DEFENCE ASPECTS OF AUSTRALIA’S SPACE ACTIVITIES

Desmond Ball
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Published by
Strategic and Defence Studies Centre
Research School of Pacific Studies
The Australian National University
Canberra, Australia,
1992
ABSTRACT

Australia has been extensively involved in space activities of one sort or another since the 1950s. In many cases, projects undertaken in Australia or Australian products have been at the very forefront of international developments. But the Australian activity has always been uneven and fitful. Opportunities have been lost and investments wasted. We have lacked a national space policy capable of providing coherence and direction to this activity.

This monograph provides a comprehensive assessment of the defence elements of an Australian space policy. It describes in some detail Australia’s defence space activities, including the joint Australian/US facilities at Pine Gap and Nurrungar; the DSD SATCOM SIGINT facilities; Australia’s involvement in the US Defence Satellite Communications System (DSCS) and the US Navy’s Fleet Satellite Communications (FLTSATCOM) system; Australia’s involvement in navigation, positioning and geodetic satellite systems; Australia’s defence satellite communications programs; and the space-related activities of the Defence Science and Technology Organisation (DSTO).

The monograph discusses four principal aspects of defence-civil cooperation with respect to space activities - the exploitation for national purposes of the skills and experience extant in Australia’s defence and intelligence space activities; the benefits to Defence of the capabilities developed in the Australian aerospace industry; the need to coordinate defence and civil infrastructural development projects with respect to space; and the possibilities for defence-civil cooperation with respect to satellite surveillance and environmental monitoring programs and capabilities.

Finally, it addresses practical and mechanical considerations concerning the coordination of Australia’s defence, intelligence and civil space activities. It argues that the appropriate machinery for coordination should be based on the existing Australian Space Board (ASB) and Australian Space Office (ASO), and it concludes with some proposals for strengthening this machinery, including more effective incorporation of Australia’s defence and intelligence space activities in a national Australian space policy.
*Canberra Papers on Strategy and Defence* are a series of monograph publications which arise out of the work of the Strategic and Defence Studies Centre, Research School of Pacific Studies, The Australian National University. Previous *Canberra Papers* have covered topics such as the relationship of the superpowers, arms control at both the superpower and South-east Asian regional level, regional strategic relationships and major aspects of Australian defence policy. For a list of those still available refer to the last pages of this volume.

Unless otherwise stated, publications of the Centre are presented without endorsement as contributions to the public record and debate. Authors are responsible for their own analysis and conclusions.
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<td>EHF</td>
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<td>IR</td>
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<tr>
<td>kbps</td>
<td>Kilobits per second</td>
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<td>kg</td>
<td>Kilogram</td>
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<td>KH</td>
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<td>Single Integrated Operational Plan</td>
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<td>Acronym</td>
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<tr>
<td>TTC&amp;M</td>
<td>Tracking, telemetry, command and monitoring</td>
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<tr>
<td>UHF</td>
<td>Ultra high frequency</td>
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<td>UK</td>
<td>United Kingdom</td>
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<tr>
<td>UNESCAP</td>
<td>United Nations Economic and Social Commission for Asia and the Pacific</td>
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<td>US</td>
<td>United States</td>
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<tr>
<td>USACC</td>
<td>US Army Communications Command</td>
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<tr>
<td>VCDF</td>
<td>Vice Chief of the Defence Force</td>
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<tr>
<td>VLSI</td>
<td>Very Large Scale Integrated</td>
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<td>WA</td>
<td>Western Australia</td>
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<tr>
<td>WBDL</td>
<td>Wideband data link</td>
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<tr>
<td>WHCA</td>
<td>White House Communications Agency</td>
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<tr>
<td>WRE</td>
<td>Weapons Research Establishment</td>
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<tr>
<td>TWTA</td>
<td>Travelling wave-tube amplifier</td>
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<tr>
<td>WWMCCS</td>
<td>Worldwide Military Command and Control System</td>
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CHAPTER 1
INTRODUCTION

Australia has been extensively involved in space activities of one sort or another since the 1950s. In many cases, projects undertaken in Australia or Australian products have been at the very forefront of international developments. But the Australian activity has always been uneven and fitful. Opportunities have been lost and investments wasted. We have lacked a national space policy capable of providing coherence and direction to this activity.

The Woomera Rocket Range, which involved an investment of nearly $600 million in then-year dollars or nearly $4 billion at present values, making it one of the largest national infrastructure projects of the post-War period, was used for a variety of major space-related activities. The missile range instrumentation equipment installed in the mid-1950s, together with a US Minitrack Radar Tracking Station and a Baker-Nunn Camera Optical Tracking Station specially installed in 1957, were used to track and monitor telemetry transmissions from Sputnik I, launched on 4 October 1957. Ten years later, on 29 November 1967, Australia's first satellite, WRESAT (1967-1184), designed and built by a team at the Weapons Research Establishment (WRE) at Salisbury, was successfully launched from Woomera. On 28 October 1971, the British Prospero utility experimental satellite (1971-93A) was also successfully launched from Woomera.

Close cooperation with the US National Aeronautics and Space Administration (NASA) was instituted during the 1960s, based formally on an Agreement Relating to Space Vehicle Tracking and Communications of 26 February 1960. This cooperation reached its peak, in terms of satellite tracking, communications and data acquisition facilities, and manpower, in the second half of the 1960s.

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2 Defence Aspects of Australia's Space Activities

Figure 1: WRESAT, Australia's first satellite, designed and built by the Weapons Research Establishment (WRE), launched on 29 November 1967.
when the American manned space program (Gemini and Apollo) was at its apogee. In September 1969, for example, the NASA installations in Australia included Deep Space Station 41 at Island Lagoon, Woomera (which also housed the Baker-Nunn Camera SC-23); Deep Space Station 42 at Tidbinbilla, ACT; Carnarvon Tracking and Data Acquisition Station, in WA; Honeysuckle Creek Tracking Station; Space Tracking and Data Acquisition Network Station at Orroral Valley, ACT; and the Applications Technology Satellite Station at Cooby Creek near Toowoomba, Queensland. Earlier, during the Mercury phase of the American manned space program there had been a NASA telemetry and control facility at Muchea, 55 km from Perth.4

Cooperation with the US with respect to defence and intelligence satellite programs began in the 1960s. In 1961, the US established a TRANET station at Smithfield, SA, as part of its Transit navigational satellite program which was designed primarily to provide navigational support to US fleet ballistic missile (FBM) submarines.5

The largest and most important US space defence/intelligence facility in Australia is the Joint Defence Facility - Pine Gap (JDF-PG), which was established near Alice Springs in central Australia in the late 1960s under an agreement signed in December 1966. With 11 radomes and a staff of some 660 personnel, Pine Gap is one of the largest satellite ground stations in the world. Operated by the Central Intelligence Agency (CIA), under the direction of the National Reconnaissance Office (NRO), the station is responsible for controlling a small number of US geostationary signals intelligence (SIGINT) satellites - the most secret of all US intelligence collection satellites. These satellites are designed to collect a wide range of foreign signals, including telemetry associated with Soviet strategic missile tests, radar emissions, and telecommunications.6

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4 For a more extensive discussion of the NASA facilities in Australia, see Desmond Ball, A Suitable Piece of Real Estate: American Installations in Australia, (Hale & Iremonger, Sydney, 1980), chapter 9.
5 The TRANET station at Smithfield is discussed in ibid., chapter 8.
6 For a comprehensive discussion of the Pine Gap facility and its operations, see Desmond Ball, Pine Gap: Australia and the US Geostationary Signals Intelligence Satellite Program, (Allen & Unwin,
4 Defence Aspects of Australia’s Space Activities

The second most important US space facility in Australia is the Joint Defence Facility - Nurrungar (JDF-N), which was established in the Woomera restricted area in 1969-1971. It is operated by the US Air Force Space Command, and is responsible for the control of US Defense Support Program (DSP) missile early warning satellites stationed over the eastern hemisphere (DSP-E). These satellites are designed to provide the first warning of intercontinental ballistic missile (ICBM) launches from the Soviet Union, and are increasingly also capable of detecting launches of shorter-range missiles from within their area of view - i.e. from the Middle East across South Asia to East and Southeast Asia.7 There are currently four radomes and a staff of nearly 500 at the Nurrungar station.8

Since 1967, when a Defense Satellite Communications System (DSCS) terminal was installed at the Naval Communications Station at North West Cape, WA, some half dozen terminals have been installed in Australia for communicating through the DSCS system. There are currently two DSCS terminals at Pine Gap, one at Nurrungar, one at North West Cape, and one at Watsonia Barracks in Melbourne.9

Other facilities in Australia involved in US defence satellite programs include a US Navy Fleet Satellite Communications

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7 For a comprehensive discussion of Nurrungar and its operations, see Desmond Ball, A Base For Debate: The US Satellite Station at Nurrungar, (Allen & Unwin, Sydney, 1987). See also Desmond Ball, The Intelligence War in the Gulf, (Canberra Papers on Strategy and Defence No.78, Strategic and Defence Studies Centre, Australian National University, Canberra, 1991), pp.6-13.


9 See Desmond Ball, Code 777: Australia and the US Defense Satellite Communications System (DSCS), (Canberra Papers on Strategy and Defence No.56), Strategic and Defence Studies Centre, Australian National University, Canberra, 1989), chapter 3.
(FLTSATCOM) satellite terminal at North West Cape, and several terminals for monitoring US geodetic satellites.

Since the late 1970s, the Defence Signals Directorate (DSD) of the Australian Department of Defence has also been involved in the operation of satellite ground facilities designed to intercept satellite signals. DSD currently maintains satellite signals intelligence (SIGINT) facilities at Stanley Fort in Hong Kong (which became operational in 1977) and at Shoal Bay near Darwin (which became operational in 1979), and a third station is under construction at Kojarena, near Geraldton, WA. A satellite facility for intelligence communications is also maintained at Watsonia Barracks in Melbourne. These DSD facilities currently constitute one of Australia’s largest single space activities.

In the mid-1980s, the Department of Defence decided to establish a satellite communications (SATCOM) component of the Defence Integrated Secure Communications Network (DISCON). Known as DEFAUSSAT, the project uses a single 12-watt transponder aboard the Australian national domestic satellite (AUSSAT), together with 11 fixed and four transportable ground stations and a central control centre.

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11 See Desmond Ball, ‘Geodetic Satellites’, (Reference Paper No.125, Strategic and Defence Studies Centre, Australian National University, Canberra, October 1984).

12 See Desmond Ball, Australia’s Secret Space Programs, (Canberra Papers on Strategy and Defence No.43, Strategic and Defence Studies Centre, Australian National University, Canberra, 1988).

6 Defence Aspects of Australia’s Space Activities

Australian industry has also become involved in space. AUSSAT Pty Ltd, a commercial company established in November 1981, owns and operates Australia’s national domestic satellite system. Australian industry has demonstrated a capability to produce satellite earth terminals of various sizes, hardware and software for remote sensing, satellite structural and sensor sub-systems of various sorts, and other space products and services. However, Australia continues to buy most of its space hardware and services from overseas.

Australian space activity has been characterised by fits and starts, lack of coordination, and lack of long-term vision and direction. The facilities at Woomera were dismantled and/or destroyed, and most industrial research and development (R&D) laboratories were essentially closed, during the 1970s. The most vigorous continuing activities, involving US space defence and intelligence programs as well as Australia’s own satellite intelligence activities, have been ‘compartmentalised’ for security purposes to the point where there is essentially no interaction, in terms of skills, technology or services, with other segments of Australian space activity. On the other hand, many private sector initiatives have naturally occurred with little government appreciation, let alone endorsement.

Australia cannot afford this state of affairs. The costs of short-term planning and of sectional perspectives and programs are too great. Space support for the Australian Defence Force (ADF) will require significant investments - initially for communications and signals intelligence (SIGINT) purposes, and, later, perhaps, for surveillance. These defence programs should be coordinated closely with Australia’s civil space capabilities and interests - to ensure that there is no unnecessary duplication and that civil resources are used wherever practicable; and that the defence investments contribute wherever possible to national development. A viable space industry and infrastructure is itself a major defence asset.

This monograph provides a comprehensive assessment of the defence elements of an Australian space policy. Chapter 2 describes in some detail Australia’s defence space activities, including the joint}

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Introduction 7

Australian/US facilities at Pine Gap and Nurrungar; the DSD SATCOM SIGINT facilities; Australia’s involvement in the US Defense Satellite Communications System (DSCS) and the US Navy’s Fleet Satellite Communications (FLTSATCOM) system; Australia’s involvement in navigation, positioning and geodetic satellite systems; Australia’s defence satellite communications programs; and the space-related activities of the Defence Science and Technology Organisation (DSTO).

Chapter 3 discusses four principal aspects of defence-civil cooperation with respect to space activities - the exploitation for national purposes of the skills and experience extant in Australia’s defence and intelligence space activities; the benefits to Defence of the capabilities developed in the Australian aerospace industry; the need to coordinate defence and civil infrastructural development projects with respect to space; and the possibilities for defence-civil cooperation with respect to satellite surveillance and environmental monitoring programs and capabilities.

Chapter 4 addresses practical and mechanical considerations concerning the coordination of Australia’s defence, intelligence and civil space activities. It argues that the appropriate machinery for coordination should be based on the existing Australian Space Board (ASB) and Australian Space Office (ASO). Finally, Chapter 5 concludes the monograph with some proposals for strengthening this machinery, including more effective incorporation of Australia’s defence and intelligence space activities in a national Australian space policy.
CHAPTER 2

AUSTRALIA’S DEFENCE SPACE ACTIVITIES

(i) Joint Defence Facility - Pine Gap (JDF-PG):

The Joint Defence Facility - Pine Gap (JDF-PG), which is located some 19 km from Alice Springs in central Australia, is one of the largest and most sophisticated satellite ground stations in the world. It is responsible for controlling a small number of US geostationary signals intelligence (SIGINT) satellites - the most secret of all US intelligence collection satellites, with code-names such as Rhyolite, Aquacade and Magnum. These satellites are designed to collect a wide range of foreign signals, including telemetry associated with Soviet strategic missile tests, radar emissions, and telecommunications. The program is the operational responsibility of the US Central Intelligence Agency (CIA), under the direction of the National Reconnaissance Office (NRO).1

The Pine Gap station became operational in 1970.2 As of August 1990, there were some 663 personnel employed at the station - 320 US personnel and 343 Australian personnel.3 The station currently consists of 11 satellite ground terminals enclosed in radomes, a huge computer room, and some 20 other support and service buildings. The first two antennas/radomes were constructed in 1968; a further two were constructed in 1969 (one of which was replaced in 1973); the fifth, sixth, seventh, eighth and ninth were constructed in 1971, 1977, 1980, 1984-85 and 1989;4 the tenth and eleventh were constructed in 1990-

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Figure 2: The Joint US-Australian Defence Facility at Pine Gap, control station for US geostationary signals intelligence satellites. Official photograph taken in 1986 shows eight radomes; three additional radomes have since been constructed.
Figure 3: Pine Gap. Close-up photograph of four radomes taken in 1986. The radome third from left houses the SCT-35 X-band antenna installed in 1973.
Figure 4: SCT-35 X-band antenna installed at Pine Gap in 1973 for operations with the US Defense Satellite Communications System (DSCS)
Figure 5: SCT-8 X-band antenna installed at Pine Gap in 1980 for operations with the US Defense Satellite Communications System (DSCS)
Several of these, including an SCT-35 antenna installed in 1973, an SCT-8 antenna installed in 1980, and two of those installed in 1989-91, are for communications purposes.

