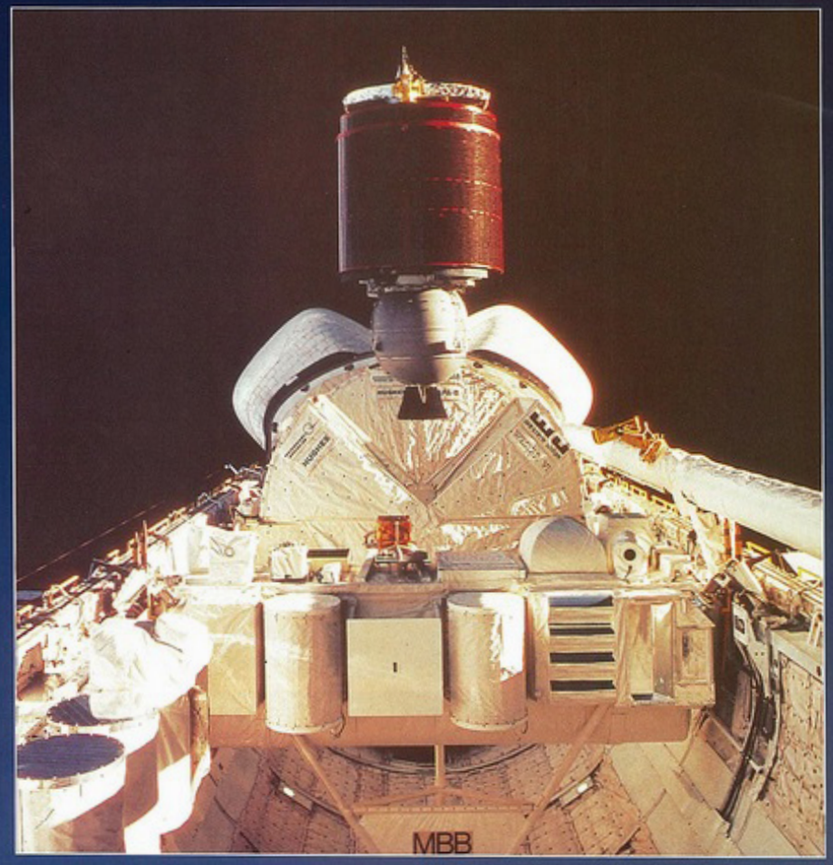


When AUSSAT K1 floated out of the Space Shuttle's cargo bay it not only heralded the beginning of one of the world's most advanced satellite systems but it signalled a potential change in the lives of 350,000 isolated Australians.

Above: *A communications satellite emerges from its cocoon in the cargo bay of the Space Shuttle to begin its life in space.*

Left: *Satellite command antenna, Belrose, NSW.*

AUSSAT

TEXT BY LAWRENCE DURRANT AND DICK SMITH
ILLUSTRATIONS BY DAN ESCOTT

GOD KNOWS our family has done all right without TV up to now," said Mrs Jano Faulkes-Taylor. "We'll just have to wait and see what changes it makes and how much discipline we have to impose on its use."

Mrs Faulkes-Taylor, from Yuin Station near Yalgoo, Western Australia, has raised her children in one of the most media-isolated areas of Australia; a place where television has, until now, been a dream, something that only city kids understood. The Faulkes-Taylor family is part of an estimated 350,000 Australians who, until the introduction of AUSSAT, were beyond the reach of either radio or television.

Now, for a total outlay of between $2000 and $3000, families like the Faulkes-Taylors can enjoy what the rest of us just take for granted: our links with the rest of the world.

Described by AUSSAT general manager Graham Gosewinckel as "the biggest development in Australian communications since the completion of the Overland Telegraph", the introduction of the new satellite technology will have a profound effect on all Australians, and put us, as a country, at the leading edge of the application of space technology.

When it was completed in 1872 the Overland Telegraph linked Australia's northern and southern coasts by telegraph wire, making it possible for people in the southern and eastern colonies to exchange telegrams with people overseas, via the world cable system.

