The Development of Wireless Technology in Australia

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SUMMARY: The development of wireless technology in Australia has been driven by necessity. Meeting the need to communicate with scattered populations over vast distances whether to extend a mantle of safety, to rally spirits in times of crisis or simply to unite us and give identity to what is truly Australian, wireless technology has played a vital role in the nation's heritage.

1. COMMUNICATING IN THE BEGINNING

By the mid nineteenth century, Australia was an agricultural producer beginning to be impacted by industrialization. The appearance of the railway and the telegraph, and the discovery of gold were almost coincident in Australia. When the Suez Canal was opened in 1869, the voyage from England to Australia was greatly reduced but Mother England was still five or six weeks away by mail and doing business with Australia still demanded a three month's cycle. It would be late in the century before all of Australia could communicate with the rest of the world by telegraph but the labour intensive nature of that technology and the high capital cost of laying undersea cables reflected in relatively high operating costs when compared to 'the post'.

In 1886 in Germany, Heinrick Rudolph Hertz demonstrated the existence of the electromagnetic waves that Briton, James Clerk Maxwell had predicted some twenty years earlier and in Italy, thirteen year old Guglielmo Marconi was beginning to experiment with electricity.

Marconi was to foresee the commercial potential of 'telegraphy without wires' but in 1895 when his overtures to the Italian Government fell on deaf ears, he took his ideas to England. It is worth reflecting on the experiments he conducted on Salisbury Plain in 1896 to gain an appreciation of the engineering challenge. Marconi's first transmitters generated very long electromagnetic waves. The efficient transfer of energy in radio frequency circuits was not well understood and large amounts of energy were wasted for relatively little radiation. Considering the insensitivity of his receivers and that he had only a cursory understanding of why electromagnetic energy caused the metal particles in his detector to 'cohere' or clump together, that Marconi managed to receive any messages at all in his early experiments is remarkable.

Fortunately for Marconi, other scientists including Professor Sir John Fleming eventually worked with him as advisors when he established The Marconi Wireless Telegraph Company Limited and opened a factory at Chelmsford not far from London.

As a new century dawned, the notion of an Empire-wide communications scheme began to ferment. Spark transmitters were beginning to be used on larger ships enabling them to communicate with coastal stations at frequencies around 500 kHz. Many kilowatts of energy were required but ranges of about 400 nautical miles (nearly 750 km) during the day and thousands of nautical miles by night raised great interest. The obvious potential for wireless to increase safety at sea was particularly pertinent to Australia, an island nation so isolated by distance.

By about 1903, some curious Australians were experimenting with wireless communication. Among them were two Roman Catholic priests, Father Joseph Slattery, a science teacher and Father Archibald Shaw. Father Shaw entered into a joint venture with a family of his parishioners to establish a factory in Randwick that helped to fund his Catholic Mission by producing marine wireless sets to Shaw's design. In its heyday, Shaw's factory employed more than a hundred and fifty people.

By 1905, with wireless technology now an imperative, the Australian Government passed the Wireless Telegraphy Act to bring some order to its development. The Post Master General's Department, with exclusive rights to transmit messages and issue wireless licences, committed £10,000 for the establishment of two coastal wireless stations, one to serve the Pacific Ocean Region from Pennant Hills near Sydney and the other to be sited at Applecross near Perth for the Indian Ocean region.

2. MARCONI'S MAN IN AUSTRALIA

At The Marconi Company in Britain, Managing Director Godfrey Isaacs was making it his business to eliminate any potential competitors. His key strategy was litigation against anyone infringing Marconi's patents. In 1911, the ambitious and enterprising Ernest Fisk settled in Australia as Marconi's representative. Fisk had been trained as a ship's wireless operator by The Marconi School of Wireless in Britain and had visited Australia on previous voyages. Prime Minister Andrew Fisher's 'Buy Australian' policy had resulted in Father Shaw's company being awarded the contract for supply of the next seventeen coastal wireless stations. Fisk joined forces with Telefunken's Australian

representatives to proceed against Shaw's company on the basis of patent infringements. The influence of Shaw's friend, Labor Senator James Long, provided the Crown Solicitor to defend Shaw's company and a promise to compensate Shaw and pay his costs if he lost the case. In a masterstroke, Fisk withdrew all Court actions, absorbed the Telefunken agency 'Australian Wireless' and set up a new company with The Australian Government as a partner and himself as General Manager. The new company Amalgamated Wireless (Australasia) Limited, 'AWA' acquired all of the pertinent intellectual property and rights for wireless technology from Marconi and Telefunken and developed them for Australia and New Zealand.