The main computer room at Pine Gap is one of the largest in the world. The computer equipment includes several IBM mainframes, a DEC VAX-11/780, and numerous smaller systems. Some of these have been inter-netted in unique and sophisticated arrangements.

The main operations building is divided into three principal sections:

- the Station-keeping Section, which is responsible for keeping the SIGINT satellites from drifting out of position and for correctly aligning them towards areas of interest;
- the Signals Processing Office (SPO), which processes the enormous volume of intercepted signals transmitted down from the SIGINT satellites; and
- the Signals Analysis Section (SAS), which analyses the processed SIGINT.

The functional organisation of the Pine Gap station is depicted schematically in Figure 6. Functionally, the most important management entity is the Joint Reconnaissance Schedule Committee, which meets daily and which, in accordance with a Joint Reconnaissance Schedule issued each month by the NRO National Reconnaissance Executive Committee, determines the particular targets for the SIGINT satellites for the ensuring 24 hours.

Since the station became operational in 1970, the number of personnel has increased from some 440 (of whom about 48 per cent were Australian personnel) to some 663 (of whom about 52 per cent were Australians) as at August 1990. However, it is fair to say that, at least until the last couple of years, the involvement of Australian

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Figure 6: Schematic Functional Organisation of the Pine Gap Station

US National Reconnaissance Office (NRO)

Central Intelligence Agency (CIA)

US Chief of Facility
Senior Australian Representative and Deputy Chief of Facility

Joint Reconnaissance Schedule Committee

Operations
- Satellite Station-keeping Section
  - Signals Processing Office (SPO)
  - Signals Analysis Section (SAS)

Communications
- SATCOM Terminals
- US National Communications Room
- Australian National Communications Room

Logistics and Support
- Supply
- Computer Support and Maintenance
- Station Security
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<td>95</td>
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<td>432</td>
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<td>454</td>
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personnel in the key management and operational areas of the station has been less than satisfactory. Indeed, in the early 1970s, when Pine Gap began operations with the first *Rhyolite* geostationary SIGINT satellites, Australian involvement in the facility was quite miserable. According to an Australian computer operator who worked in the main computer room from November 1970 to February 1975, the 50-50 relationship that was supposed to pertain to staff at Pine Gap included very few Australians in the Top Secret area of the facility:

What the Americans did was to make a huge list of all personnel at the Base, including those in the unclassified outside perimeters, who included housemaids for the motel units, cooks, gardeners, labourers, bus drivers and clerical staff. This allowed the Americans to satisfy the 50/50 relationship admirably, but leaving almost entirely all Americans in the Top Secret sector.6

By February 1975, there were still only 14 Australian computer operators employed at the station (about six per cent of the total Australian employment at that time). None of these Australians were employed in supervisory positions and, indeed, these Australians believe that there was a deliberate policy to exclude Australians from these positions.7 More importantly, former Australian computer operators at Pine Gap have stated that Australians were excluded from the critical Signals Analysis Section (SAS) of the facility.8

The first comprehensive official statement on Australian involvement in the management and operations of the Pine Gap

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8 Interviews with former Australian Pine Gap personnel, October-November 1981.
Those Australians and Americans whose briefing has been authorised by their respective Governments are fully aware of the nature of the work of the facility and how the facility is operated. Those at the site whose responsibilities so require have equal right of access to all parts of the facility and to its activities and all results of the research. This right of access excludes only the 2 national communications rooms of the operating partners, to which, in accordance with standard practice at all joint installations, access is restricted to preserve national cipher security. National privacy in this respect, however, does not, and cannot, extend to denial of knowledge of the programs and activities of the facility.

The interdependence of the staff in their work and the physical layout of the various areas of work are such that the scope of a program being undertaken is clear to all working there, Australian or American, and to supervisors visiting the areas. Even the most detailed information can be readily obtained and checked.

The senior Australian on site is the Australian defence representative. He works closely with his United States counterpart, participating daily in the decision-making concerned with program activities. He likewise attends the daily staff conferences and meetings reviewing operations. He has detailed knowledge and experience of the capability and activities of the facility and, of course, complete access at any time to all areas and operations. There are other Australians on the floor working across the various shifts and programs and with unrestricted access.9

Various new arrangements for Australian participation in the management and operations of the Pine Gap station were instituted in the late 1970s and early 1980s. Australian personnel were evidently approved for work in the Signals Analysis Section in 1979-80, and in 1983, the Australian Defence Representative was appointed Chairman of the Joint Reconnaissance Schedule Committee.

More recently, important changes to the management and operational arrangements at Pine Gap were announced by the Prime Minister, Mr Hawke, on 22 November 1988:

At Pine Gap, the number of Australians engaged in the central operational activity is being steadily increased. Some of these personnel, who are drawn from scientific and intelligence areas of the Department of Defence, are taking over functions previously carried out by United States employees. Whereas only a handful of Australian Government personnel was directly involved in the central work of the facility in the 1970s and early 1980s - contributing less than 10 per cent of the staff there - the proportion is scheduled to rise to about 30 per cent over the next two or three years. But Australians are not only doing more of the operational work at the facilities. Under the new arrangements we have agreed, Australians will carry out more of the senior management functions at both Pine Gap and Nurrungar.

At Pine Gap, a senior Australian defence official will be appointed to a newly created position as deputy chief of the facility. He will advise and support the United States chief of the facility in managing the facility and its activities, and he will share responsibility with him for that work. He will also continue to be the officer in charge of the prohibited area, with ultimate responsibility for the physical security of the facility. Other senior management positions will also be filled by Australians.10

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In summary, more than a thousand Australians have worked at Pine Gap since the station became operational in 1970s, although only a couple of hundred of these have been employed in central management or operational activities. These personnel are the repository of a wide range of space-related skills and experiences:

- management, operation and maintenance of one of the largest and most sophisticated satellite ground control stations in the world.
- satellite station-keeping, including precise alignment of satellite orientation and focussing of the SIGINT antennas.
- satellite read-out.
- real-time reception, processing, analysis and dissemination of intercepted signals.
- satellite communications.
- site preparation and installation of satellite ground terminals.
- supervision of satellite command and control operations and ground support operations.
- computer scheduling, computer operations and computer software procedures.
- ground station maintenance.
- ground station security, including security from electromagnetic interference as well as physical penetration.

(ii) Joint Defence Facility - Nurrungar (JDF-N):

The Joint Defence Facility - Nurrungar (JDF-N) is the Overseas Ground Station (OGS) for the US Air Force’s Defense Support Program (DSP) missile early warning system. It is located within the Woomera area at 136°46' E and 31°19' S, about 500 km northwest of Adelaide and about 10 km from Woomera Village. It became operational in early
Defence Aspects of Australia's Space Activities

1971, with a single satellite ground terminal for transmission of command and control signals to the DSP-E satellites stationed over the Indian Ocean and for the reception of the early warning and other telemetry data from those satellites. In 1972-74, a second antenna, a 40-foot diameter AN/MSC-46 system, was installed to provide communications between Nurrungar and the US through the Defense Satellite Communications System (DSCS). In 1988, this DSCS terminal was replaced by a 38-foot diameter AN/GSC-52 DSCS system. A third, smaller antenna was installed in 1989 to provide 'a back-up when the main antenna is out of service through maintenance or breakdowns'. A fourth antenna was installed in 1989-1990.

The Nurrungar OGS is currently operated and maintained by the 5th Defense Space Communications Squadron of the 1st Space Wing of the US Air Force Space Command headquarters at Peterson Air Force Base in Colorado. The communications and electronic support for the 5th Space Communications Squadron is provided by the 1970th Communications Squadron, the mission of which is formally described as follows:

Mission: to equip, administer, train, and provide personnel to operate and maintain satellite date transmitting, receiving, processing, display and

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11 'Foreign Involvement in Defence-Related Facilities in Australia', Hansard (House of Representatives), 10 October 1978, p.1661.
Figure 7: The Joint US-Australian Defence Facility at Nurrungar, control station for US Defense Support Program (DSP) early warning satellites stationed over the eastern hemisphere (DSP-E)
Figure 8: US Defense Support Program (DSP) early warning satellite
Figure 9: AN/GSC-52 antenna installed at Nurrungar in 1987-88 for operations with the US Defense Satellite Communications System (DSCS)
Figure 10: Schematic Functional Organisation of the Nurrungar Station

1 Space Wing
US Air Force Space Command

5 Defense Space Communications Squadron

Commander JDF-N
(USAF Colonel)

Deputy Commander JDF-N
(RAAF Wing Commander)

Operations
- DSP Satellite Readout Station (SRS)
- Data Reduction Center (DRC)
- Tactical Operations Room (TOR)

Communications
- DSCS Satellite Communications Terminal (AN/GSC-52)
- US National Communications Room
- Australian National Communications Room

Logistics and Support
- Supply
- Computer Support and Maintenance
- Precision Measuring Equipment Laboratory (PMEL)
communications equipment at Woomera Air Station, Australia.16

In particular, the 1970th Communications Squadron has the responsibility to:

plan, organise, coordinate, direct, and control the maintenance of the maintenance mission... [to] exercise supervision over the following activities required to provide data to HQ SCD: Maintenance Support, Maintenance Control, Satellite Readout Station, Computer Maintenance, Satellite Communications Terminal, and Telecommunications Maintenance.17

The Commander of the 5th Defense Space Communications Squadron is the Commander of JSF-N as a whole. Australian personnel at Nurrungar constitute 1 Joint Communications Unit, the Commander of which serves as the Deputy Commander of the facility.

Figure 10 provides a schematic outline of the functional organisation of the Nurrungar station.

The main technical building at Nurrungar consists of three general areas: the Satellite Readout Station (SRS), the Data Reduction Center (DRC), and the Tactical Operations Room (TOR).

The Satellite Readout Station (SRS) provides the link between the DSP-E satellites and the ground. It contains the various communications equipment for transmitting the command and control signals to the DSP-E satellites and for receiving data from them.

The Data Reduction Center (DRC), which was originally equipped with dual IBM 360-75J computers, and which was substantially up-graded in the mid-1980s, processes the data into

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17 Ibid..
Table 2: Number of Australian and US Personnel Employed at the Nurrungar DSP OGS

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<th></th>
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Defence Aspects of Australia's Space Activities
tactical warning information for display and transmission to designated recipients.

The Tactical Operations Room (TOR) is the operational control centre at the station. It provides central technical control and management for the DSP-E system, and contains both mission displays and satellite controller displays.

In addition, the main technical building houses the US and Australian National Communications Rooms, which are responsible for the provision of secure communications to the US and the Department of Defence in Canberra.

The technical support building is responsible for such activities as maintenance support, maintenance control, computer maintenance, and telecommunications maintenance. In addition, it contains a Precision Measuring Equipment Laboratory (PMEL) which supports the activities of both the 5th Defense Space Communications Squadron and the 1970th Communications Squadron.\(^{18}\)

Australian personnel are fully integrated into the management and operation of the Nurrungar station. As shown in Table 2, the number of Australians employed at Nurrungar has increased from an average of about 180 in the 1970s (which represented about 45 per cent of the total Australian and US personnel) to an average of some 200 in the early 1980s (which represented about 48 per cent of the total), to 221 in July 1986. The Australian unit, formally designated 1 Joint Communications Unit, is RAAF sponsored but includes contingents from the Army (some eight officers and NCOs) and the RAN. There are also civilians from the Department of Defence and AWA Defence Industries.\(^ {19}\) Postings are generally for 2-3 years.

According to the Prime Minister, Mr Hawke, ‘Australians constitute some 40 per cent of the staff in the key operational areas’ at


The Australian Deputy Commander (a RAAF Wing Commander) shares with the US Commander (a US Air Force Colonel) responsibility 'for the management of the station and its physical security'. Australian Air Force officers have undergone Space Systems Director (SSD) training in Denver, Colorado, to prepare them for management and operational responsibilities at the station. The SSD task is to supervise satellite command and control operations as well as ground support operations. This includes responsibility for supervising computer scheduling and operations (e.g. ensuring that as many computer mainframes as possible are kept on-line). Operation of the station involves four shifts - three of which work for eight hours each day while the fourth takes rest and recreation. According to the Minister representing the Minister for Defence and Foreign Affairs in the Senate:

Australian personnel are fully integrated ... into the operation of the [Nurrungar] station with standing requirements that there be at least one Australian Service Officer on each shift crew in the operations room [i.e. the TOR]. At present [i.e. August 1985] three of the four shift directors are Australian officers.

Approximately equal numbers of US and Australian personnel man the Satellite Readout Station (SRS) - in October 1986, for example, some 19 personnel were working in the SRS, of whom nine were US and ten were Australian personnel. Some of the particular duties for which Australians have responsibility have been described by an Australian Warrant Officer working at the station as follows:

All [Australian] staff are fully integrated into the overall site operation and carry out primary duties such as Unit Plans and Project Officer, Space Operations Centre Commander/Deputy Commander,

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21 Ibid.
22 'Arms Control', Hansard (Senate), 22 August 1985, p.174.
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Chief of Maintenance, Satcom NCOIC [Non-commissioned officer in charge], Satellite Readout Station, Crew Chief, Ground Station Operator and Satcom Technicians. Some of these positions are supervised by US service personnel and in the majority of cases the Australians supervise US personnel.24

Australian personnel have sole responsibility, of course, for the management and operation of the Australian National Communications Room, which provides the communications link between Nurrungar and the Department of Defence in Canberra.

In summary, perhaps as many as 1,200 Australian personnel have served at Nurrungar since the facility became operational in 1972. These personnel constitute an enormous repository of skills and experience in a wide range of space-related activities:

- management, operation and maintenance of a large and sophisticated satellite ground station.
- satellite station-keeping.
- satellite read-out.
- real-time reception, processing, analysis and dissemination of early warning data.
- satellite communications.
- site preparation and installation of satellite ground terminals.
- supervision of satellite command and control operations and ground support operations involving shifts with some 50 personnel.
- operation of sophisticated data displays.
- computer scheduling, computer operations and computer software procedures.
- ground station maintenance.

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- ground station security.

(iii) DSD SATCOM SIGINT Facilities:

Since 1977, the Defence Signals Directorate (DSD), Australia’s largest and most effective intelligence organisation, has been involved in the operation of satellite ground facilities designed to intercept foreign satellite communications.25

This activity began with Project Kittiwake, a cooperative operation with the British Government Communications Headquarters (GCHQ) designed to monitor communications from Chinese communications satellites and telemetry from Chinese nuclear weapon, missile and satellite test activities, using satellite ground facilities at the Stanley Fort Satellite Station in Hong Kong. The station has three large satellite terminals, two of which are dedicated to the SIGINT collection mission and the other responsible from the satellite communications link (code-named Maroon Shield) between Hong Kong and the Watsonia SATCOM station in Melbourne. The particular intelligence collected at the Stanley Fort Satellite Station includes:

- Telemetry from Chinese satellite launches.

