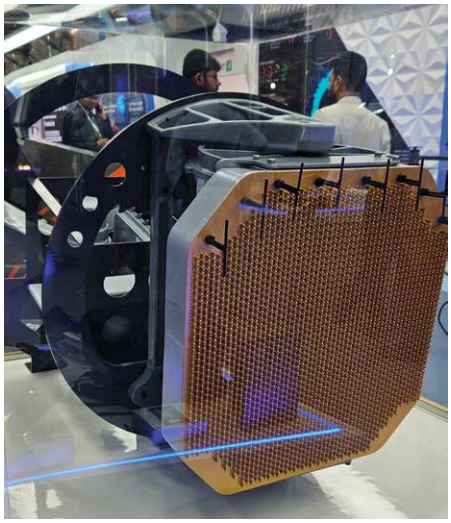
Gems from LRDE: Uttam and Virupaaksha radars

Uttam (meaning excellent) is a solid–state Gallium Arsenide (GaAs) based Active Electronically Scanned Array AESA radar under development by the Electronics and Radar Development Establishment (LRDE), a laboratory of the Indian Defence Research and Development Organisation (DRDO). Hindustan Aeronautics Limited (HAL) is the lead integrator and Bharat Electronics is the major supplier of subsystems. As per Project director D. Seshagiri of the Electronics and Radar Development Establishment, Uttam AESA radar is 95% indigenous, with only one imported subsystem. The building block is GaAs Monolithic Microwave Integrated Circuit (MMIC) using lithographic–type processes to produce microwave circuits on chips at very high levels of integration. The X–band Transmit/Receive module, in addition to a radiating element, contains additional MMIC integrated into a substrate with a few discrete components and cooling provisions in compact space. It is an LPI (Low Probability of Intercept) liquid cooled AESA radar featuring quad–band modules that can be stacked to form a larger unit.



Virupaaksha AESA radar

The Uttam Mk–1 has a total of 912 TRMs. Unofficial sources confirm radar's range against tactical–size targets at roughly 100 miles and greater electronic surveillance range. The radar is capable of tracking 50 targets with 4 in priority. Uttam AESA radar has a total of 18 modes in Air–to–Air (including Track While Scan and High–resolution raid assessment), Air–to–Ground (including High resolution imaging and tracking in Synthetic Aperture Radar/SAR Mode, Doppler Beam Sharpening and Ground Moving Target Indicator on SAR) and air–to–sea roles. The radar will inherently be capable of interleaving air–to–air, air–to–ground and terrain following modes, at ultra long ranges and at a suitable frequency to provide simultaneous assessment in every mode, no doubt a highly desirable attribute of the "strike packages" in terms of situational awareness. The fully functional active electronically scanned array (AESA) radar prototype was unveiled at Aero India 2019; the prototype was mounted inside the glass nose of a HAL Tejas prototype. During Aero India 2021, there was a licensing agreement for technology transfer from DRDO to Hindustan Aeronautics Limited for manufacturing and integration of the Uttam in the Mk 1A variant of the HAL Tejas. The technology transfer to HAL was finished by DRDO in July 2023, and the radar was approved for export as well. In April 2025, Centre for Military Airworthiness and Certification (CEMILAC) informed HAL and DRDO internally that the Uttam radar had finished four stages of flight testing. Furthermore, the radar hardware has passed qualification tests in accordance with the specifications of the Tejas Mk 1A.

Virupaaksha (a form of Lord Shiva) radar is an advanced version of the Uttam Mk 2 radar. The radar under development will replace the current N011M Bars radar being used onboard the Sukhoi Su–30MKI after the Super Sukhoi upgrade programme. Virupaaksha weighs half as much as the N011M Bars. Virupaaksha utilises Gallium Nitride (GaN) technology with improved radar operational characteristics than Gallium Arsenide (GaAs) used by earlier variants. GaN provides better power output, enhanced thermal efficiency, wider bandwidth of operation, and a longer lifespan compared to earlier variants. The radar incorporates the quad transmit–receive modules (T/R modules) similar to Uttam but has a more densely packed configuration and has around 2400 modules based on GaN based planks. The plank configuration eases maintenance operations. Reportedly, the radar succeeded to track 64 to 100 aerial targets simultaneously during trials and offers at least 1.7 times increased head–on search range over the 140 km range N011M Bars radar. It features advanced electronic counter–countermeasures (ECCM).

Uttam AESA radar

The Virupaaksha radar operates in the S–band frequency range, and can detect and track a wide range of targets like aircraft, helicopters, drones, and even ballistic missiles. It has a head–on search range of over 400 km as per another report, though the value is officially classified. In air–to–air attack mode, Virupaaksha can maneuver, control, and direct six missiles simultaneously towards the target. Virupaaksha features a combination of mechanical and electronic steering, also present on Captor–E of the Eurofighter Typhoon, allowing a higher angle of view. According to IAF Chief Air Chief Marshal AP Singh, over 200 of Sukhoi Su–30MKIs shall be upgraded to the Super Sukhoi standard with the Virupaksha radar.

As evident, Uttam and Virupaaksha AESA radars are projected to empower significant increase in the Indian Air Force fighters air–to–air target detection and tracking range and provide higher resolution Synthetic Aperture Radar (SAR) air–to–ground mapping at longer ranges while itself remaining largely immune to Electronic Counter Measures (ECM) interferences and interception. LRDE has started producing formidable airborne radars of pristine technology.

Article by Sayan Majumdar