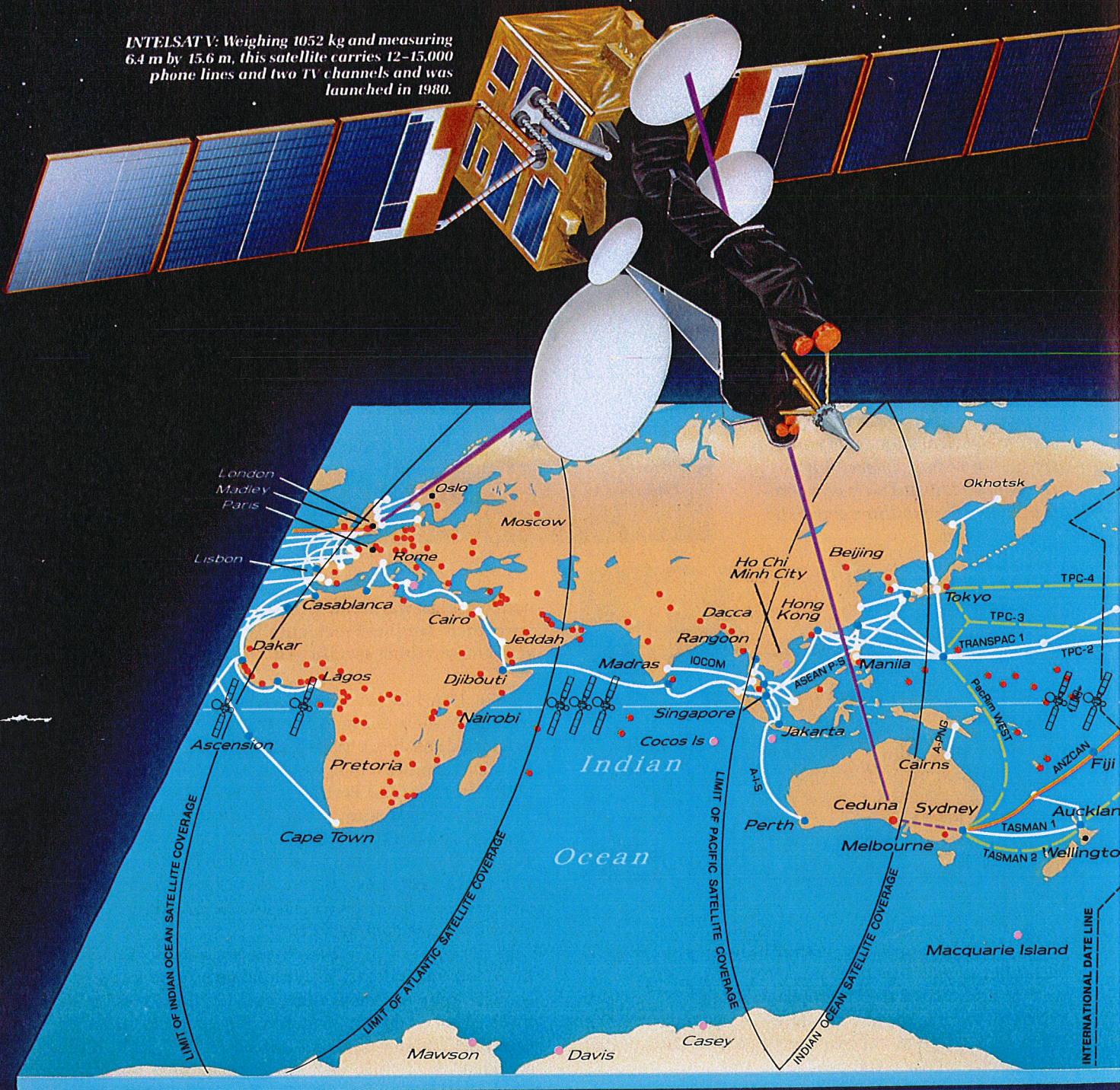


**INTELSAT V:** Weighing 1052 kg and measuring 6.4 m by 15.6 m, this satellite carries 12-15,000 phone lines and two TV channels and was launched in 1980.



## Sydney to London - via outer space or the ocean depths

To reach Christine in London I dial 0011 44 1 699 7874. Here's how my call gets through to her.

