Complete Guide

by armada

Drones

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Supplement to armada
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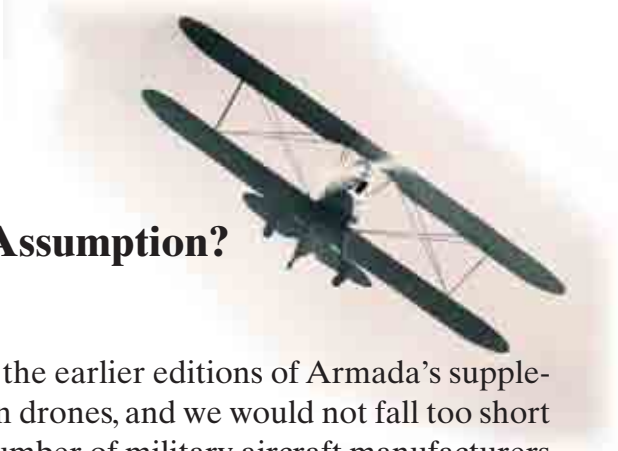

Premonition or Logical Assumption?

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Today, how many names are left in the defence aviation world? Fingers of only two hands suffice to reckon them: Boeing, Dassault, Saab, Lockheed Martin, Embraer, MiG, Eads, Sukhoi, BAE Systems, a few trainer aircraft manufacturers and, apart from a few of code-numbered factories in the Peoples Republic of China (generally clones from the Eastern World), that is about it. But for how long? Particularly in Europe, where there currently are only two manufacturers that still produce fighter aircraft of their own.

The reader will, by now, have guessed what we are driving at. Look at the four-page spread in the centre of this supplement. It is far, very far, from being exhaustive and only refers to drones that necessarily had to be cut down in terms of numbers by either technical or strategic relevance, or both – granted, it is a choice that can always be disputed. Add to this the other makes and types mentioned in the text and many others given in the earlier editions of Armada's supplements on drones, and we would not fall too short of the number of military aircraft manufacturers of yesteryear.

The development of military aviation only started to soar during the Great War and went on to grow to the above-mentioned telephone directory situation until the Second World War. Then consolidations (as euphemistically put) started to take place. Extraordinarily, the development of drones followed the same application pattern as that of piloted aircraft at the beginning of the last century. The first aircraft were used as observation "apparatuses" (aircraft were initially referred to as "apparatus" in early maintenance manuals), particularly to spot enemy artillery movements. Then came the first bombers – in fact initially the same types as the observation aircraft, but from which bombs were tossed overboard by the 'co-pilot' in WWI. Finally these needed to be countered, so the interceptor aircraft was invented, which is possibly a task that will be transferred to the so-called Ucav for its own self-protection in the future.

There is every reason to believe that the drone company consolidation process will also follow the same pattern as that of traditional aircraft manufacturers. In fact, it already started a few years ago when a Vietnam-age drone pioneer – Ryan – was taken over by Northrop Grumman, itself a company resulting from a massive consolidation.

Eric H. Biass

United States Fly High

The Northrop Grumman Global Hawk will attract military and paramilitary users

While the United States and the Soviet Union were the first to re-explore uncrewed aircraft technologies since the second world war in the 1960s, notably through Ryan and Tupolev (but with mixed results in both cases), Israel was really the first nation to turn the discipline into a viable proposition in the 1980s, before being overtaken in terms of market size by the United States.

Roy Braybrook

Compared to spending on manned aircraft (the Lockheed Martin F-22 alone receiving over $ 3.5 billion in FY08), that on drones is small, but rising impressively. The Washington-based Teal Group estimated in late 2007 that the worldwide annual spend on drones will almost double from the current $ 3.4 billion to around $ 7.3 billion within a decade, thereby making this the most dynamic growth sector of the aerospace business.

The Pentagon's own forecasts show its unmanned aircraft procurement budget rising steadily from $ 878.4 million in FY07 to a peak of $ two billion in FY10. In the latter year, America's corresponding RDT&E expenditure is predicted as $ 1.3 billion and operating & maintenance as $ 421.2 million.

The US armed services are estimated to already have a total of around 5300 drones in their inventories, and this number is clearly set to rise dramatically. Procurement of the Aerovironment (AV) RQ-11 Raven alone is aimed at 3333 systems, each with three air vehicles. The Raven has been flying over 12,000 hours/month, and is expected to fly 300,000 in 2008.

