PATHFINDER
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FUTURE SPACE CAPABILITIES

As space systems develop, their utility in enabling or improving air capabilities will inevitably increase. In the coming decade the RAAF will make better use of space data to improve situational awareness, apply effects precisely, and attempt to ensure our use of space systems while denying their use to adversaries. Other nations will attempt to do the same things. Non-state actors will also be able to access many space capabilities commercially. Our challenge is to ensure that the RAAF gains more than our potential adversaries do from future space system capabilities.

In order to understand future space capabilities, we should examine other nations' advances in the space power roles of space support, space control, and force enhancement. Force application by ballistic missiles transiting through space is not a role being pursued by the RAAF and so will not be discussed further. Space support comprises activities to deploy and sustain space systems. Other nations are trying to produce responsive launch systems that can quickly launch satellites on demand, including some proposals to air-launch small satellites from fighter aircraft. More ground stations will be established, as delivery of space data much closer to the end user will contribute to the tactical use of assets that were previously considered to be strategic. A developmental 'on-orbit servicing' capability will soon be fielded, which will extend the service life of satellites in a way similar to how air-to-air refuelling extends aircraft endurance.

Space control consists of measures to allow friendly freedom of action to effectively utilise space, while denying such freedom of action to adversaries. The foundation is space situational awareness—knowing where space objects are and what they are doing. Research in this area includes terrestrial and space-based radars and telescopes to not only detect but also image orbiting objects. The resulting knowledge of the orbital parameters and missions of spacecraft operated by other agencies allows defensive or offensive counterspace measures to be taken. Operational prototypes of deployable systems are being fielded that can jam satellite communication and navigation systems temporarily. Systems are also being developed to detect and geolocate jamming or unintended interference so countermeasures can be used. Research continues into the means to permanently deny the use of space systems to adversaries, including a variety of anti-satellite weapons. Anti-ballistic missile systems are being developed to counter adversary force application by intercepting ballistic missiles in the boost, mid-course or terminal phase.

Force enhancement describes space power activities that improve or enable military capabilities. Technological advances are influencing a number of these activities such as environmental observation, surveillance and reconnaissance, precision navigation and timing, and communications.

Environmental observation includes meteorological, terrain elevation and land usage data from satellites. Meteorology is always vital to air operations, and the ADF currently gets its meteorological data from Japanese, Chinese and US satellites. The instruments being fielded on meteorological satellites are continually improving our knowledge of factors such as sea and land surface temperatures, and cloud and aerosol density profiles, allowing better weather prediction.

The Orbital Sciences Corporation Pegasus XL launch vehicle. Fighter aircraft launch vehicles are coming soon.

Surveillance and reconnaissance systems are improving due to advances in sensor technology. In 2008, a commercial service will place a satellite in geostationary orbit to collect a moving real-time colour image covering 40 per cent of the earth—from India to Hawaii—with great benefit for maritime surveillance and meteorological reporting. Research into extremely large electronically scanned antennas in space is likely to eventually bring vast improvement in the sensitivity of space-based electronic intelligence and synthetic aperture radar (SAR). A constellation of radar satellites could offer frequently updated SAR imagery and ground moving target indicator (GMTI) detection. Hyperspectral sensors allow the visible and infra-red radiation components in each pixel of a scene to be separated into over 30 frequency bands, and in some systems over hundreds of bands, giving objects that may look similar to the eye unique signatures. Military applications include detecting and classifying camouflage nets, and in future detecting certain chemical vapours such as those emitted by explosives or chemical weapons.

Precision navigation and timing (PNT) will continue to become more accurate and more reliable. The Global Positioning System (GPS) is being progressively upgraded, as each new satellite launched into the constellation is more capable than the one it replaces. Galileo, the European global navigation satellite system (GNSS), will be deployed within five years or so, offering another source of PNT information. Dual system GPS/Galileo receivers are likely to enter ADF service within a decade, giving redundancy if one system is jammed. Russia is striving to complete GLONASS, its own independent GNSS system, which will be another potential source of data. Many nations are deploying land and space based augmentation systems that will improve the accuracy and reliability of GNSS data. GPS is already widely used within the RAAF, but assured GNSS service will become absolutely vital with the introduction of GPS guided weapons. The ADF must strive for adequate navigation warfare capability—the capacity to preserve our ability to use GNSS and deny its use to adversaries.

Satellite communication systems are currently undergoing a period of transformation led primarily by an increase in processing power. Mainbeam anti-jam signal processing and coding help improve performance in hostile electronic warfare environments. The new generation of satellites use onboard switching of user signals to continuously reallocate bandwidth to each link on a basis of need, maximising efficiency. In legacy systems, transmissions over very long distances require the signal to pass through multiple satellites and ground stations. Laser links directly between satellites will vastly reduce this 'multi-hop' burden on radio frequency uplink and downlink bandwidth. Laser uplink and downlink should become feasible for some applications, further boosting capacity and minimising the chance of intercept or interference.

Many of the advances listed above will also be applicable to near-space platforms that give some space-like capabilities at much lower cost. Near-space platforms operate in the little used altitude band between 65,000 feet and approximately 325,000 feet (100 km). Possible designs include balloons, airships, or solar powered fixed wing aircraft. These options offer a persistent, cost-effective and responsive presence for surveillance and reconnaissance, communications or perhaps carrying weapons. While largely invulnerable to current anti-air weapons, a counter to near-space platforms will inevitably arise; yet their low cost means they can be considered 'semi-expendable'. Given their capability and low cost compared to satellites, near-space capabilities warrant consideration by the RAAF.

In 2004 the NASA BESS-Polar instrument remained aloft for more than a week at an average altitude of over 126,000 feet.

The future space capabilities discussed will not be readily apparent to most RAAF personnel. To a large extent the space services already in use, and possibly taken for granted, will simply become more effective. Space technology will inevitably improve. It would be a wise military that took maximum advantage of that improvement.

> ***...nobody's interested. Why? Because we're platform-centric... You never go to an air show to go watch a balloon performance. They don't put on a very good aerobatic show and it's just not very cool.***
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> - General John P. Jumper, USAF Chief of Staff, on the past attitude to near space.

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