- Mission data from Chinese electronic intelligence (ELINT) and photographic intelligence (PHOTINT) satellites.

- Chinese satellite communications.

Given 2-3 year posting practices, several dozen Australian personnel would have had some experience in space-related activities at Stanley Fort. The station is scheduled to be closed when the Australian Defence Satellite Communications Station (ADSCS) currently being constructed at Kojarena, near Geraldton in Western Australia, becomes operational in 1993.

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25 For a more comprehensive discussion of DSDs SATCOM SIGINT operations, see Desmond Ball, Australia’s Secret Space Programs, (Canberra Papers on Strategy and Defence No.43, Strategic and Defence Studies Centre, Australian National University, Canberra, 1988).
DSDs second SATCOM SIGINT facility, code-named Project *Larkswood*, became operational at Shoal Bay, near Darwin, in late 1979. The facility is designed to intercept Indonesian satellite communications. It originally consisted of two satellite earth terminals. The larger, which is about 33 feet in diameter, monitored the Indonesian *Palapa* COMSATS stationed at 77° E and 83° E over the mid-Indian Ocean, while the smaller antenna was concerned with the *Palapa* satellites stationed over Indonesia itself.26 Subsequently, according to the Minister for Defence, ‘the Station has been modified in response to changing requirements and this has included the installation of several dish antennas’.27

The decision to establish a new DSD SATCOM SIGINT station near Geraldton in Western Australia was disclosed by the Minister for Defence, Mr Beazley, in the White Paper, *The Defence of Australia 1987*, tabled in Parliament on 19 March 1987:

The Government plans to enhance our independent intelligence capabilities by establishing a large satellite communications station in Western Australia. This will contribute to Australia’s security in our area of strategic interest. The station will be totally Australian owned and will be manned and operated by the Defence Signals Directorate.28

Construction of the Australian Defence Satellite Communications Station (ADSCS) began at Kojarena, about 25 km east of Geraldton, in September 1988. The station is scheduled to become operational in late 1993, at which time some 16 buildings will have been constructed and four 26-metre diameter SATCOM terminals will have been installed. (A $30 m contract for the four terminals was awarded to AWA Defence Industries and Baulderstone Hornibrook Engineering on 1 May

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Figure 11: Project Larkswood, DSD Station, Shoal Bay, Northern Territory
It is likely that further SATCOM terminals will be installed later in the decade. Although the total project cost of the facility has not been disclosed, the former Minister of Defence, Mr Beazley, has stated that ‘the figure is well over the $100 million mark’. Unofficial estimates of the cost range from $120 m up to $300 m. It is expected that the station will be manned by about 125 Australian personnel. (In addition, some 10 British GCHQ personnel will be stationed at the ADSCS for three years to assist in the shake-down phase of the project and to ‘transfer’ certain ‘skills’ to their DSC counterparts).

The general purpose and function of the ADSCS is to monitor communications and other signals transmitted from satellites stationed in geostationary orbits over the Indian Ocean and Southeast Asia. At the time the Kojarena ADSCS was designed, there were some 93 geostationary satellites either operational or planned for launch by 1990 within the purview of the station. The particular satellites of interest to the station can be categorised as follows:

1. Soviet communications satellites, including Ekran television broadcast satellites, Raduga domestic COMSATS, Gorizont COMSATS, and Kosmos geostationary satellites, which are used for both data relay and SIGINT collection purposes.

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Figure 12: Schematic of Australian Defence Satellite Communications Station (ADSCS), Kojarena, near Geraldton, WA, scheduled to become operational in mid-1993
2. Regional geostationary satellites, including Japanese, Chinese, Indonesian, Indian and Pakistani COMSATS.

3. International communications satellites, including INTELSAT COMSATS and MARISAT maritime communications satellites.

The construction, management, operation and maintenance of the DSD SATCOM SIGINT stations at Shoal Bay and Kojarena (as well, to a minor extent, as Australia's participation in the Kittiwake operation in Hong Kong) has provided DSD and the Australian Defence Force (ADF) with a significant pool of personnel with skills and experience in the following space-related areas:

- construction, management, operation and maintenance of facilities which are among ‘the most modern state-of-the-art facilities in the world’.34
- project engineering, including satellite communications/ systems planning, contract negotiations and management, logistic support and project monitoring/ coordination.
- computer systems engineering, including technical planning, installation and support of one of the most modern main operating system.
- communications engineering, including planning, design, acquisition and installation of communications equipment and systems.
- satellite tracking and alignment of ground antennas for optimal signal reception.
- design, acquisition, installation and operation of large satellite ground terminals.
- signal processing and analysis.
- site security.

The US Defense Satellite Communications System (DSCS):
The DSCS is perhaps the largest single US military satellite program. Although the number of satellites in the system operational at any given time is second to that of the GPS navigational/positioning satellite system, the DSCS program generally receives the largest annual budgetary appropriation, it involves the largest number of major satellite ground terminals around the world, and it supports an extremely wide range of US global military and intelligence missions.

The most comprehensive but succinct description of the DSCS is given in *Jane's Military Communications*:

The Defense Satellite Communications System (DSCS) has been designed and configured for presidential communications; to support the Worldwide Military Command and Control System (WWMCCS) by providing communications service between the National Command Authorities (NCA)/Defense Communications Agency (DCA) and the unified and specified commands, between the unified and specified commands and the general war combat forces, and by providing communication from peripheral early warning sites and from critical intelligence sites to provide a high-capacity, reliable, independent communications capability in support of contingency and limited war operations and to restore primary Defense Communication System (DCS) transmission sub-system that may have become inoperative due to natural causes, sabotage or direct enemy action; to augment the DCS with a transmission sub-system capable of providing the wide-band channels required to handle high-quality secure voice, high-speed data between automated command and control centres, high-resolution graphics and imagery, and rapid transmission of sensor data; to provide DCS communications service to remote locations not adequately served by other means; to support Navy ship-to-shore communications and other authorised users; to support the voice channel requirements of the Ground
Mobile Forces (GMF); and to support voice and data requirements of the Diplomatic Telecommunications System (DTS), the United Kingdom and NATO.

The DSCS provides communications services to components of the DoD, the National Security Agency, and special authorised users including the DTS, the White House Communications Agency (WHCA), the DCA, NATO and the United Kingdom. In addition to serving DoD components the DSCS directly supports the WWMCCS. This system provides high-priority communications to the JCS, unified and specified commands for the direction and control of forces, and for special intelligence and warning.

The DSCS provides analogue and digital transmission paths for virtually every type of telecommunications application. Its configuration can be readily changed to meet contingency requirements. Both strategic and tactical communications needs are met through the global DSCS. Telecommunications services to virtually every geographical area in the world can be established in the time required to deploy a transportable earth terminal. These capabilities make the DSCS an essential sub-system of the DCS for US telecommunications needs.

The DSCS users have the following priority:

Presidential and national authorities
JCS Unified and specified commands
DCS
Other DoD
Non DoD national
NATO and allied governments as specified by international agreements.35

The DSCS space segment currently consists of eight satellites - four DSCS IIs and four DSCS IIIs. These provide worldwide coverage from four geostationary positions - 12° W over the Atlantic Ocean (DSCS LANT); 135° W over the East Pacific (DSCS EPAC); 175° E over the West Pacific (DSCS WPAC); and 60° E over the Indian Ocean (DSCS IND).

The DSCS II satellites each weigh 590 kg (1,300 lbs), are 2.75 metres (9 feet) in diameter, and 3.95 metres (13 feet) tall with antennae extended. The electrical power is supplied by solar arrays which provide an output of 535 watts at launch, decreasing to a minimum of 358 watts after five years.

The antennae systems on the DSCS II satellites consist of an X-band multi-channel single-frequency conversation repeater with a bandwidth of 419 MHz and a capacity of 1,300 voice channels or up to 100 megabits per second of data; and Earth-coverage (ec) antenna with a transmit beamwidth of 18°, a gain of 16.8 dBi, and an effective radiated power of 28 dBw; a steerable narrow-coverage (nc) antenna, with a beamwidth of 2.6°, a gain of 33 dBi, and an effective radiated power of 43 dBw; and a steerable area coverage (ac) antenna, with a beamwidth of 6.5, a gain of 22 dBi, and an effective radiated power of 32 dBw. The nc and ac antennae are each steerable to ±10, and they are both capable of receiving and transmitting simultaneously. This arrangement provides four different channels of operation - Earth coverage to Earth coverage (ec - ec); Earth coverage to narrow coverage/area coverage (ec - nc/ac); narrow coverage/area coverage to Earth coverage (nc/ac - ec); and narrow coverage/area coverage to narrow coverage/area coverage (nc/ac - nc/ac). In addition, the satellites are equipped with an S-band biconical horn antenna with a torroidal beamwidth of 32° for the reception and transmission of telemetry and command data for satellite control.


Figure 13: DSCS II Satellite
Figure 14: DSCS III Satellite
The DSCS III satellites weigh some 1,040 kg; the central structure is 110 inches in length, and extends to 457.7 inches with the solar array fully deployed; it is 76 inches wide and 77 inches deep. The solar power system is capable of producing 1,240 watts at the beginning of each mission and 980 watts at the end of the projected 10 year satellite lifetime. A monopropellant hydrazine propulsion subsystem, with 600 lbs of fuel, is used for attitude control and stationkeeping.

The DSCS III satellite communications system consists of a six-channel SHF transponder, with each channel powered by its own travelling wave-tube amplifier (TWTA) to allow the most efficient use of the available frequency spectrum and power, and ten flexibly interconnected antenna systems. Two of the channels (1 and 2) have a power output of 40 watts, while the other four (3-6) have a power output of 10 watts; one channel (No.6) has a bandwidth of 50 MHz, one (No.3) a bandwidth of 85 MHz, and the other four have bandwidths of 60 MHz.

The ten communications antennae consist of four Earth-coverage horn systems (two each for reception and transmission); a 61-beam waveguide lens reception antenna, with an associated beam-forming network, which provides anti-jamming protection and a selective coverage capability; two 19-beam waveguide lens transmission antennae with beam-forming networks to rapidly produce selective coverage patterns tailored to the network of ground receiving terminals; a high-gain (3° beam) gimbaled dish transmission antenna for spot-beam fixed coverage; and two UHF antennae, one a bow-tie reception system and the other a cross-dipole transmission system, for use by the Single Channel Transponder (SCT). The SCT is integrated into the spacecraft to provide secure and reliable dissemination of the Emergence Action Message (EAM) and Single Integrated Operational Plan (SIOP) communications for the US strategic nuclear forces and command systems. In addition, there is a dual-frequency (UHF/S-band and SHF/X-band) Telemetry, Tracking and Control (TT&C) system for spacecraft control tracking, positioning, and housekeeping.40

40 Material on DSCS II satellites provided by Space Systems Division, General Electric, Valley Forge Space Center, Philadelphia, Pennsylvania.
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There are currently installed in Australia some half a dozen satellite ground terminals that operate either as integral parts of or in connection with the DSCS system. These are as follows:

- An AN/GSC-39(V)1 terminal at North West Cape, WA. This is a 38-foot diameter X-band system, previously designated AN/MSC-61, designed to operate with DSCS II satellites but also to be compatible with DSCS III satellites. It was declared operational on 9 July 1984.

  The GSC-39 at North West Cape replaced an AN/TSC-54, one of which was installed at the station from 1967 to 1973, and another from 1977 to 1984.


- An SCT-8, 8-foot diameter X-band system installed at Pine Gap in 1980.

- An AN/GSC-52 terminal at Nurrungar, SA. This is a 38-foot diameter antenna which was installed in 1987-88 and which replaced an AN/MSC-46 terminal which had operated at Nurrungar from 1973 to 1988.

- An AN/FSC-78 terminal, code-named Project Sparrow, which was declared operational at Watsonia Barracks in Melbourne on 1 July 1981. This is a 60-foot diameter Heavy Earth Terminal, which is operated by the Satellite Terminal Troop of Communications Squadron of 6 Signal Regiment, and which provides a communications link, via the DSCS system, between DSD headquarters in Melbourne and the headquarters of the National Security Agency (NSA) at Fort Meade in Maryland.

- A terminal operated by the Advanced Engineering Laboratory Satellite Communications Experimental Facility at the Weapons Research Establishment (WRE) at Salisbury, SA, which was built in 1971 and is used to conduct a variety of experiments relating to
Figure 15: Project Sparrow, ANFSC-78 DSCS Ground Terminal, Watsonia, Victoria
Figure 16: AN/GSC-39(V) Ground Terminal, North West Cape, W.A. The terminal became operational in July 1984.
the requirements of the satellite component of Australia’s defence communications network. These include experiments in multiple access; interference reduction; propagation problems, including the attenuation of SHF signals by rain; and the design of man-portable satellite communications terminals for operation with SHF COMSats.

Several dozen Australians have received training in the US - at, for example, the US Army Signal Corps Headquarters and US Army Signal School at Fort Gordon, Georgia; the US Army Communications Command (USACC) SATCOM station at Fort Meade, Maryland; and the US Navy’s SATCOM station at Stockton, California - in the operation and maintenance of DSCS systems and equipment.

For example, most of the original members of the Satellite Terminal Troop of Communications Squadron of 6 Signal Regiment at Watsonia received training in the US on the DSCS system in general and the AN/FSC-78 terminal in particular before the terminal was officially opened on 1 July 1981.41 From August 1980 to June 1981, 15 Army Signal Corps technicians attended training courses at Fort Gordon and Fort Meade - five of whom would become Shift Leaders on their return to Watsonia and ten Shift Technicians who would man the shifts. The training courses included:

- the SATCOM Net Controllers Course, which covered ‘the overall network formed by the worldwide deployment of AN/FSC-78 Heavy Satellite Earth Terminals employing the Defense Satellite Communication System (DSCS) Phase II satellite[s]’.

- the Digital Communications Sub-System (DCSS) course. The DCSS ‘has the function of converting the voice or data signals from the system users into an IF [intermediate frequency] signal compatible with the input of the AN/FSC-78 earth terminal’.


42 Ibid..
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- the course on the AN/FSC-78 terminal itself - including the uplink, the downlink, the tracking and servo sub-system, and the logic monitor and control sub-system.

- on-the-job training (OJT) with two AN/FSC-78 terminals and associated sets of equipment at the Fort Meade DSCS station.

- a course run by Rockwell Collins on the wideband data link (WBDL) equipment, which provides the user interface to the Watsonia station.

(v) The US Navy’s Fleet Satellite Communications (FLTSATCOM) System:

The US Navy’s Fleet Satellite Communications (FLTSATCOM) system was designed in the early 1970s to provide an Ultra High Frequency (UHF) fleet broadcast service to all US Navy ships, as well as providing command and control links for computer-to-computer exchange of digital data among shore stations, fleet ballistic missile (FBM) submarines, aircraft carriers, cruisers, selected aircraft, and other ships and submarines. It instantly connects the President and Secretary of Defense (collectively known as the National Command Authority) to field-level commanders over virtually the entire globe. It is also used for naval intelligence communications, providing a link between ocean surveillance information collection stations (such as SOSUS sites and Classic Wizard/White Cloud Ocean Surveillance Satellite ground stations), central ocean surveillance information processing and analysis stations, antisubmarine warfare (ASW) operations centres, and fleet assets.43

The FLTSATCOM space segment consists of four satellites, stationed at 110° W over the east Pacific Ocean, 23° W over the Atlantic Ocean, 72.5° E over the Indian Ocean, and 172° E over the West Pacific Ocean.