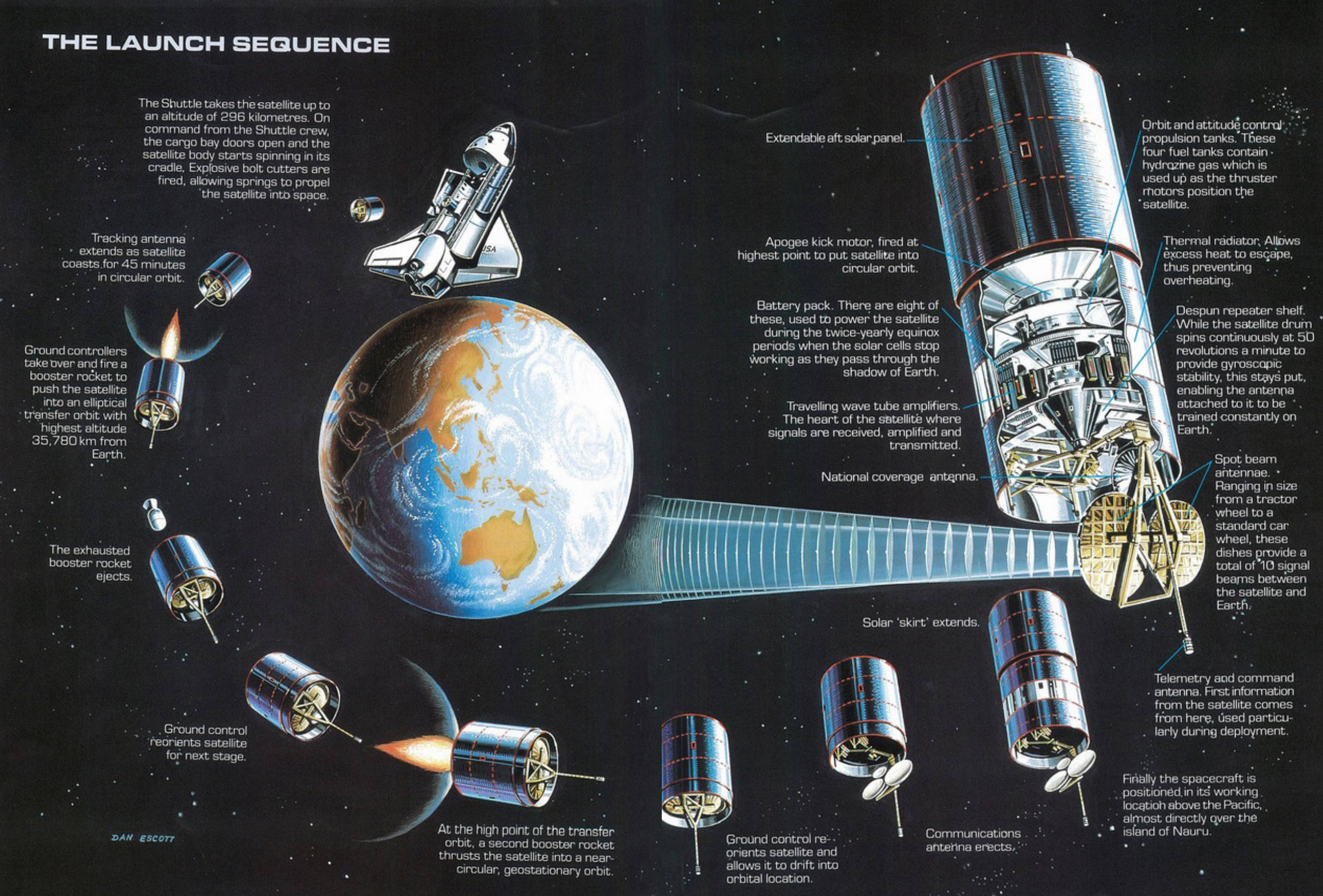
To put it simply, the satellite is a replacement for a very high mast. The radio waves used to transmit television and similar signals will only travel in a straight line, so even the highest mast will have a limited range because of the curvature of Earth. In a satellite system, signals are sent from the ground to the satellite, amplified and then transmitted back to Earth by directional aerials which cover a particular area, called the 'footprint'.

There are no microwave towers or thousands of kilometres of underground cable in this system, thus the cost of using satellite circuits is not affected by on-ground distance or the nature of the terrain.

However, remote country folk are not jumping for joy just yet. Rather, there is a 'wait-and-see' attitude in many homesteads and communities. The escalating price of satellite receivers and a lack of understanding about the capabilities of the system have combined to create a certain wariness. The lack of understanding can probably be put down to a comparison with satellite television in the USA, where receivers cost around $1000 and can bring up to 180 television stations into the home – in Australia, receivers cost between $2000 and $3000 and offer only one or two TV stations. Furthermore, a great number of remote area people already have television receivers and video recorders, so 'media shock' will in fact mean nothing more than the difference between recorded television and live television.

"I can honestly say I've never missed having television," said Mrs Faulkes-Taylor, a federal vice-president of the Isolated Children's Parents Association and her State's spokesperson on communications. "And frankly, I don't know if our family is ready for *A Country Practice* twice a week!"

