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Issue Brief

IAF's Quest for Software-Defined Radios: Enabling Net-Centric Operations

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Summary

The pursuit of indigenous Software-Defined Radios aligns with the Atmanirbhar Bharat initiative and removes India's dependence on foreign radios. The development of the Indian Radio Software Architecture (IRSA) in 2025 will create the foundation for truly integrated, multi-domain military communications. AI-enabled SDRs, meanwhile, can give indigenous defence manufacturing an edge.

Introduction

The ongoing operationalisation of Software-Defined Radios (SDRs) in the Indian Air Force aligns with the overarching concept of Net-Centric Warfare (NCW). The IAF began pursuing an operational airborne SDR in 2013, which subsequently led to the development of the Indian Radio Software Architecture (IRSA) in 2025.¹ These are not separate milestones but successive stages of the same network-centric transformation. The former addressed the immediate operational requirement to connect aircraft securely in combat. The latter established the national software standard that will allow future indigenous SDRs across the Air Force, Army and Navy to communicate through common, portable and certifiable waveforms, creating the foundation for truly integrated, multi-domain military communications. The concept of SDR has not remained limited to the Tri-services but has also been extended to Para-military forces. This brief traces the evolution of IAF’s efforts to enable secure, resilient and jam-free military-grade communication, and outlines its operational implications and deliverables.

Background

SDR, as the name suggests, is driven by software rather than dominated by hardware components. The concept of a radio whose frequency, waveform and encryption are set by software rather than by fixed circuitry began in the 1980s at the US Department of Defense laboratories and at E-Systems Inc. in Texas. Joseph Mitola coined the term ‘software radio’ in the early 1990s, and soon thereafter the Defense Advanced Research Projects Agency's (DARPA) SpeakEasy programme built the first working military demonstrator: a single radio emulating more than 10 existing military radio types across a wide frequency band.² The concept did not stay limited to the military. The North Atlantic Treaty Organization (NATO) built its own multi-vendor SDR standard, and the US National Institute of Justice has documented SDR linking police, fire and emergency medical services domestically.³

India's own SDR programme spans across its security architecture, encompassing all military and paramilitary forces. The Ministry of Defence signed its first major SDR contract, worth over Rs 1,000 crores, in February 2021, jointly developed by the Defence Research and Development Organisation (DRDO) and Bharat Electronics

¹ [**“DRDO Releases the Indian Radio Software Architecture Standard 1.0 to Enable Interoperability in Military Communication”**](#), Press Information Bureau, Ministry of Defence, Government of India, 7 October 2025.

² [**“Software Defined Radio, a Perspective from Education”**](#), *Frontiers in Education*, 5 January 2024.

³ [**“Software Defined Radio: Connecting Public Safety Officials”**](#), National Institute of Justice, U.S. Department of Justice.

Limited (BEL), with interoperability features covering an airborne variant, a naval variant and handheld sets.⁴

A Rs 5,498-crore, 10-contract package in March 2023 added 1,265 SDR portables for the Navy.⁵ In February 2024, the Air Force signed its own contract with BEL for a man-portable SDR designed for ship-to-ground, ground-to-ground and ground-to-air communication during critical operations.⁶ The Coast Guard followed in February 2025 with a Rs 1,220.12-crore contract for 149 SDRs,⁷ and the Army signed its first indigenous SDR contract in October 2025.⁸ In the same month, the DRDO released IRSA Standard 1.0, India’s first national standard for SDRs to enable interoperability and standardisation.⁹

From Analogue Radios to SDR: The IAF's Communication Trajectory

In the 1930s and 1940s, communication ran on single-function analogue radios—elementary wireless communication in high frequency (HF) and very high frequency (VHF), since the inception of the IAF. From the 1950s, it ran on tropospheric-scatter links shared across the Services, with no dedicated network linking radar posts to command centres.¹⁰ The 1962 and 1965 wars exposed this gap. In March 1971, Air Headquarters began planning the Air Defence Ground Environment System (ADGES), India's first radar-to-command network. ADGES matured through the 1970s and remained the IAF's principal network for three decades, though its backbone stayed analogue. Kargil in 1999 added the lesson that joint Army–Air Force communication had to be planned from the outset of an operation.¹¹

⁴ [“MoD and BEL Sign Contract for Procurement of Software Defined Radio \(Tactical\) Worth over Rs 1,000 crore”](#), Press Information Bureau, Ministry of Defence, Government of India, 8 February 2021.

