THE SLADE MEMORIAL LECTURE 1978

A NEW ZEALAND PERSPECTIVE ON BROADCASTING TECHNOLOGY

The Ralph Slade Memorial Lecture for 1978 was delivered by Mr. A. K. Richardson, C.Eng, MIEE, MNZIE, FNZEI, at Auckland on 23rd August 1978.

Biographical Notes:
Mr. Richardson was, until his retirement in April 1977, the head of Engineering of the Broadcasting Corporation of New Zealand (f3CNZ) under the title Controller of Engineering Services. He spent virtually the whole of his working life in Broadcasting Engineering in New Zealand, first as a technician from 1937, then as a professional engineer from 1946 onwards. He succeeded to the position of head of Engineering of Broadcasting in 1969 as chief engineer of the former NZBC and remained in that position until his retirement through the several changes of name of the broad-casting organisation and of his own position in it.

Because New Zealand has a small population it is customary to think of her enterprises other than those connected with primary industry as being on a small scale by world standards. This is not, however, true in all eases and a particular instance of technology on a substantial scale in world terms is that of our public broadcasting organisation, presently called the Broadcasting Corporation of New Zealand (BCNZ for short). I suspect it may surprise my audience to learn that in the British Commonwealth, for instance, only the British Broadcasting Corporation and the Canadian Broadcasting Corporation have a larger overall scale of technology than the BCNZ which ranks ahead of such well-known organisations as the Independent Broad-casting Authority of Great Britain, the Australian Broadcasting Commission, the Broadcasting Division of the Australian Telecommunications Commission and the other Australian public broadcasting control agencies. In South East Asia the BCNZ is probably second only to NHK of Japan. In Europe it ranks in technology with the larger rather than the smaller nations though, with minor exceptions, there are none which do not well exceed New Zealand in population.

This state of affairs arises from the number, variety and complexity of the broadcasting engineering facilities which the BCNZ owns and is responsible for maintaining in daily service for periods of typically 16 to 18 hours, though, in some cases as high as 24.

The major BCNZ radio facilities are:

1.
Twenty-two radio studios handling typically 4 programmes if located in one of the four main centres, 2 programmes if located in a provincial centre, and, 1 programme if located in a large town. The mix of programmes can be network or non-network, commercial or non-commercial in varying degrees. All studies are

also used for programme production, the range and quantity depending on the size of centre saved.

2.
Twenty-three medium frequency radio trans-mission sites comprising a building, one or more masts, main and emergency power supply and programme and telephone circuits.

3.
Fifty-one medium frequency radio transmitters established on these sites. The largest site-Titahi Bay, near Wellington houses 5 transmitters (also the 2 short-wave transmitters of the BCNZ Overseas Service). The other main centre sites typically house 4, provincial and larger district centres, 2.

4.
A central receiving station which performs essential monitoring and control functions related to the operation of the BCNZ's 51 radio transmitters, the reception for programme purposes of overseas short-wave transmissions-especially world news and sports-and the provision of data on the reception of the world short-wave services of overseas broadcasting organisations as part of a reciprocal world-wide service.

The major BCNZ television facilities are:
1.
Five television studios. Those for Auckland and Wellington are network programme origination and major production centres, while those for Hamilton, Christchurch and Dunedin are network contribution and minor production centres. The fact that programme and production functions must be commercial or non-commercial at will calls for a greater complexity in the technology involved.

2.
A microwave television programme relay system comprising some 8300 route-kilometres of microwave bearer for distributing television programme with accept-able reliability from the main network origination studios at Auckland and Wellington, to their appropriate network of transmitters. It has sufficient routing versatility to provide for required breakouts to portions of the networks and for programme contributions for immediate broadcast, or recording for later broadcast from any studio, an outside broadcast vehicle, or the New Zealand Post Office satellite earth station at Warkworth.