With the pronouncement of war in 1914, the Australian Navy assumed control of all wireless activity. It was a time of political turmoil. Australian losses at Gallipoli in April 1915 shocked a nation divided on the issue of military conscription. Following a double dissolution of the parliament and a split in the Labor party, William Morris Hughes emerged as Prime Minister in October heading a new 'Nationalist Party' Government. Ernest Fisk's position in Australian wireless circles was, by then, well established and his relationship with Prime Minister Hughes strengthened.

Through Fisk and AWA, The Marconi Company had promoted the concept of a long range, single hub wireless network to link Britain to her Empire rather than a more vulnerable series of daisy-chained relay stations. On the 22nd of September 1918 with the war all but over, Fisk's concept gained credibility when Prime Minister Hughes and Minister for the Navy Sir Joseph Cook, in Britain to boost morale, sent historic radio telegraph messages back to Australia from Marconi's high-powered station near Caernarvon in Wales. The signals were received by Ernest Fisk at his residence in Wharoonga north of Sydney. Much was made of the instantaneous nature of the communication and Ernest Fisk and AWA were now being heard by both sides of the parliament but Fisk also envisaged freedom for Australian voices to be heard on the air across the nation and throughout the Empire.

3. THE FIRST BROADCASTS

In 1919, Ernest Fisk provided a convincing demonstration of AWA's broadcasting capacity to The Royal Society of New South Wales. Amongst other items, a gramophone recording of God Save The King was played via a transmitter located at AWA's office and was heard with great acclaim at a gathering at the Society's headquarters across town. By January 1921, AWA was providing demonstration programs in Sydney and Melbourne. The broadcasts featured musical items performed live to the microphone. Gramophone records were sometimes presented but, in the absence of any other electronic means, the acoustic horn of a 'wind-up gramophone' was simply placed within ear-shot of the microphone.

When Prime Minister Billy Hughes again visited Great Britain for the Imperial Conference late in 1921, communication across the Empire was on his agenda and he took Ernest Fisk with him as adviser on wireless development. By the time they returned, we might say that Britain and Australia were 'on the same wavelength' and the future of AWA and wireless-technology was clear. An Australian Parliamentary Select Committee recommended that the Government should acquire the majority shareholding in AWA and that the company should build and maintain wireless stations that could provide direct commercial services across the Empire. The Parliamentary Committee also recommended that AWA be directed to take over the existing Australian coastal wireless stations. The new Empire services were to operate in the short-wave band where Marconi's research had shown less radiated power and directional antennas could provide the same range as the old high powered low-frequency stations.

Marconi company publicity in the nineteen twenties hinted at exclusive technology that would provide point to point transmission with "previously unused waves which eliminate atmospheric disturbances". It seems likely that Marconi was aware of studies into modulation that were being undertaken by mathematician John Renshaw Carson in the United States at that time. One of Carson's published studies was aimed at eliminating the static that detracted from wireless services. Carson concluded that a system of Frequency Modulation would be unimpaired by amplitude disturbances but was not suitable because it would theoretically introduce unacceptable distortion in telephone circuits. Fortunately for the broadcasting industry, another, perhaps more practical American, Howard Armstrong, persevered and developed the 'FM' system that has become the preferred modulation scheme in analogue radio, television and communications sets.

In 1923, AWA's supporter Billy Hughes was replaced by Nationalist Party Prime Minister Stanley Bruce who went to the Imperial Conference in October with an 'Empire Trade Policy' that called for "men, money and markets". The need to develop communications systems that distributed news and information and brought Australians in the regions closer to their city cousins was becoming more important and broadcasting clearly had a major role to play. The new Government, however was not convinced that AWA should have a monopoly in the new medium. Post Master General William Gibson held a conference in May 1923 to formulate a regulated system for broadcasting in Australia at which Ernest Fisk's powers of persuasion again came to the fore. Fisk's presentation simply left others at the meeting with relatively little to offer. The outcome was Australia's first foray into subscription broadcasting.