Figure 17: US Navy Fleet Satellite Communications (FLTSATCOM) Satellite
The FLTSATCOM satellites themselves weigh more than 4,000 lbs (1860 kg) at launch and more than 2,000 lbs (912 kg) in geostationary orbit. They consist of two principal components, a payload module and the spacecraft module, each with a basic 8-foot (2.44 metres) hexagonal body. The antenna systems include a 16-foot (4.88 metres) parabolic UHF system, a helical UHF receive antenna, an S-band omni-directional antenna, and a Super High Frequency (SHF) horn antenna used for up-link communications. Each spacecraft is equipped with 23 channels - nine 25 kHz wide-band channels for Navy relay communications; twelve 5 kHz narrow-band channels used by the Air Force as part of the AFSATCOM system for communications with Strategic Air Command (SAC) strategic nuclear forces; one 500 kHz wide-band channel used by the National Command Authorities (NCA); and one 25 kHz channel (SHF up and UHF down) for fleet broadcast. FLTSATCOM 8 also carries an EHF test package.

Australian involvement in the FLTSATCOM program has provided RAN personnel with considerable experience in UHF SATCOM operations through two particular activities:

- operation of an AN/SSR-1 FLTSATCOM broadcast receiving system which was installed at the North West Cape naval communications station in the late 1970s.

- operation of AN/WSC-3 (RAN VI) UHF transceivers and ancillary equipment which has been installed aboard most RAN ships and at most shore establishments.45

The RAN, together with the Advanced Engineering Laboratory and Thorn EMI Electronics of Australia, has developed new technology for improving the anti-jamming capabilities of the

44 'North West Cape Communications Systems', Hansard (House of Representatives), 10 June 1981, p.3569.
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WSC-3 system. The concept involves a medium-speed frequency-hopping applique (FHA) that uses a four-channel time division/multiple access (TDMA) waveform, allowing a single radio to participate in four nets. In operation, the FHA multiplexes four channels of incoming 16 kbps voice/data and then applies frequency-shift keying (FSK) to modulate a 70 MHz carrier wave. The modulated signal is then routed to the WCS-3 via a modem port, with the transmissions burst out at a rate of 140 kbps.

(vi) Navigational and Global Positioning Satellite Systems:

Australia has been involved in the support of US navigational and positioning satellite programs since 1961, when the TRANET tracking station at Smithfield in South Australia became operational as part of a global network of stations established to support the US Navy's Transit navigational satellites. The Smithfield station has subsequently been involved with all succeeding US navigational satellite programs, including, since the beginning of 1981, the Global Positioning System (GPS) or NAVSTAR system.47

The Transit satellite system was originally designed to provide the US Navy with a continuously available and relatively high accuracy navigational capability for its Polaris Fleet Ballistic Missile (FBM) submarines. The system was made available to non-US Navy users in 1967.

The TRANET station at Smithfield is 'modest in size and humble in appearance'.48 It consists of a single building and two antenna structures. The building houses the signal receivers, amplifiers, and a microprocessor system which measures and records the signals from the satellites tracked by the station. All equipment at the station was supplied by the United States, and until 1971 the

48 Ibid., p.25.
Figure 18: US Global Positioning Satellite (GPS)
Figure 19: TRANET Station, Smithfield, SA, used to track US GPS satellites
operating and maintenance costs of the station were borne by the United States.\textsuperscript{49} The station has always been manned exclusively by Australians - some 11 personnel as of 1 July 1968, seven as of 1 July 1979, and three since 1972.\textsuperscript{50}

In the early 1970s, the US Department of Defense began development of a high-precision worldwide navigational satellite system, then known as NAVSTAR (for Navigation System using Timing and Ranging) and re-named the Global Positioning System (GPS) in 1973, which would be continuously available to all interested Services and Defense Agencies. The GPS satellites transmit two spread-spectrum navigational signals - a Course/Acquisition (C/A) code which provides lower navigational accuracies and which is available to any GPS user; and a Precise (P) code which is only available to users with access to special Department of Defense codes and which provides positional accuracies of $\pm 1$ metre per second in velocity in three dimensions and tens of nanoseconds in time.\textsuperscript{51}

On 27 February 1981, the Minister for Defence announced that he had agreed to a proposal by the US Department of Defense for portable tracking equipment to be located at Smithfield to assist in field testing of the GPS system.\textsuperscript{52} One US technician and one Australian Army technician were involved in this field testing as of 1982.\textsuperscript{53}

In addition to Australia’s involvement in the GPS program through the Smithfield facility, it is intended that GPS will become the primary navigation aid for all ADF aircraft, ships and Army units. Some of the features of this involvement to date are as follows:

- In August 1987, the RAAF awarded a $4m contract to Collins Avionics Division of Rockwell International

\textsuperscript{49} Ibid.
\textsuperscript{50} ‘Defence-related Facilities: Foreign Involvement’, \textit{Hansard (House of Representatives)}, 10 October 1978, p.1661.
\textsuperscript{53} Ross Thomas, ‘Eyes on the Sky for 20 Years’.
for the supply of GPS receivers for the Black Hawk helicopters.54

- In April 1988, a contract was awarded to Magnavox to upgrade the RAN’s Transit satellite navigation receivers to enable dual reception of both Transit and GPS navigation signals.55

- A joint Army/RAN/RAAF team was established in 1988 to plan for the selection and acquisition of a common GPS receiver for the ADF.56

- On 7 February 1991, agreement was reached with the US Department of Defense to allow the ADF to use the GPS P-code precision positioning service.

- Studies are in progress to assess the application of GPS to the precision delivery of glide bombs by the RAAF.58

- The preparation of tenders, expected to be let in January 1993, for the procurement of some 1650 manpack P-code GPS receivers.

The introduction of GPS into the ADF will have an impact on most, if not all, elements of the ADF. It will involve modifications to most aircraft, ships and boats in the ADF and will introduce into the Army the wide-scale use of a high technology, very accurate navigation system at moderate cost.

Geodetic Satellites:

Although geodetic satellites are generally quite 'underrated' in most public discussions of military activities in space, they are in fact vital for accurate missile targeting and precision delivery of other ordnance over long ranges, as well as for more general mapping purposes. During the 1960s and 1970s, the US launched some two dozen geodetic satellites, employing various techniques for tracking the satellites and precisely determining the positions of points on the Earth's surface - including geometric-optical systems, Doppler techniques, and active ranging techniques. Since the mid-1980s, a single dedicated GEOSAT program has been maintained, while increasing use has been made of the NAVSAT and GPS programs for geodetic purposes.

Australia has been actively involved in the US geodetic satellite program since 1961. Much of this activity has involved the TRANET station at Smithfield which, in addition to tracking Transit and other US Navy navigation satellites for geodetic purposes has also tracked most dedicated US geodetic satellites - beginning with the first successful launch, ANNA-1B, on 31 October 1961.

In addition to the station at Smithfield, portable geodetic satellite receivers have been established at hundreds of locations in Australia since the early 1960s. Between July 1974 and 1985, for example, portable geodetic receivers were operated by the Army Survey Corps at more than 650 locations. In all, the location of some 1,500 sites had been determined by 1985. Particular sites have included Cocos Island, Swanbourne Barracks in Perth, Culgoora (NSW), Thursday Island, Norfolk Island, Manus Island, Darwin (NT), Carnarvon (WA), Townsville (Qld), Caversham (WA), Heard Island,

60 See Desmond Ball, 'Geodetic Satellites', (Reference Paper No.125, Strategic and Defence Studies Centre, Australian National University, Canberra, October 1984).
61 'Satellite Ground Stations', Hansard (Senate), 12 February 1986, p.228.
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Mawson and Casey in Antarctica, Woomera (SA), Orroral Valley (ACT) and Muchea (NSW).62

The numbers of Australian personnel involved in operating these geodetic satellite observation posts have been small - usually only one or two persons.63 Three sorts of tracking equipment were used during the 1960s and 1970s - the BC4 optical tracking system, Doppler tracking systems, and SECOR (Sequential Collation of Range) systems.64 As of May 1989, Army Survey Corps personnel were also using five Magnavox 1502 and nine Texas Instruments TI 4100 portable satellite receivers to track NAVSATS and GPS satellites for geodetic/ mapping purposes.65

Although this activity is small in terms of the numbers of personnel involved, it has been quite valuable in terms of the acquisition of specialised space-related skills and experience, including:

- the operation and maintenance of various types of portable satellite tracking and signal receiving systems.
- the application of satellite geodetic data to mapping and survey work.

(viii) Australian Defence Satellite Communications:

Australian Defence interest in a satellite communications capability began to crystallise in the mid-1970s, but it took another decade before Defence was prepared to commit itself to the DEFAUSSAT project. In 1977, the Australian Government established a Task Force ‘to inquire into all aspects related to a national

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64 Desmond Ball, ‘Geodetic Satellites’, pp.2-6.
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communication satellite system for Australia'.66 Two members of the 11-person Task Force were from the Defence Department - the Director General of the Defence Communications System Division and the Director General of Joint Communications in the Joint Military Operations and Plans Division - but the Department was unwilling at that time to participate in a national system. Rather, while noting the opportunity that a national system would present for the Defence Force, the Department was only prepared to commit itself to 'further studies ... of the military need, associated cost and time of introduction of a satellite system'.67

In November 1979, the Government announced that it had decided to establish a National Communications Satellite System, and advertised for potential contractors to register interest in the project. In November 1981, AUSSAT Pty Ltd was established by the Government as a commercial company to design, develop and operate the national COMSAT system. In May 1982, the Minister for Communications issued an Information Paper and accompanying Ministerial Statement which described the satellite and ground segments, the cost, the anticipated operational date (mid 1985) and the services to be provided by the National Communications Satellite System (NCSS).68 There was not a single mention of Defence interest or of any relevance of the NCSS to defence communications needs in these formative papers. Later in May 1982, a contract was signed with Hughes Communications International for three HS 376 communications satellites (including one spare) and two ground control stations - the Satellite Control Centre at Belrose in Sydney and a back-up control centre in Perth.69 In October 1982, AUSSAT

67 Ibid., p.119.
contracted with the US National Aeronautics and Space Administration (NASA) for two satellite launches by the Space Shuttle in 1985; and with Mitsubishi Australia Ltd for the provision of 12 Major City Earth Stations (MCEs) in the eight capital cities.

Prompted by the progress toward a fully operational national communications satellite system by 1985, the Department of Defence conducted several studies in 1982-84 which led to the decision to utilise the national AUSSAT system as a component of the Defence Strategic Communications System, with the SATCOM component designated DEFAUSSAT. The essence of the DEFAUSSAT project was defined in Defence planning documents in December 1984 as follows:

The DEFAUSSAT project encompasses a proposal to make use of AUSSAT tranponder capacity together with Defence-owned earth stations to provide a satellite transmission capability within the Defence strategic communication net-work.

On 9 September 1986, the Department of Defence signed a 15-year contract with AUSSAT Pty Ltd for the provision of a low power, 12-

73 Cited in *ibid.*, p.10.
watt transponder connected to a national beam antenna;\(^7^4\) and in March 1987, a contract was awarded to Clough Systems Limited (WA) and NEC Australia Pty Ltd for the supply of 10 fixed and two transportable earth station systems.\(^7^5\) The 10 fixed facilities were installed at Watsonia in Melbourne, Canberra, Cairns, Sydney, Williamtown, Brisbane, Townsville, Darwin, Perth and Adelaide. Provision was made for the acquisition of additional terminals, and an eleventh has subsequently been installed at RAAF Base Tindal, N.T.\(^7^6\) Two transportable ground terminals have also been acquired by the RAAF.\(^7^7\) From time to time the ADF also leases commercially available terminals, on a short term basis, to support particular requirements\(^7^8\) - such as the ITERRA terminals leased from TELECOM to supplement Defence-owned systems during Exercise Kangaroo 89.\(^7^9\)

While the present DEFAUSSAT system provides a reliable and highly capable strategic communications service, it is not well suited for tactical communications. The broad-band capacity of the current AUSSAT transponders is too valuable to dedicate to tactical purposes in peacetime, while the displacement of strategic users in contingent circumstances would be difficult in practice. The antenna beam-forming systems aboard the current AUSSAT-A COMSATs and the use of 14-14.5 GHz (transmit) and 12.25-12.75 GHz (receive) frequency bands do not favour mobile military satellite communications techniques. Further, the current ground segment of the DEFAUSSAT

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\(^7^6\) ‘Satellites and Tracking Stations’, Hansard (Senate), 29 May 1989, p.1744.

\(^7^7\) Ibid.

\(^7^8\) Ibid.

\(^7^9\) Exercise Kangaroo 89: July to September 1989, (DPUBS 13/90, Directorate of Public Relations, Department of Defence, Canberra, 1989), p.22.
system would need to be supplemented by the acquisition of ‘ruggedized’ transportable terminals for tactical usage.80

Since 1986, the Department of Defence has been involved with AUSSAT in planning the second generation of AUSSAT systems. Defence has proposed the installation of a Super High Frequency (SHF) X-band transponder on the AUSSAT-B satellites for dedicated Defence use,81 as well as the use of L-band services for mobile ADF tactical purposes.82

The skills and experience gained in designing, installing, operating, managing and maintaining the DEFAUSSAT system are quite prodigious. They include:

- the design and management of a large, national satellite communications system, including the earth terminals, control centre, trunk switching centres, and user terminal interfaces.
- procurement, operation, management and maintenance of some 11 fixed earth stations, as well as four transportable terminals.
- networking of SATCOM systems with HF radio, microwave relay and TELECOM services.