3.1
Thirty-four television transmission sites at altitudes between 350 and 1750 metres. Each site has an access road, building, transmission tower, main and emergency power supply services and (in some instances) telephone services.

3.2
Seven of these sites have, as their primary facility, two very high frequency television transmitters of l00 or 300 kilowatts effective radiated power, one for TV-1 service, one for TV-2 service, Associated facilities are microwave television programme relay links with a number of data, supervisory and control circuits, and a two-way voice frequency communications system. (It is

interesting to note that the seven transmitters each for TV-1 and TV-2 on these sites give television coverage for each ser-vice to some 75% of the population.)

3.3
The facilities provided at the remaining 27 high altitude sites fall into one of three categories:

(a) TV-1 and TV-2 service transmitters of 1 to 30 kilowatts effective radiated power associated with microwave television programme relay links with their associated supervisory and control systems. (Virtually all TV-1 transmitters have been provided for these sites but TV-2 transmitters exist on only five of them as yet.)

(b) TV-1 and TV-2 transmitters as in (a) but provided with programme via high performance, very high frequency receivers receiving signals off-air from an appropriate coverage transmitter in the same service. Basic supervisory and control is provided via a two-way radio telephone system.

(c) Microwave relay link equipment with its associated supervisory and control only, i.e. this category of site is a dedicated microwave link repeater site.

4.
An extensive complex of some 355 very low power television translators, some 325 of which are of 30 watts effective radiated power or less, required to serve scattered rural population groups beyond the service areas of the higher power television stations, or pockets of population, urban or rural, within those service areas which would not otherwise receive service because of heavy local shadowing of the television signals behind hills. The greatest possible economies are practiced in the provision of site facilities for these translators. Most TV-1 translators exist on these sites to give that channel virtually 99% coverage. Planning provides for the addition of a TV-2 translator on these sites at an appropriate time (many already exist) to give similar population coverage for that channel also.

It will be realised, of course, that for the BCNZ to own and operate this large and varied inventory of broadcasting facilities there must first have been a concept of New Zealand's broadcasting requirements, a plan for realising the concept in practical terms, and finally, an implementation of this plan. And so I now want to examine, from a New Zealand perspective, the technical philosophies involved in these matters-concept, plan and implementation.

MEDIUM FREQUENCY (MF) RADIO BROADCASTING

As in most countries of the world, radio broadcasting started in New Zealand making use of the medium frequency band, 535 kilohertz to 1605 kilohertz. The techniques of broadcasting in this band had been developed and implemented during and following the First World War, mainly in Europe and North America, and developments there were rapidly followed lip by any country having the social and technological development to make Broadcasting viable. Australia and New Zealand were two such countries. The medium frequency band, while having the advantage of a very high degree of pervasiveness of signal and simplicity of techniques, especially receivers, has the serious disadvantage that, at night-time the ratio of the interference area to coverage area of a transmitter is more than 1000:1 while, during daytime the ratio is 20:1 or even less. As a result of this, for optimum coverage by day and by night, entirely separate transmitter networks, based upon different distances between transmitters using the same frequency channel, are necessary. Any network where all transmitters remain in operation day and night leads to reduced coverage either during day time or night-time, or, in the case of a network based on a compromise between the two types of network, to reduced coverage during both day and night. In practical systems, it is most usual to provide full daytime coverage and accept reductions of coverage at night.

It does not require much imagination to realise that, in the continental land masses such as Europe and Asia, occupied by countries of widely varying size, spread over wide ranges of latitude and longitude, and having the most diverse social and political characters the implementation of such systems presents almost insurmountable problems ranging from severely compromised night-time services, at best, to transmitter power "wars", at worst. From a New Zealand perspective, however, the development of medium frequency radio broadcasting has presented few difficulties up to recent years. It is fruitful, perhaps, to recap the events that have led up to that point in New Zealand's radio services development.