⁵ [“MoD Signs 10 Contracts Worth Rs. 5,498 Cr with BEL for Indian Armed Forces”](#), Bharat Electronics Limited, 30 March 2023.

⁶ R. Anil Kumar, [“IAF Inks Contract with BEL to Procure Software-Defined Radios, Boosting Its Communication Network”](#), *India Strategic*, 11 February 2024.

⁷ [“Ministry of Defence Inks a Contract Worth ₹1220.12 Cr with Bharat Electronics Limited for Procurement of 149 Software Defined Radios for Indian Coast Guard”](#), Press Information Bureau, Ministry of Defence, Government of India, 20 February 2025.

⁸ [“Indian Army Signs Contract to Procure First Indigenously Designed, Manufactured Software Defined Radios”](#), *DD News*, 28 October 2025.

⁹ [“DRDO Releases the Indian Radio Software Architecture Standard 1.0 to Enable Interoperability in Military Communication”](#), no. 1; [“Indian Radio Software Architecture \(IRSA\) Specification Document: IRSA-001”](#), Directorate of Standardization (DoS), Department of Defence Production (DDP), Ministry of Defence, Government of India.

¹⁰ Abraham Mathew, [“A Review of the Growth of Communication in the Indian Air Force”](#), *IETE Technical Review*, Vol. 5, No. 2, 1988.

¹¹ [“Our Journey”](#), Indian Air Force, Government of India.

The break came in September 2010, when the IAF commissioned the Air Force Network (AFNET), a Rs 1,077-crore Internet Protocol (IP)/Multi-layer Switching Protocol (MPLS) digital grid on optical fibre, built to replace 1950s-era troposcatter.¹² IACCS was designed to ride the AFNET backbone, fusing ground and airborne sensors, weapons, and command nodes into one air situation picture.¹³

In parallel with the operational fielding of the IACCS, the IAF issued a global tender in 2006 for a pilot project on an Operational Data Link (ODL). It is pertinent to mention that the AFNET, on which IACCS itself rides, had already been under field testing in this period before its launch in 2010. The pilot contract for the ODL was awarded a year earlier, in January 2009, amid competing bids from three global companies. The pilot project sought to demonstrate the feasibility of networking aircraft, including fighters, transports, helicopters and surveillance platforms such as the Phalcon Airborne Warning and Control System, within the concept of IACCS.¹⁴

The experiences of the pilot programme led to the development of the airborne SDR project in the 2010s, which in turn initiated a global procurement for airborne SDRs in 2013. By Aero India 2013, two companies, including an Indian firm, had teamed up for the IAF’s SDR programme.¹⁵ Simultaneously, Hindustan Aeronautics Limited (HAL) unveiled its own indigenous airborne SDR, built for ‘Airborne Communication and Net Centric Warfare’.¹⁶

Visibility on the programme can also be deduced from the parliamentary replies on the subject, dated December 2014, which clarified that IAF’s current Integrated Radio Communication Radio Sets (INCOM) were to be replaced by SDRs in two phases. The first phase involved collaboration between HAL and the Israeli company Rafael, with fully indigenous SDRs planned for subsequent phases.¹⁷

This reflects that while domestic development of SDR continued through indigenous companies, an imported operational capability was acquired. In subsequent years,

¹² [**“Antony Dedicates AFNET to the Nation”**](#), Press Information Bureau, Ministry of Defence, Government of India, 14 September 2010.

¹³ [**“AFNET to Herald Network Centric Operations in IAF”**](#), Press Information Bureau, Ministry of Defence, Government of India, 8 September 2010.