(ix) DSTO Research and Development Programs:

The Defence Science and Technology Organisation (DSTO), through its predecessor organisation, the Weapons Research Establishment (WRE), has been involved in space-related activities since the 1950s. Facilities at Woomera, operated and maintained by

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WRE, were used to track the first *Sputnik* and *Vanguard* satellites in 1957-58. The TRANET navigational satellite tracking station at Smithfield, SA, which became operational in 1961 and which was the first US space defence operation established in Australia, has been operated and maintained by WRE/DSTO for three decades. In the 1960s, Woomera was used for sounding rocket experiments, *Black Knight* rocket launches for researching re-entry phenomena, rocket launch and tracking trials for the European Launcher Development Organisation (ELDO), and the launch of Australia’s first satellite, WRESAT (1967-11A), on 29 November 1967.83

Current DSTO R&D activities involving space include the following:

- design, construction and cooperation of a satellite communications facility, with capabilities in both UHF and SHF bands, for experimental activities with DSCS, *Gapfiller*, and FLTSATCOM satellites;
- experiments relating to the requirements of the satellite component of Australia’s defence communications network, including experiments in multiple access, interference reduction, and the network dynamics of switched communications systems;
- experiments concerning propagation problems, including the attenuation of SHF signals by rain;
- the design of low-cost satellite communications receivers;
- the design of man-portable satellite communications terminals;
- architecture and systems studies for Defence uses of AUSSAT L-band mobile satellite communications capabilities;

Figure 20: UHF and SHF Terminals, Satellite Communications Experimental Facility, Salisbury, SA
Defence Aspects of Australia's Space Activities

Figure 21: SHF Terminal, Satellite Communications Experimental Facility, Salisbury, SA
Figure 22: Schematic of Portable SHF Terminal Developed at the Advanced Engineering Laboratory, Salisbury, SA.
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- R&D into satellite SIGINT systems, including techniques and capabilities for the location, interception and exploitation of signals;
- development of differential GPS systems;
- testing of GPS equipment;
- development of a low-cost fleet broadcast demultiplexer, to enhance the security of reception by RAN ships of broadcasts via the US Navy's FLTSATCOM system;
- accurate calibration of space-based radar systems;
- modelling of performance of infrared sensors;
- measurement of IR signatures and backgrounds;
- development of low-cost synthetic aperture radars;
- use of data from civilian remote sensing satellites, including collaboration with the CSIRO and others to collect and analyse data from LANDSAT satellites;
- generation of three dimensional imagery;
- fusion of data from different satellite sensing systems;
- development of military geographic information systems with inputs from satellite systems; and
- generation of maps of various sorts of military information (e.g. lines of sight, terrain trafficability, and parachute drop zones) using inputs from satellite systems.
CHAPTER 3

ASPECTS OF DEFENCE-CIVIL COOPERATION IN SPACE ACTIVITIES

1. Exploitation of Skills and Experience from Defence and Intelligence Space Activities:

Australia's defence and intelligence space activities constitute by far the largest set of such activities in the country. Whether measured in terms of financial expenditures, numbers of personnel involved, or the numbers of major ground terminals and associated support systems, it is likely that the defence and intelligence activity exceeds all other Government and commercial activities combined - including the AUSSAT, OTC INTELSAT and INMARSAT, TELECOM, ABC, Department of Aviation, and LANDSAT and other remote sensing/imaging programs.

Australian defence and intelligence agencies are now involved in tracking, controlling, using, or otherwise supporting more than half a dozen different satellite systems - including the US geostationary SIGINT satellites; the US Defense Support Program (DSP) early warning satellites; geodetic, navigational and positioning satellites; and DSCS, FLTSATCOM, Skynet, INMARSAT and AUSSAT communications satellites. In addition, DSD facilities track and monitor transmissions from more than half a dozen foreign national and international COMSAT programs. These activities now involve the operation of more than 40 ground terminals at some 20 locations, together with some two dozen transportable or portable terminals (for tracking and/or communication with DEFAUSSAT, FLTSATCOM, GPS and geodetic satellites). About 900 personnel from the Department of Defence and the Australian Defence Force (ADF) are currently engaged in these activities. Although precise figures are not publicly available - and probably do not even exist within the Department of Defence - the number of personnel that have been engaged in these activities over the past two decades is likely to be around 2,500. Several dozen Australians have received professional and technical training in space-related operations in the US - at, for example, the US Air Force's Multi-Purpose Facility at Lowry Air Force base in Denver, Colorado; the US Army Signal Corps Headquarters
and US Army Signal School at Fort Gordon, Georgia; the US Army Communications Command (USACC) SATCOM station at Fort Meade, Maryland; the USACC SATCOM station at Fort Monmouth, New Jersey; the US Navy’s SATCOM station at Stockton, California; and the US Air Force GPS/NAVSTAR Project Office. This represents an enormous resource of skills and experience.

Skills include:

- satellite tracking
- satellite station-keeping
- ground station management, operation and maintenance
- satellite communications
- signal processing
- telemetry reception and analysis
- operation of large computer networks
- communications security (COMSEC).

2. Australian Industry Participation in Defence Space Activities:

Australia’s policy of defence self-reliance, which has been pursued by successive Governments since the early 1970s, requires a strong and efficient technological and industrial base in many areas, including aerospace, telecommunications and electronics.\(^1\) In order to ensure that Australian industry shares in Australian defence projects to the maximum practicable extent, to promote more extensive and more efficient Australian industrial capabilities, and to provide viable industrial support for defence activities, the Government has developed an Australian Industry Involvement (AII) program. This program has three principal elements:

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- the encouragement of firms receiving Defence contracts to use local products where it is economic to do so;

- the provision of defence designated and assisted work (DDAW), under which certain designated elements of a capital procurement project are required to be manufactured, assembled, tested or set-to-work in Australia (despite the costs and/or time penalties involved), in order to ensure that industry can sustain the operational effectiveness of the particular defence capability; and

- defence offsets, under which technology transfer and work to the value of 30 per cent of the imported content of a contract should generally be placed with Australian industry.

The extent of involvement of Australian industry in Australia’s defence and intelligence space activities has generally been relatively poor, although it has certainly improved over the past decade. During the 1960s and 1970s, Australian industry participation in these activities was quite meagre. In the case of the TRANET navigation satellite tracking station at Smithfield, for example, which became operational in 1961 and which was Australia’s first involvement in defence space programs, all of the equipment was provided by the United States.2 In the case of the Joint Defence Facility at Pine Gap (JDF-PG), the Minister for Supply stated in August 1969 - at a time when several hundred million dollars worth of satellite ground equipment and computer systems was being imported from the US and installed at the facility - that:

There is no significant Australian made scientific and electronic equipment on order for, or in existence at, any of the joint United States-Australian defence or scientific installations or facilities in Australia. This is due to the fact that in most cases the equipment used at these facilities is of a highly specialised, mission

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oriented type which is not available in Australia. All scientific and electronic equipment for the Joint Space Research Facility, Alice Springs, has been specially developed in the United States.3

A significant improvement in this state of affairs has occurred since the early 1980s. When the DSD SATCOM SIGINT facility at Shoal Bay, NT, was modernised in the mid-1980s, with the installation of several new satellite tracking and receiving antennas, the Minister for Defence was prepared to provide an assurance ‘that the antennas at Shoal Bay were acquired ... with significant participation by Australian companies’.4

The DEFAUSSAT project involves more than 50 per cent Australian industry participation - amounting to some $30 m out of a total project cost of some $50 m.5 Not only is the transponder on the AUSSAT satellites leased from AUSSAT Pty Ltd, a 100 per cent Australian-owned company, but the ground systems are also primarily Australian-made. In March 1987, the Department of Defence awarded an $11 m contract for the provision of the first 10 fixed and two transportable earth terminals to Clough Systems Ltd of WA and NEC Australia Pty Ltd, which formed a joint venture company to undertake the DEFAUSSAT project. An Australian Industry Involvement (AII) package of about $6 m was negotiated covering project management, equipment supply, installation and commissioning.6

In the case of the Navy’s satellite navigation receivers, the upgrading of the Magnavox Transit systems to enable reception of GPS

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signals is being done by Hawker Pacific Pty Ltd under sub-contract to Magnavox Overseas Ltd in the US.7

A large proportion of the equipment at the DSD SATCOM SIGINT station currently being constructed at Kojarena, near Geraldton, is of Australian design and manufacture. In March 1989, AWASCO Pty Ltd (part of the AWA group) was awarded the contract for the operation and maintenance of communications equipment at the station.8 In May 1990, a joint venture of AWA Defence Industries and Baulderstone Hornibrook Engineering was awarded a $30 m contract to supply, install and commission four 26-metre satellite earth terminal antenna systems at the station. The antennas are being built to a design supplied under sub-contract to AWADI-BHE by the Australian company, Connell Wagner, in conjunction with the CSIRO Division of Radiophysics. Other Australian sub-contractors involved in the project include MITEC (Qld), which is responsible for the design and supply of the electronics, and TUNRA Ltd (NSW), which is supplying the antenna pointing and tracking control systems. According to the Minister for Defence, Senator Robert Ray, some 74 per cent of the antenna systems will be Australian/New Zealand content.9

Even in the case of Pine Gap, there was increasing involvement of Australian industry in the provision of services and equipment through the 1980s. In 1982, for example, a large computer maintenance contract was awarded to Digital Equipment Australia Pty Ltd for support of the DEC VAX-11/780 computer system.10 Most recently, an Alice Springs company, TMC Constructions, built the

latest two radomes (the tenth and eleventh) to be installed at the facility.\(^\text{11}\)

There are several reasons for this increasing Australian industry involvement in these defence and intelligence space activities. First, the Australian aerospace industry itself has become more capable over the past quarter of a century. In the late 1960s and early 1970s, when Pine Gap and Nurrungar were originally built, Australian industry had relatively little to offer. Second, the extraordinary secrecy surrounding the establishment of these facilities meant that Australian industry was simply not apprised of the equipment requirements. Rather, the equipment contracts were negotiated by the US authorities - the CIA, the Department of Defense and the US Air Force - with the US companies with which secret arrangements were already in place for the provision of such equipment (including E-Systems Inc., TRW Systems Inc., and IBM). As this secrecy has progressively dissipated, at least with respect to the particular function of Nurrungar (the DSP-E satellite ground control station), the general function of Pine Gap (the control of geostationary SIGINT satellites) and the nature of the ground support and computer equipment at the facilities, the scope for Australian industry involvement has expanded. And, third, the more recent Australian defence space programs have been somewhat less sensitive than the operations of the joint facilities, and the procurement procedures administered by the Australian Department of Defence rather than US authorities, and hence, again, there has been greater scope for Australian industry participation. In addition, the Department of Defence has become more mindful of the need to establish a more self-reliant defence industry in this country, and hence has made greater efforts to ensure that Australian industry receives significant proportions of the equipment and work involved in recent programs.

However, notwithstanding this increasing Australian industry involvement, there remains much more which can be done. With respect to the joint facilities, which together still comprise the largest defence space activity in this country, it is still the case that new equipment requirements are determined by the relevant US authorities.

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and discussed with US 'black' contractors well before Australian industry ever learns of them. The participation of Australian industry in the progressive modernisation of these facilities is therefore inevitably limited to the provision of secondary and supporting services and equipments. And while there has been a significant improvement in Defence's policies and actions concerning acquainting industry with defence requirements and ensuring increasing Australian content in Defence programs, there remains virtually no feedback from the other direction. In other words, there is no effective process in which industry is able to inform Defence of research activities or product developments which, at least as modified through continuing Defence-industry dialogue, could be very valuable to Defence. Savings might be made and capabilities enhanced.

Some of the recent developments in the civil scientific, technological and industrial community which could be valuable to Defence are as follows:

- design and production of satellite earth terminals. International state-of-the-art expertise in this area ranges from large (e.g. 26-metre, 250-tonne) fixed terminals, through specialised tracking and receiving terminals (e.g. for reception of data from environmental and meteorological satellites), to 'smart' mobile terminals for L-based mobile satellite communications.

- design and prototyping of spacecraft antennas, including sophisticated spot beam antennas.

- design and development of data network control systems for optimum interface of space and ground segments of data networks.

- microwave technology, including design and manufacture of filters, waveguides, frequency converters, and low noise and high power amplifiers for use aboard satellites as well as in ground stations.

- study and design of low cost (i.e. $15-20\,m) lightweight (i.e. less than 300\,kg launch mass) satellites.
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- design and production of satellite-borne sensor systems, including ultra-violet telescopes, infrared focal plane assemblies, visible and short-wave infrared scanners, laser sounders, radiometers, atmospheric pressure sounders, synthetic aperture radar (SAR) systems, and digital imaging telescopes.

- design and development of other spacecraft components, including advanced composite materials, high efficiency silicon solar cells for solar panels, and other structural sub-assemblies.

- data processing techniques and systems, including personal computer (PC)-based image processing systems (such as microBrian), general purpose imaging processing packages, and the high-speed Fast Delivery Processor (FDP) for one-tenth real-time processing of high-bit rate data from synthetic aperture radars.

- manufacture and operation of satellite tracking, telemetry, command and monitoring (TTC&M) ground facilities.

- management of small- and large-scale high technology space-related activities.

- provision of maintenance and logistic support for high technology space-related activities.

This list is far from exhaustive. In the first place, it is meant only to be illustrative of the sorts of capabilities currently available in Australian industry which could have defence import. Second, however, Australia currently lacks any mechanism through which the research, products and services that are available in the civil sector and that might be of defence import could be comprehensively and reliably identified and elucidated.

An essential requirement is the institutionalisation of some mechanism for continuous dialogue between Defence and industry (including the research community), so that Defence can keep industry abreast of its interests and requirements and industry can keep Defence informed of its extant and potential capabilities with respect
to space products and services. Without such a mechanism, it is simply not possible to realise the full potential of the Australian space science, technology and industry capabilities.

3. Infrastructure Coordination:

Defence planning and civil infrastructure development should proceed in close harmony. No major development project should be undertaken without the most careful consideration of the defence implications, both positive and negative, since such projects invariably add to the infrastructure which can be utilised by the Australian Defence Force (ADF) but can also pose defence problems. At the very least, the people and the property require protection. On the other hand, no major defence project should be undertaken without consideration of the implications for national development. The establishment of an airfield or a major communications facility in some areas can have a quite marginal effect on national development, whereas the same investment elsewhere can generate significant development.12

Given Australia’s limited resources, any duplication in the military sector of capabilities in, or likely to become available in, the civil sector should be resisted. On the one hand, the civil infrastructure has much to offer the military; on the other hand, the military can often do much to promote the civil sector and advance regional and national development plans. Planning for national development and national security should be indivisible.

Civil space projects are frequently of sufficiently large scale and involve advanced technologies as to be of direct utility to defence planning and operations. The use of the AUSSAT system and its associated infrastructure to provide the DEFAUSSAT component of the Defence Integrated Secure Communications Network (DISCON) is a good example of this.

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The establishment of a RAAF bare base (RAAF Scherger) on Cape York, which will proceed in about the same timeframe as the Cape York Spaceport should this project eventuate, provides an opportunity to use defence investments to promote regional and national development while perhaps leading to significant saving in the Defence vote itself.

A RAAF bare base on Cape York is needed to fill the last major gap in the RAAF air base network across northern Australia. The cost of the base is likely to be around $70m (in 1987 dollars). The base will have extensive runways with hard stands and loading areas, fuel facilities, and basic power, water, sewerage and other services to support a substantial infusion of RAAF aircraft and personnel at short notice. In normal circumstances, the only occupants would be a small caretaker staff.

In June 1987, Defence Minister Beazley announced that the preferred site for the RAAF base was near Weipa on the west coast of the Cape York Peninsula. Since then, a site survey has been completed on Sudley Station, some 40 km east of Weipa.

The proposed Cape York Spaceport will also require substantial airport facilities. There remain some uncertainties about the viability of the project, and hence whether and when a commercial decision to proceed will be made, as well as about the location of the Spaceport, although an east coast site is preferred for launch safety and

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14 Ken Blanch, 'North to Get $70m Fighter Base Early in 1990s: Beazley', Courier Mail (Brisbane), 25 June 1987, p.3.

15 See Ross Babbage, The Strategic Significance of Torres Strait, (Canberra Papers on Strategy and Defence No.61, Strategic and Defence Studies Centre, Australian National University, Canberra, 1990), p.113.

16 Ken Blanch, 'North to Get $70m Fighter Base Early in 1990s: Beazley', Courier Mail (Brisbane), 25 June 1987, p.3.
logistic support reasons. This raises the prospect that two airfields may be built almost simultaneously to take international standard aircraft (such as Boeing 747s) within 80 km of each other on remote Cape York.