4. THE SEALED SET SYSTEM

Fisk proposed, and the Government duly accepted, that a limited number of broadcasting stations should be licensed to operate on specific frequencies. Receivers could be purchased that would be pre-tuned to those frequencies and then sealed. Consumers required a listener's licence from the PMG costing 10 shillings if they were equipped to receive one station or £1 if they were equipped to receive two or more. An additional subscription fee collected by each broadcasting licensee went towards their costs of programming, operating and maintaining the stations. The perils of competition in a relatively small market can be seen in the commencement of the first two authorized broadcasting stations in Sydney in November and December 1923. Broadcasters (Sydney) Limited (2BL) set up specifically for the new industry, set its subscription fee at 10 shillings. Department store operator Farmer and Company (2FC) weighed-in at a hefty 3 Guineas (£3-3-0). Farmer and Company were also in the business of selling wireless sets and AWA was in the business of manufacturing a range of receivers to meet the expected demand. It was far from overwhelming. In 1924 when the basic wage was £1-10-0 for a 51 hour week, a crystal set could be purchased for £1-5-0. AWA offered a one valve 'Radiola' for 15 Guineas (or ten and a half week's wages). David Jones stores offered a top of the range receiver for £45, or £4-10-0 down and 17s 3d a week. Alternatively, an economy model could be purchased for £25 (half a year's wages for ordinary people).

Enthusiasts were able to construct a set of their own for a fraction of the cost of production-models and they could 'tune-in' to all the available stations. By mid 1924, 2FC had only managed to attract about 1,200 subscribers although there were probably considerably more 'pirates' listening in. It was obvious that listeners wanted all stations or nothing and there was growing discontent from other potential broadcasters wanting to be heard. The sealed-set scheme was abandoned.

5. TWO CLASSES OF LICENCE

Government regulations from July 1924 established a 'two licence scheme' for broadcasters. Stations operating under 'A-Class licences' received a proportion of listener-licence fees. 'B-Class' licensees had to rely entirely on advertising revenue or other sponsorship for their incomes. Some of the successful B-licensees had previously been amateur broadcasters with established audiences but many applicants were the progenies of the music industry, equipment retailers or public interest groups such as churches and trade unions.

PMG Licences cost 35 shillings a year for listeners living up to 200 miles (320 kilometres) from the city. The fee was reduced to 30s for listeners up to 400 miles distant and 25s beyond that because it was recognized that the received signal would be variable and of generally lower quality at remote locations. By the end of 1924, 38,000 listener licences had been issued and that number had doubled by the end of 1925. A year later, licence numbers had swelled to 190,000. There were still some 'pirates' who enjoyed the benefits of the new medium without paying the fee. This raised the ire of other listeners, some of whom were likely to 'dob the pirates in'. The giveaway was the long-wire antenna that was necessary for good reception. A 'Ducon adaptor', however, provided a means of joining the receiver's antenna terminal to the power-line to make use of the overhead wires as an aerial. One historian notes that in Western Australia in 1925, the official number of listener-licences had reached 1,200 but the known sales of Ducon adaptors had exceeded 4,000.

A Royal Commission into wireless broadcasting commenced in January 1927. It was driven by the discontent of some aspiring broadcast licensees and the Government's concern about the lack of regional broadcasting services. Although there were nearly a quarter of a million licensed receivers in Australia, the B-licensed broadcasters were struggling financially and the A-licensees were not doing particularly well. By October, the Royal Commission had concluded that the A-licensees should pool their funds so that they could extend their services to regional areas. The A-licensees considered that they were already meeting their obligations and that unprofitable regional services were really the Government's responsibility. As Prime Minister Bruce's tenure neared its end, the Nationalist Party Government announced that it intended to progressively acquire all of the A-stations as their 5-year licences expired and establish a National Broadcasting Service. The PMG would operate the technical facilities for the Government and a contract would be let for the supply of programs. The successful programming tenderer was The Australian Broadcasting Company, a conglomerate of entertainment companies, two theatre operators and a music distributor.

In October 1929, Labor won the Federal election, and James Scullin became Australia's Prime Minister. Within days the collapse of the New York Stock Exchange sent shock-waves around the world. The money supply for capital works dwindled, loans were called in and a large part of the population was thrown out of work as Australia entered 'The Great Depression'.

6. RADIO'S GOLDEN AGE

The nineteen thirties have sometimes been described as the beginning of the Golden-Age of radio because Australians in the Great Depression came to rely on broadcasting as the mainstay of their entertainment. It was certainly a decade of discovery for engineers and technicians as radio station installations were refined and conventional approaches to common problems emerged.