THE LAUNCH SEQUENCE



Satellites and Earth Stations

AUSSAT K1 is a barrel of electronics wizardry about the size of a cement truck. It whirls through space at 11,124 km an hour, its equipment tirelessly slaving away. Its sister satellite, K2, does the same thing some 6000 km away. They glide across the sky side-by-side like a celestial Torvill and Dean.

The AUSSAT twins will be joined by yet another satellite later this year, to complete the first generation of AUSSAT satellites which are expected to be in use until the 1990s. Built in Los Angeles to Australian specifications, the first two were launched at Cape Canaveral, Florida, while K3 will depart from Kourou, French Guiana, aboard France's ARIANE rocket.

From the moment they are launched into space and put into a geostationary orbit above the Pacific, north-east of Australia, they are, in the minds of most people who use them, the be-all and end-all of AUSSAT. But there is much, much more to this $350 million communications system, and to understand its workings it is necessary to explain the basics of satellite communications.

Satellites are put into different orbits for different purposes. Most communications satellites – including those of AUSSAT – make use of an orbit whose usefulness was first pointed out by *2001 – A Space Odyssey* author, Arthur C. Clarke, some 40 years ago. This is the geostationary orbit, which is achieved by placing the satellite in orbit 35,780 km above the equator and giving it just enough orbital velocity to counteract the pull of Earth's gravity. It then stays in step with the Earth's rotation, giving the appearance from the ground of standing still and enabling earth station antennae to be constantly trained on it.

The satellites themselves are neat bundles of electronic hardware which weigh, at launching, slightly less than a small car. Once in orbit and functioning, they are, in effect, radio signal repeater towers in space, receiving signals from the ground, boosting them in strength and beaming them back to the ground.

An AUSSAT satellite has 15 repeaters (or 'transponders') but each has only the power of a very weak light bulb: 30 watts on the four so-called 'high power' channels used mainly for radio and television broadcasting; a mere 12 W on the others. But each of these transponders can channel up to a thousand telephone conversations, or a stream of high-speed data, or one or more TV and radio broadcasts, all of which can be received by an infinite number of homes within the beam footprint.

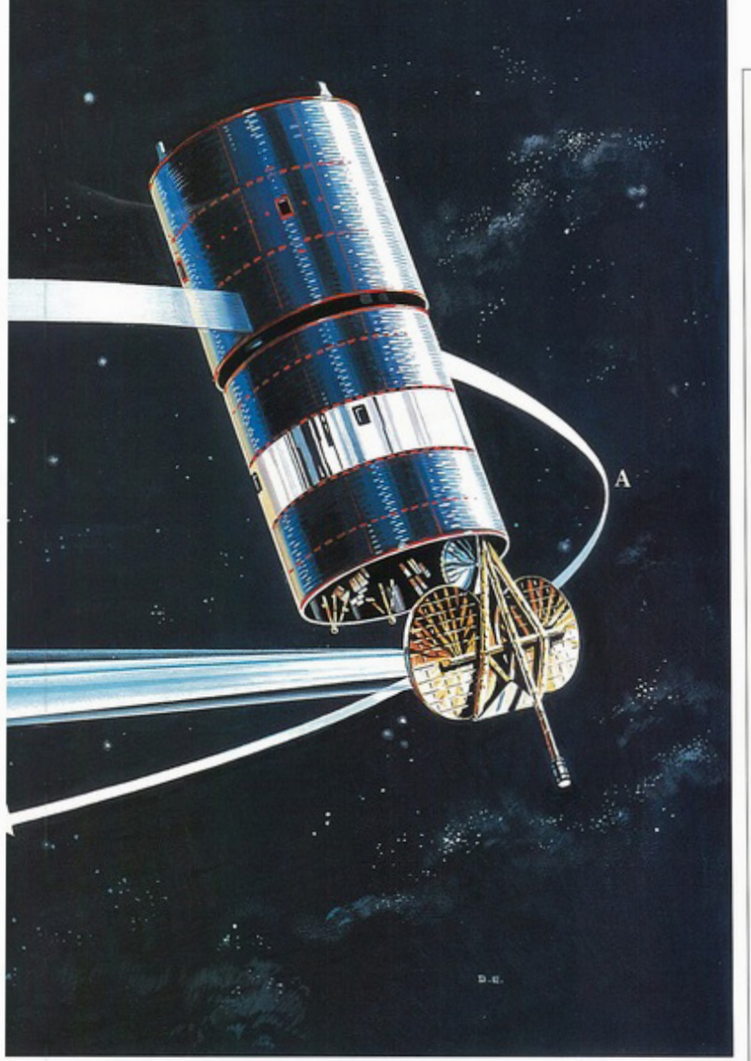
At launch an AUSSAT satellite stands only three metres tall, but in orbit it extends to the height of a two-storey house, revealing antennae which are unique to AUSSAT and the most complex antenna system yet devised for any nation's communications satellites.