Engineering studies conducted in 1987-88 provide some idea of the scale and type of airport facilities that would be required by the Spaceport. According to the *Infrastructure and Environmental Scoping Study* produced for the Institution of Engineers Australia, for example, the initial requirements would include an international standard airport with a runway 3,700 m long by 45 m wide, to service large transport aircraft such as C-5s, 747s, and C-130s. To cater for the take-off and landing requirements of advanced reusable vehicles (such as the HOTOL, Aerospaceplane or Trans Atmospheric Vehicle), the runway length and width would have to be extended to 5,000 m and 80 m respectively. The runway would have to be located within the Spaceport, at least in the case of reusable vehicle operations, for reasons such as security and proximity to the control centre and payload preparation facilities. The airport would also require taxiways, aprons, terminal buildings and storage facilities. Construction of the airport would constitute a major cost item (of the order of 10 per cent) of the Spaceport.\(^{17}\)

Assuming a decision were made to build the Spaceport on the east coast of Cape York, there would be a strong case for Defence to consider the possibility of a joint approach to the airfield development. Some of the primary advantages of co-location on the east coast were adumbrated by Ross Babbage in a report prepared for the Department of Defence by the Strategic and Defence Studies Centre in 1989, as follows:

- First, there could be a substantial saving in overall expenditure. There may also be political ramifications in spending tax payers

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money building a second international standard airfield in such close proximity.

- Second, were Defence to offer to build the airfield for the spaceport (with various accompanying safeguards), this would be a substantial indirect subsidy to the spaceport at no (or little) real cost to the Commonwealth. This could be an important factor in the economics of the overall project. To the extent that the nation has an interest in the spaceport being built and operating profitably, cooperation of this sort could be of substantial mutual benefit.

- Third, the spaceport plans a number of facilities and services for the airport and adjacent area that Defence is not planning for its bare base, but which co-location would provide. For instance, the spaceport plans to install sophisticated radar and range tracking facilities that could be useful for RAAF area surveillance, aerial warning, air traffic control and possibly (with some modifications) air combat manoeuvre training. The Space Agency will need its own fuel at the airfield and probably fire and other services. Many of the staff at the spaceport will be skilled aeronautical engineers and technicians who will work in well-equipped workshops. These people may have a latent capability to support RAAF operations as forward-deployed RAAF Reservists.

Security for the spaceport is expected to be tight, involving a 20 km radius secure buffer zone with a range of specialised protective measures.

- Fourth, in order to attract and retain the 2,000 mostly highly skilled staff required for stage one, the Space Agency plans a very modern town with a range of supporting facilities. These amenities could readily support any
additional RAAF personnel that may periodically be deployed to the airfield.

- Fifth, the east coast location has important economic and security advantages. Logistic support for the spaceport should be comparatively easy and inexpensive up the east coast inside the Great Barrier Reef. An off-shore fuel float line and a large barge ramp are planned by the Space Agency at Bolt Head. Support shipping would not need to pass through Torres Strait, nor traverse the narrow, shallow and potentially vulnerable 11 km channel in Weipa Harbour.

Moreover, in many contingencies, an east coast location would be significantly less exposed to harassment and raiding activities than one close to the comparatively open and accessible west coast. This, together with the spaceport’s broader security measures, could reduce substantially the scale of the ground defensive task in a range of contingencies.

- Sixth, co-location would mean that in a range of defence contingencies protective defence measures would be required at only one major new facility rather than two.18

There may, of course, be some disadvantages with co-location. Some of these have also been summarised by Dr Babbage.19 Questions have been raised, for example, about the possible weather limitations of east coast locations. Available data suggests, however, that cyclone occurrences are less frequent on the east than the west coast of Cape York. The Cape York Space Agency believes that its proposed airfield site, about 8 km inland, is largely unaffected by weather constraints. It is located on a wide, well-drained heath and scrubland plain.

18 Ross Babbage, The Strategic Significance of Torres Strait, pp.115-117.
19 Ibid., p.117.
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A second possible difficulty could arise were important RAAF requirements found to be incompatible with those of the Spaceport. This deserves careful consideration.

The most serious danger of constructing the RAAF base in conjunction with the Spaceport is that the latter may fail. Protection against this eventuality would need to be incorporated in any Defence agreement with the Spaceport authority.

The import of this discussion is not to suggest an early decision for co-location, but merely to point out that the possibility of a large civil space project has important implications for Defence planning. If the Spaceport is built, Defence could acquire airfield and other support facilities at greatly reduced overall cost to the taxpayer, while enhancing the overall viability of the Spaceport project. The issues at stake are certainly worthy of serious inter-departmental consideration.

4. Surveillance and Environmental Monitoring:

A national approach to space programs would allow the acquisition of capabilities which would be valuable to both the civil and defence communities but which could not be justified in terms of cost-effectiveness by either the civil or defence communities proceeding separately. A national remote sensing capability, involving the use of spaceborne imagery and other sensor systems for...

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20 For a case study of this approach, see Desmond Ball, J.O. Langtry and J.D. Stevenson, *Defend The North: The Case for the Alice Springs-Darwin Railway*, (George Allen & Unwin, Sydney, 1985).

It is argued in this study that a transcontinental rail link from Darwin through Alice Springs would be invaluable in most conceivable northern defence contingencies but that the construction and operating costs are beyond Defence resources given other Defence requirements; that the economic and social benefits of the rail link would be enormous but that the project would probably not be viable in straight economic terms; and hence that a national approach, involving some Government supplementation of the project on defence grounds to offset any lack in financial viability, would provide a major and affordable national asset.
environmental monitoring as well as surveillance of Australia's region of primary strategic interest, provides a superb example of the potential of such a national approach.

For several years now, studies have been underway within the defence establishment of the possibility of a satellite surveillance capability. There have been three areas of particular focus. First, Australian defence planners are interested in geographic information - both physical and infrastructural - for planning the defence of Australia. Such tasks as mapping, vegetation and terrain characterisation, and the development of digital elevation models could be accomplished using spaceborne visible light, infrared and microwave sensors. Second, there is a particular interest in ocean surveillance capabilities for monitoring shipping movements across the maritime approaches. And, third, there is a more general interest in the surveillance of Australia's area of primary strategic interest.

For states with global strategic interests, such as the United States and the Soviet Union, investments in radar imaging, photographic and electro-optical imaging, infra-red, SIGINT and ocean surveillance satellite systems, amounting to several billion dollars a year, have not been difficult to justify on national security grounds. For states with more limited areas of strategic interest, however, it is a different matter. Australia's area of primary strategic interest is extremely large. It includes an 'area of direct military interest', where Australia seeks to exert independent military power, and which extends over 4,000 nautical miles from the Cocos Islands in the west to New Zealand and the islands of the Southwest Pacific in the east, and over 3,000 nautical miles from the archipelago and island chain in the north to the Southern Ocean; and it encompasses Southeast Asia and the South Pacific generally, in which developments can affect our national security - a total of some 20 per cent of the earth's surface.

Despite this enormous expanse, however, satellites in low-earth orbits (LEO), whether in equatorial or polar orbits, would spend as much as three-quarters of their time over areas of little or no interest to

Australian defence planners. Moreover, much of Australia’s area of primary strategic interest lies in the tropics, where semi-permanent cloud cover and high atmospheric moisture content greatly limits the value of visible and infra-red sensors, and where data must be accumulated from multiple passes in order to provide sufficient worthwhile imagery. Microwave radar sensors would be most advantageous. It is likely that airborne platforms, equipped with radar, visible light and infra-red sensors, capable of being directed at areas of interest at short notice and of real-time data dissemination, would prove more cost-effective. On the other hand, the calculus could well change if the civil requirements for environmental monitoring were incorporated in system evaluations.

Australia is very well placed, both geographically and with respect to extant skills, experience and capabilities, for engaging in remote sensing from space. This was officially recognised when the Government announced its establishment of a national space policy in September 1986, at which time it endorsed the recommendation of the Madigan Report, *A Space Policy for Australia*, that:

The major market thrust of Australian space activities should be in the remote-sensing sector, involving both hardware and software....

The recommendation ... recognises the significant competence in this field which already exists in Australia.23

Geographically, Australia provides ‘a politically stable and acceptable, strategic location in the Southern hemisphere from which to monitor such problems as the greenhouse effect, ozone depletion, El

Nino and other global environmental factors. In addition, 'the geological processes within the horizon of Australian reception facilities span almost every geological era and phenomenon.  

The skills, experience and capabilities which already exist in Australia in the area of remote sensing are manifold. They include:

- long exposure to the technology, including 50 years usage of aerial photography and airborne geophysics, 25 years with meteorological satellite data and 17 years with earth observation satellite data (as of July 1989).

- internationally respected research centres in the CSIRO and several Australian universities.

- strong acceptance of remote sensing by the mineral industry.

- the accumulation of extensive experience with practical applications - including meteorological applications, covering a wide range of climatic conditions and temperature regimes; mineral exploration; well-developed shallow water and reef mapping capabilities; and land management applications.

- hardware R&D, design and manufacturing capabilities, exemplified by developments such as production of receiving stations for NOAA oceanographic and meteorological satellite data, production of CSIRO-designed antennas; hardware associated with the Australian Centre for Remote Sensing (ACRES) facility in Alice Springs and the Tasmanian Earth Resources Satellite Station (TERSS) at the University of Tasmania in Hobart; and the

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25 Ibid..
design of VLSI chips, CCD sensors and the ERS-1 fast delivery processor.

- the design and manufacture of sensing systems, including the Geoscan scanner, imaging spectrometers, atmospheric pressure sensors, ocean colour scanners, the infrared focal plane assembly (IRFPA) of the Along Track Scanning Radiometer (ATSA) for the ERS-2 satellite, ultra-violet telescopes, and synthetic aperture radar (SAR) systems.

- the development of commercial image processing systems and software packages, such as the MicroBrian image analysis system, the CSIRO DSIMP image analysis software package, the Gipsy, Arluny and A-Image image processing systems, the GSAR radar software, and the MOS-1 upgrade software.

- remote sensing education and training capabilities.26

The benefits to be derived from these remote sensing capabilities are enormous. Commercially, the market for remote sensing systems and services is growing rapidly; it was estimated in 1989 that ‘Australia should be capable of commanding an aggregate value-added services and image processing market share of $450-560 million over the next ten years’.27 Even greater economic benefits are likely to be achieved from the application of remote sensing to mineral exploration, exploitation of fishery and other marine resources, natural disaster monitoring, management of cash crops (such as cotton and rice), urban and landscape planning, and land management generally. Over the longer term, the principal benefits of remote sensing will ensue from an enhanced ability to monitor the global environment, ecosystems and climate. Indeed, the maintenance of ‘global habitability’ is likely to prove to be the principal justification of the enormous investments involved in the development and implementation of spaceborne remote sensing technology.28

26 Ibid., pp.16-27.
27 Ibid., p.3.
28 Ibid., p.2.
Australian authorities have recognised that 'substantial budgets' would be required to establish a satellite environmental monitoring program, and that 'particularly during times of economic constraint, it is sensible to maximise the nation's cost recovery through commercial and industrial development based on the technology'. 29

Although it is unlikely that the total cost of a satellite remote sensing program could be recovered from commercial returns, it is also unlikely that the Government would commit itself to long-term funding of such a program 'unless a reasonable level of cost recovery from spin-off commercial operations can be demonstrated'. 30

The calculus would become much more positive if a significant defence value could be demonstrate for spaceborne remote sensing. As noted above, the nature of the tropical atmosphere in Australia's area of primary strategic interest and limitations imposed by the physics of orbital parameters greatly reduce the utility to Defence of many of the sensor systems and operations that would be required for environmental monitoring. Given the essential commonality of much of the systems and processes involved in the surveillance and environmental monitoring activities, however, separate programs could not be justified. Indeed, it is unlikely that a program dedicated solely to surveillance could be justified on its own grounds for at least a couple of decades. There is simply no practical alternative to a common program. Compromises and trade-offs would often have to be accepted, but these would be imposed by the objective of optimising the national value of the program.

Three particularly promising areas for common programs are as follows:

- the joint development of Geographic Information System (GIS) capabilities and techniques. There is a very substantial overlap between Defence's requirements for mapping, vegetation and terrain characterisation, trafficability models and infrastructure information and the civil requirements of GIS for land management, infrastructure development, and conservation.

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29 Ibid.
30 Ibid., p.16.
the joint development of oceanographic capabilities and applications. The Navy has an interest not just in monitoring shipping movements, but also in monitoring weather conditions (e.g. sea squalls and cyclone activity), sea states (e.g. significant wave heights), sea temperatures, ocean circulation signatures (fronts and eddies), acoustic conditions, water clarity, ice edges, beach conditions, etc. Sensors which provide ocean colour images, infrared signatures and altimetry would satisfy much of the Navy's interest as well as those of the environmental monitoring community.

- the joint design of a spaceborne microwave radar system. A synthetic aperture radar (SAR) with both scan and 'pencil beam' capabilities would effectively allow Defence to obtain all-weather high-resolution surveillance data and the environmental community to monitor such things as tropical deforestation at lower resolution. It should be possible to operate the spacecraft in equatorial orbit (perhaps 30° inclination) with ground tracks optimised to satisfy both surveillance and environmental monitoring interests.

Perhaps the major problem in implementing a national satellite surveillance and environmental monitoring program, with maximum commercial cost recovery, is organisational. Australia's current activities in remote sensing are characterised by fragmentation and duplication of effort and resources.31 The reasons for this fragmentation were succinctly summarised by the Remote Sensing Working Party of the Australian Space Board in July 1989 as follows:

[T]he Federal/State system of government, the number of departments which have had responsibility for remote sensing, the lack of development strategy and the effect of commercial competition between the private industry, government and academic sectors.32

31 Ibid., pp.5,20.
32 Ibid., p.20.
This problem of fragmentation is compounded by 'the minor role played by the Australian defence sector in providing the focus, financial support and R&G contracts for remote sensing which have been a major stimulus to industrial development in other countries'.

It is unrealistic to expect Defence to serve as the primary dynamo for remote sensing in this country but, nevertheless, there is no doubt that Defence could be a much greater stimulant than at present. The Laser Airborne Depth Sounder (LADS) developed by DSTO is one of the few examples of where the Defence sector has generated a marketable remote sensing product. Defence R&D and applications in the remote sensing area to date have largely developed in isolation. Yet 'the defence sector, particularly in the areas of mapping, surveillance and terrain assessment, is potentially one of the most significant users of the technology' - and, as such, it 'should contribute to the strategic planning process' concerning the development of space-based remote sensing in this country.

In its report issued in July 1989, the Remote Sensing Working Party of the Australian Space Board made two important recommendations for addressing the fragmentation of Australia's remote sensing effort in general and for involving Defence in the national effort more particularly. With regard to Defence involvement, the Remote Sensing Working Party recommended that:

A joint task force between the ASB [Australian Space Board] and the Department of Defence should be established to investigate the present and potential role of the defence sector in remote sensing development and the requirements of the defence sector from remote sensing. This investigation should include an assessment of procurement plans for remote sensing equipment.