There was a perception among consumers that the Australian Broadcasting Company was making huge profits while producing generally unsatisfactory programming. In fact, the Government retained ninety percent of any surplus. Before the company's contract expired in June 1932, the Government stepped in and in July, an Act of Parliament created the Australian Broadcasting Commission with its charter proclaimed by Prime Minister Joe Lyons;

"To provide a national service of integrity and which will provide entertainment, information and culture and to satisfy the diversified tastes of the public".

The ABC gradually assumed the remaining A-licensed stations but several years were to pass before new key regional medium-wave transmitters would begin to be added to its network. In 1934, however, short wave services to the outback and remote areas were added.

There had been substantial steps forward in technology since wireless's humble beginnings broadcasting music from wind-up gramophones. By the nineteen thirties, parallel developments in radio and 'talking-pictures' had provided a vast improvement in the fidelity of the audio in broadcasting. A better understanding of electro-magneto-mechanics had given rise to electrically powered turntables, 'moving iron' and 'moving coil' pickups and pressure and velocity conscious microphones. Cutting lathes enabled 'acetate' recordings to be made on aluminium discs coated with cellulose nitrate. In Australia, the PMG's Department had a significant standardizing influence. The National carrier provided the technology enabling programs to be relayed via land-lines with repeater amplifiers at telephone exchanges. AWA led the way in producing audio mixing consoles and affordable transmitters. Receiving valves became smaller and transmitting tubes became larger. It was possible to power wireless sets in motorcars and AWA was testing equipment operating in the Very High Frequency band. Howard Armstrong, a professor at Columbia University had perfected Frequency Modulation for broadcasting in 1933 but, for the time being, it remained in the theoretical domain as far as Australia was concerned.

One of the music-store broadcasting aspirants in Perth during the depression was Nicholson's Limited. Their station 6PR came on the air in October 1931. 6PR was what we would, today, call a 'turn key installation'. It was built and operated by AWA. Since AWA also operated the Applecross Wireless Station under contract to the Government at that time, 6PR's transmitter was also located at Wireless Hill. Nicholson's Limited was, doubtless, by then selling The 'Baby Astor' receiver that did not require an outside antenna or an earth connection. Its price tag at just about half the cost of previously medium-priced sets must have pleased the Government who had come to rely on broadcasting as a dependable connection to its public.

Live broadcasts of sport had been eagerly embraced by Australians from the inception of radio services. 1933 was the year that the 'body-line controversy' erupted and it is estimated that interest in cricket in the 1930s sold about £2 million worth of domestic wireless sets.

7. SPECTRUM ISSUES

Control of available frequencies occupied much of the Post Master General's attention in the thirties as new licence applications were received for more commercial stations. There were some innovative approaches to spectrum management by some licensees to maximize their revenue earning opportunities. One, Frank "Poppa" Whitford was already in the entertainment business manufacturing cinema advertising slides when he gained a licence to broadcast to the farming district surrounding Northam about 100 km to the east of Perth. Legend has it that the Northam station's long-wire antenna, strung between two free standing towers was oriented so that, at its operating frequency, 980 kHz, its signal could be heard loud and clear in the mornings, not only in Northam but also in Perth. The call-sign of the station was 6AM. It was another three years before Whitford was able to gain a licence in metropolitan Perth. His new station was sited near Fremantle but its antenna beamed back to Perth and all points east. The station's range increased with nightfall and its call-sign was 6PM.

8. WORLD WAR 2

The Second World War was a catalyst for rapid development of wireless technology. The super-hetrodyne receiver became established, radio transceivers, for aviation became lighter and more reliable, radar was developed and more versatile forms of plastic emerged. The broadcasters' biggest challenge during the war was staffing. A contingent of PMG technicians was 'manpowered' to fight their war in Australia and ensure that the national broadcasting stations were always available to provide the Government public communication. John Curtin became Australia's Prime Minister for the duration of the war and in 1942, a Department of Post War Reconstruction was commissioned under Doctor H.C. 'Nugget' Coombs.

After the war, Australia enjoyed an economic resurgence. Again, there was a flood of immigrants from Europe and the Golden Age of radio broadcasting peaked as the industry became part of the indoctrination process for those 'New-Australians'. The National broadcaster expanded with an increase in the numbers of regional transmitters and the introduction of special programs for farmers. There was renewed interest by newspaper groups and others in establishing commercial radio stations in country areas which was generally encouraged by the Government.