In the early days of medium frequency radio development in New Zealand, her physical isolation and the modest requirements of her small population combined to make frequency planning simple indeed. The eastern coastal plain of Australia was then the only world area which had any potential for mutual interference problems for New Zealand's broadcasting services, and the relatively few channels required for use in either country enabled initial developments for each to be satisfied with a modest degree of mutual consultation on frequency allocations. Indeed those were the days when New Zealand radio listeners could, during the hours of darkness, supplement their local programmes with those from many Australian eastern-seaboard stations or even further afield in Australia or other parts of the world, particularly the Pacific coast of North America. A significant factor in this situation was that, although Australia does not enjoy physical isolation from the countries of the land masses of South East Asia, particularly Indonesia, at that time no significant amount of medium frequency radio development was taking place in those countries. Consequently, Australia and New Zealand could act as an independent regional block and arrange channel allocation and transmitter power agreement by bi-lateral negotiation. By 1949, radio broadcasting in both countries had developed to the stage where it was felt that a formal Australian/New Zealand regional medium frequency agreement was desirable and negotiations Culminated in the Wellington Agreement in December 1949. While not formally part of the Agreement the requirements of the South Pacific Island countries were also taken into account in this treaty which set the pattern for medium frequency broadcasting in the South Pacific for the next twenty-five years.

This happy state of "splendid isolation" in broad-casting for Australia and New Zealand was, however, gradually reduced during the two decades from 1950 onward by the steady expansion of medium frequency radio services in the emerging nations of Asia ranging from the eastern borders of Europe to the Indonesian archipelago. Medium frequency radio in Europe was already deeply embroiled in the gross mutual night-time interference to services and transmitter power "wars" resulting from insufficient willingness to formulate and adhere to viable international frequency plans, and these undesirable features were tending to be reproduced throughout the whole chain of Asian nations down to the nations of the South Pacific. The situation was further complicated by the fact that ITU Region 1 (Europe and Africa) observed a 9 and 8 kilohertz channel spacing in the medium frequency band, while Region 3 (Asia and Oceania) observed 10 Kilohertz channel spacing. As a consequence, transmitters operating on either side of the border of Regions 1 and 3 produced heterodyne whistles of 1 and 2 kilohertz frequency which were some 50 times more powerful sources of interference than that produced by two transmitters operating an the same channel. Such night-time heterodyne interference occurs over several thousand of kilometres, even with relatively moderate transmitter powers, so the whole of Region 1 and 3 are potential night-time heterodyne interference zones in this context. Increasingly, it came to be realised that this already chaotic and steadily worsening situation with medium frequency broad-casting throughout ITU Regions 1 and 3 must not be allowed to persist and at two conferences in Geneva in 1974 and 1975 a frequency plan on 9 kilohertz channel spacing was worked out for some 10 000 stations throughout these two Regions an the basis of agreed interference levels calculated by computer methods. This plan is to take effect from 23 November next, when all existing transmitters in the two Regions, including those in New Zealand, will change to their agreed channels. In common with most countries, New Zealand acquired more medium frequency channels, at the expense of reduced night-time co-channel protection ratios, though an agreed policy among the nations of the South Pacific area has provided for this area to have, within the agreement, a night-time interference protection ratio which is same seven to eight times better than that provided for Europe.

The ironic fact is that despite the many extensions that have been provided in medium frequency radio in New Zealand over the past 30 years, it can be said that night-time coverage of the rural area has been steadily deteriorating during that time. Whereas some 150 000 people in rural areas are inadequately covered by medium frequency radio during day-time, it is probable that that number is more than doubled at night-time and will increase still further in the future. Various techniques can be adopted to make limited localised improvements but these will be significantly affected by the economic law of diminishing returns, though remaining an interesting and, to some extent, effective technological exercise.

