Jane's Defence Weekly

Sky searchers

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Sometimes known as passive or optical radar, airborne infrared search-and-track capability has matured over the last 10 years. Michael J Gething reports on the systems in service and under development today

For a fighter pilot, gaining and maintaining air superiority over any battlespace is a given. Detecting 'the bad guy' without being detected oneself is highly desirable. Radar, however clever, is an active sensor and can be detected. The 'mark one eyeball' - the human eye - can only see so far. Enter the thermal imager in the form of an infrared search-and-track (IRST) system: a passive sensor equipping air-defence fighters for long-range thermal identification of airborne targets.

Close-up view of the Selex ES Skyward-G IRST's sensor head mounted ahead of the canopy of the Gripen NG demonstrator. (Saab)

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The IRST has been with us for half a century. US Air Force (USAF) F-101B Voodoo interceptors and F-102 Delta Daggers were equipped with an early form of IRST during the mid-1960s. US development then seemed to stagnate until the mid-1980s, when the then-Soviet Union revealed its MiG-29 'Fulcrum' fighter equipped with what was referred to as an 'optical radar'. Appearing in Finland in 1986, the UK in 1988, and Paris in 1989, this Russian IRST became the catalyst for the West's renewed interest in the technology.

By the mid-1990s the US Navy's (USN's) F-14D Tomcat was equipped with the AN/AAS-42 IRST and work was in hand to provide IRSTs for the Dassault Rafale and Eurofighter Typhoon, with Sweden committing to an IRST for its Gripen-E in 2010. Meanwhile, Russia continued its IRST development across the MiG-29 and Su-27/-30/-35 'Flanker' fighter models and beyond.

The first Russian IRSTs were known as opto-electronic pointing stations (OEPS) and fitted to the MiG-29 (OEPS-29) and Su-27 (OEPS-27). They were developed by the Urals Optical and Mechanical Plant (UOMZ) and are essentially the same equipment, only the OEPS-27 is larger and heavier (174 kg against 78 kg). They are part of the aircraft's integrated weapon systems: an electro-optic (EO) sighting system providing search, detection, tracking, and ranging functions against airborne and ground targets.

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The sensor head of the UOMZ OLS-35 optical locator station equipping the Su-35 'Flanker-F' displayed at Le Bourget in June 2013. (IHS/Michael J Gething)

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For the further-developed Su-35 fighter, UOMZ has evolved the OLS-30 even more, providing significantly increased detection and target-recognition ranges. Designated the OLS-35, this version was first displayed at the Paris Air Show in 2007. It comprises a scanning IR detector array, a collocated daylight TV system, a multimode laser rangefinder/target designator (LRF/TD), a full field-of-view stabilisation system, and an integrated monitor.

The OLS-35's enhanced functionality includes all-aspect search and detection, together with acquisition, recognition, and tracking of airborne targets. The LRF/TD enables accurate measurement of slant range and the output of angular co-ordinates and range values into the Su-35's EO sighting and navigation system to provide for target designation for medium-range AAMs and an asynchronous shooting mode for the integrated gun system.

A parallel development of the OEPS-29 by UOMZ produced the OLS-13S and OLS-13SM (for the MiG-29SM and MiG-29SMT upgrade programmes). These units feature increased target detection and tracking range, improved reliability, and reduced size and weight. They include a scanning thermal detector, laser rangefinder, and built-in test system. The OLS-13SM sensor dome has a leuco-sapphire fairing (raising the reliability and safety margins), a new eye-safe laser rangefinder, and a modernised photo receiver.

UOMZ told *IHS Jane's* that the company has conducted work on the OLS for the MiG-29s of air forces including those of Ethiopia, Kazakhstan, Malaysia, Poland, and Slovakia.

The OLS-13S optical locator station for the MiG-29SM and MiG-29SMT versions of the 'Fulcrum'. (UOMZ)

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As the MiG-29 evolved into the MiG-35, UOMZ revealed a further development at the Paris Air Show in June 2007 - the OLS-13SM-1 - with what was described as "significantly increased" target detection and recognition ranges. Further reduced in weight (60 kg), the OLS-13SM-1 comprises a scanning thermal detector, a TV sensor for daylight target recognition, a multimode LRF/TD, a field-of-view stabilisation system, and built-in test equipment.

