 10C-T2
WHEN ANALOGUE TO DIGITAL CONVERSION OCCURS THE SWITCHED PATH STAYS DIGITAL.

NOTES
1. Tx, Ty IS CONSIDERED THE SAME EXCHANGE, Ty STAGE TERMINATES ANALOGUE TRAFFIC ONLY.
2. T1, T2 IS CONSIDERED THE SAME EXCHANGE. T2 STAGE TERMINATES DIGITAL TRAFFIC ONLY.
3. 'B' DIGIT=8 AVAILABLE FROM AXE ONLY.
4. AVAILABLE ON ARF/ARK CALLS ONLY.
5. AXE 1 AND 3 SHARE THE SAME SUBSCRIBERS.

Fig. 1: Simulated national network — routing and numbering.

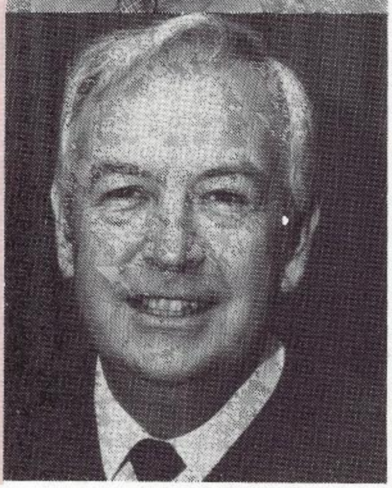


PETER WELLARD is a Senior Technical Officer Grade 1, Testing Services Section, Switching Development and Support Branch, Headquarters. Prior to joining Telecom in 1970 as a Workshop Assistant at the Fishermans Bend ARK pre-installation centre, he was engaged in private employment as an electrician and motor mechanic.

In 1973 he transferred to exchange maintenance duties at the South Melbourne telephone exchange, at that time equipped with the ARF Reg LM crossbar system.

Promoted to Headquarters in 1974 as Technical Assistant Grade 2 in Testing Services Section of the Switching Laboratory, he was involved in testing and production duties on the 10C model exchanges.

He completed Bridging Training to qualify as a Technical Officer in 1985 and is currently employed on design and facility testing for AXE and AOM systems at the Laboratory.



IAN McKAY is a Principal Technical Officer Grade 2, Section Manager in the AXE-Rural -- Testing Services Group, Switching Development and Support Branch, Headquarters.

He first joined the P.M.G. Department in 1952 as a Technician-in-Training, and as a Senior and Supervising Technician worked in the Country Installation Sections in Victoria for thirteen years.

In 1969 he transferred to Telephone Exchange Equipment Branch, Headquarters, and was involved in the design of traffic measurement equipment for ARF exchanges. During 1972 he transferred to Network Performance and Operations Branch, returning to Switching Design in 1976 for the REMO project and the introduction of the ARE-11 switching system.

Since 1981 he has been Section Manager of Testing Services Section and occupied this position during the Switching Laboratory move to the Exhibition Exchange Building in 1983.

The final agreed network configuration, numbering and routing plans are shown in **Fig. 1 to 3.** It represents the essential compromise between providing all possible trunking, switching and signalling combinations and the practical constraints of budgetary costs, operating efficiency and the proper use of very expensive building space. All the significant traffic cases have been provided with sufficient flexibility inherent in the design to allow reconfiguration for the study of obscure fault conditions and feasibility studies.

A digital network which overlays the earlier analogue crossbar-based system is being implemented and this network is shown as part of **Fig. 2 and 3.** This network uses AXE digital switching equipment and digital 2 Mbit transmission links.

SIMULATED NATIONAL NETWORK ROUTING AND NUMBERING SCHEME

The Basic Metropolitan Network shown in **Fig. 2** is a 7 digit closed numbering area. The numbering scheme is directly associated with route selection to enable ease of operation by the Laboratory staff and visiting technical experts.

As tabled in Fig. 1 the 'B' and 'E' digits of the terminating number select the type of terminating exchange and the 'C' and 'D' digits the network routing to be used to access the selected exchange. The last 3 digits — 'F', 'G' and 'H' — select the required 'B' number from the installed capacity of the terminating model number range. This system has proved to be simple to manage and, usually, network trunking and numbering drawings are not required by staff to operate the network.

To provide for the special cases, where routing patterns may be required, routes to Network Simulators from each switching stage have been provided.

Circuits between models in the network have been limited to about 4 incoming and 4 outgoing. Some bothway circuits are provided but these have been restricted to as few as possible. Only the most common form of junction interface equipment has been permanently installed, usually L1 type and 'T3' type or equivalents. A number of other crossbar type line relay sets are held in store and can be quickly installed into wired miscellaneous rack positions for use if particular equipment patterns are required for fault investigations. T type signalling relay sets use circuits derived over a Siemen's Z12N carrier system and T6 signalling is available using 30 Ch PCM system circuits.

A number of connections are also provided to the Public Switched Telephone Network so that conditions not available in the Simulated Network can be tested. These connections include:

- circuits from the originating 10C model Main Trunk Exchange to the Lonsdale ARM for some STD codes. ISD access is also provided directly via Pitt 10C exchange from the 10C originating model.
- interconnection with the ITERRA Main Earth Station at Bendigo for test traffic originating and terminating in the Simulated Network ARK521M exchange modified for AUSSAT working.

Other external connections are provided for the Queensland ARK design group, which is the national ARK Design Leadhouse, for access to the ARK models via permanent tie circuits. Interworking circuits are also provided to the Headquarters PABX Test Centre and the Research ISDN model located at Clayton.

NETWORK MODEL EQUIPMENT AND FEATURES

The equipment used and the main features of the model exchanges making up the Simulated National Network (SNN) are described in the following sections:

Step-by-step and Crossbar Types

The step-by-step and crossbar models are fully described in Ref. 1 and they have been re-established at Exhibition with the exception of the ARF Reg-LM metropolitan model. The equipment types now used in the SNN are:

Type	Capacity
RAX-B	40 L
RAX-C	50 L
ARK-511, D, M	40, 30 L
ARK-521, D, M	100, 200 L
ARF-LP, 2/160 GV, GIV 1/80	200 L
ARF-LP, ELP/H4-2/160 GV, GIV 1/80	200 L
X, Y Tandem 2/160/700	
Step Branch (DSR-SE 50)	25 L
Step Main (SE 50)	75 L
SR-B (ARF)	50 L
SR-B (ABID)	50 L
ARM (REG Y1, H1, EH2 Y2)	100 I/C, O/G

Each terminal exchange model is fitted with a Subscriber Universal Line Test Access Network (SULTAN) Robot Tester and is available for use by the SULTAN Test Centre. ADR/ADX working is used on the ARF models for alarm and fault supervision and Traffic Dispersion Equipment (TDE) is also collected.

The ARE Models

Two ARE Models are installed as terminal exchanges in the metropolitan and Minor Switching networks. They are designated 'ARE-C: Conversion', and 'ARE-N: New Start'. Each is of 200 line capacity with a 2/160 3-stage GUV and 1/80 GIV.

The ARE-C is a level 3 installation with internal MFC signalling; i.e. the Group (GV) and Subscriber (SL) switching stages are not under direct processor control. The model is equipped with two Traffic Control Processors (TCPs) and an Operations & Maintenance Processor (OMP), with the early type ferrite core central stores. The terminal interface arrangements use the TEI configuration.

ARE-N is a level 4 exchange using direct processor control of the SL and GV stages. It is equipped with two TCPs and an OMP. Central memories are the modern semi-conductor CSU type and an IOT rack is used for interface to the terminal equipment and to provide an X25 data link to the AOM. Prototype equipment for STD Electronic Call Changing (ECC) is fitted with the X25 AOM link used for downloading of charging data for off-line processing. SR-B subscribers' equipment connected to the ARF model with calling party number identification equipment (ABID) is controlled from this exchange.

AXE Models

The AXE equipment provided at the Laboratory consists basically of the metropolitan types AXE 101/102/103, and the recently developed AXE 104; the AXE Rural System. Features of these installations are discussed further below.

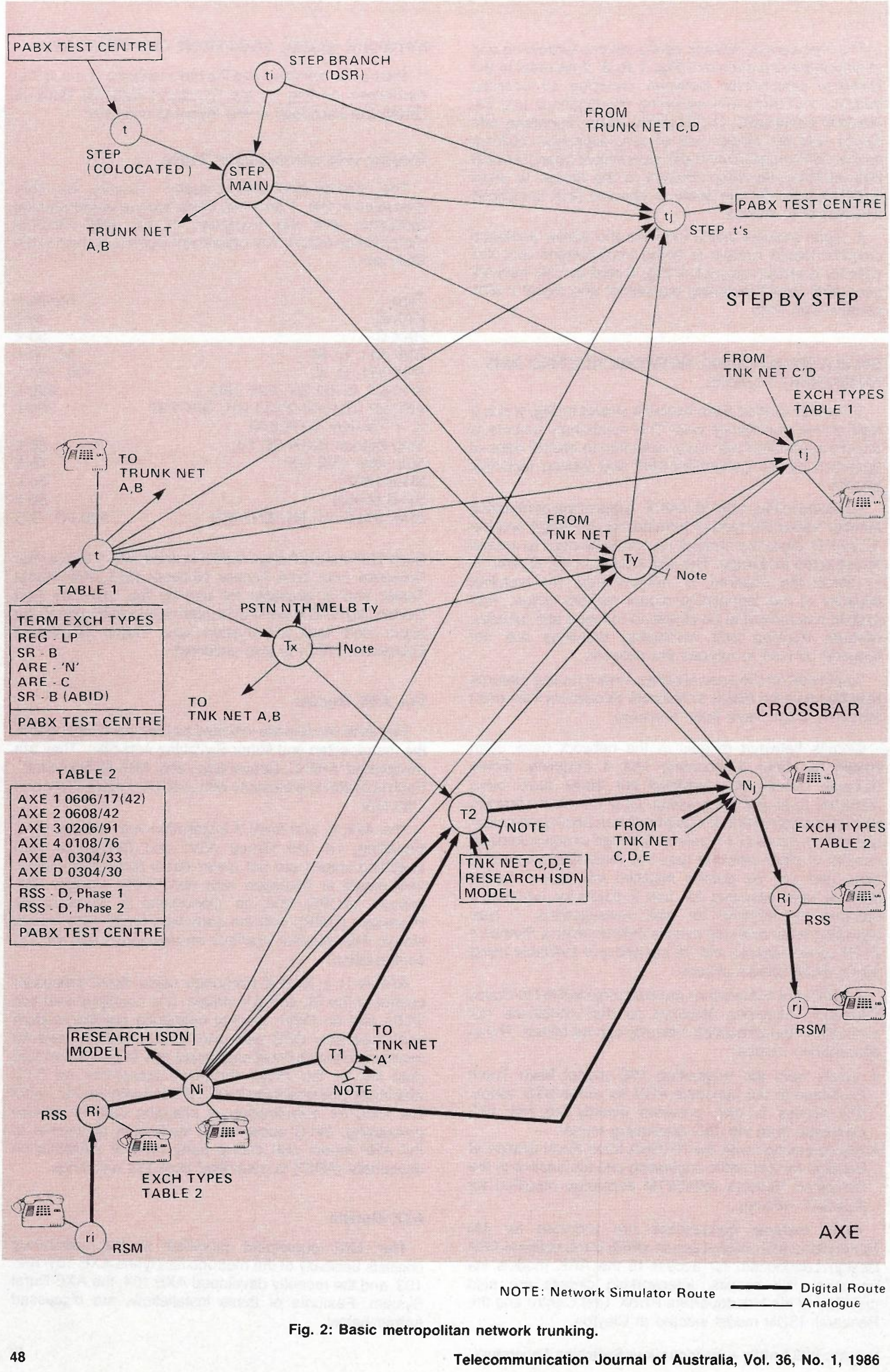


Fig. 2: Basic metropolitan network trunking.

