Australian Government
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Safeguarding Australia's borders

Geoscience Australia contributes to satellite surveillance

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Australia has one of the largest Exclusive Economic Zones (EEZ) in the world. The total area being larger than the nation's land area. Parts of the EEZ extend from Heard and McDonald Islands in the southwest to Norfolk Island in the east and from the Arafura Sea in the north to the Australian Antarctic Territory in the south.

The Border Protection Command (BPC), which is part of the Australian Customs Service, has responsibility for protecting Australia's offshore maritime areas within the EEZ, overseeing surveillance and response operations. The BPC is specifically responsible for coordinating and controlling operations to protect Australia's national interests against maritime security threats such as: illegal exploitation of natural resources, illegal activity in protected areas, unauthorised arrivals, prohibited imports/exports, maritime terrorism, piracy, compromising biosecurity and marine pollution.

Figure 1. Surveillance areas monitored from Geoscience Australia's ground stations at Hobart and Alice Springs.

Geoscience Australia recently collaborated with the BPC in a satellite surveillance trial to evaluate the viability of monitoring sections of the nation's vast EEZ using remote sensing satellites. In their 2007–08 Portfolio Budget Statement, the BPC was tasked with monitoring 8.15 million square kilometres of the EEZ using aerial and satellite surveillance. This task was proving difficult because of the world-wide shortage of qualified pilots and operational restrictions on some of the available satellites. Consequently, BPC initiated discussions with Geoscience Australia seeking to utilise its tracking and data processing systems to reach the Budget targets.

In 2007 the BPC signed a contract with a subsidiary of the French Space Agency–Collecte Localisation Satellites (CLS) of Toulouse, for the provision and processing of Synthetic Aperture Radar (SAR) data from the Canadian Radarsat-1 and European Envisat satellites for ship monitoring and detection in areas of Australia's EEZ. These satellites have onboard recorders that can capture data in any part

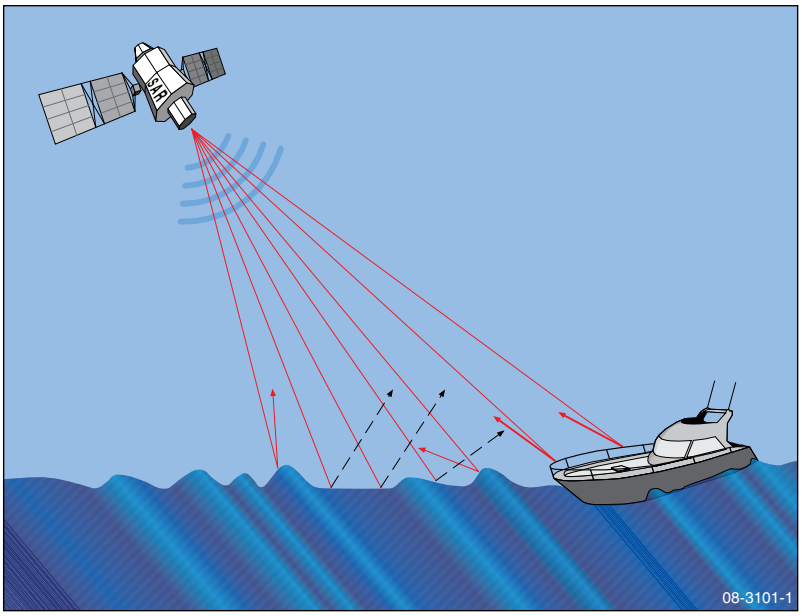

Figure 2. Synthetic Aperture Radar detection of a ship. The satellite emits a radio signal which is reflected back to the satellite's sensor.

of the globe and download it when the satellite is in view of one of the operators' ground stations. However, the onboard recorder on Radarsat-1 was operating below its designed capacity, limiting its ability to record and deliver imagery data back to Canadian ground stations. Geoscience Australia overcame this problem by tracking Radarsat-1 and downlinking data from the satellite when it was within view of Geoscience Australia's ground stations at Alice Springs and Hobart. Geoscience Australia then processed the data before delivering the images to CLS (figure 1).

"The ship's wake creates turbulence and areas of smoother water that stand out from the surrounding ocean."

Satellite-borne Synthetic Aperture Radar (SAR) uses microwave radio frequency transmissions to create an image of the earth's surface and any objects that are present. Microwave energy is beamed towards an area of interest and the reflected signals are captured by the satellite's sensor (figure 2). SAR can operate night or day, and through clouds, fog and rain and is therefore well suited to ship detection and monitoring of large areas of ocean. Also, most SAR Satellite sensors can vary their beam modes to either scan large areas in lower resolution or to focus on small areas in high resolution. Processed SAR imagery may depict a ship in various ways, dependant upon weather conditions, ship orientation and construction, and beam focus.

One way of detecting ships is by detecting the ship's wake. The ship's wake creates turbulence and areas of smoother water that stand out from the surrounding ocean in a SAR image. The bow of a ship when pushing the water aside also creates a wave known as the Kelvin wake (figure 3). This wave emanates from either side of the bow and forms a distinct part of the ship's SAR signature.

Ships are usually moving targets, so it is important to report the detection of a ship *as soon as possible after satellite overpass*. Initial testing showed that it could take more than six hours from detection to reporting. However Geoscience Australia was able to streamline the process, reducing data transfer time from the tracking stations, the processing time at Geoscience Australia, and the transfer time from Geoscience Australia to Toulouse. A number of processing steps were also automated, and overall delivery times were reduced by almost half.

To reduce reporting times even further the BPC, through its contractor CLS, installed an automated ship-detection system at Geoscience Australia. The output file from this ship detection system is a small subset of the full image data and, because it is greatly reduced in volume, is considerably faster to transfer to CLS in Toulouse for compilation of a ship report. The next step is for CLS to send the

compiled report to the Regional Operations Centre for Surveillance and Rescue (CROSSRU), located on Reunion Island in the Indian Ocean, for validation by their expert analysts. Finally, a validated ship report including the date, time, location, speed, course and quite possibly the vessel's size, construction type and even its name and registration details, is forwarded to the BPC in Canberra. BPC then assess the need for further action which could include sending an aircraft or patrol vessel to intercept the ship, storing the data as evidence, or taking no action.

Ultimately the total time from detection to delivery of ship reports in Canberra was reduced to under two hours. Between November 2007 and March 2008 Geoscience Australia's systems were responsible for the delivery of more than 1100 ship detection reports to the BPC.

Figure 3. A turbulent wake usually indicates a ship is present. The light coloured line is the Kelvin wake.

For more information

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