¹⁴ [**“IAI Bags Contract for IAF's Pilot Operational Data Link Project”**](#), *Domain-b.com*, 20 January 2009.

¹⁵ [**“Rockwell Collins, Tata Team Up for IAF's SDR Contract”**](#), *Airforce Technology*, 10 February 2013.

¹⁶ [**“Union Minister Inaugurates SDR System at HAL”**](#), Press Information Bureau, Ministry of Defence, Government of India, 31 May 2013.

¹⁷ [**“Integrated Radio Communication System”**](#), Press Information Bureau, Ministry of Defence, Government of India, 12 December 2014.

400 Rafael BNET SDR variants were reportedly purchased in 2019.¹⁸ Continuing the trajectory of technological evolution and self-reliance in defence led to the 2024 BEL contract, and SDR-relayed IACCS communication demonstrated a tri-services synergy during Operation Sindoor.¹⁹

The Indian Radio Software Architecture (IRSA) Standard 1.0 is India’s first national specification, released in 2025 by DRDO, the Integrated Defence Staff, and the three Services. It is the next step in the evolution journey of SDR. It is a common software specification that standardises the software architecture of military SDRs by defining a set of common interfaces, waveform (the specific radio signal format a mission requires) portability mechanism, application programming interfaces (APIs), execution environments so that a waveform built for one SDR can, in principle, run on another regardless of manufacturer, ending the practice of each Service certifying its own radios in isolation. It is meant to enable different SDRs to interoperate seamlessly through shared, certifiable waveforms across the Air Force, Army and Navy.²⁰

Need for SDR and Its Relevance in the IAF

In the arena of communication, technologies have evolved so rapidly in the last few decades. Still, across the entire gamut of communication structures, SDR has risen to meet the needs of NCW. The SDR matters strategically because modern militaries fight through networks rather than isolated platforms. A sensor is only as useful as the radio carrying its data to the weapon or to the commander best placed to act on it. The feature of frequency agility makes software-reconfigurable radios help links survive jamming and evolve without new hardware, a capability that Ukraine's sustained electronic warfare exchanges have shown to be decisive rather than optional.²¹ This is the technical foundation of NCW—that combat power comes from integrating sensors, decision-makers, and shooters into a single real-time system rather than fielding stronger platforms in isolation.

¹⁸ Neelam Mathews, [“Indian Air Force Gets Desperate for Software-defined Radios”](#), *Shephard*, 5 August 2019.

¹⁹ [“Operation SINDOOR: Forging One Force”](#), Press Information Bureau, Ministry of Information & Broadcasting, Government of India, 18 May 2025.

²⁰ [“DRDO Releases the Indian Radio Software Architecture Standard 1.0 to Enable Interoperability in Military Communication”](#), no. 1; [“Indian Radio Software Architecture \(IRSA\) Specification Document: IRSA-001”](#), no. 9.

²¹ Matthew Slusher, [“Lessons from the Ukraine Conflict: Modern Warfare in the Age of Autonomy, Information, and Resilience”](#), Center for Strategic and International Studies, 2 May 2025.

Traditionally, the IAF's radios were built around fixed hardware: one frequency range, one function, replaced whenever either had to change. This meant separate radio types for separate roles, years-long upgrade cycles, and no common link between aircraft, airborne warning and control systems (AWACS), and ground stations built by different vendors. An SDR replaces most of this hardware with a digital signal processor and a field-programmable gate array, allowing frequency, waveform and encryption to be reconfigured through software alone.²² Airborne SDRs typically form a Mobile Ad hoc Network (MANET), an autonomous system of mobile routers linked wirelessly, with no fixed infrastructure, allowing aircraft, AWACS, and ground stations to connect without a fixed relay.²³ SDR contributes to fewer radio types to certify and maintain frequency agility against jamming, and a path to a genuinely shared network.