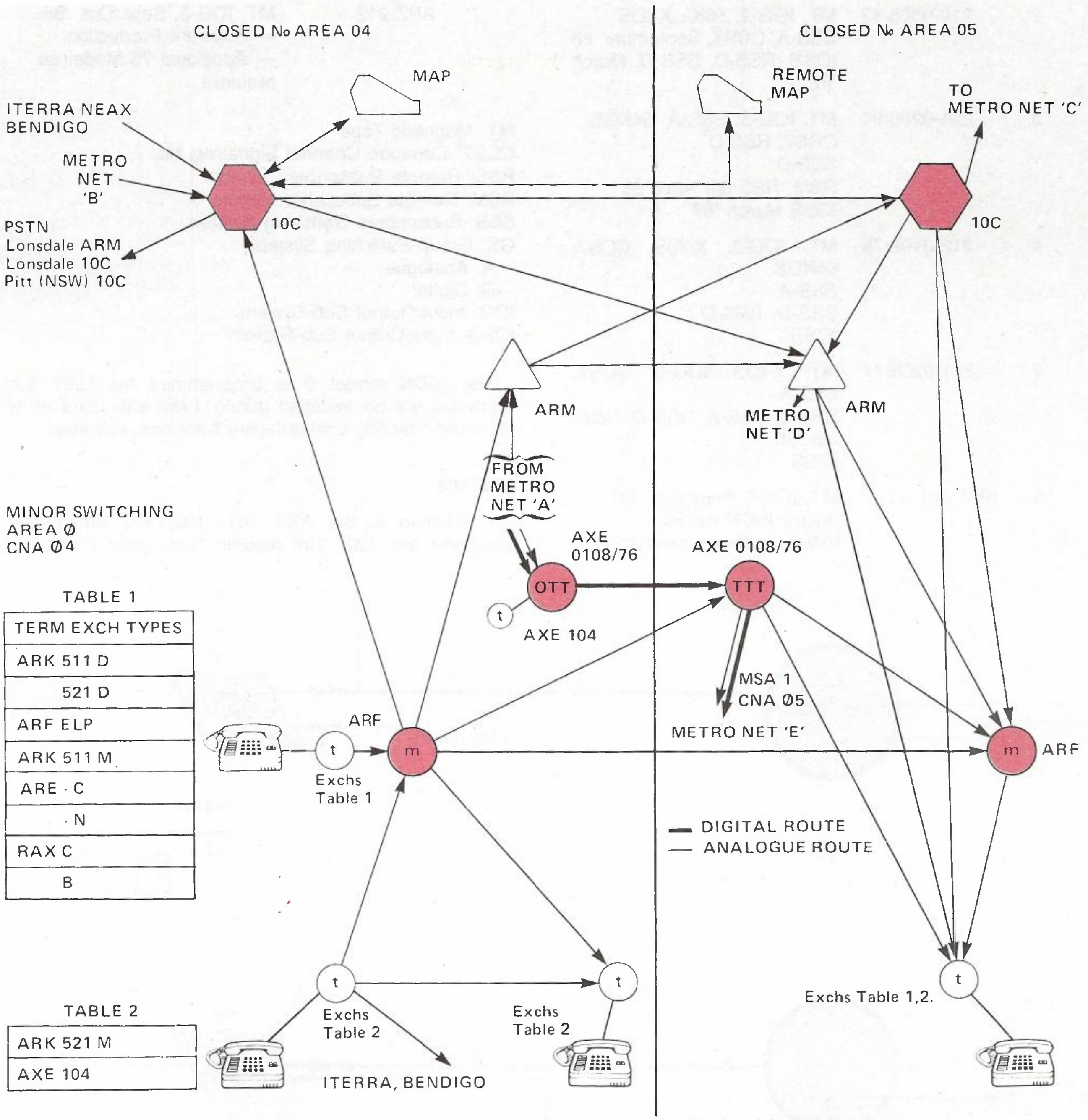


Fig. 3: Minor switching and trunk network in the switching laboratory.

AXE 101/103 Exchanges

This area of the Laboratory is undergoing frequent and rapid change to its hardware configurations. The principle is to provide 2 models of each application system used in the field. This gives sufficient model capacity for testing new and updated software, ongoing field support activities and the production of software packages for new AXE exchanges.

The model exchange has the capacity to service the following application systems on a permanent basis.

Model	Application System	Major Facilities Available
1	210-0606/17	MT, IOG-2, SSS-A, 16KGS, CCS7, RSS-D
2	210-0608/42	MT, IOG-2, X-IOS, 16KGS
3	211-0206/91	MT, IOG-3, SSS-A, 64KGS, CCS7, RSS-D

With some hardware changes it is possible to configure and support the earlier application systems 210-0304/30 & 33 as used in the initial AXE field trial exchanges and at Endeavour Hills, Narre Warren and Lyndhurst in Victoria

Proposed future developments will see the addition of two new application systems together with expanded facilities on existing application system, as follows:

Model	Application System	Major Facilities Available
1	210-0606/17 (42)	MT, IOG-2, SSS-A, 16K/64K Option, CCS7 RSS-D, SSS-D RSM, RSS-04 IOSS, March '87

Note: /17 application system upgraded to /42.

2	210-0608/42	MT, IOG-2, 16K/, X-IOS SSS-A, CCS7, September '86 IOSS, RSS-D, SSS-D, March '87
3	211-0206/91	MT, IOG-3, SSS-A, 64KGS, CCS7, RSS-D SSS-D RSM, RSS-04, April '86 IOSS March '87
4	212-0108/76	MT, IOG-3, X-IOS, CCS7, 64KGS SSS-A SSS-D, RSS-D IOSS
5	211-0208/77	MT, X-IOS, IOG-3, CCS7, SSS-A SSS-D, SSS-A, RSS-D, October '86 IOSS
6	APZ 211	MT, IOG-3 Sept./Oct. '86 (future ISDN model) Initially software production
7	APZ 212	MT, IOG-3, Sept./Oct. '86 — Software Production — Additional 76 Model as required

MT: Magnetic Tape
CCS7: Common Channel Signalling No. 7
RSS: Remote Subscribers System
RSM: Remote Subscriber Module
SSS: Subscribers Switching System
GS: Group Switching System
—A: Analogue
—D: Digital
IOG: Input/Output Sub-System
IOSS: Input/Output Sub-System

The ISDN model 6 is programmed for 1987 but hardware will be installed during 1986 and used as a production facililty until software becomes available.

AXE 104

In addition to the AXE 101, 102, 103 equipment discussed two AXE 104 models have been provided.

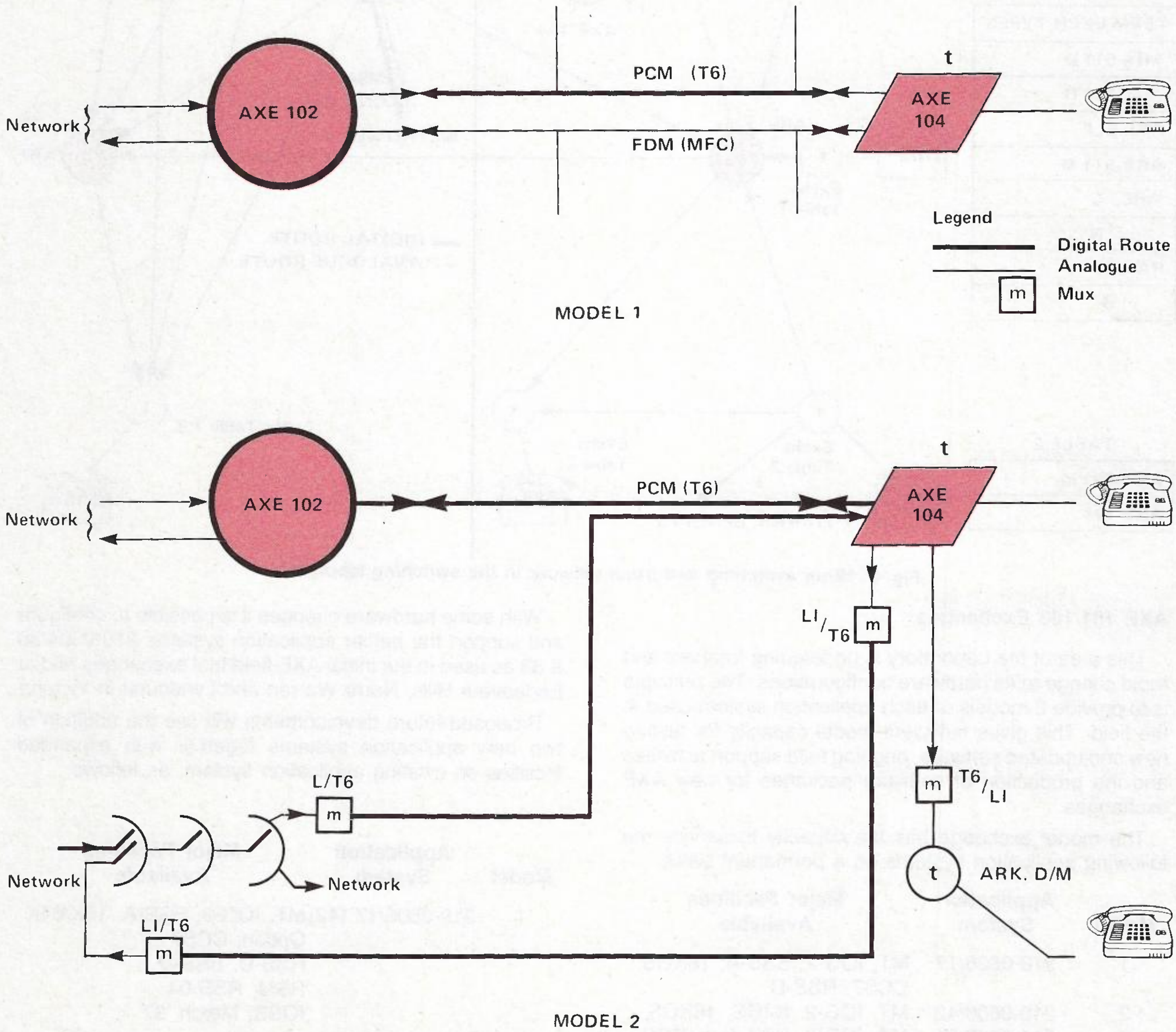


Fig. 4: AXE 104 rural exchange trunking.

These exchange types are used in the national network as AXE Rural exchanges to upgrade, replace or extend existing small automatic country terminal exchanges. In the Simulated National Network one model is located adjacent to the existing ARK models and uses the normal 50V exchange power distribution arrangement. The second model is installed with the AXE metropolitan equipment and uses the standard AXE 104 240V/50V conversion rack for power supply. Trunking arrangements are shown in **Fig 4.**

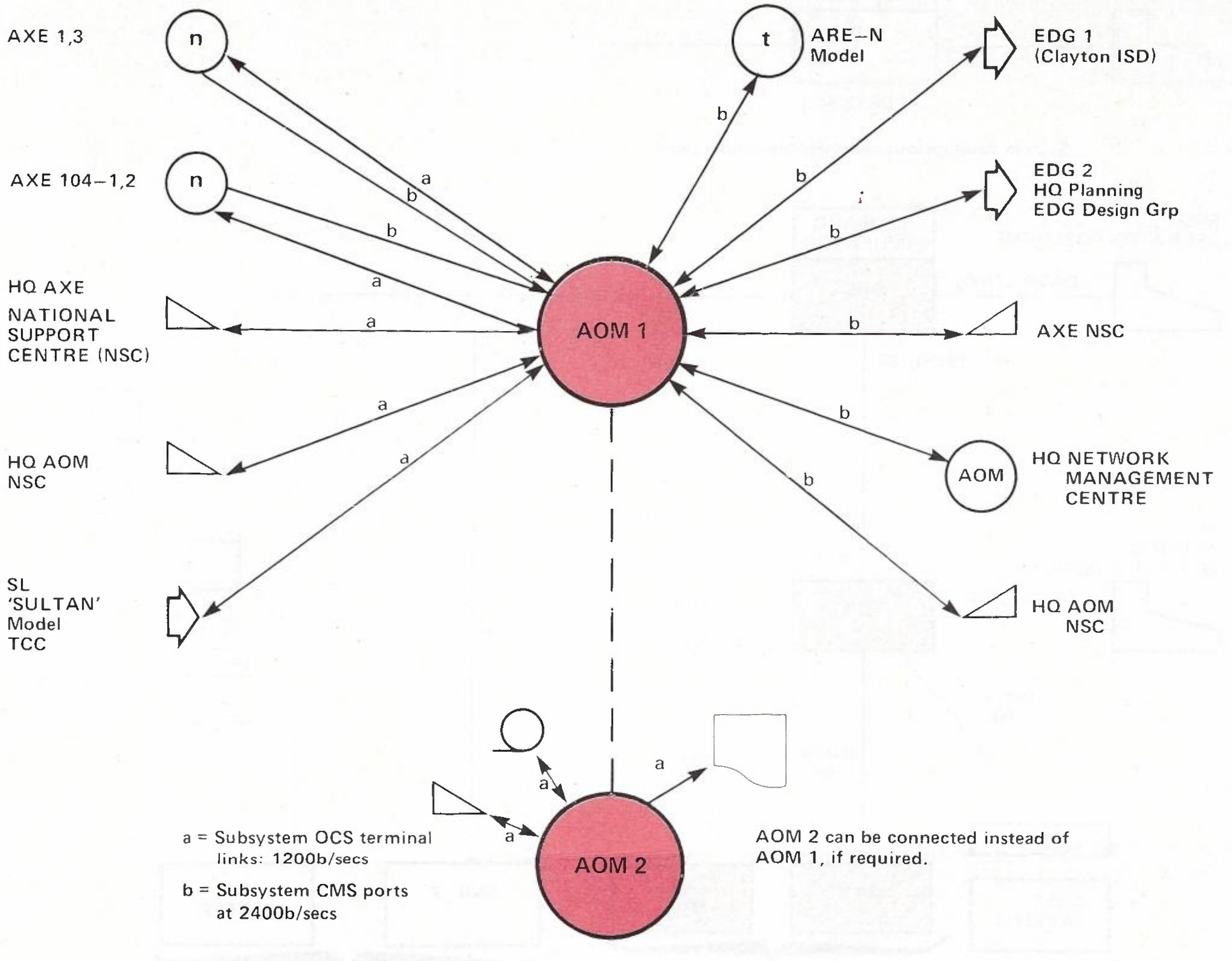
Main Trunk Exchange Model

The main trunk exchange model is an ITT 10C type installation using 3 Central Processing Units ITT 3200, and 1024K32 of ferrite core memory. The associated switchblock is installed as a standard 2K unit, of which 128 incoming and 128 outgoing circuits only are equipped.