The biggest and most complex AUSSAT earth stations are the eight major city earth stations which will provide access for users such as the ABC. At six of these centres, signals are received by dish antennae some 13 m in diameter, but in Brisbane and Darwin, where heavy rain can create signal problems, the dishes are 18 m in diameter.

The Sydney station is the nerve centre of the system, and its computers can monitor and control the operations of all the other stations. It and its back-up in Perth, house additional antennae which track, command and monitor the satellites.

As AUSSAT becomes established a variety of business and communications organisations will use earth stations of different sizes. Commercial television broadcasters, for example, may choose to install their own earth stations for satellite broadcasting. The cheapest two-way earth station will cost more than $30,000, but the greatest number of privately owned stations will be the simplest and smallest, designed to receive but not to transmit.

The Homestead and Community Broadcasting Satellite Service will become known, people who have to use its name are hoping, by the simple if inelegant acronym of HACBSS – pronounced 'hackbuss'. Provided by the ABC, which has leased almost two-thirds of the total satellite capacity, this service will introduce direct sat-



◀ILLUSTRATION

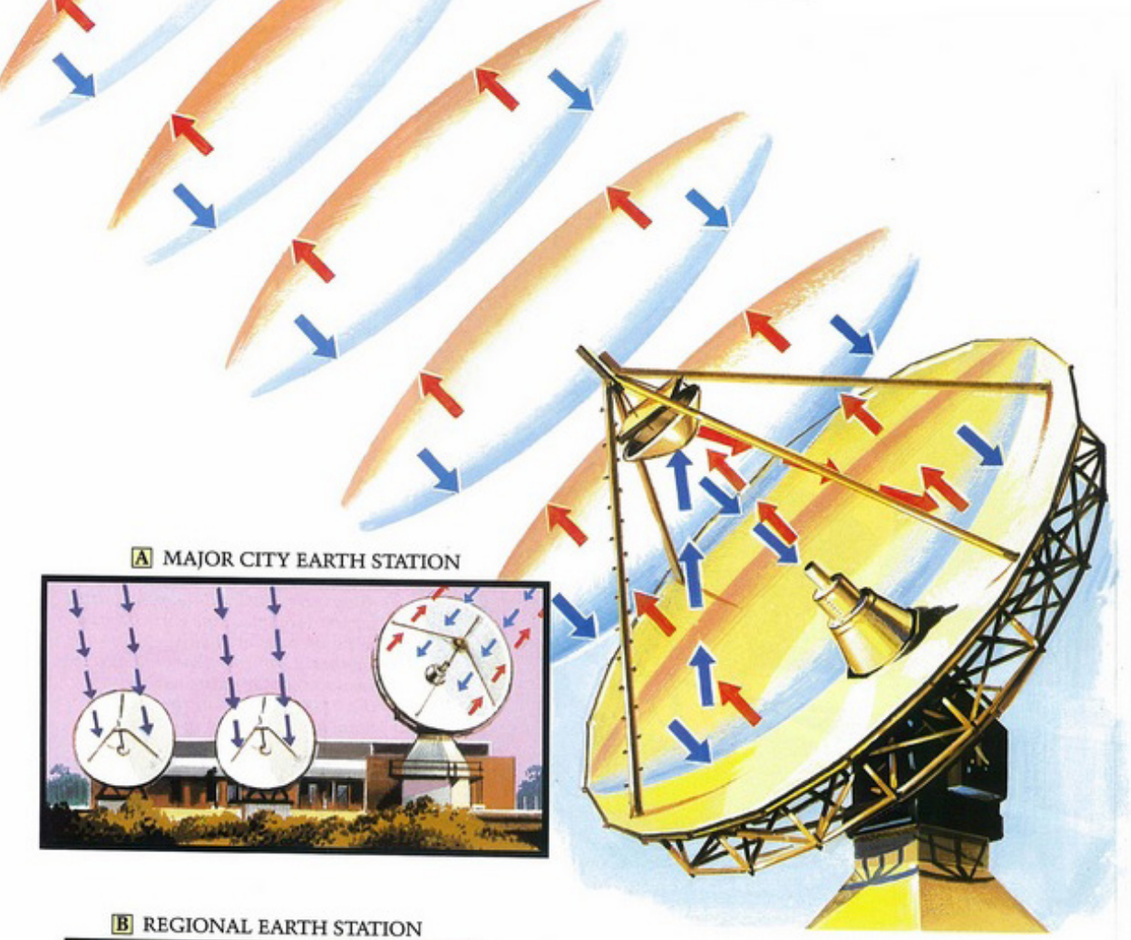
Satellites are put into different orbits for different purposes. Most communications satellites, including those of the AUSSAT system (A), make use of the geostationary orbit, in which a satellite appears, to an observer on the ground, to be standing still. In fact, it simply stays in step with Earth's rotation, thus making it easy for an earth station antenna to be kept trained constantly at the satellite and providing continuous communication.