All calls, whether local, interstate or international, go first to a local Telecom exchange. This screens out all calls beginning with 0, which includes interstate and international calls, and sends them to one of Telecom's five trunk exchanges around the country. These screen out the international calls, which begin with 0011.

When my call reaches Telecom's Pitt Street trunk exchange in Sydney, a computer checks

that I have dialled a valid country code, in this case 44 for the UK, before sending the call to OTC's Broadway or Paddington gateway exchange. There another computer checks the country code and for larger countries it also checks the area code, in my case 1 for London. This ensures lines aren't tied up with junk numbers that will only be rejected at the other end.

When the codes have been validated, the computer chooses a route for my call. With both satellite and cable links to England, there are up to 20 possible routes,

all stored in order of priority in the computer. OTC's computers constantly monitor each route. The one chosen depends on traffic and cost - using cheaper routes enables OTC to keep its charges down.

A route may include hops on both satellite and cable, but never two satellite hops, which would make the delay between the time a word is spoken and heard unacceptably long. According to Brian Travis, acting principal technical officer at the Paddington gateway, calls from Australia are most likely to go via satellite, leaving cables open for

# Our Links With The World

- Submarine cables
- Submarine cable stations
- Satellite earth stations
- Submarine cable stations and satellite earth stations
- VISTA satellite earth stations
- Planned optical fibre cables
- INTELSAT IV-A satellites
- INTELSAT V satellites
- Possible satellite route for Margaret Wertheim's call
- Possible cable route for Margaret Wertheim's call

INTELSAT IV-A: Weighing 863 kg, this carries 6000 phone lines and two TV channels. It was launched in 1975.



ILLUSTRATION BY LANGDON HALLS  
COMMISSIONED BY AUSTRALIAN GEOGRAPHIC

transit calls through Australia from other Pacific countries.

Once my call is given a route, a special signal, called a seizure signal, is sent to the destination gateway exchange, which sends back an acknowledge signal. Then the number I want to reach is transmitted. If the call is going via satellite, it is passed from the gateway exchange to a satellite earth station. My call to Christine most likely goes to the Ceduna earth station in South Australia by one of four routes.

From Ceduna my call is transmitted by microwaves to an INTELSAT satellite 36,000 kilometres above the Indian Ocean and down to an earth station at Madley on the

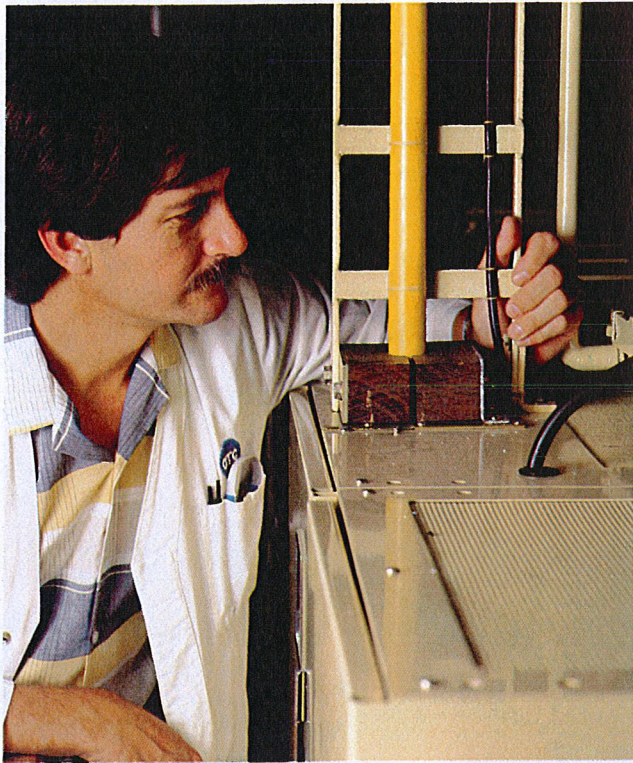
border between England and Wales.

If the computer decides to send my call by cable, it will probably go via the ANZCAN cable to Vancouver in Canada. From there it is carried across North America by microwaves and across the Atlantic by one of the CANTAT cables. In England it goes to a gateway exchange belonging to OTC's British equivalent, then to a London trunk exchange, a London local exchange and finally to Christine in Vauxhall, South London.