Manual assistance positions for 3 operators, a monitor and supervisor are provided. Call record information is stored on Burroughs disk or Vermont magnetic drum devices. Special "on-demand" software can be produced for the 10C field exchanges using either mylar punched paper tape or the new Personal Computer floppy disk systems.

AOM Models

Two AOM 101 models are used in the Simulated



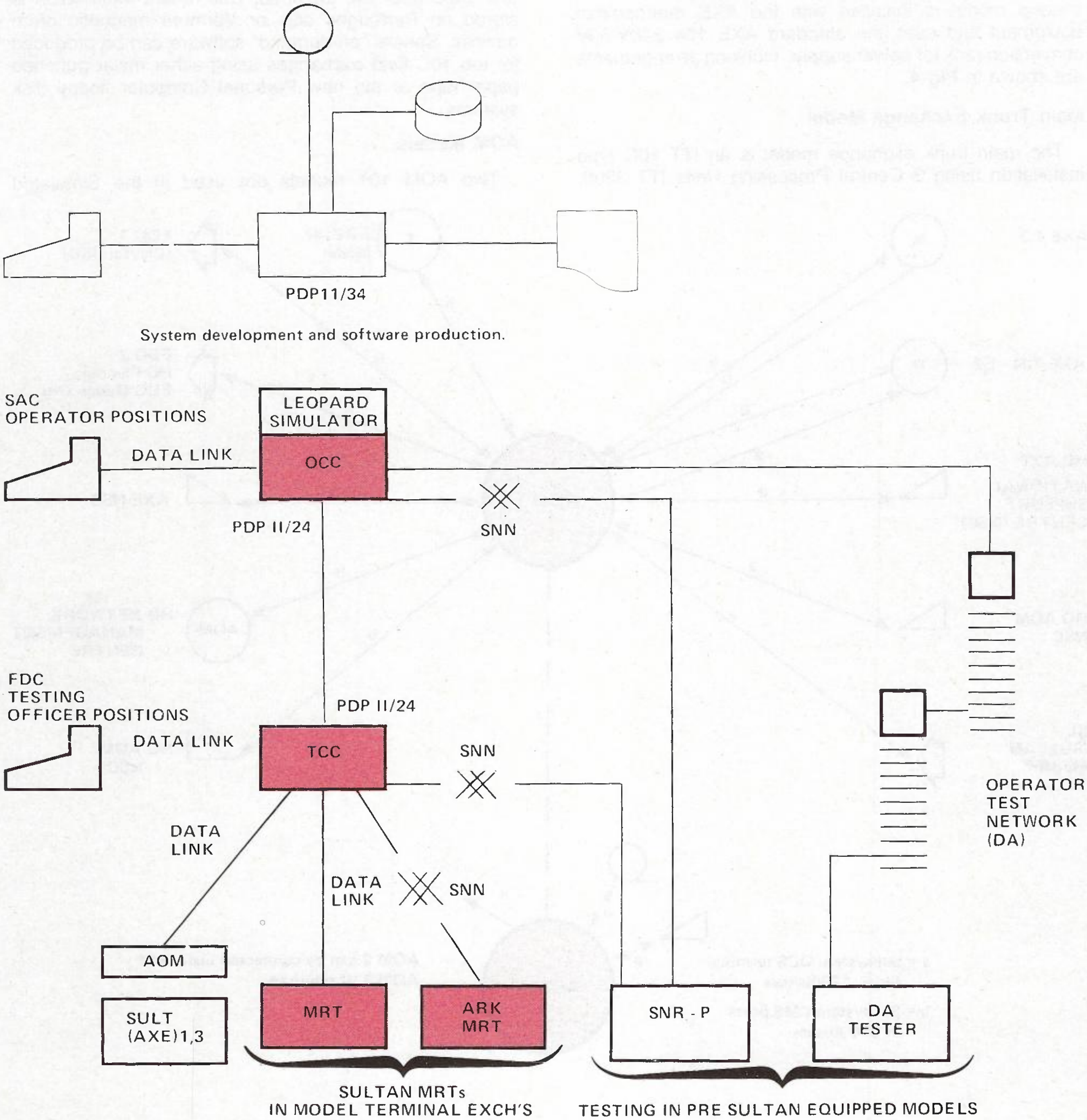
SUBSYSTEM	NAME
DMS	Disc Management
OCS	Operators Communication. (Terminal links)
ALS	Alarm Subsystem.
CMS	Communication. (Data ports)
PRS	Printouts.
TMS	Tape Management.

Active Subsystems in AOM 1,2.

Fig. 5: ADM systems.

National Network as data communications systems and to realise the centralised exchange maintenance concept.

The models serve as an interconnect system between AXE, ARE and SULTAN models and the Network Operation Centres (NOCs) such as an Exchange Data Gateway (EDG) and a Traffic Engineering Centre (TEC). (**Fig. 5** refers to the available configuration). One model is kept in a network operational mode to allow testing of data transfer from the model exchanges to the developmental NOCs located elsewhere in Melbourne, while the second



SAC – Service Assistance Centre
OCC – Operator Communications Controller
FDC – Fault Despatch Centre
TCC – Test Communications Controller
MRT – Microprocessor Robot Tester
ARK – Small, crossbar exchange used in country areas
AXE – Processor controlled exchange
AOM – A message switching processor for operational access to AXE exchanges
DA NETWORK – Dedicated, decadic network used for test access in the case of 'doesn't answer' (DA) and 'always busy' reports
DA TESTER – Existing, 'go no-go' type test device accessed via the DA network
LEOPARD SIMULATOR – The processor for the LEOPARD system, simulated on TACONET
SNN – Simulated National Network Model and Development, Switching Laboratory

Fig. 6: Sultan model and development centre.

model is available for software development and production for field sites.

The SULTAN Centre

The Subscribers Line Test Access Network (SULTAN) developmental facility at Exhibition consists of two Digital Equipment Corporation PDP11/24, one PDP11/34 mini-computers and PSTN interface equipment. This system was designed by Telecom Australia to replace the existing manual customer line testing facilities and is currently being implemented throughout the metropolitan areas of the nation. It uses central mini-computers communicating with microprocessor driven test robots in terminal exchanges to replace the existing test networks used by Service Assistance Centre operators and Fault Despatch Centre testing officers.

The facilities and operational aspects of the system have been extensively covered in a number of articles recently published in the Journal; Ref 2.

The model facility is equivalent to a standard field installation with the two PDP11/24s used as the Operator Communication Controller and the Test Communication Controller. The PDP11/34 is used for continuing software development. Each terminal exchange in the Simulated National Network is fitted with a Microprocessor Robot Tester and the interconnecting network is to field standard. The basic system trunking is shown in **Fig. 6.**

Ancillary Facilities

The foregoing summarises the systems and operation of the Simulated National Network at the Laboratory. Additional to these facilities, and essential in fulfilling the function of the Laboratory, is one additional peripheral area, the Test Instrumentation Sub-section. This area is responsible for the support of all areas in the Laboratory in regard to the provision and use of test instruments. Instrument purchases are arranged each year after an investigation of future requirements within the Laboratory and advice from equipment areas regarding new or modified facilities in switching systems under their control.

Test instrument purchasing policy has, for the past five years, concentrated on the building up of the Instrument Controller/Instrument Control Bus concept, based on the IEE488 standard. All new instrument purchases are consistent with this standard and an increasing use is being made of the ability to control a number of instruments by software command in the gathering and presentation of data.

The current instrument stock of the Laboratory is valued at approximately $M1.1 and new purchases and replacement of old instrumentation costs about $150,000 each year. To test equipment against specifications the Laboratory now has the capability to perform measurements in both the analogue and digital realms to a high level of accuracy so that the test results may be compared directly with those obtained by equipment manufacturers.

CONCLUSION

The Switching Laboratory as re-established at Exhibition, represents a large investment by Telecom in maintaining the integrity of the Public Switched Telephone Network. As the Public Switched Telephone Network grows and develops further towards ISDN, the Laboratory is well placed to play an important part in supporting future goals, both in terms of equipment and skilled staff resources.

The authors wish to acknowledge the work of the many technical staff, draftsmen and engineers, both in Headquarters and the Victorian Administration, who contributed to the design and construction of the Simulated National Network of the Switching Laboratory, Exhibition Building, Melbourne.

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Information Transfer News

NEW SCOTCHCODE SYSTEM RELEASED

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3M's latest addition to its popular SCOTCHCODE Cable and Wire Identification System.

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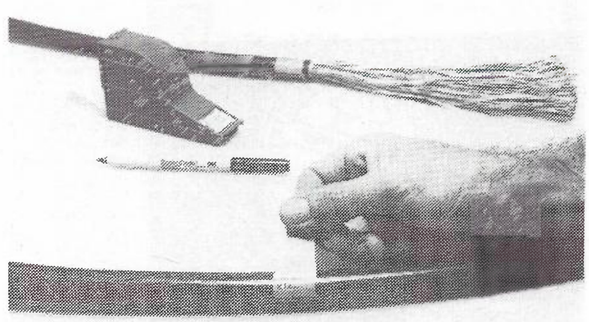
The dispenser incorporates a "window" with a flat, stable surface to facilitate writing on the markers. Once dispensed, the end with the identification details is applied to the cable first and the clear tail is wrapped around, providing a barrier against contaminates.



3M's new SCOTCHCODE wire and cable marking system provides total flexibility and convenience.

Manufactured from transparent vinyl tape with an acrylic self-laminating adhesive, the die-cut markers resist flagging, dirt, oil, heat, abrasion and solvents.

Operating temperatures of up to 100 degrees celcius are acceptable for the SCOTCHCODE System.

Contemporary Tele-Education Developments

MICHEL LYRMONT, B.A. (Melb.), M.A. (Tas.)
Principal Planning Officer
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Telecom Australia.

This paper reviews some modern tele-education trends in the context of contemporary technological developments, and the socio-economic characteristics peculiar to specific regions.

CONTEMPORARY TRENDS

There are some surprising developments in contemporary tele-education. Traditionally the subject has been associated with the education of a student population residing in remote areas. The Australian "School of the Air" epitomises the concept even if it does not encompass tertiary education. It is therefore somewhat surprising to find that a reversal of this historical association is currently taking place, particularly in countries which already have a well developed telecommunications and educational infrastructure (e.g. USA, Japan). What one witnesses at present is the emergence of tele-education systems which take the form of sophisticated and intensive networking between well established centres of learning. Tele-education has thus come full circle and has become an "on-campus" activity, implemented by well appointed centres located in high population density areas. Whilst, at first, this may appear to be somewhat paradoxical, an analysis of the parameters involved points to the current developments as the logical manifestation of a natural and predictable progression associated with the characteristics of key variables in tele-education, and in particular variables which bear upon the following aspects:

- The Medium.
- The Cost Justification.
- The System Configuration.
- The suitability for purpose.

MEDIUM

Tele-education is commonly identified with electronic transmission. "Tele," however, means "distance," and other forms of transmission still have much relevance even today. This certainly includes the proverbial written material, but it can also encompass hi-tech items, such as the timely delivery of updated software and interactive video-disks. For sure, all of the above could be transmitted electronically, but apart from the fundamental factor of cost, one would also have to take into consideration the availability of the terminals required, as well as the suitability of the medium chosen for the purpose of the exercise. In other terms, the medium, i.e. the ability to transmit, cannot be divorced from the other three parameters mentioned.

This interdependence of parameters is stressed, because, as will be shown later in this paper, it is this interdependence which determines the direction of contemporary tele-education.

COSTS

As a rule of thumb the higher the capacity mobilised to link-up the terminals, the higher the cost. This would put a fully interactive audio-visual at the top of the range cost-wise.

The cost structure means that in practical financial terms, the more interactive the educational programme, the greater the need to centralise the terminals and the target population. Thus, typically, a complex, interactive, real time TV programme would be from "campus to campus" or from "campus to study centre." While this mode of communication certainly fits the definition of "tele-education", it also has many of the constraints and limitations of an "on campus" education, in that the student population is required to be at a given location at a given time. This highly constrained mode is at variance from what is often implied in the notion of "distance education", which is commonly associated with a remote, decentralised and flexible approach typified by the concept of an "Open University". But since current trends are in the opposite direction, it is not surprising if the Open University finds itself at odds with some important developments in tele-education. Thus Paul Bacsich, Senior Project Manager in Information Technology at the Open University of Milton Keynes, U.K., claims that the University never used video-conferencing, and abandoned unsuccessful trials at audio-conferencing. Such comments raise interesting questions as to the nature of the population which will be the prime beneficiary of electronic tele-education and why.