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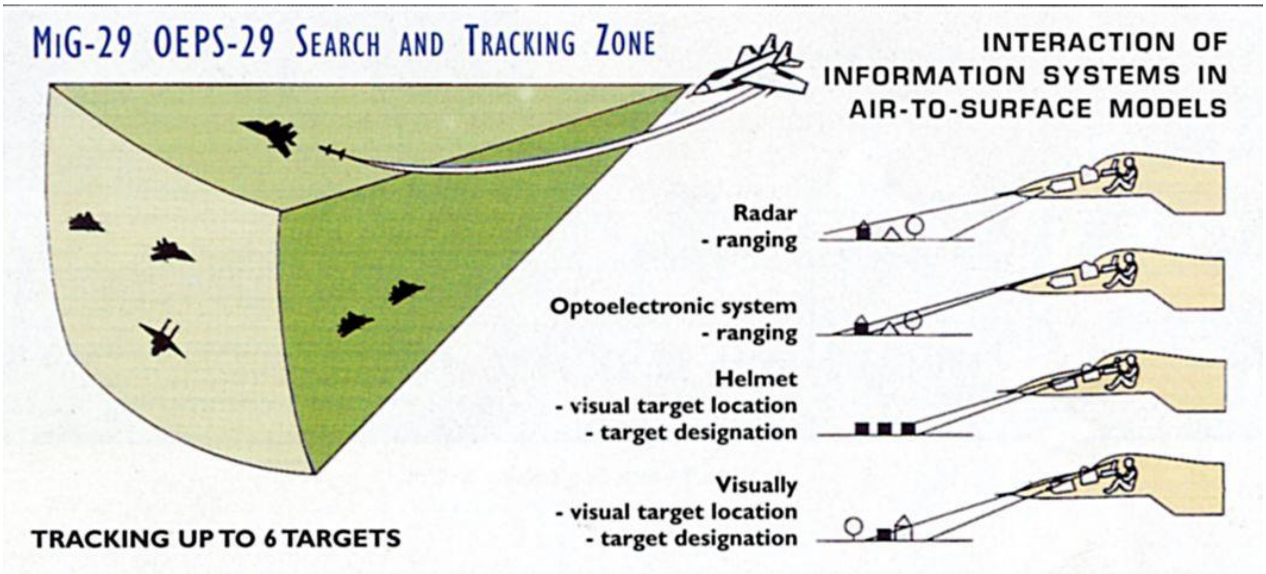
After extensive flight test evaluation of both MWIR and LWIR detectors at the Pacific Missile Test Center, Point Mugu, California, the USN selected the LWIR (8-12 µm) scanned linear array, having demonstrated its superior performance at operationally significant ranges. The F-14D's sensor head, located in a chin pod, contained the optics and IR detector assembly, mounted on a three-axis, stabilised gimbal. It was capable of multiple tracking of targets emitting heat at extremely long ranges to augment information supplied by conventional tactical radars.

The withdrawal from service of the F-14D in September 2006 saw the USN lose its IRST capability, but it was not the end of the AN/AAS-42. It had a brief career on the Boeing YAL-1A to provide early missile launch detection and tracking for the Airborne Laser (ABL) programme until cancellation in February 2012. In April 2002 it was revealed that the Boeing F-15K Eagles ordered by the Republic of Korea included the AN/AAS-42 IRST in the aircraft's EO sensor suite. Subsequently, in April 2006, it was confirmed that the AN/AAS-42 was part of the EO suite of the F-15SG Eagle ordered by Singapore. These systems are newbuild units.



The LMMFC AN/AAS-42 IRST installation in the leading edge of the port shoulder pylon of a Singaporean F-15SG Eagle. (IHS/Michael J Gething)

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On both F-15 versions the AN/AAS-42 is mounted on the leading edge of the port shoulder pylon. At the Singapore Air Show in February 2008 LMMFC showed a mock-up of a pod-mounted AN/AAS-42 aimed at offering IRST capability to the F-16 community. While the company reported regional interest, no orders for this variant have been reported.