The ‘airborne internet’ project, worth Rs 5,000 crore, to procure 2,500 SDRs for the IAF is set for approval by the Defence Acquisition Council (DAC), strengthening real-time communication and coordination in combat operations. The SDRs will allow coordination not only between pilots in the air but also between fighters in the air and AWACS, and between fighters in the air and decision-makers on the ground, assessing real-time scenarios for precision strikes and enabling interoperability across services.²⁴

These radios are designed for instantaneous and advanced encrypted communication across diverse assets, including fighter jets, helicopters, transport aircraft, airborne early warning systems and ground stations. They will provide a single operational view by uniting sensors, weapons and radar systems. They are designed for complex roles and multichannel operations, ensuring robust transmission of video, voice and data exchanges without interruption, even in contested and jammed air situations.²⁵ In the event of electronic jamming, communication can be shifted to another frequency via frequency hopping, thereby enabling the mission to be executed unhindered.

²² A digital signal processor performs mathematical operations on digitised signals; a field-programmable gate array is reconfigurable by the user after manufacture rather than fixed at fabrication.

²³ [“Mobile Ad-hoc Networks \(manet\) Charter”](#), Internet Engineering Task Force.

²⁴ Srinjoy Chowdhury, [“DAC to Approve Rs 5,000 Cr SDRs for IAF and Shipborne Drones; INS Khanderi AIP Refit Also on Agenda”](#), *ET Now*, 3 July 2026.

²⁵ Raghav Patel, [“IAF Seeks DPB Approval for 2,500 Indigenous Software Defined Radios to Secure ‘Airborne Internet’ Capability”](#), *Defence.in*, 5 April 2026.

SDR in Global Forces

United States

The Joint Tactical Radio System (JTRS) program, launched in 1997 to field one SDR family across ground, maritime and air platforms, grew to an estimated US\$ 37 billion project before major elements were restructured, as per a 2006 US Government Accountability Office (GAO) report, as unstable requirements outran engineering capacity. Another challenge is the lengthy certification process by the National Security Agency.²⁶ The US Army has replaced its ARC-231 radios on helicopters with a new software-defined AN/ARC-231A Multimode Aviation Radio Set (MARS) from BAE Systems, as evidenced by reports in 2025.²⁷

Additionally, an US\$ 84 million order for Next Generation Command and Control (NGC2) manpacks was placed in July 2026.²⁸ Its advancement is AI-SDR, which offers enhanced waveform adaptability, increases the efficiency of secure military communication by approximately 25 per cent and provides a solution for spectrum optimisation. AI-SDR can intelligently select its own waveform, manage spectrum automatically, and achieve electronic warfare survivability that much more effectively to meet the needs of a contested environment.²⁹

NATO

Rather than a single radio family, the Alliance standardised the ESSOR (European Secure Software-defined radio) High Data Rate Waveform (HDRWF) as STANAG 5651, allowing radios from several manufacturers to interoperate, with a dedicated air-to-ground-to-air waveform, ESSOR 3D Waveform (E3DWF), in development.³⁰ This multi-vendor model is closer to IRSA's aim than JTRS's. The ESSOR programme began in 2009 under the European Defence Agency, and its High Data Rate Waveform now runs on national radios.³¹

²⁶ [“Defense Acquisitions: Restructured JTRS Program Reduces Risk, but Significant Challenges Remain”](#), GAO-06-955, U.S. Government Accountability Office, 11 September 2006.

²⁷ Ronald Watkins, [“US Army Deploys New Software-Defined Radios Across Helicopter Fleet”](#), *The Defense Post*, 5 September 2025.

²⁸ Dan Taylor, [“Manpack Radios Ordered for US Army Command-and-Control Program from L3Harris”](#), *Military Embedded Systems*, 10 July 2026.

²⁹ [“The Companies Leading Innovation in AI-Software Defined Radios”](#), *S&S Insider*, 14 July 2026.

³⁰ [“Tactical Waveforms”](#), Bittium Corporation.

³¹ [“ESSOR – The Way Towards Communications Interoperability Amongst European Armed Forces”](#), Bittium Corporation, 1 April 2026.