SYSTEMS

The nature of the terminal, their configuration, their functional relationship to the medium and to the purpose, constitute the system. The relationship must be harmonious, it must suit the purpose and it must be compatible with the prevailing economic parameters. Again, interdependence is stressed.

A good deal of contemporary R & D is dedicated to the improvement of the terminals. This permits enhanced transmission capability and thus cost reduction. Significant advances have been made in this respect through the development of special T.V. cameras, bandwidth compression, and the "Electronic Blackboard". The electronic blackboard is connected to a similar unit at the receiving station. What is written on the board by the session leader appears in identical colour and shape on the unit at the receiving station. The advantage of this over video transmission is that it requires a bandwidth of only 1200 bits-sec as against 34 Mbit-s for broadcast quality video. This is very significant, not only in terms of cost, but also in terms of the availability of bandwidth when required.

The technology available for electronic tele-education is well advanced. The prime limiting factor is cost, and this has the following effect: high costs prevent ready accessibility, and this, of course reduces usage. Limited usage acts as a damper on the development of the relevant competencies. Inadequate competencies will in turn discourage the demand, and limited demand will contribute to maintaining the costs high. The obverse, however, is just as true! The development of the relevant competencies will increase the demand, and increased demand will reduce costs. For all there is to observe, contemporary competencies in tele-education leave much to be desired. This form of education calls for specific skills particularly in the following two areas:

(a) A specialised pedagody for electronic tele-education.
(b) A corollary of the above which is that of providing the student population with special training for the purpose of optimising the benefits of tele-education.

There are several pointers which support this contention: Bacsich of Milton Keynes (Ref. 1) reports that students found the audio-teleconferencing mode "stressful". Closer to home, John Collins of the Adult Education Council in Melbourne makes a plea for the marketers of teleconferencing systems to train end users in the human dimension in addition to providing the usual technical training. (Ref. 2). These pointers are also consistent with the findings of the Information Technology Task Force of the Commission of the European Communities, which reports that electronic tele-education may only suit specific purposes and that it is rash to assume that tele-education is applicable right across the board. This aspect is particularly important and it constitutes the substance of the next heading of this overview.

PURPOSE

Purpose is the most fluid, but also the most critical factor in tele-education. From current observations it is also this factor which determines whether a society will embark on a tele-education program and the form which this tele-education program will take.

As already emphasised, the technology can only be as good as the purpose. Under this heading three major issues are immediately indentifiable.

(a) Culture

What constitutes an "education" is intimately linked to the culture of the society concerned. Depending on cultural biases, the idea of tele-education will be given a certain slant or it may even by rejected outright. Social values will determine the perceived needs for tele-education and the format that such an education should be given. This factor, it would appear, is a prime determinant of the differences found from country to country.

(b) Nature of the Discipline

Some disciplines may simply not lend themselves to distance teaching even with the benefits of electronic wizardry. The need for a specialised pedagogy has already been mentioned and this caveat must be extended to the subject matter.

(c) Information vs Education

The concept of education certainly transcends that of imparting information, even if the transfer of information is a subset of education. With the contemporary explosion of viewdata systems, and the mobilisation of the videotex medium for tele-educational purposes (e.g. Milton Keynes makes use of PRESTEL), it is tempting to elevate the medium to the level of purpose. This can only result in an impoverished form of education as well as in a confusion of responsibilities between the educational and the telecommunication authorities.

Against the background outlined above, let us now compare tele-education trends in a number of overseas countries which have made significant strides in the field.

THE U.K.

The U.K. experience is particularly interesting. The U.K. boasts a unique experimental setup umbodied in the Open University of Milton Keynes. Most of the U.K. based developments in tele-education are associated with this University. The University works in close association with the BBC, and together they have produced the BBC computer and its impressive range of software, state of the art interactive video disks, and a variety of successful conventional educational videos. The Centre also makes good use of the PRESTEL viewdata operating system.

In the past, the Centre tried all the tele-education techniques as they became available. Currently the Centre believes that a more rewarding strategy is that of identifying needs, objectives, costs, and to develop specific applications for specific purposes. This is fully consistent with the remarks made earlier in this paper. As already mentioned, audio and video-conferencing have

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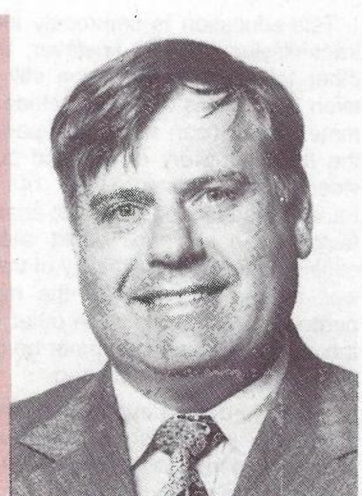
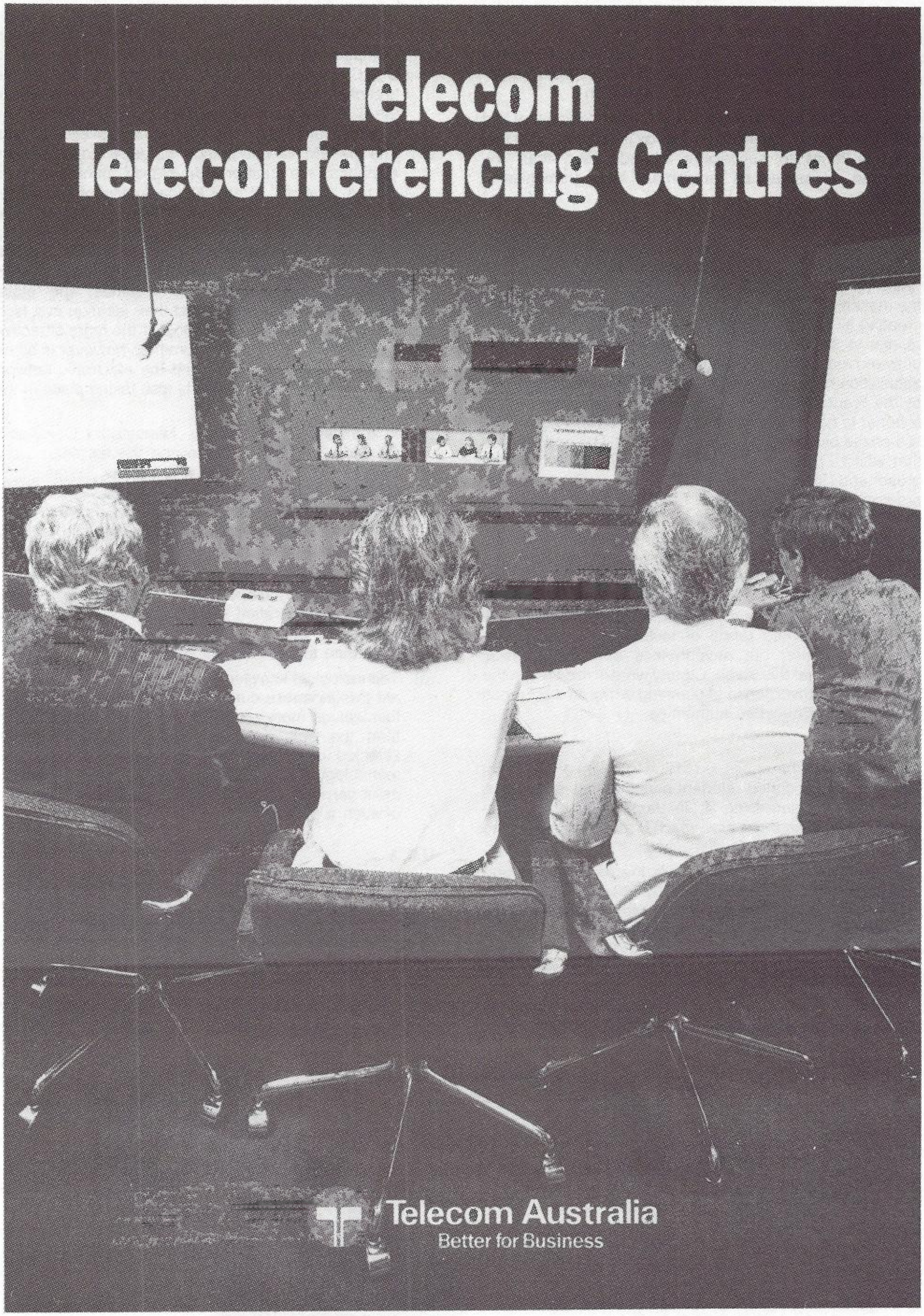
His vocational profile includes 12 years as a psychologist in the Australian Department of Heatth, followed by four years teaching Administration at the University of Tasmania, and two years at the University of the South Pacific, Fiji. He joined Telecom in 1982 in the capacity of Staff Development Officer (HQ) and was for a period of three years the Director of Studies of Telecom's Advanced Management Seminars.

Michel has published several papers on administration and management and other interests include Management Education, languages (French, Russian and some forgotten Spanish), church activities, epistemology and nature oriented pursuits. He is married with one daughter.





Picture of an electronic whiteboard (left side of picture) installed in the Telecom Teleconferencing Centre, Melbourne. This "writing board" allows users to transmit drawings etc. in full colour to a video monitor, projection screen located in another location.

not fared well, and this raises important and as yet unanswered questions regarding the future of tele-education. In particular, it raises the question of whether the supply of lavish technologies will necessarily guarantee the success of this mode of instruction.

It would thus appear, from the U.K. experience, that first and foremost a specialised pedagogy is required, and that there is more to successful tele-education than the provision of advanced equipment and transmission facilities.

FRANCE

Tele-education in Fance may be best understood by referring to two outstanding features. The first feature is the massive national and world leading program aimed at creating a French information-based society. The second relates to the French ethos which discriminates sharply between education as a cultural achievement and the acquisition of information. A 16th century pronouncement by the French philosopher Montaigne to the effect that "it is better to have a well made head than a well filled head" is a prized piece of the national heritage. The end result is that whilst France has made striking advances towards broadband ISDN and has available a range of educational programs specially structured for electronic transmission, it still remains that French electronic tele-education is not perceived as an alternative to "on campus" education. Furthermore, unlike the U.K., France does not have the advantage of a centralised research institution on the subject matter as embodied in the Open University of Milton Keynes. The result is that tele-education in France offers a fragmented range of facilities of a technically advanced nature, but nevertheless of a hypothetical practical value at this stage. Clearly what is required in the context, is a convergence of planning between the French Telecom and Education authorities.

JAPAN

One would be hard pressed to find in Japan a significant "remote" and "isolated" student population. It is therefore not altogether surprising if, in Japan, electronic tele-education is given a direction which is at variance from the historical pattern already discussed.

What one witnesses in Japan is the electronic link-up through state of the art technology of education centres in very high population density areas and in close proximity to each other. Obviously this is not the pattern of remote area education nor that of a flexible individual education as espoused by the "Open University" concept. The phenomenon is epitomised by the Tokyo, Nagatsuda, Ookayama combine (Pic B). The following observations offer a possible interpretation of the phenomenon:

(a) What is witnessed is not a development in tele-education as such, but a logical progression of the Computer and Communications office system. As the C & C system expands it integrates with the remote branches-areas of the organisation. The next step in the C & C integration with sister or complementary organisations, e.g. partnership, supplier-user etc. The pattern is not unique to Japan and can be evidenced in a number of developed countries. Whilst such a "merger" of educational institutions is somewhat peculiar, it is, nonetheless, a merger. The purpose then is not that of providing an education to a deprived population but that of enhancing, through collusion, the power end quality of the organisations involved. In the Japanese instance, the close proximity of the schools, and their location in a high population density area made it all the more attractive and economical. The phenomenon however is by no means unique to Japan, and the electronic networking of campus to campus is also taking place in the U.S.A.

(b) In the case of the Tokyo, Nagatsuda, Ookayama combine, the optical fibres and the terminals were provided by NEC. As a business organisation NEC,has staked its future on the development of a global C & C society. Patently NEC has a vested interest in the project as an R & D exercise and this may explain the lavish provision of a first class state of the art technology.

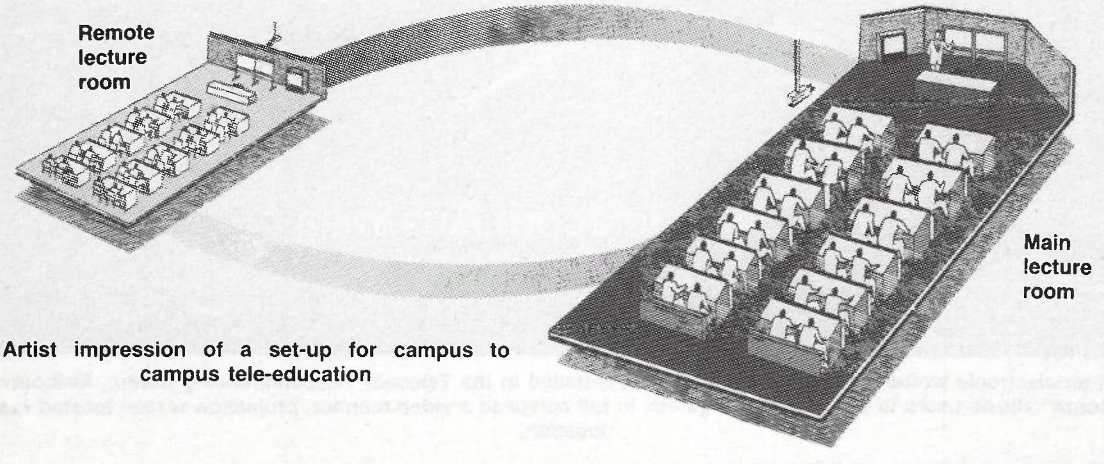
(C) The Japanese culture values "Commonness". The electronic integration of centres of learning is fully consonant with such an ethos, and this can only contribute to the success of the project.