It's probably taken you nearly three minutes to read this. It takes my call just 10 seconds to get through to London from the moment I finish dialling. Whatever anyone says, I still think it's magic.



Three satellites can provide total global communication. Orbiting at 36,000 km, the INTELSAT satellites remain over the same spot on the Equator.



*Inconspicuous in the heart of the Paddington gateway, the yellow ANZCAN cable emerges from the power feed equipment that boosts the signal on its 14,820 km journey across the Pacific Ocean to Port Alberni, near Vancouver in Canada. Senior technical officer Ken Arnold of the International Testing and Maintenance Centre inspects the cable assembly.*

*First stop on the ANZCAN cable's trans-Pacific route is Norfolk Island, 1676 km north-east of Sydney. The laying of this cable began in 1982 and was completed in 1984. Here the oil rig tender Chantik, specially chartered for work in the shallows around Norfolk Island, brings a section of the cable into Anson Bay on the north-west side of the island in February 1983.*

ASRs – Answer Seizure Ratios – indicate calls received as a percentage of those made. Brian, 39, told me that every country has a typical ASR rating, rather like its own signature, which quickly shows if anything unusual is happening with calls to or from it.

"The day of the first Fiji coup [14 May 1987], at about 8 a.m., Fiji's ASR rating suddenly dropped to zero," Brian said. "No equipment had failed but no calls were getting through, so I knew something was wrong."

On the orderwire, a special communications channel for technicians, Brian heard there had been a coup. He immediately told his superiors but they didn't believe him. "Twenty minutes later we heard it on the ABC," Brian said. "So we were some of the first in Australia to know about it."

The exchange's computers automatically choose a route for each call. This route includes either satellite or cable sections. If a cable route is chosen at Paddington, the call will be switched to either the ANZCAN, A-PNG or TASMAN cables. Through OTC, Australia is a shareholder in some 13 cables.

Deep inside the Paddington gateway building a yellow cable snakes down out of the ceiling and disappears into a metal box about 1.8 metres high by 60 centimetres



COURTESY OTC



PHOTOS - COURTESY OTC

*January 1983 - the ANZCAN comes ashore on mainland Australia. Surf lifesavers George Quigley and Tony Falstein head for Sydney's Bondi Beach in a speedboat trailing a rope. The rope is attached to the ANZCAN cable aboard*

*the cable ship Mercury. Near the beach the two men dive into the surf, swim ashore and drag the rope to a winch that hauls the cable from the ship. Willing hands then join in to manhandle the cable into its trench.*





**Hi-tech in the bush.** The dishes at OTC's Oxford Falls earth station stand out from the greenery of Sydney's north. The microwave dish on the hilltop tower (left) communicates with the Paddington gateway and is linked to the earth station by an optical fibre cable. The incomplete structure is the 32 m Moree dish. In the foreground is the 18 m dish. A view from the Moree dish (opposite), renamed Sydney 2, shows the two smaller dishes flanking Sydney 1, the 18 m dish. The earth station beams signals up to INTELSAT satellites in geostationary orbits above the Pacific Ocean. On the 18 m dish, technical officer Nick Palavic prepares to enter the feed housing. Inside (inset), he checks the feed device that transmits and receives signals through the dish.

square. This inconspicuous wire, not more than 5 cm thick, is one end of the ANZCAN cable that carries 1380 calls simultaneously across 14,820 km of ocean, linking Australia, Norfolk Island, New Zealand, Fiji, Hawaii and Canada.

I was surprised when I saw it. It seemed so fragile. I had expected a cable that lies on the ocean floor as deep as 6 km to be much bigger and more robust. The box it disappears into contains its power feed equipment, supplying the energy to boost the signal on its journey. Outside the building the cable runs in underground ducts to the southern end of Bondi Beach where it passes 2 m under sunbathers on its way into the Pacific. Every 14 km of the marathon journey the cable has repeater units to boost the signal on its way.

Although cables are made as strong as possible, they can be broken by undersea earthquakes or mudslides or by trawlers. OTC and its equivalents around the world jointly run cable repair ships, two of which service the Pacific Ocean, one from Hawaii and the other from Fiji.