There is one further matter for concern. ITU Region 2 (North and South America) did not take part in the Geneva conferences of 1974 and 1975 and, as medium frequency stations within this region will remain on their present 10 kilohertz channelling, the night-time heterodyne interference, already discussed, will still remain but will manifest itself in different areas of the world from those previously affected. Unfortunately, one of the areas most affected will be the South Pacific. This expected interference has been verified experimentally by an arranged night-time temporary 1 kilohertz shift in frequency of one Los Angeles transmitter and Auckland's 1ZB transmitter, when heterodyne whistles of significant strength were detected in Fiji and the North and South Islands of New Zealand. The New Zealand delegates at Geneva, being aware of this incipient problem, concentrated on a channelling plan which minimised it as far as possible for the South Pacific countries likely to be affected by it. For the future, it is hoped that as the Geneva channelling plans for nations in the West African regions are implemented as medium frequency broadcasting on 10 kilohertz channelling develops further on the eastern seaboard of South America, the manifestation of severe heterodyne interference in these areas will ultimately force Region 2 to adopt 9 kilohertz channelling also. The fact that there are proposals, which might or might not be approved, for a substantial increase in power from 50 kilowatts to 500 kilowatts for some transmitters on the Western coast of North America and in Hawaii make the need for a solution even more crucial as far as the South Pacific is concerned.

LOW FREQUENCY RADIO BROADCASTING

It is a matter for regret that, when the establishment of the first radio broadcasting services were being considered for New Zealand in the 1920's no proposal appears to have been entertained for the use of the low frequency band, 150 to 285 kilohertz. It is true that in most countries broadcasting started in the medium frequency band, the techniques having been developed largely in Europe. In Europe, however, the low frequency band was also used, and, in not following suit, New Zealand deprived itself of the opportunity to have one basic countrywide radio service from an early date. (Such a service using one transmitter on 200 kilohertz has operated in the United Kingdom since 1924, though now, it is duplicated by one of the four BBC very high frequency-VHF/FM-sound radio services.)

In recent years, there has been a resurgence of interest in the use, for broadcasting, of the low frequency band among several Region 3 countries. It is possible that this may culminate in a request for a low frequency broadcasting allocation for Region 3, which does not at present exist, at the 1'I'U World Administrative Conference of 1979, which is to review the present use of the complete radio frequency spectrum with the object of deciding whether any changes may be appropriate. Should such an allocation be made, there are sound reasons for considering the provision within New Zealand of one basic sound radio service in the low frequency band.

HIGH FREQUENCY (SHORT-WAVE) RADIO BROADCASTING

New Zealand, as a nation, has never, until recently, been able to make up its mind what use it can make of a short-wave broadcasting service. Its initial venture into this field appears to have been on the basis that it must have such a service because all nations of equivalent social and economic development had one. For this reason, no doubt, its present service was established in 1947/48, on a minimum budget, using old war-surplus, low power (7.5 kilowatt) transmitters and a limited complement of home-built low performance aerials at the medium frequency transmitting station at Titahi Bay. It was upgraded in the early 195U's, again on a minimum budget, by the addition of further home-built, only slightly higher-performance aerials, to cover almost the full short-wave broadcasting frequency range. A remote aerial switching system was also provided at this time.

Since then those engineering facilities have become steadily more obsolete and inadequate by international standards but the service, which is to the Pacific Islands and eastern Australia, has proved useful, kept that way by the determination and ingenuity of the engineering staff who operate the station and the dedication and enthusiasm of the staff who provide the programmes.

Since 1975, serious consideration of the philosophy behind short-wave broadcasting by numbers of nations and a study in-depth of the engineering requirements, using the latest powerful computer techniques, have been made. In general terms, it is considered that New Zealand should have at least two, but possibly four, medium power (250 kilowatt) short-wave transmitters for use in concentrated, one to three hour duration, broadcasts to selected targets. The future short-wave station, the establishment of which is currently delayed by the economic situation, will be established at a central North Island location possessing a large area of flat terrain, clear of obstruction in the beam directions required, and remote from concentrations of population.