More generally, the Working Party argued that:

The present national remote sensing management committee structure must be rationalised to minimise fragmentation and duplication of effort and to provide

33 Ibid...
34 Ibid., p.43.
35 Ibid..
coherent direction. This management structure should incorporate the existing ALCORSS [the Australian Liaison Committee on Remote Sensing by Satellite] and the ASB Remote Sensing Working Party and involve other relevant departments such as Foreign Affairs and Trade and Defence.36

The rationalised management structure recommended by the Working Party would consist of a National Remote Sensing Development Committee, with three chapters - ALCORSS, the Australian Space Board Remote Sensing Committee, and a Commonwealth Agencies Committee.37 The Working Party recommended that ‘a representative from the Defence Force should ... be invited to serve on ALCORSS and the Department of Defence should be represented on the Commonwealth Agencies Committee’.38

There has been some progress in implementing these recommendations. The Australian Space Board established its Committee on Remote Sensing in July 1989, but it includes no Defence representation, and there is still no Defence representative on ALCORSS. The Commonwealth Agencies Committee has been established in the form of the Commonwealth Remote Sensing Committee, on which Defence is represented by the Director General of Space and Special Projects in the Defence Science and Technology Organisation (DSTO). However, these steps still leave a long way to go. The management structure for Australia’s remote sensing effort remains fragmented, and Defence’s involvement in that structure remains peripheral.

Regional Cooperation:

The security value of a spaceborne remote sensing capability could go well beyond the direct benefits to Australian defence planners. Australia’s security is, in the long-term, fundamentally dependent upon our relationships with our neighbours. It is therefore important that Australia involve itself as a partner in as many regional

36 Ibid., p.5.
37 Ibid., pp.40-41.
38 Ibid., p.44.
cooperative security arrangements and confidence building measures (CBMs) as possible. Direct collaboration with our neighbours in remote sensing, and mutual assistance in the solution of common problems, could provide Australia with a significant leadership role in the region.

Australia is already participating in regional collaboration through its active support of the regional Inter-governmental Consultative Committee (ICC) and the UNESCAP Regional Remote Sensing Programme. Other Australian initiatives have been suggested which would provide:

- a focus for government to government collaborative projects aimed at the investigation and solution of common applications problems;
- assistance to those countries in the region which presently lack remote sensing facilities;
- a vehicle for commercial development of image analysis systems and methodologies to take advantage of the particular skills of each country;
- a vehicle for the joint research and development of sensors and systems of particular relevance to the region, such as tropical sensors, marine and flood monitoring systems, etc.;
- a vehicle for the development of common training programs; and
- a basis for mutual study and monitoring of long-term regional environmental and climatic changes.

39 See Desmond Ball, Building Blocks for Regional Security: An Australian Perspective on Confidence and Security Building Measures (CSBMs) in the Asia/Pacific Region, (Canberra Papers on Strategy and Defence No.83, Strategic and Defence Studies Centre, Australian National University, Canberra, 1991).


41 Ibid.
Australian leadership in regional collaboration in remote sensing would provide a mechanism for identifying and solving common regional problems which concern Australia as much as our neighbours; a means of paying Australia's dues to the international community and ensuring continuity of access to earth resources and meteorological satellite data; a means of promoting Australia's commercial position in regional markets; and a means of giving practical effect to the Government's regional security policies of 'comprehensive engagement' for Southeast Asia and 'constructive commitment' for the South Pacific.42

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CHAPTER 4
NATIONAL SPACE POLICY AND MACHINERY

Australia needs a national space policy which incorporates defence and intelligence space activities as well as civil and commercial space activities. The appropriate machinery for coordination of the country's space activities should be based on the existing Australian Space Board (ASB) and Australian Space Office (ASO).

By the early 1980s, the need for a national space policy and some machinery to provide oversight of Australia's various space-related activities and to encourage further development of Australian space capabilities had become widely recognised throughout the Australian space science and aerospace industry community. As a result, in May 1984 the Minister for Science and Technology, the Hon. Barry Jones, invited the Australian Academy of Technological Sciences 'to establish a working party to articulate a set of national goals for Australia in space and to recommend a structure to implement them'.1 The report of the Working Party, entitled A Space Policy for Australia (but commonly referred to as the Madigan Report, after the chairman of the Working Party, Sir Russel Madigan), presented to the Minister in June 1985, was the most ambitious and comprehensive review yet undertaken of Australia's potential scientific, technological and industrial capacity with respect to space. It argued that 'our space potential is fragmented and dispersed, and requires to be drawn together and fostered under a national space policy'.2 It recommended that 'Australia should as a matter of urgency establish a national space policy to facilitate the achievement of an appropriate industrial,

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2 Ibid., p.1.
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technological, and scientific structure for Australia's participation in space'; and that:

An independent Statutory Authority, with its own Board of Management, should be created to:

- advise the Government on space R&D policies and priorities;
- coordinate and manage the national space programme;
- liaise with research institutions, user groups, government departments, and other agencies to establish long-term development requirements;
- formulate and implement a coordinated and cohesive series of space projects in accordance with the national space policy;
- place government-funded contracts in industry, research establishments, and centres of higher education; and
- interface with the major overseas space organisations.

However, notwithstanding the fact that the Madigan report was more comprehensive than any previous review of Australia's space potential and possible coordination arrangements, it had one major lacunae - it 'specifically excluded' the defence elements of a national space policy. Despite the fact that the Department of Defence has policy responsibility for Australia's largest set of space activities, there was no representative from Defence on either the Working Party or the Secretariat staff. Submissions to the Working Party were received from the Defence Science and Technology Organisation (DSTO) and its Advanced Engineering Laboratory, as well as from the Department of Defence Support, but not from the Department of Defence itself.

In any event, while the Government 'accepted the thrust of the Madigan Report's recommendations', it believed that some of the

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3 Ibid., p.4.
4 Ibid., p.11.
5 Ibid., p.15.
particular proposals were too ambitious. For example, the Minister for Industry, Technology and Commerce and the Minister for Science stated in a joint statement issued on 22 September 1986 that:

The Madigan Report proposed the setting up of a statutory authority to pull together all of the country’s space efforts and the Government supports this view in principle.

But we believe the magnitude of Australia’s current space involvement does not yet warrant such a body.

Accordingly, an Australian Space Board will be formed for the time being as a non-statutory body.6

The Australian Space Board:

The terms of reference of the Australian Space Board have been officially summarised as follows:

The role of the Board [is] to co-ordinate and manage a national space program, provide a focal point for liaison activities both nationally and internationally, encourage the involvement of industry in space R&D activities, and provide advice to the Government on space R&D priorities in accordance with the Government’s broader general industry policy framework.7

The Board has six members, including the Chairman - three senior executives from the Australian aerospace industry, two with backgrounds in space science, and one from the Department of Industry, Technology and Commerce. Senior officers from other Departments, including Transport and Communications, Science, Administrative Services and CSIRO, attend Board meetings in an advisory/observer role. The Ministerial announcement of the

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establishment of the Board stated that ‘liaison with bodies in the Defence portfolio is also possible’,8 and two Defence officers have subsequently been co-opted as advisers/observers - the Director General of Space and Special Projects in the Defence Science and Technology Organisation (DSTO) and the Director General of Military Strategy and Concepts in the Australian Defence Force (ADF) headquarters in the Department of Defence.

The Board met for the first time on 4 November 1986, and held a further 12 meetings over the next 12 months (i.e. in the period to December 1987).9 It met nine times in the 18 months from January 1988 to June 1989,10 and seven times during the 12 months from July 1989 to June 1990.11

There is almost no discussion of Defence policies, plans or programs at Board meetings. The Defence ‘observers’ generally take a few minutes at each Board meeting to report on particular matters concerning Defence, but these are almost invariably peripheral to Defence’s major space-related activities - for example, Defence’s position on the use of the Woomera Rocket Range for commercial launches, or Defence’s attitude to the operation of French DORIS (Doppler Orbitography and Radiopositioning Integrated by Satellite) beacons in Australia. The Board has been advised of the Defence Communications Corporate Plan for 1991-2001 and Defence’s MILSATCOM project, which is designed to provide Defence with L-band mobile satellite communications services and subsequently with X-band ‘military frequency’ services. However, given the range of subjects discussed at Board meetings which should be of interest to Defence planners - such as the Space Industry Development Program, the proposals for an Australian Launch Vehicle, the prospects for satellite remote sensing, developments in satellite navigation technologies, the opportunities for international collaboration, and the

8 Ibid., p.33.
9 Ibid., p.2.
direction of the National Space Program - there is no doubt that Defence contributions to Board meetings could be much more substantial.

In order to facilitate specialist advice on priority areas under consideration, from time to time the Board appoints specialist Working Parties. In recent years these have included a Remote Sensing Working Party (RSWP), which assessed the strengths and weaknesses of Australia’s remote sensing industry capabilities, examined the potential for greater commercial development of remote sensing products and services, and developed a national strategy and action plan for the industry; a Satellite Communications Working Party (SCWP), which was established to formulate a national strategy for the Australian satellite communications industry, with particular respect to industrial opportunities in the areas of satellite mobile communications, satellite navigation and positioning systems, satellite communication systems, and international collaboration in space flight; and a Tracking Industry Working Party, which assessed the ‘prospects for development in Australia of a commercially viable satellite operations industry’. As recommended by the Remote Sensing Working Party, the Australian Space Board has also established a Committee on Remote Sensing to develop appropriate policies and strategies to promote an internationally competitive remote sensing industry in Australia.

Despite the extensive Defence involvement in the various areas of remote sensing, satellite communications and satellite tracking, there was not a single officer from Defence on any of these Working Parties or on the Committee on Remote Sensing.

15 Ibid., p.17.
The Australian Space Office:

The Australian Space Office (ASO) was established in 1987 within the Department of Industry, Technology and Commerce to support the Australian Space Board in the implementation of Australia's space policy. Its principal functions include:

- providing policy and administrative support to the Australian Space Board;
- developing strategies for Australian industry to become more involved in space activities;
- advising the Government on space R&D priorities;
- supervising and managing the National Space Program;
- managing space operations, including supervision of the operation of the NASA tracking stations in Australia;
- acting as a focal point for liaison with international space agencies;
- liaising with research institutions, industry and user groups to establish long-term national space needs; and
- gathering and coordinating information on Australia’s space related research and industrial capabilities, and providing an information referral service to potential users.17

The ASO operates under the direction of the Executive Director, who also serves as a member of the Australian Space Board. The Office currently has 21 staff members, and comprises four Sections:18

17 Australian Space Board, Australian Space Board January 1988-June 1989, p.1; and Australian Space Board, Australian Space Board July 1989 to June 1990, p.34.
18 Ibid., p.34-35.
Space Policy and Program Section: This Section is responsible for the development of policy and advice concerning Australia's space activities, the development and implementation of policy objectives, and servicing the Australian Space Board and its Committees.

Space Projects Section: The Space Projects Section is responsible for the implementation of space projects approved by the Australian Space Board for funding under the National Space Program.

Launch Services Section: This Section provides coordination of Commonwealth Government Activities relating to the development of the Cape York Spaceport. It also provides policy advice on proposals to develop launch vehicles, launch services and recoverable satellite payloads.

NASA Administration and Finance Section: This Section administers the contract between NASA and the contracting company for the operation of the NASA facilities at Tidbinbilla, ACT, and Yarragadee, WA.

Inter-action between the ASO and Defence is essentially non-existent, apart from that which involves the Defence observers on the ASB, which, as noted above, is fairly peripheral to the major activities of both the Board and Defence. Staff of the ASO rarely visit Defence facilities and laboratories, and officers from Defence rarely initiate meetings with ASO personnel. This lack of interaction between Defence and the ASO must rank as one of the most important weaknesses in the efforts to develop a national space policy.

The US Practice:

The United States maintains the largest space program in the world in terms of budget expenditures - more than $(US)30 billion in 1991. More than half of this activity involves US defence and intelligence space programs - including photographic reconnaissance,
SIGINT, ocean surveillance and other technical intelligence collection satellites, defence communications satellites, early warning satellites, navigation satellites, and space research associated with the Strategic Defense Initiative (SDI). About 43 per cent of total US space activity, or some $(US)14.7$ billion in FY 1992, involves the National Space and Aeronautics Administration (NASA). Cooperation between NASA and the US defence and intelligence community is very close, though not always devoid of tension and sometimes even downright hostility.

NASA was established by act of Congress on 16 July 1958 to administer the civilian space program. Until July 1958, all US space-related activities were under the control of either the military services or the National Advisory Committee for Aeronautics, itself principally a consultant and tester for the US Air Force on spacecraft design and development. NASA was very much a product of the shock induced in the United States by Sputnik I (launched on 4 October 1957) and Sputnik II (3 November 1957). Although NASA was to be essentially a civilian organisation, it was appreciated from the outset that 'because there is a gray area between civilian and military interests, and unavoidable overlapping', NASA would be involved in some defence-related activities. A Civilian-Military Liaison Committee was established to make determinations of responsibility and jurisdiction over space projects as between NASA and the Department of Defense, to ensure that where separate military and civilian projects were maintained there would be 'full exchange of such information as the other agency may require to carry out its responsibilities', and to oversee projects 'determined to be of sufficient joint interest as to be conducted cooperatively'.

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In September 1960, NASA and the Department of Defense agreed to enhance cooperation by means of a new Aeronautics and Astronautics Coordinating Board (AACB), with the Deputy Administrator of NASA and the Director of Defense Research and Engineering (DDR&E) in the Department of Defense as co-chairmen. The general function of the AACB is to provide 'broad policy guidance on major problems of concern to both agencies [i.e. NASA and DoD] in the aeronautics and space areas'. According to testimony to Congress in March 1977, the AACB has proved to be 'a highly effective means of maximizing benefits to be derived from NASA programs for Defense use, in turn, assuring that technology developed in military programs is available for civil applications'. In addition to the AACB itself, numerous other subsidiary NASA-DoD mechanisms have been established 'for project cooperation, technology transfer, and for [mutual] technical assistance'. These include various panels and sub-panels of the Board, which provide annual reviews of objectives, programs and budgets, numerous memoranda of understanding between NASA and DoD, joint steering committees, Joint Technology Coordinating Groups and Boards, topical reviews of technology, workshops, and joint study teams.

Through the 1960s, the principal thrust of NASA programs was directed at 'achieving the goal, before this decade is out, of landing a man on the moon and returning him safely to earth', as President Kennedy stated in a special message to Congress on 25 May 1961. This involved extensive cooperation with the Department of

23 Ibid., pp.1602, 1630.
24 Ibid., p.1650.
25 Ibid.
Defense and the Services. All the original NASA astronauts came from the Services. All the Mercury, Gemini and Apollo launches took place from the US Air Force facilities at Cape Canaveral. A modified Atlas ICBM booster was used for the Mercury launches, and the Titan II ICBM booster for the Gemini launches.

