FACT SHEET

Jindalee Operational Radar Network

Australia's Jindalee Operational Radar Network (JORN) comprises three Over-The-Horizon Radar (OTHR) systems and forms part of a layered surveillance network providing coverage of Australia's northern approaches

What is an Over-the-Horizon Radar?

- An OTHR is a type of radar designed and operated specifically to see 'over the horizon'. Conventional microwave radars such as those commonly seen at airports propagate in a straight line and cannot detect objects beyond their line of sight i.e. beyond the visual horizon. OTHRs overcome this limitation by 'bouncing' High Frequency (HF) radio waves off the ionosphere.

- OTHR utilises the refractive properties of the ionosphere to refract or bend transmitted HF electromagnetic waves back to Earth. When these refracted HF waves hit a radar reflective (metal) surface of sufficient size — either airborne or maritime — some of the energy is reflected back along the transmission path to the OTHR receiver. Sophisticated computer systems then process the received energy to discern objects within the radar's footprint.

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How does it work?

- OTHR systems operate on the Doppler principle, where an object can be detected if its motion toward or away from the radar is different from the movement of its surroundings.

- OTHRs are typically made up of very large fixed transmitter and receiver antennas (called ‘arrays’). The location and orientation of these arrays determines the lateral limits or arc of a radar’s coverage. The extent of OTHR coverage in range within this arc is variable and principally dependent on the state of the ionosphere.

- OTHRs do not continually ‘sweep’ an area like conventional radars but rather ‘dwell’ by focusing the radar’s energy on a particular area – referred to as a ‘tile’ – within the total area of coverage. The transmitted HF energy can be electronically steered to illuminate other ‘tiles’ within the OTHR’s coverage as required to satisfy operational tasking or in response to intelligence cuing.

- OTHR key operating principles are depicted in Figure 1.

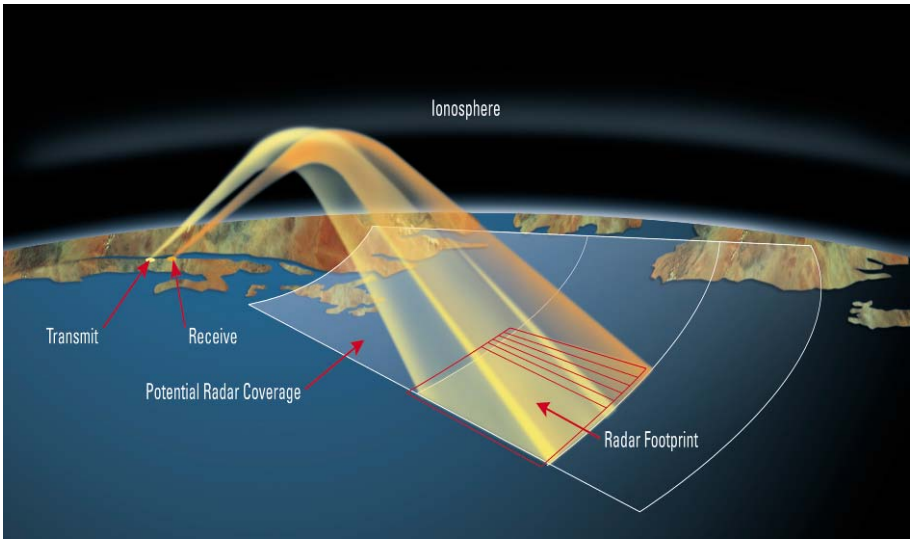

Figure 1: Key OTHR Operating Principles

What is JORN?

- The Australian Defence Force (ADF) currently operates three OTHR systems as part of the Jindalee Operational Radar Network (JORN). These radars are dispersed across Australia — at Longreach in Queensland, Laverton in Western Australia and Alice Springs in the Northern Territory — to provide surveillance coverage of Australia's northern approaches.

- Radar data from these sensors is conveyed to the JORN Coordination Centre (JCC) within the Air Force's No 1 Radar Surveillance Unit (1RSU) at RAAF Base Edinburgh in South Australia. 1RSU is tasked by higher headquarters to operate the JORN capability on a daily basis.

- JORN does not operate on a 24 hour basis except during military contingencies. Defence's peacetime use of JORN focuses on those objects that the system has been designed to detect, thus ensuring efficient use of resources.

- The JORN radars have an operating range of 1000–3000km, as measured from the radar array. Figure 2 depicts the locations of the three OTHR systems and the JCC, and highlights the coverage of each radar. Of note, the Alice Springs and Longreach radars cover an arc of 90 degrees each, whereas the Laverton OTHR coverage area extends through 180 degrees.

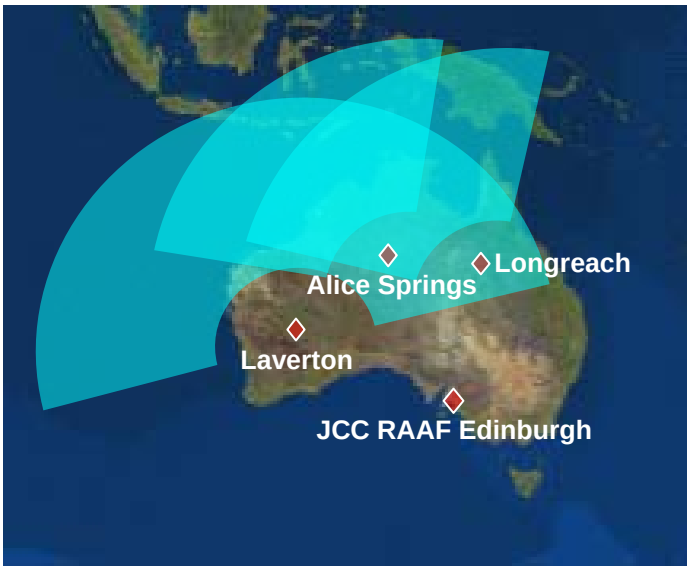

Figure 2: JORN radar locations and coverage

What can JORN do?