(d) Technological knowledge, the hard sciences, dominate the Japanese curriculum. These disciplines lend themselves more easily to electronic tele-education than the soft sciences. Thus a combination of selected disciplines, a lavish supply of first class technology and a highly compatible cultural environment can only contribute to the successful outcome of such a project.

U.S.A.

True to its pluralistic reputation, the American society presents a variety of tele-education developments which span a broad spectrum extending from the basic voice transmission for remote and isolated students to the university-owned local network which integrates video, voice and data and links state of the art terminals.

Wisconsin University has pioneered much of the distance-education efforts in the U.S.A. and is an



Artist impression of a set-up for campus to campus tele-education

acknowledged leader in the field with other Universities such as Colorado, North Dakota, Ohio, Alaska, also strongly committed to distance teaching.

As in Japan one also witnesses the interconnection of affiliated and neighbouring institutions, but in the U.S.A. what currently attracts a good deal of interest and funding too for this matter, is the "on campus" development of electronic transmission facilities. This is tele-education with a difference.

The rationale of "on campus" tele-education is obviously at variance from that of the orthodox distance-education for the deprived student population. The well heeled centres of higher learning have correctly interpreted the power of electronic storage, analysis and transmission of information as a significant educational instrument. The development of "on campus" facilities is aimed at enhancing the quality of education already available and is thus an additional option, not an alternative one. To illustrate the situation:

Lehigh University, which has a population of 6300 students had budgeted 20 million U.S. dollars to equip every student residence, faculty and staff office with simultaneous voice and data links.

The University of Illinois has designated a dormitory as a pilot project; 261 students will have a PC (supplied by IBM) installed in their room. The purpose of the exercise, in the first place, is to find out what is being used, how it is being used, and with what effect on the students' personal life and academic achievements.

The University of Michigan has earmarked 31.8 million U.S. dollars to link up the Ann Arbor, Flint and Dearborn campuses with fibre optic, cable, and microwave systems. It represents the largest university installation of its kind in the nation.

Temple University, Philadelphia, has plans for the campus of the future, with voice data and video links connecting 104 buildings including the dormitories and the Temple University hospital.

CONCLUSION

So where is tele-education at today?

A first impression is that it is not where we would like it to be; that is, out there with the deprived population. On the contrary, it is the progressive, the well-heeled campus which is busy wiring its premises with an optical fibre network.

The next step is the pooling of resources with another compatible campus or organisation (e.g. research centre, hospital . . .). The campus to campus network creates synergism and a more economic utilisation of high capital resources.

It appears then that the contemporary trends in tele-education will first favour the more affluent, the well appointed centres of learning, and the "on campus" students.

What of the remote areas and of the "off campus" students? A reasonable assumption is that they will benefit from a parallel development associated with PCs and the interactive video disks. The success of the interactive video disk will depend very much on how well the programmes meet the expectations of the students. The appropriate technology is available, and though costs are high at present, they will tumble if the demand soars. Making interactive video disks for educational purposes calls for a complex and unique combination of skills. While it certainly requires competencies in the subject matter taught, it also requires an understanding of the psychology of perception, a specialised pedagogy, and it requires production skills as well as programming skills. Thus successful production may well involve academics, researchers, producers, professional actors, artists, computer and electronic boffins.

So far, the trials by Milton Keynes in this direction have been very encouraging. Other indicators which came to hand include a very substantial investment by China in interactive video systems (Philips signed a $146 million contract with Shenzhen Ref. 3) and the considerable importance given to the interactive video disk by the "Monash Overseas" program.

Computer Based Learning is currently far too broad a term to lend itself to meaningful analysis in the context of this paper. One would have to specify the nature of the learning program, the target population, as well as the software and hardware intended for the purpose.

What are the implications for Australia?

As a nation we have a few peculiar characteristics in that our larger coastal cities and neighbouring regions present many of the characteristics of the First World high population density countries and, on the other hand, the rest of the land is sparsely populated and it is huge. It also happens that the sparsely populated and distant regions provide a sizeable portion of the export revenue, and that they have a not insignificant political clout.

The most probable scenario for Australia then, is that with the tumbling costs of the relevant high technology and the benefits of the experience of overseas developments, centres of learning in high population density areas will network. This will probably take place, first of all, between institutions which are already affiliated, e.g.: Caulfield-Frankston; Deakin-Gordon; University and Teaching Hospital . . .

At the same time, the combined pressures of our existing commitments to remote education in Australia and the political lobby of the areas concerned, will probably result in the accelerated transfer of high technology to our national distance education programmes.

Certainly there are many exciting developments in tele-education in both network connected and stand-alone systems. The situation is very luid and multifarious; nonetheless some broad trends are identifiable as evidenced in this paper.

ACKNOWLEDGEMENT

In writing this paper I received invaluable assistance from Mr Fred Cox, Manager of the Corporate Analysis Unit, Business Development Directorate, Telecom Headquarters. Fred provided me with a wealth of information on the subject matter following an extensive study tour which took him across several countries of Europe and Asia in late 1985. I am also much indebted to him for his enlightened guidance with the relevant technical aspects of the paper, a high risk area for me since my claim to competency is limited to the social and behavioural perspectives.

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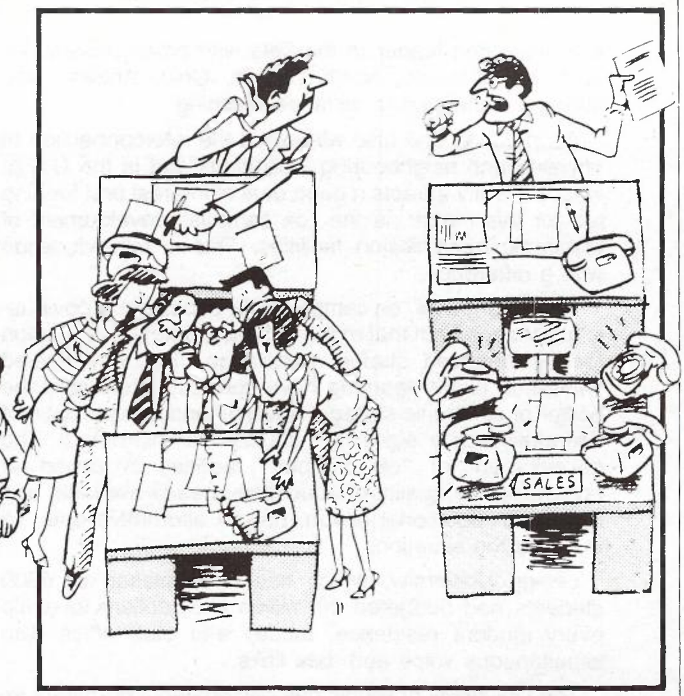

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Telecom Australia — Its Organisational Structure

P. HARDING
Telecom Australia

INTRODUCTION

On 1 July 1975 the former Postmaster-General's Department was split into two Commissions, the Australian Postal Commission and the Australian Telecommunications Commission, in accordance with the recommendation of a Commission of Inquiry in 1973. The Australian Telecommunications Commission is known commercially as Telecom Australia. The Telecommunication Journal of Australia published an article in 1975 (Vol. 25, No. 3) describing the features of the new Commission, its charter and its organisation. Now, eleven years on, Telecom Australia has gone through significant organisational change.

THE NEED FOR CHANGE

Organisational change in Telecom Australia has come about in response to, and in preparation for, progressive demands for the organisation to move from technology base to customer orientation. New technology has had an impact on the organisation with the introduction of new products and services and the convergence of telecommunications and information management. Significant change has also been introduced, and is being constantly revised, to facilitate Telecom Australia's success in competitive and deregulated market places.

THE ORGANISATION STRUCTURE

Telecom Australia's organisation is structured on three levels: the Headquarters Administration, six State Administrations and 79 Districts spread nationally across the States and Territories.

Headquarters and State Organisation

The formulation of corporate policies and objectives is the responsibility of Headquarters. The translation of these policies and objectives into operational fact is the responsibility of the State Administration. In effecting this separation of responsibilities the need for co-operation, consultation and interaction between Headquarters and the State Offices is fully recognised. The emphasis at all times is on the management of Telecom Australia as a total team fully committed to the goals and objectives of the organisation.

An organisation chart for Headquarters is shown in **Fig. 1. Fig. 2** shows a typical State organisation.

District Organisation

To make it convenient for customers to do business with Telecom, a network of District Telecommunications Branches handles day to day operations in metropolitan and country areas throughout Australia.

Each District is managed by a District Telecommunications Manager (DTM) who is responsible for operations within an exclusive geographical area. These areas range in size from less than 100 square kilometres in the central business district of major cities to more than a million square kilometres in sparsely populated regions such as the Northern Territory. The number of Staff working in each District ranges from approximately 220 to approximately 1650.

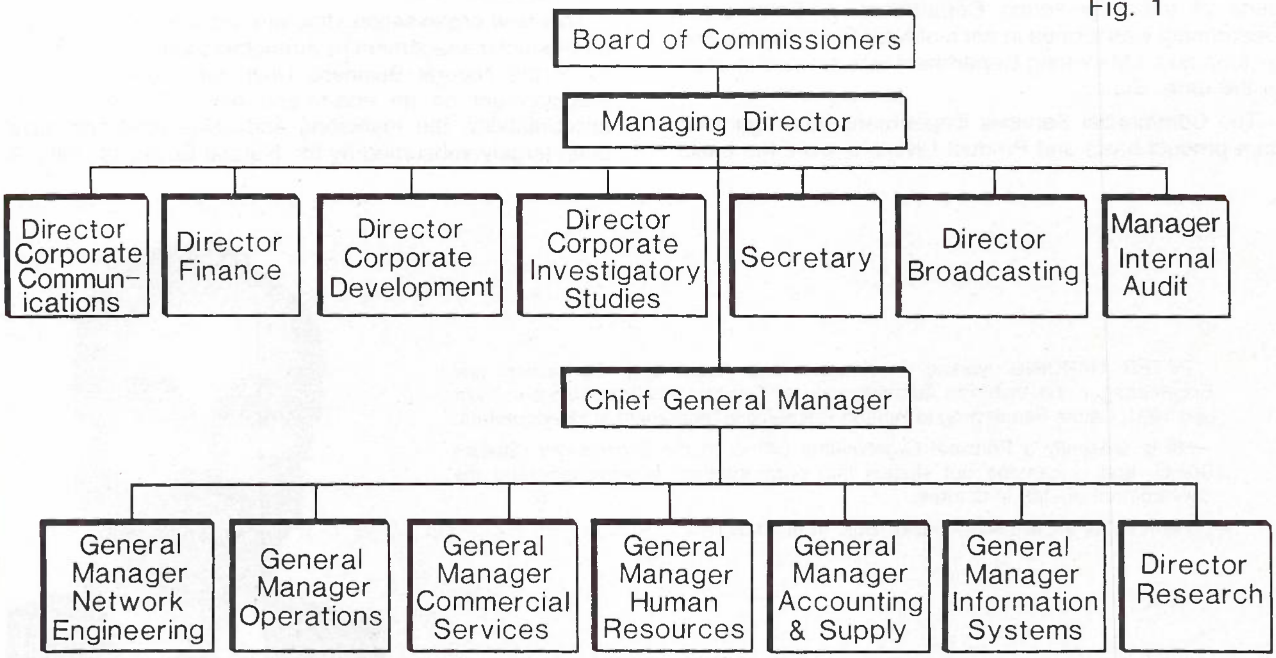
The DTMs are controlled by a Chief Manager, Operations, either directly or via a Regional Manager, Operations.