Don Nicol said it might take 6–8 days to find and repair a break in the ANZCAN cable. Breaks can be pinpointed by analysing special signals sent out by the repeater units. On the scene, when the repair ship drags a grapnel along the seabed, instruments measuring the tension on the

grapnel's line indicate when the cable has been hooked. The cable is raised, attached to a buoy and released again. The other part of the cable is then recovered in the same way. A new section is spliced on and the ship returns to the buoyed end to complete the repair. While repairs are in progress, telephone calls are rerouted.

"Fortunately the Pacific is generally a very good region for cables," Don said. "It's deep in most of its extent, particularly near Australia, and the continental shelf is narrow. Also there is relatively little shipping so we don't have the same problem with trawlers as they have, say, in the North Sea and the English Channel."

If the Paddington gateway routes a call via satellite it will be sent to an earth station and transmitted to one of the INTELSAT satellites orbiting above the Equator. If it's destined for North America, the Pacific or ASEAN regions it will be sent to OTC's newest earth station at Oxford Falls in Sydney's leafy northern suburbs for transmission to satellites over the Pacific. If it's destined for Europe or Africa it will go to Ceduna in South Australia and then to satellites over the Indian Ocean.

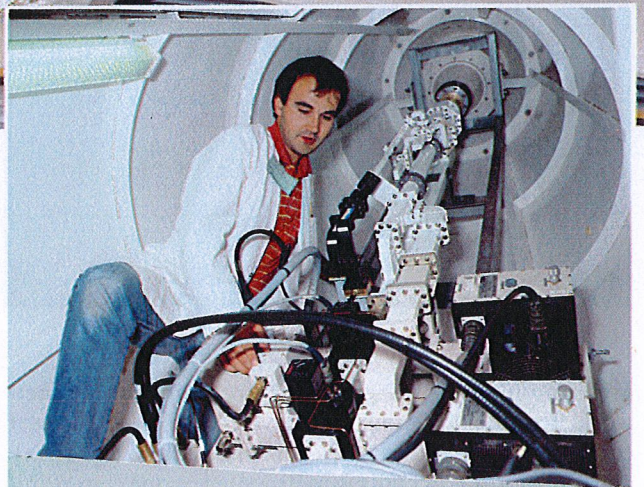
The Oxford Falls earth station is in attractive bushland – banksias, eucalypts and some peach trees. As I drove down the hill leading to it, the gentle curve of a



large white dish suddenly came into view above the trees. Hi-tech and nature make a pleasing combination. This station is being built to replace the one at Moree in NSW. In the past it was necessary to keep the dishes away from the electromagnetic "pollution" in cities (generated by radio and television stations, CB and taxi radios and other sources of high-frequency waves). But today more powerful and sensitive electronic equipment on the satellites make this unnecessary. Hence the move to Oxford Falls.

As well, OTC likes to have its earth stations as near as possible to its gateway exchanges because, as the station's manager, Bruce Anderson, explained, it costs a lot to lease the landlines from Telecom to carry calls from Sydney to Moree. Besides, long landlines are more likely to fail. OTC's other earth stations are at Ceduna in SA, Healesville in Victoria and Perth in WA. Healesville and Perth, however, are not yet involved in the telephone network; they mainly take television traffic.