- JORN is expected to detect air objects equivalent in size to a BAe Hawk-127 aircraft or larger and maritime objects equivalent in size and construction to an Armidale-class patrol boat or larger.

- On any given day JORN may be affected by the following:

  - **State of the ionosphere.** The ionosphere is the upper part of the atmosphere extending from 75 to 450 km above the Earth's surface that consists of particles that have been ionised by solar radiation emitted by the Sun. The state of the ionosphere depends on the level of solar activity. Other more localised phenomena also affect the stability and/or structure of the ionosphere, and t is the combination of these phenomena and solar events which determines the quality of ionosphere support for OTHR operations. The most significant factors affecting such support include:

    * the 11 year solar cycle;
    * solar disturbances (i.e. flares and coronal mass ejections);
    * meteors;
    * geomagnetic activity;
    * ionospheric disturbances; and
    * ionospheric variations throughout the day/night.

  - **Environmental conditions.** The natural environment can also limit the effectiveness of OTHR in detecting specific objects, namely:

    * rough seas and winds can cause increased radar clutter making the detection of maritime vessels extremely difficult; and
    * lightning associated with thunderstorms can cause localised ionospheric changes.

- Additionally, the probability of detecting a particular object is dependent on the object's characteristics and/or behaviour.

- **Object characteristics.** For an aircraft or maritime vessel to be detected, it must possess a radar reflective (metal) surface of sufficient size so that sufficient HF radar energy is reflected back along the transmission path to the JORN receiver. For example:

    * it is highly improbable that an OTHR will detect a small wooden boat

    * OTHR is very unlikely to detect a hot air balloon or a glider constructed largely of wood

- **Object behaviour.** OTHR systems operate on the Doppler principle, where an object will only be detected if its motion toward or away from the radar is different from the movement of its surroundings. Objects travelling tangentially to an OTHR are therefore unlikely to be detected by that radar.

JORN's history and development

- The first OTHR was installed at Alice Springs in 1974 under a Defence Science and Technology Organisation (DSTO) research program. Under Project Jindalee, the Alice Springs radar was upgraded from its original design and commenced further trials in early 1982. It detected its first ship in early 1983 and its first aircraft was automatically tracked in early 1984.

- Project Jindalee finished in December 1985.

- The decision to develop JORN as a Defence asset had its beginnings in February 1985 when the Minister for Defence, Kim Beazley, commissioned an analysis of Australia's defence planning seeking recommendations for future developments. This analysis, by Paul Dibb was published in March 1986 and recommended that Australia abandon the remaining elements of the forward defence policy and concentrate its military resources on the geographic areas relevant to defending the country and its economic interests from direct attack. Dibb recommended that Australia's military posture be based on a strategy of denying aggressors the ability to attack the country. This was to be achieved through using a layered defence of over-the-horizon radar, patrol aircraft and maritime strike aircraft to protect Australia's approaches.

- At the time of Dibb's report, the experimental OTHR at Alice Springs was in operation and proved that 'modern technology in the form of OTHR offers the prospect for the first time of broad-area real-time surveillance of our air and sea approaches out to 1500 nautical miles.' Dibb's review recommended that additional resources be applied to the Jindalee OTHR program to further

exploit this promising technology and added that there was a strong case for considering at least two further OTHRs.

- His recommendation to invest in OTHR research and acquire an operational system was adopted in the 1987 Department of Defence White Paper, '*The Defence of Australia*', which stated that 'the Government has given high priority to the design and development of this [OTHR] network, based on the Australian designed Jindalee experimental radar. The OTHR network will be a basic element of a national system for air defence and airspace control.' The paper identified the Government's intention to acquire three OTHRs.

- Based on the 1987 Defence White Paper, Joint Project 2025 (JP2025) was initiated to build a further two OTHRs. In 1991, a contract was awarded to Telstra, in cooperation with GEC-Marconi, to build two operational OTHRs that would form JORN. After considerable project difficulties, responsibility for the project moved to Lockheed Martin and Tenix (who formed the RLM Group) in 1997, and in 1999 1RSU moved from Alice Springs to RAAF Base Edinburgh to remotely operate the Alice Springs OTHR from the JORN Coordination Centre. In 2003, RLM Group delivered two JORN OTHRs to the Australian Defence Force. These radars, along with the Alice Springs radar, comprise JORN in its current form. During the period where the JORN project was unable to deliver an operational system, the Alice Springs radar continued to receive a number of upgrades based on DSTO research and development.

- JP2025 Phases 3 and 4 commenced in 2003 to provide incremental upgrades to the newly delivered radars and concluded in 2007.

- JORN is currently undergoing a capability upgrade under JP2025 Phase 5. This project will incrementally deliver a number of capability enhancements to the current JORN radars located at Longreach and Laverton, and will compliment upgrades delivered under Phases 3 and 4 to bring these radars up to the current technological specification of the OTHR at Alice Springs. Phase 5 will also integrate the Alice Spring OTHR into the Jindalee Operational Radar Network.

- The capability upgrade under JP2025 Phase 5 is based on the specifications originally described in the 1987 Department of Defence White Paper, 'The Defence of Australia'.