The Operations Department in each State is a major organisational unit under the control of a Chief Manager, Operations, reporting to the State Manager and responsible for the day to day customer oriented activities of Telecom Australia. The key objectives of the Operations Department are the:

- satisfaction of customer demand for telecommunications services;

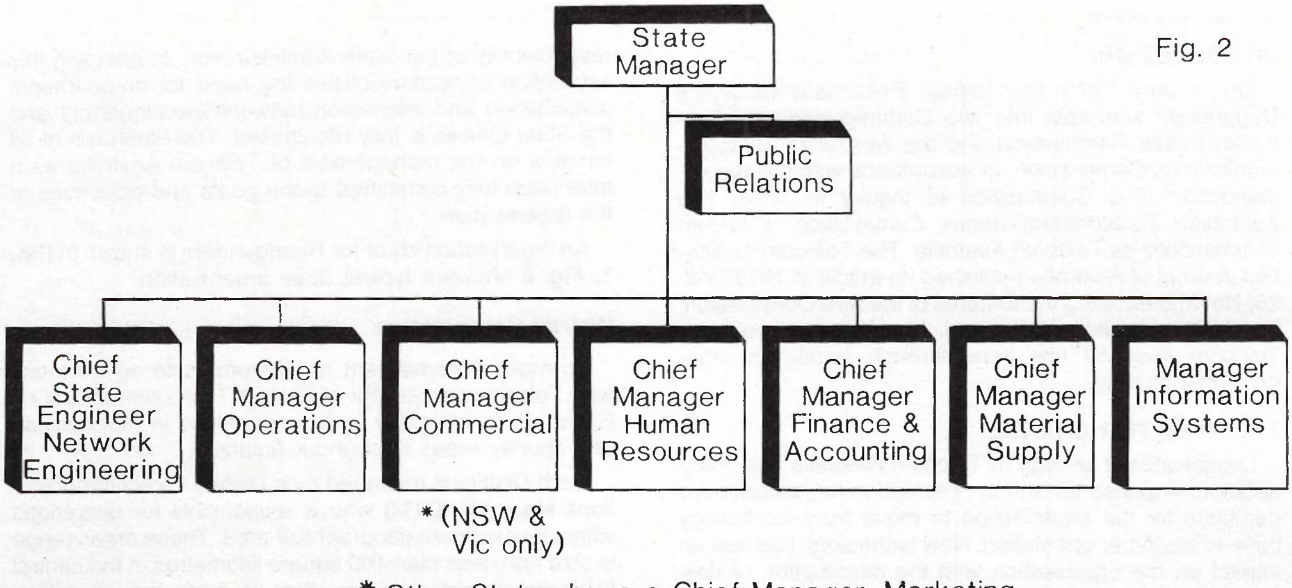
Headquarters Organisation

Fig. 1



Typical State Organisation

Fig. 2



- maintenance of an adequate quality of service to customers;
- efficient operation and maintenance of the telecommunications network;
- implementation of national and state policies in the operational area;
- attainment of satisfactory profit contributions compared with approved budgets.

Fig. 3 shows the organisation of a typical District.

MAJOR ORGANISATION CHANGES

Commercial Services Department

In 1981, the Commercial Services Department was formed in the Headquarters Administration through the amalgamation of the Customer Services Department with parts of the Engineering Department. A Commercial Department was formed in each of New South Wales and Victoria and a Marketing Department was created in each of the other States.

The Commercial Services Department was organised on a product basis and Product Divisions were the basic organisational unit. Generally, each Product Division brought together marketing, professional engineering and technical staff concerned with the planning, development, launching and management of products and services. These Product Divisions were given maximum reponsibility to ensure that new products and services would be brought to the market in a timely and cost effective manner.

Changes in technology, markets and Telecom's environment brought about an audit of the Commercial Services Department in 1984/85. This resulted in Product Divisions being grouped under three Natural Business Units:

- Dedicated Network Services
- Public Network Services
- Business Services

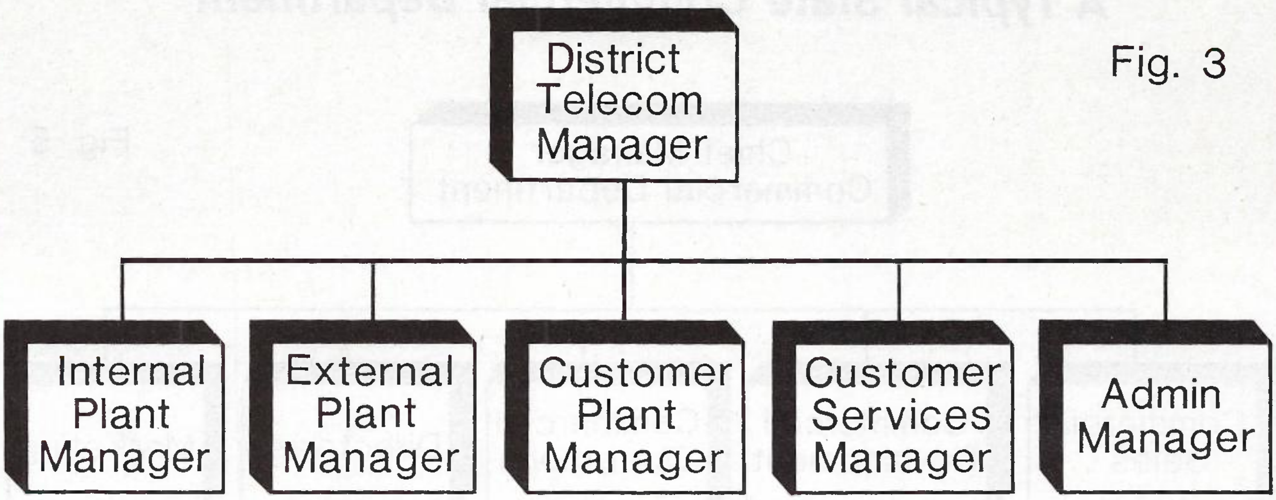
This new organisation structure consolidates the focus on product management by strengthening the responsibility of the Natural Business Units for overall business management on an end-to-end basis. To ensure full accountability, the marketing and sales functions have been largely subsumed by the Natural Business Units. A

PETER HARDING worked in Finance and Accounting, Operations and Engineering in the Victorian Administration of Telecom Australia between 1971 and 1981, before transferring to Human Resources Department at Headquarters.

He is presently a Principal Organisation Officer in the Organisation Studies Branch and is carrying out studies into organisational effectiveness and the development of staff structures.

Peter holds a Cert. Bus. and B. Bus. from RMIT.

Typical District Organisation



Sales Branch is still responsible for a restricted but highly significant range of key sales development activities. A new Strategic Analysis Branch brings a customer sector focus to strategic planning within Telecom. The organisation structure of the Commercial Services Department, Headquarters, is shown in **Fig. 4. Fig. 5** shows a typical State Commercial Department.

Network Engineering Department

In 1983, a national organisational effectiveness review of the Engineering Department commenced in the New South Wales State Administration. The other States and Headquarters were reviewed progressivly and the Headquarters' new Network Engineering Department came into effect in April 1985. The new title of the Department better reflects its role in strategic development of the overall network.

Some of the significant features of the new organisation are:

- The Programming and Resources Management Division, which brings together the previously fragmented management of resources to provide a clear focus for the integration of all programmes and the resources management function.
- The Network Management Division improves the focus for this increasingly important activity by grouping together the functions of general network management with such activities as network performance and monitoring, traffic engineering, and service restoration.
- The Computer Services Support Division improves the focus within the Network Engineering Department for assessing the need for, and development of, computer-based management information and operations support systems which have become basic requirements in most areas of Telecom activity.

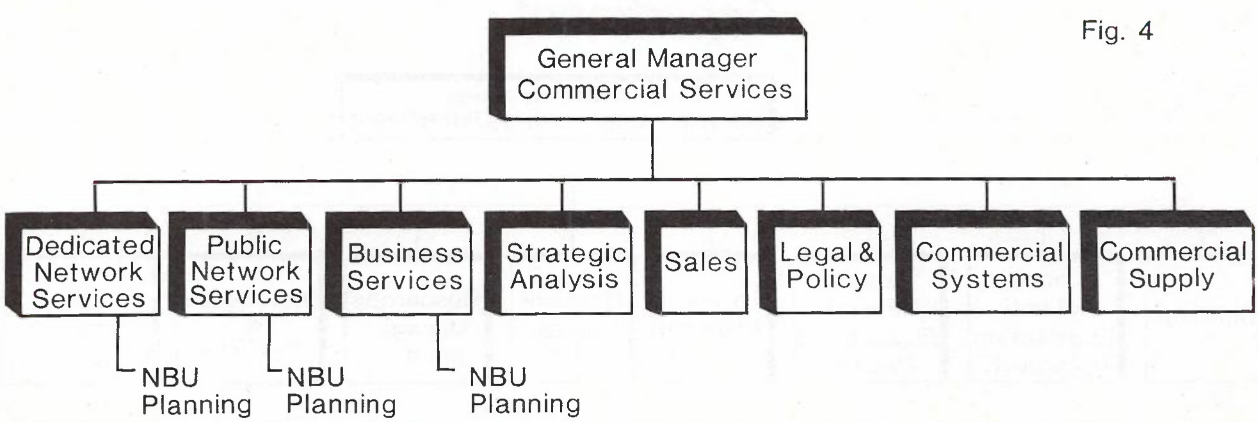
The organisation structure of Network Engineering Department, Headquarters is shown in **Fig. 6.** Figure 7 shows a typical State Network Engineering Department.

FUTURE CHANGE

Telecom Australia will continue to go through organisational change in preparation for, and in response to, customer demands, new products and services, competitive markets and advancing technology.

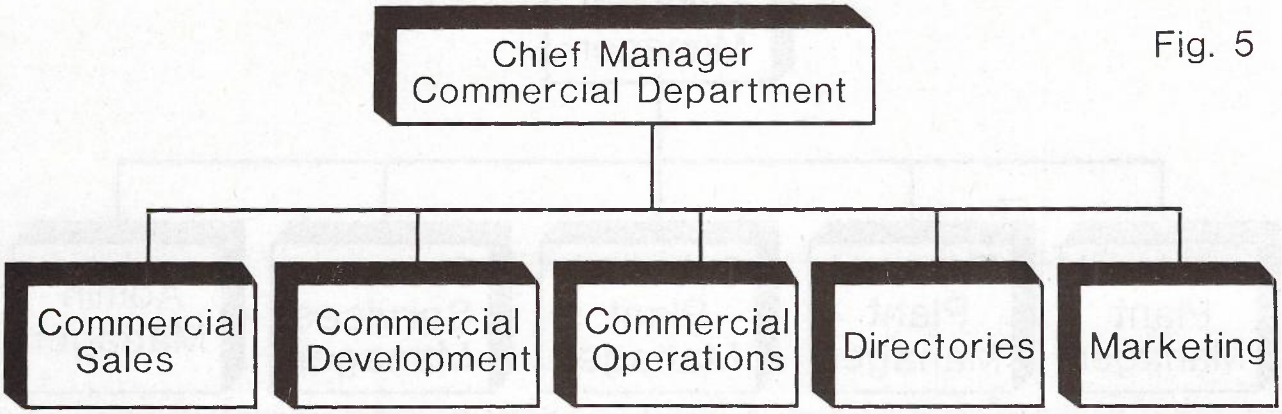
While the organisation has seen considerable change in the past 11 years, the next decade is expected to provide a demanding challenge in setting Telecom Australia's organisational direction.

Commercial Services Department, Headquarters



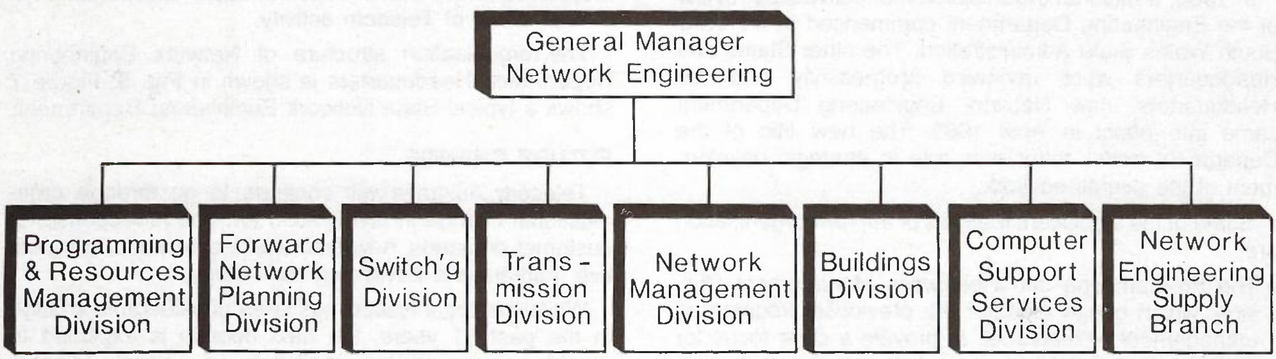
A Typical State Commercial Department

Fig. 5



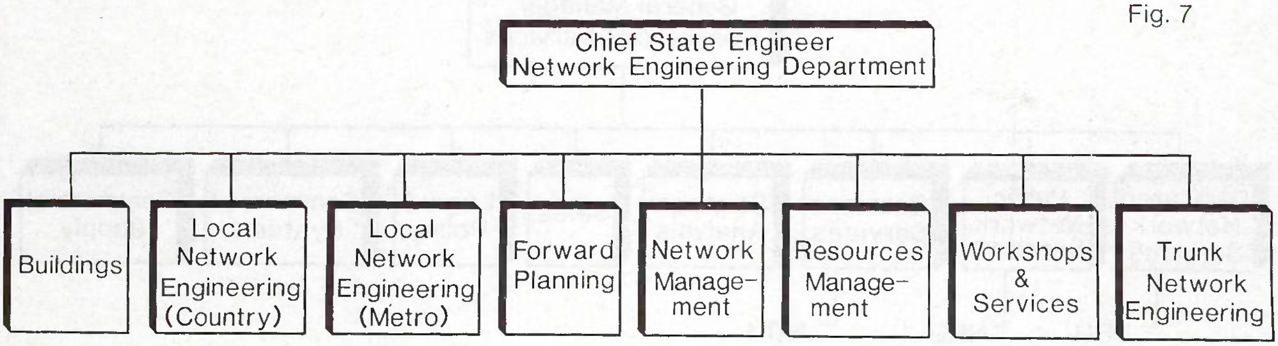
Network Engineering Department, Headquarters

Fig. 6



A Typical State Network Engineering Department

Fig. 7



DIGITAL TELEPHONE EXCHANGES AID WORLD COMMUNICATIONS

by
John Williamson, BSc
former Editor
"Communication Engineering International"
London

The modernisation of the world's sixth largest national telecommunications network is being substantially accelerated with the introduction of System X. This range of micro-electronic digital exchanges was designed and developed in Britain, and is made jointly by Plessey Telecommunications (1) and GEC Telecommunications (2).