The US military drone flying total was 165,000 hours in FY06, and 258,000 in FY07. Even when small hand-launched systems are excluded, American drones are currently flying over 15,000 hours per month in southwest Asia. The AAI RQ-7 Shadow 200 is contributing over 7000, the General Atomics MQ-1 Predator over 6000 (out of a global total of more than 10,000), the Northrop Grumman MQ-5 Hunter around 1700 and the Northrop Grumman RQ-4 Global Hawk over 500 hours.

Lighter-than-Air

Uncrewed lighter-than-air vehicles exploit the drone's freedom from the constraints of human endurance. The systems used operationally by the US Army are the Raytheon/Tcom Raid (Rapid Aerostat Initial Deployment), the Lockheed Martin/ISL-Bosch Aerospace Reap (Rapidly Elevated Aerostat Platform) and the Lockheed Martin PTDS (Persistent Threat Detection System). The Raytheon/Tcom Jlens (Joint Land Attack Elevated Netted Sensor) is being developed to warn deployed US forces of cruise missile attack.

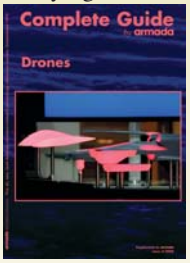
Other nations using aerostat-mounted sensors include Israel, with Elta EL/M-2083 radars on Tcom platforms. India has bought similar systems. Israel also operates the Tcom 32M aerostat with EL/I-3330 radar. Pakistan uses the ILC Dover Tars (Tethered Aerostat Radar System), developed for the US Air Force. The United Arab Emirates use the Tcom Tas (Tactical Aerostat System) with 17M and 71M balloons.

Hale

The leader in the Hale (high altitude, long endurance) category is still the Northrop Grumman RQ-4 Global Hawk. The first of seven YRQ-4A development aircraft flew in 1998. Nine production RQ-4A Block 10s (seven for the US Air Force and two Global Hawk Maritime Demonstration aircraft for the US Navy) have been followed by six stretched RQ-4B Block 20s, with gross weight increased to 14,628 kg. The first of 26 RQ-4B Block 30s with 'multi-intelligence' payload including Asip (Advanced Signals Intelligence Program) was delivered to the US Air Force in late 2007. The service plans to buy up to 15 RQ-4B Block 40s with the Northrop Grumman/Raytheon MP-Rtip (Multi-Platform Radar Technlogy Inser-

On the Cover

Will modularity have a future in drones? Eads, France, Spain and Germany seem to think so, as they are studying this feasibility with the Advanced Modular UAV featuring 'plug and play' modules, and this not only includes payloads but also wings of varying spans to best match the mission profile.

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This illustration may relate to the study programme for a twin-engined high-altitude, long endurance drone project that Boeing is conducting in cooperation with Aurora Flight Sciences. (Boeing)

tion Program) sensor, giving it a total of 54 production aircraft. Two of the YRQ-4As have been assigned to Nasa/Dryden. Three RQ-4A Block 10s are deployed with US Central Command (and reportedly based in Qatar) for missions over southwest Asia.

The US Air Force FY09 budget request includes five RQ-4B Block 40s for $ 712.2 million. Northrop Grumman has quoted a unit flyaway cost of $ 66.3 million for a Block 40, including a $ 39 million payload. In 2007 Washington formally declined to sell RQ-4s to South Korea until MTCR regulations are changed.

On 22 March 2008, an RQ4 – the first Global Hawk Block 20 – surpassed both the official and unofficial world un-refuelled endurance records by completing a mission of 33.1 hours at altitudes of over 60,000 ft over Edwards Air Force Base.

In January 2007 EuroHawk, a joint venture by Northrop Grumman and Eads, was awarded a $ 559 million contract by the German Ministry of Defence to build the Euro Hawk sigint, surveillance and reconnaissance system, a derivative of the RQ-4B Block 20, with a payload developed by Eads. The first contract includes one Block 20 to be delivered in 2010. The remaining four air vehicles are planned for delivery in 2011 and 2014.

The RQ-4B has also been selected for Nato's Alliance Ground Surveillance (AGS) programme, now to be based on eight off-the-shelf RQ-4B Block 40s. Northrop Grumman will be prime contractor, supported by various companies from the 21 participating nations.

Bams

The latest major win for the RQ-4 is the US Navy's Bams (Broad Area Maritime Surveillance) programme, which is estimated to be worth around $ 3.08 billion (including $ 780 million for the procurement of three initial production aircraft) over the next five years. A further 62 production aircraft are expected to cost $ 3.4 billion in current values.

The RQ-4 will form the uncrewed adjunct to the Boeing P-8A Poseidon. The Navy wants to be able to mount five 24-hour orbits (one over each deployed fleet) for seven days at a time, at 3700 km radius from their bases, with 80% reliability.