Having lost its only airborne IRST capability in 2006, the USN began looking for a replacement capability for its F/A-18 Hornets. By July 2007 Boeing selected LMMFC to supply up to 150 new-generation IRSTs for F/A-18E/F Block II Super Hornets. Between them both companies invested more than USD10 million of their own funds to conduct a risk-reduction demonstration, with USN participation. This saw a test-article IRST mounted in the front of a centreline fuel tank and test-flown on an F/A-18F Super Hornet during late 2007. The modified fuel tank provided a cost-effective, software-only integration approach, requiring no structural or wiring changes to the aircraft.

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Operating passively in a wide variety of flight regimes, the AN/ASG-34 offers robust performance against a wide variety of targets, while ensuring immunity to electronic detection and radio frequency (RF) countermeasures. It provides the F/A-18E/F mission computer with track file data on all targets, at the same time providing IR imagery to cockpit displays. It can operate in either track-while-scan or single-target-track modes, with cockpit-selectable hands-on-throttle-and-stick (HOTAS)-controlled scan volumes in azimuth and elevation. The pilot interface is consistent with other F/A-18E/F sensors to reduce aircrew workload.

In August 2011 Boeing (as prime contractor for the F/A-18E/F) was awarded a USD135 million contract for the engineering, manufacturing, and development (EMD) phase of the IRST by US Naval Air Systems Command and, in November 2011, LMMFC (as equipment supplier) announced receipt of a contract to begin the EMD phase. Following initial trials on a King Air flying test-bed in 2013, in February 2014 Boeing was reporting that USN flight trials on a Super Hornet had started. The company also stated that current plans call for the first AN/ASG-34 IRST units to be deployed by 2017.

US Navy technicians make minor adjustments to the AN/ASG-34 IRST unit, mounted in the front of a *centreline external fuel tank of an F/A-18F Super Hornet. (Lockheed Martin)*

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As the USN programme evolved, by September 2009 it emerged that the USAF was interested in acquiring a pod-mounted IRST capability for about 100 of its F-15C/D Eagle fighter fleet, based on the USN's concept of the IRST sensor mounted in the front portion of an external fuel tank, located on the centreline stores pylon. In April 2010 Boeing contracted LMMFC to continue development of IRST requirements for the USAF F-15C Eagle IRST programme.

As part of the USAF development LMMFC packaged its IRST into a LANTIRN targeting pod and, mounted on an F-16C of the Air National Guard (ANG), conducted flight tests. According to a company statement issued on 24 February 2012, the podded system "successfully acquired, tracked, and provided a weapons cue during a recent live-fire flight test conducted by the Air National Guard". This exercise was part of the risk-reduction effort for the USN, USAF, and ANG AN/ASG-34 IRST programmes. During exercise 'Red Flag 3-13' in March 2013 an F-16C of the USAF's 64th Aggressor Squadron was seen carrying a pod-mounted IRST, believed to be an AN/ASG-34, as part of a further evaluation.

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The under-nose fairing of the AN/AAQ-40 EOTS under an F-35 Lightning II fighter, framing other F-35s, offers the aircraft an embedded IRST capability. (Lockheed Martin)

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As of mid-October 2014 LMMF had delivered about 140 EOTS systems for the F-35 Lightning II programme. Jerry Arlow, LMMFC's F-35 EOTS programme director, told *IHS Jane's* : "We are in various stages of execution of contracts in LRIP [low-rate initial production] lots 4-9. EOTS continues to fly on F-35 mission systems aircraft at Edwards Air Force Base and Patuxent River, as well as the missionised Boeing 737 Cooperative Avionics Test Bed aircraft."

In Europe, meanwhile, work on IRST systems for both the Eurofighter Typhoon and Dassault Rafale was in hand by the early 1990s. In the UK, following trials of a development IRST from Marconi Avionics (later BAE Systems and now part of Selex ES) for the UK Ministry of Defence in March 1995, work progressed on the parallel development of a dual-role IRST/FLIR system - PIRATE (Passive InfraRed Airborne Tracking Equipment) - for the Typhoon.

PIRATE is a joint development from the trinational consortium of EuroFirst, led by the Italian part of Selex ES (formerly Galileo Avionica, originally FIAR), with Thales (formerly Pilkington) Optronics of the UK and Grupo Tecnobit of Spain as major partners. Germany, as one of the four Eurofighter partners, opted out of the IRST capability. The PIRATE production contract for Typhoon was awarded in December 2003.