The first production System X exchange came into operation recently in Coventry in the English midlands. Within three years British Telecom plans to install at least 30 System X trunk exchanges and 1200 local exchanges. The latter will be made up of some 300 large systems, with 900 local connector units used to extend System X services to much wider areas than the localities served directly by the main local exchanges.

Despite the fact that the British network is already fully automatic, with direct national and international customer dialling to 158 countries, it shares with many other national telecommunications networks a number of serious constraints.

Two Wire Switching

It is dominated by two wire switching and by signalling associated with the connection path established for each call. This affects network transmission efficiency, severely restricts customer facilities, and makes centralised supervision of the network difficult.

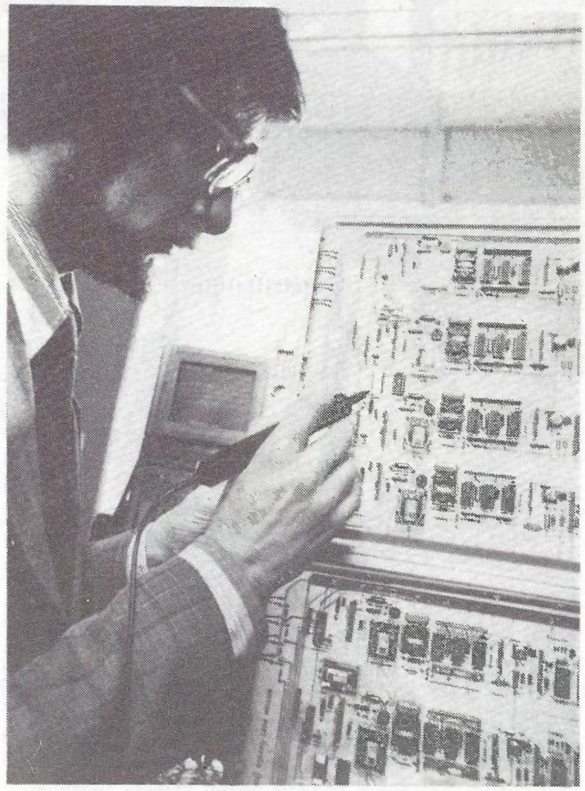
At the same time, numerous types of signalling system are used and, because these have to work together, this limits the capacity to convey information about the call and caller. Connection times are long for calls routed through several exchanges, and calls are subject to variable transmission losses, noise, and distortion. In addition, Strowger switches are prone to wear and require expensive maintenance.

There is limited scope for further evolution and development of new facilities. The equipment has no potential for miniaturisation to minimise the cost of accommodation in expensive city centre sites.

Although many telecommunications experts argue that computer control is at least as important as the method chosen for routing signals through a telephone exchange's switching matrix, digital switching techniques offer real economic and operational advantages. Fully digital exchanges are very reliable, economical to build and maintain, and much more compact than their electromechanical counterparts.

The Same Carrier

Digital operation also makes for great flexibility in the use of the network by enabling different services



A final check for a System X component board.

— data, text, graphics and pictures, as well as speech — to be sent more cheaply over the same carrier, whether copper cable, optical fibre, microwave radio beam or satellite.

When allied to a digital transmission system the arguments for the technology become irresistible. The major advantage of customer-to-customer digital operation is that once voice signals are converted from analogue to digital form they can be routed without further conversion over the whole network. This is a cheaper process, with simplified control, improved transmission quality and reduced error rates. The result is an integrated network capable of supporting every modern telecommunications task and service.

The forrunner of British Telecom (BT) — when the operation was part of the Post Office — first attempted to switch traffic telephone digitally in the mid-1960s. Due to the time required to move from a small scale experiment to a fully developed production system, an interim system had to be found. The authority thus took an evolutionary approach to the technology, with reed switched electronic exchanges such as Plessey's TXE 2 and STC's TXE 4 being introduced in large numbers in the late 1960s and the 1970s. The 1800 or so of these now in service will form a bridge to a fully digital network.

The United Kingdom has been criticised for not making a serious commitment to digital technology earlier than it did; after all, the first pre-production System X machines did not appear in the national network until 1980. In fact, there are a number of reasons why this approach was preferred, if not inevitable.

Checking System X using a visual display terminal.

An Intricate Task

Changing over from a very diversified national network primarily based on electromechanical exchanges of different types is a difficult, time consuming and intricate task. While digital technology, of a very early generation, could have been bought from overseas, the perpetuation of a viable British supply industry was considered to be in the best interest of the country as a whole. And the by BT strategy had one inestimable technical advantage in that it allowed the United Kingdom to overtake developments in other countries.

The evolutionary nature of digital technology in Britain is matched by an evolutionary approach to its implementation. Wholesale substitution of new technology for old in more than 6000 exchanges is not in any case feasible because of the need to maintain uniform service and amortise existing plant. BT has identified a number of implementation strategies.

One can be termed augmentation. Under this concept, network codes are progressively extended with digital switching. This has the advantage that disruption to the existing network is minimal, but has the disadvantage of requiring a large quantity of interface equipment. Another strategy is simple replacement of older equipment by digital exchanges. A third is to create an overlay, in which a digital network is built up side by side with an existing network and is linked to it in a controlled fashion. The last is basically the strategy adopted BT in the majority of circumstances and will result in the most rapid penetration of new customer facilities.

In essence, this overlay strategy allows digital elements to be fitted into existing analogue networks with minimal changes and, at the same time, provides a simple means of expanding the digital network.

Building Blocks

The component parts of a System X exchange can be envisaged as building blocks that interact to provide the total function.

The eight major blocks are:

- The concentrator accepts customers' calls and concentrates them on to high traffic channels.
- The distributor switches calls to other destinations.
- Signal interworking enables System X to work with the analogue exchanges.
- The testing unit makes possible maintenance checks on customers' lines and on interconnecting circuits to other exchanges.
- Inter-processor signalling sets up calls and "talks" to other System X exchanges using an internationally agreed standard.
- The man-machine interface enables staff to monitor, control and maintain an exchange.
- The processor is the "brain" that provides instructions to other sub-systems. It contains a number of software packages controlling such exchange functions as call processing and accounting, management statistics, overload and maintenance control. Starting with the Spires exchange in Coventry, the production versions of System X use a new processor which is up tos ten times as powerful as the original. This gives these exchanges a very large traffic handling capacity, and up to 500,000 calls an hour can be carried with the new processor.
- Automatic announcements guide the subscriber through the use of the sophisticated exchange facilities.

The Right Signals

The existing analogue exchanges use a wide variety of signalling systems in which control signals are sent over the same channels as the conversation. System X rationalises this in a radical fashion.

Currently, analogue telephone networks employ a range of direct current (short distance), alternating current (long distance) and multi-frequency tone (transit network) signalling systems.

In present pulse code modulation systems, transmission technology time slot 16 is used for signalling for the 30 speech channels and is the first stage of a migration away from what is known as channel associated signalling to separate channel signalling. The latter is a feature of System X.

A separate System X data link of 64 kbit/s capacity puts virtually no constraint on the number of signals that can be used. Signals are transmitted rapidly to set up and clear down calls, and, most important, the data link permits signalling to continue during the call without interference. This feature is important both for data communication and for utilising the new range of System X facilities.

Network signalling will be reduced by System X to two basic systems. The first is the direct access signalling system (DASS), which signals between the customer and the local System X exchange for the intergrated services digital network (ISDN). In essence, the ISDN converges all customer services — voice, data and text — through encoding and multiplexing equipment into a common digital network. This is CCITT Signalling System 7, which deals with national and international network operation.

Star Services

Ultimately, the success of System X will be determined by its popularity with users. In addition to the operational advantages already outlined, System X will offer what are termed as "star services". These are accessed by the subscriber using a push-button telephone in conjunction with automatic voice guidance from the exchange.

Included among those services are:

- Abbreviated dialling.
- Call diversion to an alternate number.
- Three way conversations.
- Alternation between an existing call and new one.
- Repetition of last number dialled.
- Reminder call.
- Call barring.
- Charge advice.

Among the additional voice services being considered by BT is ringback, which involves getting the exchange to keep trying an engaged number and calling the subscriber when it is free; voice "mail"; and charging calls made from other telephones to a personal account.

BT, along with the System X manufacturers, believes the overseas sales potential for its exchange system is considerable. This belief is based on the recognition that many countries have similar problems to Britain, and require similar solutions.

Information Transfer News

CIRCUIT BOARDS SOON TO WRAP AROUND HUMAN BODIES?

Moulded plastic circuit boards may soon wrap around the human body, creating a new form of "artificial intelligence." Advances in circuit board fabrication technology will lead to the possibility of designing custom made "intelligence enhancers" that will enclose themselves around parts of the human body in a new form of symbiosis. In fact, eventually, as these computer systems become more and more "intelligent," the human body itself may be viewed as parasitic by the new life form moulded in the image of ourselves. This is but one of the startling conclusions of a new 151-page research report entitled "Printed Circuit Board Market Opportunities" published by International Resource Development Inc., a market research firm located in Norwalk, CT.

Advances in the fabrication of circuit boards have enabled manufacturers to create flexible boards, some of them made by moulded plastic injection. These advances have extended the realm of electronics to include shapes previously thought impossible. In fact, as the entire field of artificial intelligence has progressed, manufacturing fabrication technology has become equally important. As semiconductors become smaller and thinner, systems that can wrap around or into human skin itself will become technically feasible. "The printed circuit board industry is undergoing a revolution that will affect the way we think about electronics," says Peter Kibler, a senior consultant with IRD. "Intelligence will be built into common objects and may well become built into the human body someday." In the meantime these electronic systems will increasingly be considered as "high-tech clothes," rather than as artificial encumbrances. As other miniature high-tech hydraulic and activator devices are added on, the well-dressed "techie" of tomorrow may be wearing a suit which combines sartorial elegance with bionically-fortified forearms, suggested Kibler.

But Next: Renewed Profitability for the Printed Circuit Industry

Before the printed circuit board industry gets into the "softwear" business there's going to be some better times in the hardware business, predicts the new IRD report. New miniaturization technologies, stimulated by consumers' appetites for ever-smaller electronic products, are challenging the printed circuit board makers, but also are providing some new profit opportunities, says the report. As boards become smaller, denser and more complex, revenues attained by the PC board makers will increase this year and for several years to come. This will be good news indeed for the industry, which suffered through a poor year in 1985. The printed circuit market — currently about $4.5 billion — is expected to roughly double over the next five years. Important to the growth of the printed circuit market will be the underlying health of the major equipment markets upon which it depends, including consumer electronics, computers, instruments, telecommunications and defence equipment.

The Tough Road Ahead

"Yet this growth will not be easy," says Peter Kibler. "The new tools and techniques which will be required of PCB vendors is going to leave a lot of oldtimers behind. They'll need to keep up with the technology, which will involve a lot of money and a lot of new skills." Even the captive vendors, such as IBM, DELCO and AT&T, will need to master the new board technology necessary to remain competitive.

In particular, vendors will need to make the transition to surface mount. Traditionally, semiconductors have been inserted into a board surface by means of inserting the leads through a plated hole in the board. Surface mounting utilizes a method of mounting components directly onto a substrate by adhering the leads directly onto the solder pads on the board itself.

This eliminates the need for drilling holes. The result is a more reliable system and one that can allow double the usage of board real estate. Increased efficiencies and higher volume production are expected to allow surface mount prices to drop, making them more competitive with through-hole techniques. This means smaller, denser products for the consumer and businessman.

Another effect that the trend towards smaller products is having is that more and more multi-layer boards are being used for production purposes. While the most extensively used boards today are single-layer, double-sided, there is a clear trend towards the use of multi-layered boards, ranging from 4 to 8 layers. Another type board becoming more common is the flexible board. A flexible board can be bent to fit into a confined area and fills a unique market niche. As miniaturization continues, boards may have to follow more natural forms and thus flexible boards may come into their own.

Automate or Emigrate

Board vendors face more obstacles than simply learning new technological tricks, says the IRD report. As technology becomes more complicated the cost of doing business goes up. PCB vendors are facing the dictum "Automate or Emigrate." The PCB industry is making greater use of automated equipment to help stave off the inexorable pressure of off-shore competition. This is being felt in the increasing use of both Computer Aided Design (CAD) and Automatic Visual Inspection systems (AVT).