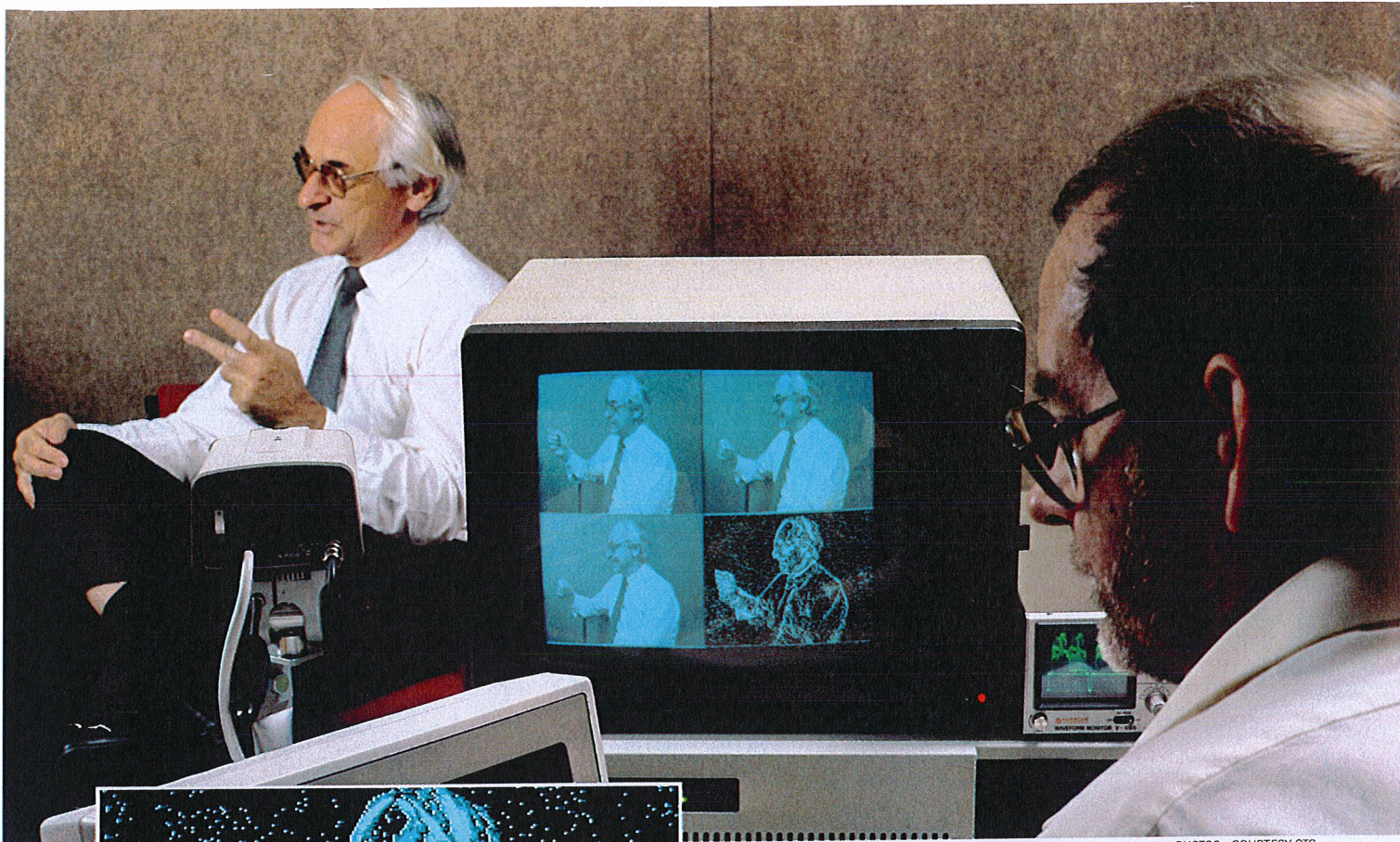
Why build an earth station at Ceduna, I wondered. Bruce supplied the answer. "It's the most easterly point in Australia where an earth station can see the Indian Ocean satellites," he said. In other words, if it were any farther east, the satellites would be below the horizon and signals wouldn't reach them. The eastern limit of the area covered by the Indian Ocean satellites is very



close to Ceduna. Its western limit is the west of England, Portugal and West Africa.

On my first visit to Oxford Falls I saw only two dishes, a small test dish and an 18 m all-Australian dish made jointly by the CSIRO, MacDonald Wagner and Boral John Perry Industries. On my second visit these had been joined by an 8 m dish. The family will be complete when Moree's 32 m dish is rebuilt at Oxford Falls, which is due to take over from Moree by the middle of the year.

Inside the station, equipment was being installed and tested. There was a relaxed feeling about the place. Most of the staff looked young, under 35, and I sensed they had the situation very much under control. If there is



PHOTOS : COURTESY OTC

*Optical fibres will transmit higher quality video images than conventional methods. Before transmission, pictures are digitised and coded (inset). Peter Crosthwaite of OTC's systems development carries out a coding experiment with chief of development Maurie O'Connor as his subject.*

*OTC's VISTA earth station in Ho Chi Minh City enables Australia's Vietnamese immigrants to keep in touch with relatives in the old country. Phoning Vietnam from the Sydney suburb of Sefton are, from left, Mai Thi Hoang Vo, Tri Kim Cang Nguyen, Ha Thi Chieu Vo and Ha Thi Thu Vo. They're chatting to Ha Thi Thu Vo's sister, whom they call frequently.*



ever a problem in the global telecommunications network, technicians around the world can be in instant contact via the orderwire, over which they can speak and send telexes. According to Bruce, everyone communicates in English except the French, who always send telexes in their own language and who, though they speak English most of the time, refuse to do so on Bastille Day, 14 July, their national holiday.