The PIRATE sensor head is mounted just ahead of the Typhoon's cockpit canopy (the optimum positioning for IRST air-to-air operations) and slightly to the left of the aircraft centreline (allowing for limited 'look-down' in FLIR mode). Working in both MWIR and LWIR spectrums, PIRATE automatically detects the IR signature of aircraft at long ranges (beyond visual range in excess of 50 km) over the entire field of regard. The signals-processing technology used in PIRATE demonstrates a very high suppression rate of false alarms and is derived from proven algorithms used by the Thales Air Defence Alerting Device.

A pair of Typhoons of the Royal Saudi Air Force equipped with the PIRATE IRST, located on the upper port *nose aft of the radome. (Eurofighter)*

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As part of Typhoon's integrated avionics suite, PIRATE performs automatic detection and track-while-scan operation in its IRST mode and, in FLIR mode, IR imagery for cockpit multifunction head-down displays (HDDs) and helmet-mounted displays (HMDs).

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While RAF and Italian Air Force Typhoons made their combat debut over Libya in 2011, F2-standard Dassault Rafale B (two-seat) fighters from the French Air Force had already been in action over Afghanistan in May 2007 in support of the International Security Assistance Force (ISAF) using US-supplied GBU-12 Paveway II laser-guided bombs. The significance of the F2 standard, which entered service from mid-2006, is that the avionics suite on the aircraft incorporates the Optronique Secteur Frontal (OSF) IRST system, as does the follow-on F3-standard aircraft.

The OSF is the result of a collaboration between Thales Optronique - responsible for the EO sensors - and Sagem Défense Sécurité (part of the SAFRAN group) - responsible for the infrared detectors. Designed to meet the operational requirements for both the French Air Force and Navy, the initial OSF contract from France's Délégation Générale pour l'Armement (DGA) procurement agency, worth EUR110 million (USD140 million), was placed in late 2000.

Along with the SPECTRA countermeasures system and RBE2 radar, the OSF is the third element of the Rafale's navigation and attack system (Système de Navigation et d'Attaque - SNA). The Rafale's weapon system uses this variety of sensors to perform air-to-air and air-to-ground ranging, tracking, and targeting functions, including IR, TV, and laser rangefinding. Having multi-spectral capability allows the OSF to perform several of these functions in parallel.

The two elements of the Optronique Secteur Frontal (OSF) installation ahead of the Rafale's canopy, *showing the CCD TV sensor (left) and the IRST ball (right). (Sagem)*

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Unlike most IRSTs, the OSF has dual sensor heads - the long-range IR passive detector (with very low false-alarm rates) and a high-definition charge-coupled device (CCD) TV sensor - plus an eye-safe laser rangefinder. Fusing the imagery from the IR detector (with a very large field of regard) and CCD TV sensor (with a narrow field of view), which can be supplemented by employing the seeker heads of MICA missiles fitted to the Rafale's wingtip launchers, enhances target detection. Together they can facilitate multiple, simultaneous search/identification/telemetry operation.

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The Skyward-G made its first flight on the Gripen NG demonstrator aircraft on 31 March 2014. This was to verify the system's functions and aircraft integration and, according to Saab's Hans Eineth, "the IRST has performed with good results ... multiple targets were detected, tracked, and identified and the system works perfectly as expected". Selex ES has since confirmed that integration activity of Skyward-G at Saab continues on schedule.

While no specific performance details have been revealed, a general capability emerged during a press briefing at Saab's Linköping facility in early March, ahead of the first flight of Skyward-G. Bob Mason of Selex ES told *IHS Jane's* that IRST systems can detect all aircraft flying faster than about 300 kt, even if the exhaust plume emissions are reduced. This was possible, he said, as a result of the aerodynamic heating coming from the engine core being absorbed into the airframe, with the low-observable coatings on 'stealth' aircraft being particularly prone to aerodynamic heating.

It is curious that none of Israel's three major electronic houses - Elbit Systems Electro-Optic (Elop), Israel Aerospace Industries (IAI), and Rafael Advanced Defense Systems - has yet revealed an airborne IRST product, as they are known to be working on the technology.

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