In the area of CAD, smaller products require more complicated design and routing. Fortuitously for vendors, the price of CAD systems is declining and the availability of PC-based CAD systems is providing even small suppliers with capabilities that just a few years ago were not available at any price. CAD is an enabling product which is allowing PCB vendors improved turnaround time, increased resolution and a reduction in labor requirements. The increasing requirements for finer detailed design and for growing quantities of large complex boards makes multi-layered design a perfect candidate for a CAD system.

Increased board complexity is also creating a companion problem; the difficulty in PCB quality control. It is no easy task to check the adequacy of solder lead connections by human eyesight. Couple this with demands for greater turnaround and fewer defects and it becomes clear that a new approach is called for. One answer to this problem has been increased development of automatic visual testing, or machine vision systems. Automated visual inspection utilizes a combination of cameras, computers, software and lights to imitate the human eye and to increase inspection accuracy. These systems are used to detect such problems as shorts or pinholes, bent or missing leads and excess solder adhesive. According to the report such systems are expensive, usually with a great deal of customization required, and are being used mainly by the captives and large volume independent board manufacturers. But vision systems will become increasingly common among PCB vendors in the future.

International Resource Development Inc. is an independent market research firm which has been specializing in the analysis and sizing of computer and communications markets since its inception in 1971. Its market research reports, of which it has published almost 400, are routinely purchased by governmental and corporate organizations from around the world. IRD has also performed scores of consulting assignments for companies such as General Electric, AT&T and Nippon Electric. Further details on the $985.00 report (No. 694) entitled PRINTED CIRCUIT BOARD MARKET OPPORTUNITIES, including a free table of contents and description, are available from IRD at 6 Prowitt Street, Norwalk, CT 06855 U.S.A.

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Telecommunication Journal of Australia

GUIDE FOR AUTHORS

Readers are encouraged to contribute to the Journal. The following guide outlines the major points most authors would need to know in order to publish a quality article in the Journal. A more comprehensive guide is available from the Editor-in-Chief.

Type of article

Articles should deal with interesting recent developments in matters relating to the management, planning, design, installation, operation and marketing of telecommunications generally. In particular, the Journal should record those special contributions made by individuals to the Australian telecommunications industry. Overseas contributions are also encouraged.

Length of Articles

As a broad guide, articles should consist of about 4000 words. This is about 14 pages of double spaced typing on A4 size sheets. Short articles and brief technical notes are also welcome.

Subdividing the Article

Three major types of headings are used:

- **MAJOR HEADING** — BOLD CAPITALS
- **Secondary Heading** — Bold Capitals and Lower Case
- Tertiary Heading — Small Capitals and Lower Case

Abstract

An abstract of 75 words at the most must be provided when an article is proposed. It should state the scope of the article and its main features.

The Text

The text should be in an impersonal, semi-formal manner. Consistency in spelling, headings, symbols, capitalisation etc. is essential. Some examples of common abbreviations and units are as follows:

kbits/s, Mbits/s, mW, MHz, Fig.

References

References should be numbered consecutively and listed at the end of the paper. The preferred format is:

1. Smith, R. & Jones, A., "Marketing Videotex," Journal of Marketing in Australia, Vol. 20, No. 3, June 1985, pp 36-40.

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Members of the Board of Editors can assist you to obtain drafting support. However, the Board will accept good quality artwork.

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Tables must be typed on separate sheets and presented so that they may be set by the printer. Use diagrams, graphs and illustrations to improve the general presentation of the article. Illustrations, etc., are referred to in the text by figure numbers, consecutively.

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Abstracts: Vol. 36, No. 1

LINE TRANSMISSION CONSTRUCTION PRACTICE: J. R. CAIRNS and R. A. J. REYNOLDS, Telecom. Journal of Aust., Vol. 36, No. 1, 1986, Page 3.

Telecom Australia has over the years adopted styles of transmission equipment construction practices which have been shaped by the combined influence of Telecom's history, associated equipment practices and manufacturing practices dominated in recent times by Australian industry. The recent dramatic change towards a digital transmission network has modified the equipment form and produced what is now known as the Type 84 transmission equipment practice. Associated with the change to digital working there has been a consolidation of attitude within Telecom to associated design matters such as equipment reliability and lifetime.

ELECTRO-STATIC DISCHARGE CONTROL: K. NG and I. CAMPBELL, Telecom. Journal of Aust., Vol. 36, No. 1, 1986, Page 7.

The development of semi-conductor technology has resulted in low power, high density micro-circuits, which are extremely susceptible to damage by electro-static discharge. This article has been written to assist in understanding ESD and the means of controlling its effects.

WORLD DEMAND FOR MOBILE COMMUNICATIONS: O. LUNDBERG, Telecom. Journal of Aust., Vol. 36, No. 1, 1986, Page 15.

The Director General of INMARSAT discuss the world wide demand for mobile communications. He outlines the types of service in demand, the economic rational for mobile communications, the rapid growth in mobile markets, factors affecting market growth, competition, potential service providers and the future of mobile services.

THE AUTOMATED BASEBAND MONITOR: D. DORMAN and M. BASTOCK, Telecom. Journal of Aust., Vol. 36, No. 1, 1986, Page 23.

An Automated Baseband Monitor (ABM) has been developed and introduced into the Australian Telecommunication Network to specifically meet Telecom Australia's need for automated transmission performance surveillance and demand measurements on the broadband analogue network.

This article describes those specific needs and gives an insight into the hardware and software configuration of the ABM highlighting the tests that it performs.

TIME DIVISION CROSS CONNECT (TDCC) AND THE DEVELOPMENT OF THE DIGITAL DATA NETWORK: S. M. ELDRIDGE, Telecom. Journal of Aust., Vol. 36, No. 1, 1986, Page 29.

This paper provides an overview of the Australian Digital Data Network (DDN) and the proposed strategy for the introduction of the Time Division Cross Connect system (TDCC) and associated Management and Control System (MACS) into the network. The Time Division Cross Connect (TDCC) is a digital crossconnection system that enables data services to be automatically crossconnected under operator control and the Management And Control System (MACS) is a minicomputer network to control the TDCCs and to provide advanced operations and maintenance functions. The TDCC and associated Management And Control System (MACS) will provide the infrastructure for the ongoing expansion of DDN and will support a new range of dedicated digital services including data, voice and wideband services.

THE DDN TIME DIVISION CROSS CONNECT SYSTEM (TDCC): S. M. ELDRIDGE, Telecom. Journal of Aust., Vol. 36, No. 1, 1986, Page 35.

This paper provides a system description of the Time Division Cross Connect (TDCC) that is to be incorporated into the Australian Digital Data Network (DDN). The TDCC is an operator controlled digital crossconnection system that provides semi-permanent connections between data channels that are multiplexed into digital streams that terminate on the TDCC. The TDCC and associated Management and Control System (MACS) will provide the infrastructure for the ongoing expansion of DDN and will support a new range of dedicated digital services including data voice and wideband services.

THE DDN MANAGEMENT AND CONTROL SYSTEM (MACS). K. KUMAR, Telecom. Journal of Aust., Vol 36, No. 1. 1986, Page 41.

This paper provides a brief description of the Management and Control System (MACS) which is a major new development in the evolution of the Australian Digital Data Network (DDN). It is a distributed minicomputer network designed to provide centralised control of the Time Division Cross Connect (TDCC) systems as well as advanced operations and maintenance functions for the DDN.

In conjunction with the TDCC, MACS will provide the appropriate infrastructure for the ongoing expansion and management of the DDN into the 1990s and support a range of new dedicated digital services including data, voice and wideband services.

THE HEADQUARTERS MELBOURNE SWITCHING LABORATORY: I. McKAY and P. WELLARD, Telecom. Journal of Aust., Vol 36, No. 1, 1986, Page 45.

This paper traces the history of the laboratory and the simulated national network, model equipment and test facilities set up in the laboratory.

CONTEMPORARY TELE-EDUCATION DEVELOPMENTS: M. LYRMONT, Telecom. Journal of Aust., Vol 36, No. 1, 1986, Page 55.

This paper reviews some modern tele-education trends in the context of contemporary technological developments, and the socio-economic characteristics peculiar to specific regions.

TELECOM AUSTRALIA — ITS ORGANISATION STRUCTURE: P. HARDING, Telecom. Journal of Aust., Page 61.

This paper reviews the organisational changes in Telecom Australia which have occurred from 1975 to the present.

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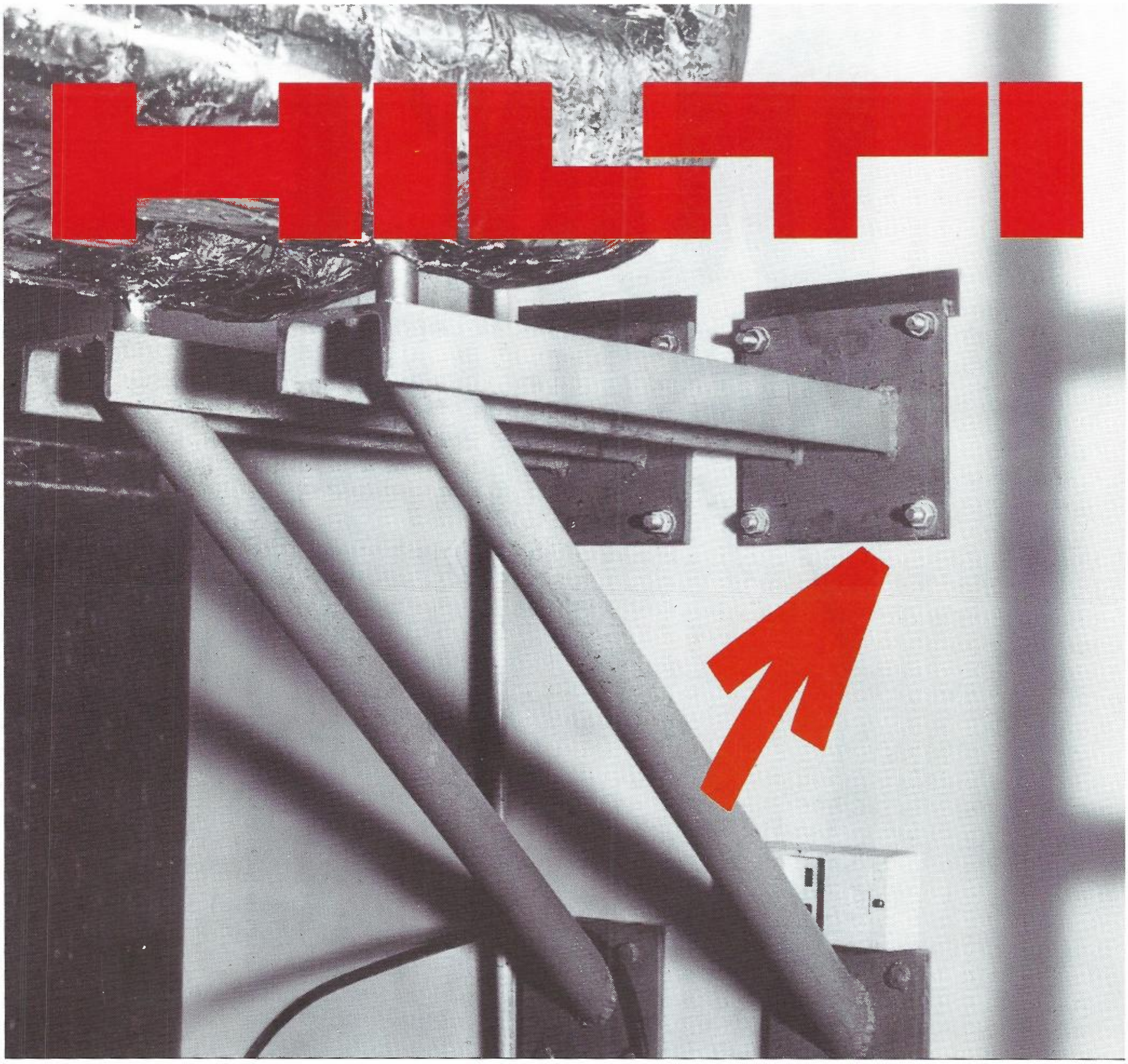

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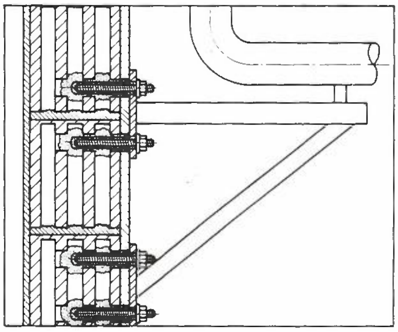

Hilti offers added value.
That's all backed up by Hilti's comprehensive service covering professional advice, comprehensive documentation, rapid delivery and more. In other words, we make your problem our problem.

Please phone us.
A Hilti salesman is ready to give you full information about HIT, or any other fastening system. Hilti has everything it takes to solve your fastening problem.
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