The Soviet Union's Molnya communications satellites (B) travel in an elliptical (oval) orbit with an apogee (highest altitude) of about 40,000 kilometres. Their orbital period (time taken to complete one Earth orbit) is 12 hours. Several satellites follow one another in sequence. The orbit selected ensures that the entire territory of the USSR is covered by the satellite beam for eight hours in each circuit.

A weather satellite (C) using a polar orbit circles Earth at an altitude of about 1500 km, its cameras taking daylight photographs of cloud cover along its north-to-south track. Scanning radiometers provide cloud cover pictures on the dark side of the planet as the satellite makes its south-to-north pass. The track shifts progressively westward as Earth revolves beneath the satellite.

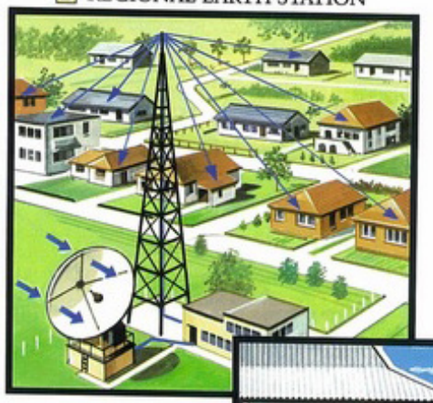
Satellites of the LANDSAT Earth resources series (D) circle the planet in a near-polar orbit at about 900 km altitude. Their TV cameras and multispectral scanners provide data which enables scientists to construct pictures of patches of Earth's surface 185 km square. These pictures enable experts to monitor the health of crops and forests, to create improved maps, to survey shallow sea regions such as the Great Barrier Reef, and to identify areas where oil may be found.

NASA's Space Shuttle orbiter (E) launches communications satellites at a height of 300 km. During a typical mission, lasting 6–10 days, the orbiter may complete more than 100 Earth orbits, reaching a maximum altitude of about 500 km.