I've always thought of satellite dishes as huge hi-tech flowers. As I walked around Oxford Falls with Bruce, he showed me the rails on which they moved and explained how they track their satellites, automatically adjusting under computer control to point in the right direction. So to me they became even more like flowers, like sunflowers, following the movement of their own little suns.

The INTELSAT satellites OTC uses orbit at 36,000 km above the Equator, each covering a third of the globe. They are in geostationary orbits, which means they are orbiting at a speed that matches the Earth's rotation, so

that they are always roughly over the same spot on the planet's surface. Those that the Oxford Falls earth station communicates with are over Kiribati at longitude 174° and the international dateline at 180°. The ones that Ceduna uses are at 60° and 63° over the Indian Ocean. Although theoretically geostationary, they do move around a bit, and sometimes have to be corrected by firing thrusters on board.

"One of the great advantages of satellites," Bruce said, "is that you can put up a small earth station fairly cheaply (for between \$1 and \$2 million) and have immediate access to all the countries of the region."

Cables and satellites are enormously expensive. The most recent addition to our network, the A-I-S cable linking Perth with Indonesia and Singapore, cost \$300 million, or \$65,000 a kilometre. The new optical fibre Pacific Cable Network that will link Australia with New Zealand, Asia and North America in the early 1990s will cost about \$2 billion, or \$70,000 a kilometre. It will, however, carry



TRẦN THỨC NGUYỄN

## Who Pays?

**H**AVE you ever wondered how the Alaskan phone company gets paid if you make a reverse charge call from, say, Nome in Alaska to Broome in Western Australia?

Four different companies – the local Alaskan phone company, the international American authority (AT&T), OTC and Telecom – have contributed to placing the call. How they all get paid is fascinating, and the amount each company receives has little to do with how much you, the subscriber, pay for the call.

Each company automatically records the number called and the time, date and duration of the call. Fees are agreed between the companies, based on the length of the call and the distance it travels on each network. The companies settle their accounts every month and generally accept each other's invoices on faith, but occasional checks can be made if suspicious trends emerge.

In our Alaska/Broome example, Telecom bills the subscriber at the prevailing Australian rate (\$2.10 per minute). Telecom is then billed by OTC, which is billed by AT&T, which is billed by the Alaskan phone company, all at their own rates.

If you had direct-dialed or placed a person-to-person call you would have paid the Alaskan phone company at the prevailing American rate and the billing process would work in reverse. However, in this instance, Telecom would charge a flat rate regardless of where in Australia the call was going. This rate is based on an average of the destinations of incoming international calls.


So next time you're overseas and want to call home, compare the difference between local and Australian rates before you decide whether to call collect. In the case of those countries that have a much higher charge rate, such as Indonesia, you'll save money for yourself and Australia if you call collect.

10 times more phone lines than the A-I-S cable.

No one country can afford the entire cost of these facilities, so they are jointly owned and maintained. Many of the smaller Pacific countries have no cable links; they only have satellite earth stations and have to "transit" through other countries to reach most of the world.

New Zealand, Fiji, Kiribati, the Solomon Islands, Tonga, Vanuatu and Papua New Guinea, among others, rely on Australia for their link with the rest of the world. Other transit centres in the region include Hong Kong, Singapore and Japan. Among OTC's biggest transit clients are the American telephone companies US-SPRINT and MCI, which use Australian facilities for their communications with the Pacific, Asia and Europe.

After leaving Australia, calls go to the appropriate earth or cable station overseas. From those they pass into gateway exchanges run by OTC equivalents, then to trunk exchanges, local exchanges and finally to the subscriber whose number you dialled.

SO I'D FOUND out how my voice gets to Christine. Her voice makes the same journey as mine, only in reverse. But what I still wanted to know was how to cure telephonitis. Every time I call Chrisy I promise myself it will only be for five minutes, but always, oh always, I am still on the phone half an hour later. I dread the arrival of the quarterly Telecom bill. (OTC sets the rates for international calls, but Telecom bills the customer.) The international telephone system is indeed a marvelous thing, but for phone junkies like me it's a compelling and addictive habit. I admit it ...  I'm hooked.

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