VERY HIGH FREQUENCY TELEVISION BROADCASTING

It is not intended to discuss here the sequence of events which could have led New Zealand to adopt the British 405 line, 50 field, positive video modulation, amplitude-modulated sound, television system. The British Broadcasting Corporation and the Independent Broadcasting Authority have been trying to abandon this without success, since the mid-1960's. In fact the reason for referring to it at all, is that it pinpoints New Zealand's coming of age in broadcasting technology; the time when it was realised that the engineers could no longer be expected simply and safety to translate to the New Zealand environment technologies that had been used with success overseas. From that time on, to an ever increasing extent, the engineers have been allocated staff, apparatus and above all, time and travel to investigate newly developed technologies and their relevance to New Zealand's requirements before irrevocable policy decisions regarding their use in this country were taken.

Very high frequency television coverage was the first phase of broadcasting technology to benefit from the new attitudes, and, as a consequence is undoubtedly one of the most effective in the world today. The basic concept was for the provision of two television programmes nationwide to the planning standard of the CCIR (the Radio Consultative Committee of the ITU). A first order appraisal of the techniques of planning for very high frequency signal coverage of a country can be gained from the use of a linear lattice grid of lines to be set over a theoretical land area of regular geometrical shape and flat terrain. The television channels available (only nine in New Zealand's case) are then allocated in permissible co-sited pairs (for two programmes) to each intersection of the grid lines in sequence, in such a way that a11 restraints on the use of channels, such as the minimum distances at which the same and adjacent channels can be used, are observed. The shape of the lattice and the dimensions of its quadrilaterals are then adjusted to take account of the true shape of the country and the actual nature of its terrain. In this way, a practical network of transmitting stations, which achieves New Zealand's planning objective for television signal coverage for two programmes, has been largely realised-a task which is dismissed in a few words in this paper but which called for a cost of tens of millions of dollars in engineering facilities and a prodigious effort on the part of the engineering manpower involved. In physical terms, the transmitting sites have been provided and the TV-1 service transmitters and translators, as the case may be, are operating from them to give coverage to more than 99 per cent of the population; however, only 35 sites have TV-2 transmitters or translators operational from them, giving coverage to some 78 per cent of the population at this date.

It should be pointed out that not all television trans-mission sites are those indicated by the primary lattice and established at the cross-points of that lattice, as described above. It is not possible in countries with areas of heavily broken terrain (and New Zealand is certainly one) to avoid gaps in the signal coverage of the primary stations of the fundamental coverage lattice, because of heavy local shadowing of the signal such as occurs, for instance, in deep valleys. These gaps are filled by what the BCNZ engineers call "pocket stations", which, typically, are in-band translators allocated channels on the use of which, in that particular area, there are no restraints. It is found that this condition is normally fulfilled when the channel allocated to the pocket filler is one of those of the next adjacent stations in the primary lattice to that from which the pocket filler receives its input signal. An essential condition for the successful operation of pocket fillers is that their coverage must be kept to closely defined area limits. The classic example of a pocket filling system working reasonably successfully on the principles described above are the 26 (at last count) pocket translators in the Wellington City, Hutt Valley, Wainuiomata, Golden Coast area each receiving their input from Mt Kaukau (Wellington) main lattice station and using, in the main, the channels of the Grampians (Nelson) and Otahoua (Wairarapa) next adjacent main lattice stations.