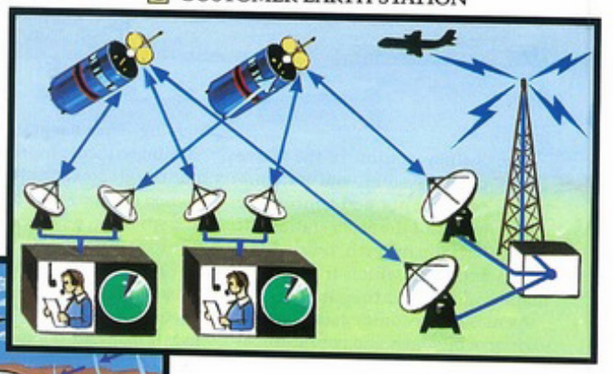


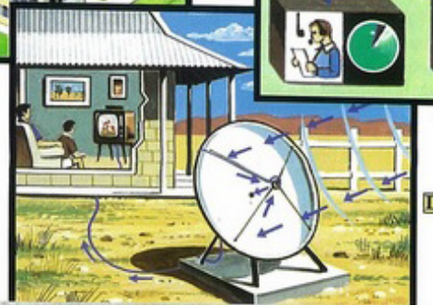
A MAJOR CITY EARTH STATION

B REGIONAL EARTH STATION

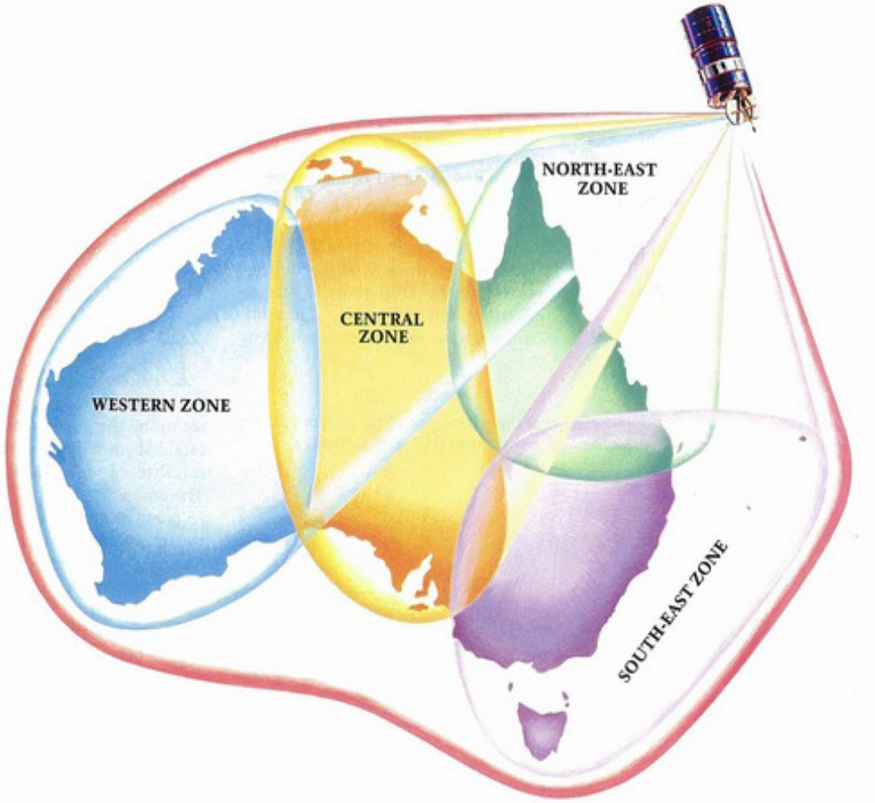


C CUSTOMER EARTH STATION





D HACBSS RECEIVER



Signals from the satellite are beamed, or concentrated to an area on Earth's surface called a 'footprint', by moving the satellite's antennae. There are four AUSSAT footprints covering Australia and once K3 is launched, an additional one covering the south-west Pacific.

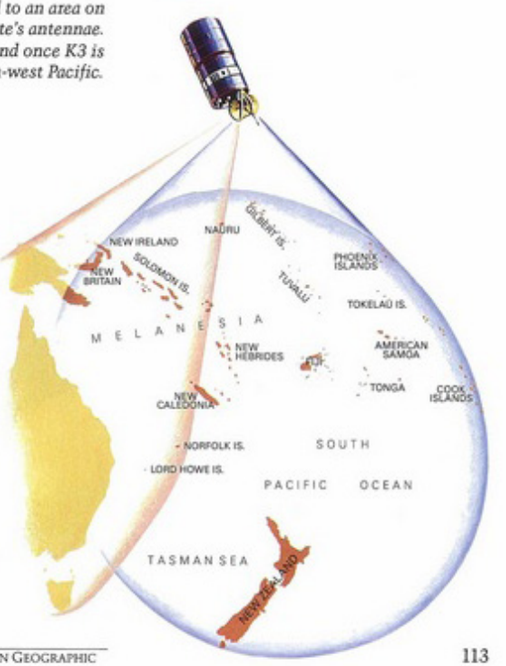
◂ ***Opposite page:***

A *The biggest and most complex earth stations are AUSSAT's major city earth stations. There are eight of these providing access to the satellite for major users such as the ABC. At the Sydney and Perth stations there is a third, larger antenna in addition to the two required for two-way communications with the two satellites. This is for tracking, telemetry, command and monitoring of the satellites. The Sydney station is the control centre but the same facilities have been installed in Perth as backup.*

B *Regional receive-only earth stations receive from the satellite, television and radio programs sent to it from earth stations located in the capital cities. The signals are then retransmitted locally by conventional transmitters.*

C *An example of a 'customer' earth station, in this case an aviation satellite communications system provides air–ground voice and data channels. Notice how two satellites are used for continuous backup.*

D *A simple HACBSS satellite receiver linked to radio and television.*



ellite broadcasting into Australian homes. It will do this through the installation of backyard antenna dishes about the size of coffee tables. These HACBSS earth stations, manufactured by a number of electronic equipment firms, retail between $2000 and $3000.

The backyard dishes, held firm in a slab of concrete, receive simultaneous transmissions from the satellite. Sorting them out is the function of the indoor unit which sits on top of the television set. This little box contains the unique element of the HACBSS system, the B-MAC decoder. Australia is the first country to adopt B-MAC for its satellite home broadcasting system and its advanced technology opens up a whole new range of possibilities for HACBSS users.