During the 1970s, NASA's primary efforts were focused on the development of the Space Transportation System (STS) or Shuttle, the first launch of which took place on 12 April 1981. Although managed by NASA, the Shuttle program was very much a joint NASA-Defense program. The original NASA Shuttle designs were modified in several significant areas (including payload lift capacity and cargo bay dimensions) to satisfy the requirements of the defense and intelligence community. Through the 1980s, most of the Shuttle crew members came from the Services. The Shuttle became the principal launch vehicle for US defense and intelligence satellites. About one-third of all Shuttle flights to date have been entirely dedicated to defense and/or intelligence missions, while another 23 per cent of Shuttle flights have also contained significant Defense payloads - i.e. some 60 per cent of total Shuttle flights have involved defense and/or intelligence missions.27

Although the US Air Force, following the Challenger disaster on 28 January 1986, has developed its own heavy launch vehicle, the Titan IV, for the 'highest priority' defense and intelligence satellite launches, NASA remains deeply involved in defense-related activities. NASA Scout boosters and civil facilities at the Wallops Flight Facility in Virginia have been used to launch targets for the US antisatellite (ASAT) program.28 The Shuttle itself is still used for Strategic Defense

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Initiative (SDI) experiments. Several NASA programs which are publicised as being entirely civil in fact have significant defence involvement - including the GEOS (Geodetic Earth Orbiting Satellite) program, which has been used to obtain geodetic and gravitational data for missile targeting; the NASA/EOSAT LANDSAT satellites, which were used during the recent Gulf War to provide multispectral imagery of Saudi Arabia, Kuwait and Iraq for topographic mapping, terrain analysis and tactical planning; NASA/National Oceanic and Atmospheric Administration (NOAA) GOES (Geostationary Operational Environmental Satellite), TIROS-N and Meteosat meteorological satellites, which provided real-time weather data to US forces in the Gulf; and the NASA Tracking and Data Relay Satellite System (TDRSS), which was used during the recent Gulf War, for example, to down-link digital imagery from the KH-11 and KH-12


imaging satellites and the *Lacrosse* radar imaging spacecraft,\(^3\) as well as relaying Defense Department message traffic.\(^4\)

The US practice is very illuminating. It demonstrates that close cooperation is possible with respect to both R&D programs and operational systems, even where activities of the highest intelligence sensitivity and where actual war-fighting situations are involved. This is not to argue that specific US practices and mechanisms are easily translatable to other national space programs. The sheer magnitude of the US activity means that many of the practices and mechanisms are simply not reproducible in much more modest programs. Nevertheless, general principles can be discerned - both positive and negative. On the negative side, it is important to ensure that the compromises required by joint programs are mutually beneficial rather than subtractive. (Many commentators have argued, for example, that the compromises to the NASA Shuttle design caused by the need to satisfy the requirements of the defence and intelligence community, in a situation of declining budgetary allocations in the 1970s, contributed directly to the *Challenger* disaster in January 1986.\(^5\)

More generally, the US practice demonstrates the need to ensure that civil-military collaboration does not lead to the military interests overwhelming and distorting the civil programs and priorities. (Many senior NASA personnel have reportedly expressed anxiety about the 'virtual military takeover' of the Shuttle program.\(^6\) There is

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obviously little chance of this happening in Australia’s circumstances. Nevertheless, it would be fruitful for Australia’s space planners to carefully assess the US practice with respect to civil-military cooperation.

The UK Scene:

In Britain in the early 1980s, reflecting many of the same concerns that were developing in Australia at that time, policy-makers and others from the scientific community and industry with a significant interest in space began searching for a strategy to promote a coordinate British space activities. In January 1985, following a high-level enquiry chaired by Sir Robin Nicholson, then the Government’s Chief Scientific Adviser, the Government decided to establish the British National Space Centre (BNSC). The purpose of the BNSC, which was set up in November 1985, was ‘to improve the development of space technology in the United Kingdom, ... to co-ordinate policy more effectively, ... and provide a sharper focus for Britain’s space effort’.37

Although the BNSC has done much to improve on the fragmented approach which had preceded its creation, its achievements have fallen short of the original intentions. Hence, as a Select Committee of the House of Lords concluded in December 1987, the UK remains ‘effectively without a space policy’.38

There are two principal reasons for the lack of success of the BNSC, both of which are relevant to Australia’s current circumstances. The first is that the Centre is not strong enough as an agency to achieve a ‘targeted assessment of objectives, funding and programmes’.39 The Centre has not been given the funds to enable it to promote British space science, technology or industry, and lacks the bureaucratic-

38 Ibid., p.9.
political weight to effectively promulgate a national space policy or to effectively control over or impose any judgement on priorities between Britain's space activities.

Second, the defence and civilian dimensions of the British space effort 'are still not integrated' - a major weakness when the Ministry of Defence spends more on space-related activities (some £116 m. in 1986/87) than the total expenditure of other Departments (about £100 m in 1986/87), and where the same technologies 'and often the same missions and satellites serve both civilian and military purposes'.

Integration of the defence and civilian dimensions of the British space effort is hampered by the lack of any coherent space policy within the Ministry of Defence itself. Despite the fact that the MoD is the major player in the British space scene, space is not high on the agenda within the MoD. Space is regarded as something which is useful in facilitating certain existing military functions, such as communications and surveillance, but not a domain which is 'important in itself'. Hence, the parameters of the British defence space activities have been sub-optimised in terms of other defence objectives and missions, and the MoD has been unable to contribute to the definition and development of a British national space policy.

Australian Defence Perspectives:

The principal obstacles to the incorporation of Defence perspectives and activities into a national Australian space policy and program are, first, the sensitivity of many of the defence space activities, particularly those involving space-related intelligence operations; and, second, the lack of any single coherent or comprehensive Defence perspective on space matters - let alone any

40 Ibid., p.xii.
41 House of Lords, Select Committee on Science and Technology, United Kingdom Space Policy, pp.20-21.
42 James Eberle and Helen Wallace, British Space Policy and International Collaboration, pp.xii-xiii.
43 Ibid., pp.41-44.
44 Ibid.
single focal point within the Defence establishment for developing and representing a Defence position on space matters.

Rather, there is a myriad of Defence units, branches, sections, facilities and laboratories concerned with various particular aspects of space - including planners within the Department of Defence and the Headquarters of the Australian Defence Force (HQADF), managers and financial administrators within the capital equipment procurement areas, operators and users of space systems in the Services, scientists in the defence R&D community, and significant elements within the Australian intelligence community. More specifically, these include:

- the Joint Defence Facilities Section of the International Policy Division under the Deputy Secretary Strategic and Intelligence in the Department of Defence, which is responsible for the development and implementation of policy in relation to the joint Australia/US defence facilities;
- the Force Development and Analysis (FDA) Division under the Deputy Secretary Strategic and Intelligence, which is responsible for policy advice on the space-related capabilities required for defence operations and intelligence support;
- the Capital Equipment Program Division under the Deputy Secretary Acquisition and Logistics in the Department of Defence, which is responsible for the development and review of major capital equipment programs (such as the Australian Defence Satellite Communications Station currently being constructed at Kojarena, WA), including the provision of policy advice on technical, financial, resource and commercial aspects of capital equipment acquisitions;
- the Military Strategy and Concepts (MSC) Branch of the Development Division in the Headquarters of the Australian Defence Force (HQADF), which is responsible for the development of military aspects of strategic guidance, ADF long-range plans, operational concepts, force development objectives and
infrastructural support requirements concerning space-related systems and capabilities;

- the Communications and Information Systems (CIS) Branch of Development Division in HQADF, which is responsible for the development of policy concerning space-related communications and information systems;

- numerous elements of the Army, RAN and RAAF, which are responsible for the development of Service requirements for space-related communications, navigation and information systems;

- numerous elements of the Army, RAN and RAAF, which are responsible for the operation and maintenance of Service space-related communications, navigation and information systems;

- elements of the Defence Signals Directorate (DSD), which are responsible for the development, operation and maintenance of the DSDs SATCOM SIGINT facilities; the satellite communications links (such as the Convoy, Simpson and Maroon Shield networks) for relaying SIGINT; and the processing and analysis of SATCOM SIGINT;

- the Imagery Exploitation Section and Geographic Information System (GIS) elements of the Defence Intelligence Organisation (DIO), which are involved in the processing and exploitation of remote sensing data, including that acquired from space-based systems;

- the Space and Special Projects Branch of the Defence Science and Technology Organisation (DSTO), which is responsible for the coordination and provision of technical policy advice on existing and potential intelligence, surveillance and other applications of space technology;

- the Surveillance Research Laboratory (SRL) of the DSTO, Salisbury, which is involved in research and
development of space-based radar and optoelectronic surveillance techniques and capabilities; and

- the Electronics Research laboratory (ERL) of the DSTO, Salisbury, which is involved in R&D concerning satellite communications, SIGINT and electronic warfare techniques and capabilities.

These various organisational entities within the Defence establishment have different objectives, interests and perspectives, and have varying degrees of bureaucratic/political power with which to pursue their disparate goals. Cooperation between them is generally quite good, although there is sometime competition and tension, and the compartmentalisation of the more sensitive activities remains a powerful impediment to full cooperation. There is no machinery for reconciling the diversity of interests and goals. The extremely sensitive nature of the space-related intelligence activities and some of the defence programs places a real constraint on the extent of interaction and cooperation within the Defence establishment. Nevertheless, the lines of compartmentalisation are not immutable. Many were defined as much by historical circumstances as by current security concerns. Moreover, the compartmentalisation provides significant privileges for some elements of the community, in terms of resource management, oversight and political access, which the privileged elements are understandably loath to concede. In the bureaucratic/political context, the security considerations are, at least sometimes, inevitably used as an excuse to frustrate more extensive cooperation.

On the other hand, there has clearly been an increasing recognition on the part of some elements of the Defence establishment of the benefits, to both Defence and the broader national interest, of Defence doing more both to coordinate its own disparate goals and activities and to support a national space effort. This is especially apparent within the Air Force, where some officers have offered considered arguments for developing an ADF Space Policy both to promote the self-reliance capabilities of the ADF and as an essential ingredient of a comprehensive national space policy.45

45 The work of RAAF officers at the Air Power Studies Centre, RAAF Fairbairn, and in the office of the Space Co-ordinator under
It has been suggested that an ADF Space Command should be established as a new Service to integrate ADF space activities, to consolidate ADF space requirements, to develop ADF space doctrine, to provide an institutionalised and forceful advocacy base, and to provide a mechanism for liaison and cooperation with the civil space community. Such a development would be too ambitious at this stage. A more appropriate development would be the establishment of an Australian Defence Space Coordination Office (ADSCO), which would operate under the joint supervision of the Deputy Secretary Strategic and Intelligence and the Vice Chief of the Defence Force (VCDF). The purview of such an office and two-hatted supervisory arrangement would encompass most of the significant current space activities of the Department of Defence and the ADF, and it would provide a sufficiently high level focal point for liaison with the national space policy machinery. Further evolution of this structure could occur in accordance with the future development of ADF space interests and capabilities, the growth of Australia’s space technological and industrial capabilities, and the national space policy machinery itself.


Ibid., p.68.
CHAPTER 5
CONCLUSIONS

It is now more than six years since the Working Party of the Australian Academy of Technological Sciences under the Chairmanship of Sir Russel Madigan reported that Australia's space potential was 'fragmented and dispersed' and recommended the establishment of a national space policy,1 and more than five years since the Government announced that it had 'accepted the thrust of the Madigan Report's recommendations'.2 However, notwithstanding the subsequent establishment of the Australian Space Board (ASB) and the Australian Space Office (ASO) to develop and manage a national space policy and program, there is still no truly national policy or policy-making structure. The terms of reference of the ASB and ASO fall short of those of the statutory authority recommended by the Madigan Report; the Government has not provided the funding commitment recommended by the Madigan Report; and the space activities of the Defence establishment have not been coordinated with those of the civil community.

The inability of the ASB and ASO to live up to the recommendations of the Madigan Report has caused considerable dissatisfaction within some elements of the Australian space community. This is particularly the case within the 'research establishments and centres of higher education' which the Madigan Report had recommended should receive substantial government-funded contracts,3 but which believe that they have been effectively

3 Space Science and Technology Working Party of the Australian Academy of Technological Sciences [chaired by Sir Russel Madigan], A Space Policy for Australia: A Report Prepared for the
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ignored by the ASB/ASO. The dissatisfaction is so strong in some quarters that it has been argued that the ASB/ASO structure should be abolished and the process of establishing a national space policy and program should be started again, based on Recommendation 15 of the Madigan Report.4

It seems to me, however, that the objectives of the Madigan Report and the concerns of some elements of the space science community can be satisfied without dismantling the structures developed over the past half decade. Rather, the agenda should be to build on these structures, to strengthen and broaden the capacities and purview of the ASB/ASO, and to seek a greater commitment from the Government to promoting Australia’s space activities. The deficiencies in the current structures are due, as much as anything else, to inadequate Government funding. The Government needs to be persuaded that the allocation of additional resources to space activities, particularly in the space science and basic technology areas, would have large long-term payoffs. The experience of overseas countries is unequivocal. Investment commitments made a decade or two ago have led to national capabilities and commercial benefits which could not have been predicted in any specific fashion at the time but which are now incontrovertible.

Together with a stronger Government commitment and an enhanced appreciation of the value of space science and basic technology, there is a need to incorporate Defence activities into the national space policy process. An essential preliminary step here is to establish some coordinating centre within the Defence establishment itself. This would be achieved by the creation of an Australian Defence Space Coordination Office (ADSCO) operating under the Deputy Secretary Strategic and Intelligence and the VCDF, as discussed in the previous section. In order to complete the liaison loop there would need to be established a small section, perhaps consisting of two or three people with appropriate security clearances, within the ASO. Overseas experience demonstrates that the security considerations involved in sensitive space defence and intelligence activities are not

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4 Minister for Science, (Australian Academy of Technological Sciences, Parkville, Vic., June 1985), p.11
4 Ibid., pp.11, 58.
an inevitable obstacle to close cooperation between the defence and civil communities.

Australia cannot afford to be without a national space policy. The costs of fragmentation, sectional perspectives and duplicated programs is too great. The benefits of comprehensive planning, joint programs and coordinated infrastructural development are immense. It only requires imagination and good will on the part of the concerned parties for these to be realised. The benefits will accrue in terms of enhanced defence self-reliance. But they will also be seen in terms of commercial payoffs and an enhanced national capacity to utilise space to build a better world for all of us.
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This monograph provides a comprehensive assessment of the defence elements of an Australian space policy. It describes in some detail Australia’s defence space activities, including the joint Australian/US facilities at Pine Gap and Nurrungar; the DSD SATCOM SIGINT facilities; Australia’s involvement in the US Defence Satellite Communications System (DSCS) and the US Navy’s Fleet Satellite Communications (FLTSATCOM) system; Australia’s involvement in navigation, positioning and geodetic satellite systems; Australia’s defence satellite communications programs; and the space-related activities of the Defence Science and Technology Organisation (DSTO).

The monograph discusses four principal aspects of defence-civil cooperation with respect to space activities - the exploitation for national purposes of the skills and experience extant in Australia’s defence and intelligence space activities; the benefits to Defence of the capabilities developed in the Australian aerospace industry; the need to coordinate defence and civil infrastructural development projects with respect to space; and the possibilities for defence-civil cooperation with respect to satellite surveillance and environmental monitoring programs and capabilities.

Finally, it addresses practical and mechanical considerations concerning the coordination of Australia’s defence, intelligence and civil space activities. It argues that the appropriate machinery for coordination should be based on the existing Australian Space Board (ASB) and Australian Space Office (ASO), and it concludes with some proposals for strengthening this machinery, including more effective incorporation of Australia’s defence and intelligence space activities in a national Australian space policy.