Before leaving the matter of television coverage 1 want to recount events, which, more than any others, typify the New Zealand perspective of this paper. I refer to the private translator era of the 1960's which followed the earlier establishment by the BCNZ, in a "crash" programme, of four temporary medium-power transmitting stations, one for each of the four main centres, on the three Band I frequency channels and with a local studio centre to originate programmes. The signals from these transmitters just about gave an adequate service to the main population concentration of the city in which each was located but, of course, also propagated some 50 to 100 kilometres beyond. Persons with electronic expertise and personal initiative began to make use of these signals by establishing home-built translator stations of relatively unsophisticated design on elevated sites in outlying areas to provide an acceptable television service to nearby, though necessarily small (because of the low powers of the translators), population concentrations. The initial problems caused by the political, legal and engineering implications of these events were disturbing, but wise counsels gradually prevailed and the existence of some translator stations, using BCNZ input signals, was legalised around a system where the BCNZ, the New Zealand Post Office and properly incorporated societies of translator owners co-operated to reduce interference effects and to regulate their establishment and operation. From that time on, wherever there was an adequate justification, whether the source was directly from a BCNZ transmitter or via another private trans-lator, translator stations were set up, and in a surprisingly short time, most of the sizeable concentrations of population located near the outer fringes of BCNZ coverage received a service. This was a continuing process; as BCNZ planned coverage expanded, so did the coverage of private translators beyond its fringes, though, at the same time, some of the earlier private translator coverage disappeared as it became absorbed into the coverage provided by new Corporation transmitters.

The presence of private translators in this way had both advantages and disadvantages for the BCNZ and for the viewing public. It must be conceded however, that for each it produced one overwhelming benefit. The viewing public was able to receive a television service, admittedly somewhat haphazard as to priority and effectiveness, years before the BCNZ could have provided one for them; for its part the BCNZ received additional licence fee and advertising revenue to that which it would have received on the basis of the extent of its own coverage. This enabled it to finance virtually the whole of first programme (TV-1) coverage out of income until the early 1970 period.

A "spin off" of the private translator era was the establishment, in New Zealand, of a tradition of co-operation between BCNZ engineering staff and groups of private citizens. This tradition is still continuing in the form of a type of translator station which serves a very small group of households, or conceivably, even one household, in very isolated localities, the establishment and operation of which is contributed to jointly, in appropriate ways, by BCNZ engineering staff and the viewers in the locality involved. In this way, New Zealand's ultimate percentage of viewers are given service to bring this country's television coverage to virtually 100 per cent of citizens.

VERY HIGH FREQUENCY, FREQUENCY MODULATED-VHF/FM-RADIO BROADCASTING

Unlike the densely populated areas of the world of equivalent, or greater, economic and social development, New Zealand as a country (and broadcasting planners included), has, up to relatively recent times, been unenthusiastic towards the establishment of VHF-FM sound radio services. One of the earliest by-products of this state of affairs was that the VHF band of 88 to 108 Megahertz which, in New Zealand, was allocated in ITU agreements to broadcasting and land mobile telecommunications services on a shared basis, was largely exploited for the latter. Only the section 90 to 94 Megahertz was left free entirely for broadcasting. This amount of spectrum is now seen to be quite inadequate - a classic example of why each generation of planners of the frequency spectrum must in future take a long term viewpoint.

The original lukewarm attitude to VHF-FM stemmed from these main factors:

1. The relative freedom, of earlier times, from day-time or night-time interference to our medium frequency radio services. The fact that they used such a low proportion of the total 100 or so channels available, resulted in channelling at spacings of 20 kilohertz or greater in most urban areas. This wide separation and relative freedom from, interference enabled high quality reception to be obtained.

2. In pre-television days there would have been a need to provide costly high altitude sites for the transmitters of a properly planned VHF-FM service and this made the extension of radio services by medium frequency cheaper and quicker, at that time, than by VHF-FM.

3. After 1960 and the advent of television, the combination of the massive national investment in monochrome television receivers and again (in the early 1970 period in colour television receivers), and the very heavy commitment of

the receiver manufacturing and servicing industry to television, made it impracticable to embark on VHF-FM receiver provision at that stage.