In summary, by the end of 1986 we will have three AUSSAT satellites seemingly hovering above us, strengthening and redirecting the communications signals transmitted by our major earth stations. All over the continent, from the big cities to the remote outback areas previously unserviced by electronic media, users of the system will be able to receive sounds and images of the highest quality.

Technicians at work at Belrose, the heart of the nation's satellite system. "At Belrose, you'll be hard pushed to find anyone over 35," says AUSSAT general manager Graham Gosewinckel.

Satellite Communication's New Breed

THE WORD AUSSAT came into the language in November 1981. It was the name given to a company set up by the Fraser Government to establish, own and operate a national satellite communications system. The company – AUSSAT Pty Ltd – is 75 per cent owned by the Commonwealth and 25 per cent by Telecom Australia. Its formation was the result of four years of planning and examination of existing satellite systems by a team led by then OTC executive Graham Gosewinckel.

During 1977–78 Gosewinckel served on the Commonwealth Government Task Force inquiring into the introduction of a national satellite system and studied scores of submissions from community organisations. He also spent much time travelling to remote parts of Australia to learn what communications needs remained unsatisfied. When the Government announced in October 1979 its plan to develop a satellite system, very few people were surprised that Gosewinckel, who had worked as a planning engineer for OTC and as a technical planner for the INTELSAT global satellite system, was appointed to head the project team.

By late 1985 AUSSAT had a staff of about 250, many of them highly qualified engineers and technicians, and most of them young.

"It's hard to find someone as old as me around here these days," Graham Gosewinckel quips. "Walk into our control centre at Belrose and you'll be pushed to find anyone over 35."

There is certainly an air of youthful informality about the Belrose earth station. It is clean, uncluttered, light, spacious and, above all, quiet. All there is to show that this is the beating heart of the nation's satellite system is a solitary line of computer display screens and keyboards. The atmosphere is air-conditioned to keep the equipment at a steady temperature. Through the double-glazed windows you can see the green bushlands of Sydney's suburban fringe, which seemed quite unreal, quite out of place.

MICHAEL LEES

AUSSAT control centre at Belrose, north of Sydney. The larger antenna is used for command, control and telemetry, the smaller two for sending and receiving from the two satellites.

By pressing buttons in the control room, AUSSAT technicians keep a check on the status of all the systems on the orbiting spacecraft. They check such details as battery temperatures, voltages and rocket-motor fuel levels, and send commands to the satellites to keep everything in working order. Elsewhere in the room a continuous stream of signals from the spacecraft is processed and recorded by computers. Other computers help analysts determine what action is needed to bring any errant part of the system back into line. When a satellite wanders out of position the controllers command the appropriate rocket motors to fire, pushing it back into its correct orbital slot and keeping it tilted at precisely the right angle to Earth's axis.

A Multitude of Uses

THE ARRIVAL OF television in the remote areas of Australia has so many sociological implications that the ensuing debate between pressure groups and prospective commercial licensees has tended to overshadow the many other uses of the AUSSAT system. For example, the second-largest user of the system after the ABC will be the Department of Aviation, even though communication between aircraft via satellite is not yet possible. The department is in the process of installing earth stations at 100 remote airfields and outback locations which link flight service centres to improve air-to-ground voice communication. This will create better communication between flight decks and air traffic control.

In Queensland the State Government is using the satellite system to bring greater efficiency to a wide range of government services in far-flung areas. One of the possible benefits will be access to video medical advice from Brisbane specialists. A Gulf crocodile attack victim, for example, could have injuries examined by a microsurgeon, via satellite, within the hour.

Satellite education is another area in which Queensland has taken the lead. The Mount Isa-based School of the Air will transmit via satellite to children at isolated homesteads throughout this school year, using a number of earth stations on loan from AUSSAT.

However, the satellite is unlikely to replace the existing two-way HF [high

B-MAC: A Monopoly on Magic

BY DICK SMITH

ALTHOUGH THE HACBSS receiver dishes that will begin to sprout at country homesteads this year will probably be seen as the motif for our entry into space-age communications, it is in fact the unobtrusive boxes which will sit on top of the television receivers that put Australia a jump ahead of the rest of the world in satellite technology.

Normally a television signal received via satellite is exactly the same as a television signal received directly from a local television station. The signal simply contains the picture (video) information and a sound (audio) channel. Now, however, through the genius of electronic engineers and the miniaturisation made possible by microelectronics, a system has been developed which allows additional information to be carried on each television signal, as well as providing a far superior signal in adverse conditions.