Before the war, Ernest Fisk had declared;
"Television is coming but it will be years before it reaches the stage when a public service can be rendered."
In 1949, Labor Prime Minister Ben Chifley called for;
"A national television system as soon as possible".

9. TELEVISION FOR AUSTRALIA

Robert Menzie's Liberal Party was returned to Government in December 1949 and his more conservative approach aligned with the general concern of church leaders and others expressed to a Parliamentary Committee considering television as early as 1942 that the new medium might threaten the integrity of the family unit. The influence of American cinema on Australian culture was recognized and the use of Australian actors mimicking American accents recreating American scripts to supplement the content for Australian radio while remaining within Australian production quotas had not gone unnoticed. The Government had already established the Australian Broadcasting Control Board to oversee the performance of commercial broadcasters. The ABC was exempt from Control Board regulation provided that it stayed within its charter which included nurturing Australian culture. A characteristic that distinguishes the Australian broadcasting industry is its philosophy that all citizens should expect a 'full and comprehensive' range of broadcasting services. In contemplating television at its inception, The Labor Government had favored a national network but in the nineteen fifties, the Liberal Government was under some pressure to take a more commercial view. Sir Ernest Fisk's powers of persuasion again came to the fore. Fisk now argued that if commercial television were to succeed, it would have to reflect society and it followed, said Fisk, that if the medium were reflecting society then it could not be harming society. For the time being, however, there were many other capital projects considered more essential to Australia's growth and the Government was able to delay further debate about television on economic grounds.

The prospect of television was also perceived as a threat by commercial radio, and cinema proprietors. Commercial Radio's approach in seeking a competitive edge was to turn to improved technology. Soon, with the development of the transistor, radio would be able to 'go anywhere', even on the tractors and harvesters in regional Australia. 'Wirelesses' were becoming more common in cars. 'FM radio' was still under consideration but its introduction was deferred because Government was wary of television's future requirement for radio frequencies.

In Britain, a practical electronic 405 line television system was up and running. Sound and picture were both amplitude modulated and radiated on separate carriers. Suitable antennas to operate at about 45 MHz were large and cumbersome. Receivers were complex and temperamental. It was soon realized that for conservation of radio-spectrum, an amplitude modulated vision carrier with one sideband suppressed, augmented by a Frequency Modulated sound carrier was a more practical approach.

Television designers chose scanning schemes that related to the electricity supply frequency in each region to reduce picture flicker and assist synchronization but there were different supply frequencies in different parts of the world. The 525 line system that meshed with the 60 Hz mains supply used by the US was already in conflict with the 24 frames per second projection rate used in the cinema. In Australia immediately after World War Two, some States had '40 cycle' and '50 cycle' (40 Hz and 50 Hz) power and some regions still relied on Direct Current supplies from local authorities. Resolving those issues and considering appropriate standards caused further delays.

In 1953, the Menzies Government finally bowed to commercial pressure and held a Royal Commission into television. ABC Chairman Sir Richard Boyer argued that only the National Broadcaster could manage the best cultural interests of Australia. Commercial interests, mostly the newspaper and magazine publishing houses argued strenuously for free choice. By the end of the year, The Royal Commission had recommended that The Broadcasting Act be amended to include commercial television stations and that the Post Master General oversee licensing arrangements following suitable hearings to determine that the successful promoters were 'fit and proper persons' to hold licences. There were to be two commercial television stations and one ABC station licensed in Sydney and in Melbourne and their target on-air date was November 1956 to coincide with the Melbourne Olympic Games. It transpired that five of the six stations were established in time for The Olympics and there was a full complement on the air by January 1957. Their licences were issued for five years from December 1955.

The training of technicians was a major issue when television began in Australia. Radio servicemen had to be converted in anticipation of the new technology and a new industry evolved for the installation of television aerials. The broadcasters had not only to build their stations but also maintain them to Commonwealth specifications. Certificates of Proficiency awarded after rigorous examination by the PMG were already in place for amateur operators, broadcast radio station and ship's radio operators. A Television Operator's Certificate of Proficiency was soon in place under the auspices of the Australian Broadcasting Control Board. The Control Board exams were considered onerous by all but the more engineering oriented staff and the 'TV-Ops' became the standard qualification for television broadcasting technicians and remained so until the

industry became more de-regulated in the nineteen eighties.