In recent times there has been a gradual but significant change in outlook towards VHF-FM broadcasting and this has arisen from the following considerations:

1. The widespread ownership of high-fidelity stereophonic music-playing equipment has led to a critical attitude among a significant proportion of the population towards the deficiencies in sound quality of the medium frequency radio services. It is fair to say that this attitude is as prevalent among the devotees of the pop music format of commercial radio as with listeners to the BCNZ's Concert Service. While the inherent quality of the medium frequency transmissions is not usually fully exploited in commonly used receiving apparatus, there can be no argument that VHF-FM broad-casting has significantly greater inherent potential for better quality audio-frequency reproduction, is inherently less vulnerable to man-made, atmospheric, galactic and receiver noise and is, to date, the only type of sound radio broadcasting which commonly permits stereophonic 'listening and which has proved capability for quadraphonic listening.

2. There has been a resurgence of interest in sound radio, including increased support for long-standing demands for the extension of many services countrywide which are at present limited to a few localities (e.g. the Concert Service). The inherent and increasing daytime to night-time disparity in the coverage area of medium frequency transmitters, described earlier in this paper, make its use less attractive now than it was previously for extension of such services.

3.The establishment by the BCNZ of its country-wide network of high altitude transmission sites for television, provided with full basic engineering facilities, will make it simple and relatively cheap to establish VHF-FM transmitters, either as a country-wide network or individual stations serving one particular locality. It should be noted that trans-mission facilities need not necessarily be entirely BCNZ owned and operated. There could be investment in this area from the private sector by way of bond issues or the hiring out of BCNZ Trans-mission Services to programme organisations or contractors.

The current planning for VHF-FM broadcasting is the responsibility of the FM Advisory Committee, which is required to provide a report and recommendations to the Minister of Broadcasting. To deal with techno-logical planning the Advisory Committee has an Engineering Sub-Committee which has already made considerable progress with its studies, including the issue of a draft document setting out the New Zealand FM System Characteristics for coverage planning purposes and comment by interested parties. At a later stage it is expected that the Standards Association of New Zealand will draw up a standard for VHF-FM receivers for use in this country, whether locally manufactured or imported. Also, the New Zealand Post Office is putting in hand the rechannelling at 12.5 kilohertz spacing of the land mobile services in the 88 to 108 Megahertz band to increase the allowable number of these services while at the same time making available sufficient spectrum for an adequate number of VHF-FM broadcasting services in the band.

The indications are that VHF-FM broadcasting in New Zealand will provide:

1. Countrywide coverage for some two or three programmes, plus one or two additional local programmes in the main population centres.
2. High quality stereophonic services.
3. In the long-term subsidiary carrier services (in addition to 2) to provide any supplementary services of proven value and feasibility that may be required. The planning "lead" in VHF-FM broadcasting is seen to be adequate, since, with the BCNZ preoccupation with the full countrywide development of TV-2 and the receiver manufacturer's preoccupation with the production of colour television receivers to some 100 per cent saturation, a lapse of some three years can be envisaged to the establishment of the first permanent VHF-FM services.

A pilot service for further planning investigation could precede that by (say) two years.

SATELLITE BROADCASTING

Satellite broadcasting, in being and proposed, takes two forms:

1. Distribution broadcasting satellite systems where television programmes are distributed from their point of origin via one or more geostationary satellites, to terrestrial television transmitters for broad-casting into the homes of the viewers.
2. Direct broadcasting satellite systems where television programmes are sent from the point of origin to a geostationary satellite which broadcasts them directly to the receivers in the homes of the viewers. The first category have been in use elsewhere in the world for some '15 years and New Zealand has been involved, bath as a recipient and contributor, for some 8 years. The satellites involved are the INTELSAT communications satellites normally used in conjunction with complex and expensive satellite earth stations for telecommunications and data traffic, but able, by arrangement, to be diverted partially to the passing of television transmissions. Radio programmes are treated similarly.