The system Australia has opted for is B-MAC. (Its name is derived from the description 'multiplex analog component, type B'.) With this system each television channel will be able to carry up to four separate radio channels plus a teletext service (enabling users to receive on-screen information displays on demand) and a utility data channel which will facilitate a wide range of direct-to-the-home services (such as electronic mail, educational programs, on-screen emergency warnings, etc.). All this in the same signal space normally taken by one television channel!

The disadvantage of this system is that simple satellite receivers will not work with it. A special – and expensive – decoder (or de-scrambler) is required even if the user simply wants to receive television and not the other services.

There is no doubt that B-MAC offers superior service, but its adoption by the Federal Government means an increase of a minimum $1000 to the cost of a satellite receiver. Furthermore, the Government has allowed one company to hold a monopoly on the manufacture of the all-important B-MAC decoders, and monopolies quite often create higher prices.

Plessey Australia, a wholly owned subsidiary of Plessey (UK), holds the exclusive licence from the manufacturers, Scientific-Atlanta of the USA. While Plessey remains cautiously quiet about its extraordinary coup, AUSTRALIAN GEOGRAPHIC wonders why the licence could not have been shared with Australian companies in order to nurture healthy competition.

YOUR OWN SATELLITE RECEIVER

AUSTRALIAN GEOGRAPHIC would like to present a HACBSS satellite receiver to an isolated Australian family or community. Please write to us nominating a family or community and outlining why they would benefit from having one. Yes, feel free to nominate yourself. The publisher's decision will be based on the remoteness of the applicant and the uses to which the receiver would be put. The decision will be announced in a future issue.

DEPT OF COMMUNICATIONS

A HACBSS receiving dish (or antenna) in use at a remote area homestead. Inset: Circuit board for the all-important and controversial B-MAC decoder. Without it, AUSSAT satellite reception is not possible.

frequency) radio network for economic reasons. A two-way HF radio costs about $2000, compared with $30,000 for the cheapest two-way satellite earth station, and even this will transmit only voice. All two-way applications of the satellite – such as telephones, river height gauges, telex etc. – are expensive because of the complex nature of the equipment needed to transmit to the satellite. Thus it is unlikely that country properties will use AUSSAT for the School of the Air, the Royal Flying Doctor Service or telephone calls, simply because of the expense involved.

While satellite receivers will no doubt become popular in remote areas, the HF radio service is likely to reign supreme at least until 1990 when Telecom will have connected all the remote areas of Australia to the standard automatic telephone system. This will be achieved by using small, solar-powered, ground-based repeaters at a maximum charge of $1250 a connection, regardless of location.

In the meantime Telecom is utilising AUSSAT for its Iterra (the word means 'quick' in an Aboriginal dialect) service. This satellite-operated system will cost over $60,000 (or $30,000 a year rental) and is expected to be installed only by mining and other large companies operating in remote areas who move location constantly.

The system will allow Telecom to provide at short notice modern business services such as telephones, data transfer and facsimile to companies operating in remote areas. Customers will buy their earth stations from Telecom and switch into the ground network via a 'gateway' earth station at Bendigo in Victoria.

For all that, however, it is the prospect of seeing live television – in many cases for the first time – or seeing it better than ever before, which excites many people.

For some 350,000 Australians who live in remote areas of the continent, the satellites will provide both national and commercial service links direct to the homesteads through HACBSS dish. As well, the AUSSAT system will greatly enhance television reception to the point where the quality of image will be among the best in the world.

Because satellite capacity is limited, commercial broadcasters must wait until K2 becomes fully operational before they can use the system. By the middle of the year, households with earth stations installed should have a choice of programs from at least the ABC and one commercial station and up to six radio stations. Some TV stations have also announced plans to introduce teletext services, giving subscribers access to certain information at the press of a button.

Television stations will also be able to take advantage of the use of portable earth stations which will transmit sound and video. For the first time we might be able to watch the Birdsville races live!

Satellite Future

LIKE ALL SPACECRAFT, these first-generation AUSSAT satellites have a limited working life. The repeated firing of small thruster motors to maintain spacecraft position and attitude (the angle of the satellite's axis to the earth's axis) uses up the fuel supply. This means that new satellites will have to take over, at the latest, about seven years from now.

Since the demand for satellite circuits is likely to grow, the first of the AUSSAT-2 series may well be needed by 1990. Three years must be allowed for construction. So AUSSAT engineers, knowing that it could be necessary to place an order with a spacecraft manufacturer around 1987, are already working on design plans for the second-generation satellites.

A tricky balancing act is involved. A delay in making major decisions could prove disastrous. On the other hand, there is a risk of making design decisions too early. A couple of years' experience of using the system will teach AUSSAT – and the community – a good deal about how satellite communications can best serve Australia.