Northrop Grumman was selected for the Bams SDD (system development and demonstration) phase on 22 April 2008. This is to lead to first delivery in 2011, Lrip (low-rate initial production) in 2011, IOC (initial operational capability) with three Lrip aircraft in 2015 and FOC (full operational capability) in 2019 at the same time as the P-8A.

Australia will take part in the SDD phase, expecting to acquire Bams under the RAAF's Air 7000 programme, to operate with the Lockheed Martin P-3C and later the P-8A, at an increased radius of 5560 km. It is planned to place a production order (probably for six aircraft with an option on six more) in February 2012.

The Northrop Grumman proposal for Bams is the 'RQ-4N', a modified RQ-4B Block 20 with an endurance of over 24 hours at 3700 km radius. This will allow the requirement to be met by two or three aircraft for each orbit.

One alternative to the RQ-4N was the optionally manned Boeing Bams 550, based on the Gulfstream G550 corporate jet. The G550 was originally designated G-V SP, and is operated in small numbers by the US services as the C-37A. An earlier Gulfstream proposal for a drone version was labelled 'RQ-37'. Around 200 members of the G-V series have been built.

Deliveries of the General Atomics MQ-9 Reaper to the US Air Force began in March 2007. A Reaper is shown here in Afghanistan armed with Hellfire missiles and GBU-12 Paveway II laser-guided bombs. (General Atomics)

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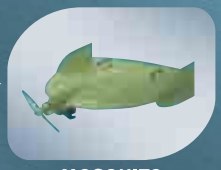

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Britain's Royal Air Force regards the Reaper as a dual-role drone, with equal emphasis on the surveillance and attack roles, whereas the US Air Force sees it more as a dedicated weapons platform. (General Atomics)

The Boeing Bams 550 would have been about three times as heavy as the RQ-4N, grossing 43,250 kg, and the airframe-engine combination cost at least 50% more, but offered a much larger payload. Compared to the RQ-4N, the Boeing project would have cruised somewhat lower, with a ceiling of 51,000 ft, and had a shorter endurance of 16 hours, but with a faster dash speed, cruising at up to 890 km/h.

Extreme Endurance

In 2007 Darpa launched its remarkable Vulture programme, aimed at developing a drone that could stay in the air for five years with a 450-kg payload. Vulture is seen as an alternative to Rapid Eye: a system to place a Hale drone anywhere in the world within one hour using a ballistic rocket and a self-deploying airframe.

In the solar-powered category it is noteworthy that in 2007 a 31-kg Qinetiq Zephyr 6.1 achieved a flight of 54 hours and reached a maximum altitude of 58,355 ft during flight trials in New Mexico. The Zephyr used amorphous silicon solar arrays supplied by United Solar Ovonic, and Li-S (lithium-sulphur) batteries by Sion Power, giving a specific energy of 350 Wh/kg.

Piston engines are relevant to less extreme Hale missions. The 9000-kg Boeing Condor, powered by two 130-kW Continental engines, reached 66,980 ft and had an endurance of 80 hours. Boeing is now working with Aurora Flight Sciences under US Army funding on the 3175-kg Orion Hall (High Altitude, Long Loiter) drone, which will burn hydrogen in a piston engine, and is aimed at a four-day endurance at 65,000 ft. The first of two Orions may fly before the end of 2008 with a conventionally fuelled engine, leaving the advanced version to fly in 2009.

Italy is the first export customer for the General Atomics MQ-1 Predator. The IAF has purchased two batches, some of which began a deployment to Ali AB in Iraq in January 2005. (General Atomics)

Aurora is also participating in a Boeing-led study of a larger, twin-engined drone.

In February 2007 Mitsubishi was awarded a contract as part of Japan's Technology Research and Development Institute Future Unmanned Aircraft Systems Study. Mitsubishi is to carry out the preliminary design of a piston-engined drone that could fly higher than the Global Hawk and carry radar and infrared sensors to detect Chinese and North Korean missile launches.

In 2005 AV flew a sub-scale Global Observer with a hydrogen fuel cell, this being the first flight by a hydrogen-fuelled aircraft. The projected full-scale GO-2 would gross 4100 kg with a 450 kg payload and fly for up to seven days at up to 65,000 ft. In September 2007 US Special Operations Command (Socom) awarded AV a contract for the development of the Global Observer, involving the construction of up to three aircraft and aiming to demonstrate an endurance of seven days within three years.