The INTELSAT system works internationally, but the principle of programme distribution in this way has been extended to distribution within a large country. The best known example is the Canadian ANIK system whereby the television and radio programmes of the Canadian Broadcasting Corporation are distributed country-wide to terrestrial transmitters for broad-cast to viewers and listeners. (The ANIK system also handles telecommunications and data.)
The only examples of the use of direct broadcasting satellites so far have been in reference to experimental ones. The best known one is the Indian SITE one year experiment in educational broadcasting of 1975. This used a NASA applications technology satellite (ATS-6) and the ultra-high frequency (UHF) band. However, over a period of some 10 years there has been intense study of the technology of direct broadcasting satellite systems. New Zealand has participated in this work through the Engineering Committee of the Common-wealth Broadcasting Association, the Engineering Study Groups and the Engineering Committee of the Asia-Pacific Broadcasting Union, the Study Groups of the Radio Consultative Committee of the International Tele-communications Union and the Satellite World Administrative Radio Conferences of the International Telecommunications Union of 1971 and 1977.

The 1977 ITU World Administrative Radio Conference on Satellite Broadcasting could be described as the culmination of this prodigious study exercise, and it resulted in world-wide agreement on system parameters for direct Broadcasting satellite systems in the 12 Gigahertz frequency band and the allocation of satellite orbital positions and frequency assignments for the nations of Europe, Africa, Asia and Oceania (but, for reasons which need not be considered here, not for those nations of North and South America).

The New Zealand delegates consider that the plan finally approved at the Conference was a success from the New Zealand point of view. It provides for four direct broadcasting satellite television programmes for New Zealand (including the Chatham Islands) or alternatively, a combination-say three to one-of television programmes and groups of stereophonic sound radio programmes. Some of the orbital positions and channel allocations for New Zealand, Papua-New Guinea and Australia have been co-ordinated in such a way that an interim, lower-power, shared system can be considered.

Direct satellite broadcasting can now move into the phase of implementation in the areas of the world for which agreement was reached at this Conference, and in anticipation of this, experimental systems are contemplated (and may already have been implemented in some cases) for Europe and Japan. Some permanent systems are expected to be in operation as early as 1981. Costs of up to one hundred million dollars American in current values per programme are predicted for a satellite life of 7 to 10 years, after which further expenditure for the space segment must be met. In addition, each country will have to meet the cost per household of a receiving installation involving typically a one metre parabolic antenna and frequency converter for use in conjunction with a standard television receiver; this cost is expected to approximate half that of a standard colour television receiver on today's values.

New Zealand, of course, has no immediate requirement for a direct broadcasting satellite system, even if it were conceivable that she could meet the cost involved. But like most of the countries at the Conference, she had to participate to ensure that her future interests in spectrum and orbital position allocations were safeguarded. But it is a matter for some pride that she had positive contributions to make. One New Zealand delegate chaired one of the main Conference committees while another chaired an important working party of the Conference. In addition, a rapid cover-age plotting programme devised by the BCNZ, used in conjunction with an engineering calculator, provided a powerful aid to the Working Parties which handled channelling and coverage planning detail, the most difficult work of the Conference.

CONCLUSION

When I named this lecture "A New Zealand Perspective on Broadcasting Technology", I must confess I did not clearly perceive the immense scope of my subject and the impossibility of adequately treating, in a paper of this length, all the topics it encompasses. I quickly found that I had to make the choice, either to compress all topics to a degree that would render them sterile of interest, or to omit a high proportion of them. i chose the latter course, and in doing so, have concentrated in the lecture on the technology of broad-casting transmission systems with which the engineers have had to grapple over the years, since their success or otherwise in manipulating the techniques involved, in the New Zealand context, are what ultimately matters most to the listener or viewer.

In simple terms, the worst radio or television programme is the one the public, because of technical shortcomings, cannot hear or see at all, and every step upward from that point, brings that listener or viewer closer to the stage where he or she is interested only in the programme content and takes the technology entirely for granted.

But there are other topics with which I have not had time to deal, those of broadcasting hardware development technology and of hardware and systems operation and control technology, the New Zealand perspective of which make them subjects of absorbing interest. At this stage I cannot do more than suggest that these could well be the subject of a future NELCON paper.