With the minimum wage at £7-1-0 for forty seven hours work per week in 1956, the first Australian television receivers cost the equivalent of six to ten week's wages and consequently, when the first stations came on the air, there were only about 5,000 sets tuned in. In the first year of operation, penetration of television sets rose from one percent to twelve percent of population in Sydney. In Melbourne the figures were more encouraging, rising from five percent to about twenty six percent. In some regional centres that were just out of range of the capital city transmitters, antenna companies sold thousands of 'phased array' aerials made of stacked elements connected to greatly increase their sensitivity in the direction of the stations. In cities like Bunbury, stacked antennas on tall guyed poles gave those centres a distinctive appearance.

At the transmitter end of the business, a common approach was to employ a pair of AWA or Marconi 5 kW transmitters in parallel feeding a multi element transmission antenna with a power-gain of 10 times. Interestingly, the original transmission antennas at Channel 7 in Townsville and Channel 9 in Perth were supplied by AWA but based on a design by Telefunken. They featured an arrangement of phased feeder cables to provide a slight downward tilt of the radiated beam to optimize their service-area.

9. SPACE - THE NEXT FRONTIER

Australia, had been growing closer to the United States since World War Two. America was still wary of the threat of communism and was determined to beat the Soviet Union in 'the space-race'. The Russians had successfully launched their 'Sputnik' in 1957. The 'point to multipoint' concept of satellites broadcasting from way out in space to millions on earth captured the world's imagination and radio enthusiasts everywhere eavesdropped on Sputnik's pulsing signal. The idea of an orbiting 'geo-stationary' radio-relay platform was compelling but first, America had to recruit allies. In February 1960, Australia joined a consortium of fourteen countries with the objective of circling the globe with satellite ground-stations by 1968. In 1966, nearly 50 years after Prime Minister Hughes sent the first international telegram to Australia from Caernarvon in Wales, the ground station at Carnarvon in Western Australia delivered its first international television pictures.

The need to carry more and more information gave rise to the technique of 'frequency division multiplexing' where a great number of radio frequency signals or 'sub-carriers' could be modulated onto a microwave beam or transmitted along a coaxial cable. With that technology, a large number of telephone channels of typically 3 kHz bandwidth could be grouped to provide a 5 MHz television 'bearer'. Multi-hop microwave services with their radio energy magnified by parabolic reflectors created bi-directional point to point links

around the nation. Wireless technology had also extended to the television studios where radio frequency energy was being used to record television pictures as a Frequency Modulated signal onto 2 inch wide magnetic tape. Television stations across the nation and around the world were able to network together and share programs. Important events could be transmitted instantaneously or saved on tape and re-broadcast to suit the audiences in each time zone.

The world knew a lot more about wireless in 1968 than Marconi knew in 1918 but the technical challenges were equally daunting. Microwave signals, even focused by huge parabolic reflectors were miniscule when they arrived from space. So small in fact that the intelligence they conveyed could be lost amongst the thermal activity of the electronic circuitry. Special low noise amplifiers had to be developed. Raising the transmission power on the spacecraft was not an option because its power supply was limited. Ground-stations had to be able to tune to a beacon from the satellite and use its information to drive the antenna to mechanically track the spacecraft when it was moving. Considering that an angle of one degree subtends one kilometer in every sixty kilometres distance, staying focused on an antenna on a satellite about the size of a motorcar over three thousand kilometers away requires remarkable engineering in many disciplines. Australian engineers had much to learn during the advent of satellite broadcasting. Now we talked about 'gain-budgets' and 'dispersal' as we milked the last jot of energy from system designs.

In 1969 another ground station was established at Ceduna. Although these facilities were connected with NASA and the space-race, they started carrying international telephone traffic almost immediately. With a man on the moon, it seemed that the sky was no longer the limit for broadcasters. News services and major events were flashed 'live' around the world. It was said that 'London was more accessible than Longreach', albeit sometimes plagued by propagation delays. The satellite operators took some time to acquaint themselves with the nuances of television-broadcasting and in the early seventies in Perth, depending on the density of the traffic on the network and the circuit availability on the ground, it was not unusual to get the pictures for an international event via Carnarvon and the accompanying sound from Ceduna. The difference in propagation delay sometimes caused annoying 'lip-synch' problems that precipitated a deluge of 'phone calls to television stations to inquire whether the discrepancy had been noticed by the engineers (who were usually frantically diverting the audio signal onto and off a tape recorder to synchronize its arrival at the transmitter with the accompanying pictures).