Israel

Its defence establishment built the BNET family around MANET networking for contested terrain and exports an airborne variant to the IAF through a domestic joint venture worth up to US\$ 200 million.³² BNET has been field-proven for tactical operations on both land and air platforms since 2014, and serves as the main communication system for the Israeli Air Force's existing and future platforms.³³

China

The People’s Liberation Army (PLA), including its air arm, has spent roughly two decades building command information systems at every echelon under a doctrine that treats modern war as a contest between operational systems rather than platforms.³⁴ Its tactical radio hardware traces its lineage to systems procured from the United States in the 1970s and 1980s, and its modernisation remains uneven. While encrypted radio networks are fielded at the company and battalion levels, extending secure communications to every squad and integrating land, sea and air communications remain works in progress.³⁵ China’s military tactical radio companies generated US\$ 537.2 million in revenue in 2025, accounting for 9.2 per cent of the global military radio market.³⁶

Important Lessons

Ukraine war underscores the need for secure, multi-waveform combat communications. Ukrainian military forces easily targeted radio transmissions from radios used by ill-equipped Russian soldiers. This also poses an important challenge on the battlefield: keeping pace with changing technologies.³⁷ Israel's Rafael built its BNET family of SDRs, including an airborne variant, around exactly this problem: sharing video, targeting and situational data between aircraft,

³² Seth J. Frantzman, [“Israel Company Targets Opportunities in Europe and Asia for Software-defined Radios”](#), *C4ISRNET*, 2 June 2020.

³³ [“Rafael Successfully Demonstrated the BNET System in Romania”](#), *Defence Industry Europe*, 10 July 2023.

³⁴ Jeffrey Engstrom, [“Systems Confrontation and System Destruction Warfare: How the Chinese People's Liberation Army Seeks to Wage Modern Warfare”](#), RAND Corporation, 2018, p. 8.

³⁵ [“Chinese Whispers”](#), Armada International, 8 November 2022.

³⁶ [“China Military Tactical Radio Market Size & Outlook”](#), Grand View Horizon.

³⁷ Dan Parsons, [“Software-defined Radios: Critical for the Military’s Future Secure Communications Needs”](#), Avionics International, January/February 2023.

vehicles and drones over a mobile ad hoc network that does not depend on fixed infrastructure.³⁸

India's own experience reinforces this. During Operation Sindoor, the tri-service response to the April 2025 Pahalgam terror attack, the IAF's IACCS was credited with real-time coordination, fusing radar, sensor, and interceptor data into a single operational picture, enabling forces to track and neutralise aerial and missile threats across domains.³⁹ These conflicts have validated the SDR as a pivotal enabler of resilient, quick and secure communication capabilities and emphasised that SDR capabilities need to be continuously exercised and upgraded.

Conclusion

Modern air warfare rewards whichever side moves sensor and targeting data to the right platform fastest and keeps doing so once an adversary starts jamming that link. Platform performance alone no longer determines outcomes, as Ukraine's and Israel's air campaigns, and India's own Operation Sindoor, have each shown in different ways.

The IAF's pursuit of an operational airborne SDR is rooted in its concept of network-centric operations. Its February 2024 BEL contract and its stake in IRSA are genuine steps, resting on an IACCS that Operation Sindoor has already tested under pressure. A significant share of its networked communication still runs on imported BNET radios. The indigenous SDRs align with the ‘Atmanirbhar Bharat’ initiative and remove its dependence on foreign radios.

IRSA's value to India's wider security architecture, tying the Air Force, Army and Navy into one interoperable network, is what the Integrated Theatre Commands actually require to function. Extending it to the country's internal-security forces is worth pursuing. AI-enabled SDR can give indigenous defence manufacturing an edge and offer new avenues for future secure military communication, a notch higher in the most contested electromagnetic spectrum.

³⁸ Seth J. Frantzman, [“Israel Company Targets Opportunities in Europe and Asia for Software-defined Radios”](#), *C4ISRNET*, 2 June 2020.

³⁹ [“Operation SINDOOR: Forging One Force”](#), Press Information Bureau, Ministry of Information & Broadcasting, Government of India, 18 May 2025.

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