10. NEW TELEVISION TECHNOLOGY

During the sixties, the broadcasters had been seriously debating the merits of several available colour television systems. In 1968, they recommended the German Phase Alternating Lines ('PAL') system. Debate continued about the viability of moving away from black and white television until 1972 when a target date of March 1975 was finally determined. Colour television meant a total rebuild of studio equipment and outside broadcast units but some of the greatest challenges lay in the wireless area where microwave links, transmitters and aerials came under scrutiny because the energy bandwidth and phase relationship demands of colour signals were considerably more stringent to accommodate the additional 4.43 MHz superimposed signal that was modulated with the colour information. Again, the take up of receivers was slow in the beginning due to the relatively high cost of a largely imported product base but Australians soon embraced the advantages of the colour services.

Stereo sound, satellite 'direct to the home' delivery and subscription-television followed in quick succession, each with its unique technical challenges but by far the greatest wireless challenges were bandwidth, and spectrum to contain it. World bodies continue to argue spectrum issues and to shuffle services to meet the demands of the military, a myriad of different forms of broadcasting and the expectations of data service providers and mobile telephone users as technology and commercial potential balloon exponentially.

Broadcasters were quick to adopt the Aussat satellite when it was launched in the mid eighties. From a satellite's point of view, vast distances on the earth's surface become negligible and a satellite's wireless footprint can easily cover the Australian outback to deliver television broadcasting. The Homestead and Community Broadcast Satellite Service, 'HACBSS' was welcomed by remote viewers and the Australian Government began subsidising the rollout of receivers and satellite dishes. For terrestrial services, The Government promoted an 'equalization and aggregation' policy that mandated the sharing of audiences in the more populated country areas to ensure that, as far as possible, all Australians had the choice of the national television service and at least two commercial channels. Wireless links by microwave radio, and satellite relays provide much of the infrastructure to deliver those services.

11. THE DIGITAL REVOLUTION

On the first of January 2001 all capital city stations in Australia officially commenced digital terrestrial television broadcasting. Again, the change necessitated a refit of studios and transmitting stations at enormous cost to the broadcasters. The revolution had, in fact, been progressing quietly for a decade as the industry found digital answers for analogue problems. A convergence of technologies has resulted in a common platform for sound, picture, information and data. All the components of a broadcast are interchanged in digital file formats that lend themselves easily to efficient storage and convenient conversion from medium to medium. To provide an affordable transition for consumers, Australian regulators required the broadcasters to 'simulcast' their services in digital and analogue mode. At the time of writing, simulcasting amounts to producing content in digital formats and processing it through the television stations in digital form. A digital to analogue conversion at the end of the chain provides the analogue transmitter input. The digital transmitters broadcast the digital files in packet form.

To affect a gradual conversion to a fully digital service, the Government provided a spare, channel in VHF band 3 for each existing broadcaster so that the analogue and digital signals could co-exist. This initially drew claims of "a digital free-kick" from other contenders seeking to re-use the spare spectrum and the Government has found itself juggling the best interests of all consumers against its imperative to nurture and grow the new technology. Penetration of digital receivers (which were initially all standard-definition set-top-boxes) was slow due to cost. The starting price of $800 represented more than a week's wages for average Australians. At the same time, DVD players were becoming available at less than half that price and were tumbling at a greater rate but as stocks of set-top-boxes became more available and prices dropped to match that of DVD players, antenna installers began a brisk trade using the digital receivers to easily overcome analogue reception problems and produce noticeably improved pictures and sound. That phenomenon is not unlike the nineteen thirties emergence of 'mantle radios' that were more affordable and freed listeners of the burden of a long wire antenna and an earth connection.

As we look to a future where almost every Australian carries a personal wireless set capable of conveying voices, images and information in a world where distance is no longer an impediment to communication, we might reflect on the words of former Prime Minister Billy Hughes spoken at a 1935 ceremony commemorating his landmark, first wireless telegram from England to Australia at the end of World War One;

"Wireless is a miracle……..an achievement of man most likely to influence his life and future."

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