The MQ-1C Sky Warrior differs from the Predator in having a Thielert diesel HFE (heavy fuel engine) and atol (automatic take-off and landing) facility, to avoid the need for a qualified pilot. (General Atomics)

High-to-Medium

Once drones began to be used as weapons platforms (in 2001), warload-range considerations militated in favour of something larger than existing Male (medium alti-

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The 170-kg AAI RQ-7B Shadow 200 has served with the US Army since 2002 and has also been adopted by the US Marine Corps to replace the RQ-2 Pointer. It is launched from a ten-metre rail. (AAI)

tude, long endurance) designs. This new need might have been satisfied by a twin-piston engined project, but the simpler approach was to install an off-the-shelf turboprop, such as the Honeywell TPE331 or Pratt & Whitney Canada PT6A.

The leading drone in this new category is the 4763-kg General Atomics MQ-9 Predator-B, which has been given the US Air Force name Reaper. The MQ-9 has a payload capacity of 1700 kg (including 363 kg internal) and a ceiling of up to 50,000 ft. However, relative to the piston-engined MQ-1, endurance is reduced from 40 to 30 hours. It is powered by a 670-kW TPE331 and will use the Lockheed Martin AGM-114 Hellfire II missile, and the Raytheon GBU-12 Paveway II and Boeing GBU-38 Jdam guided bombs.

The GAO has estimated that the MQ-9 programme will cost $ 782.2 million (in FY07 values) for 63 aircraft, including $ 209.4 million for R&D. The FY09 US Air Force budget request includes nine MQ-9s for $ 161.4 million, indicating $ 18 million apiece with initial spares, compared to less than $ ten million for the MQ-1. The US Navy is acquiring one MQ-9 for R&D purposes.

The first YMQ-9A flew in 2001. Deliveries to US Air Force's first operational Reaper unit, the 42nd Attack Squadron at Creech AFB, Nevada, began in March 2007, and the first operational sortie was flown over Afghanistan in the following October. The service plans to buy 50 to 70 Reapers by 2012 to equip and sustain nine four-aircraft systems.

In April 2007 the US Air Force issued a request for information for a multi-purpose drone system to replace both the MQ-1 and MQ-9.

Britain's RAF has purchased an initial batch of three Reapers, the first of which was deployed to Kandahar, Afghanistan in September 2007. A further batch of ten has been requested, together with nine General Atomics APY-8 Lynx radars and nine Raytheon Das-1 multi-spectral targeting systems (also known as the MTS-B). However, Reaper production is booked by the Air Force until 2012 and, besides, the British Ministry of Defence is short of funds.

In developing the Mariner version to primarily meet the US Navy's Bams requirement, General Atomics increased the gross weight from 4763 to 5897 kg, and extended the wingspan from 20.1 to 26.8 metres. Fuel has been increased by 907 kg to 2722 kg, and payload is up to 2426 kg

The Mariner's cruise speed will be 350 km/h, with a dash capability of 425 km/h. Endurance is increased to 48 hours and ferry range to 13,000 km. Ceiling is 50,000 ft, but patrols would normally be performed at around 40,000 ft. Compared to the high-flying jets, the Mariner is argued to be more suited to frequent changes of altitude, to take a closer look at ships.

In promoting the Mariner for the Bams programme, General Atomics teamed with Lockheed Martin, who designed a fully computerised 'stickless' cockpit. Four or five aircraft were proposed for each US Navy orbit. A Mariner demonstrator has already been evaluated by the Australian authorities in the context of surveillance of the country's North-West Shelf, the principal problem area for drug-running, people-smuggling and illegal fishing.

Males

The drone that is piling up the hours for the US Air Force in southwest Asia is the General Atomics MQ-1B Predator-A, which is operated from Balad AB in Iraq and Kandahar AB in Afghanistan. In-flight control is provided via landlines and satellite links from the Predator Operations Center at Nellis AFB, Nevada or (more recently) Air National Guard bases in Arizona, California and North Dakota. The US Air Force plans to increase its current twelve Predator in-theatre combat air patrols to 21 by December 2009.

The AV RQ-11B Raven-B is the current leader in the hand-launched drone category, with well over 5000 already delivered and production heading for more than twice that number. (US Air Force)

Over 170 MQ-1s have been delivered (out of the 250+ Gnat/Predator/Reaper family total) and 97 currently remain in the US Air Force's published inventory. The service has requested 38 MQ-1s (for $ 378.2 million) in the FY09 budget, following 48 in FY07 and 24 in FY08. Six MQ-1s have been sold to Italy (five assembled by Meteor), and five more are on order. Since 2005, three Italian Air Force Predators have been operating from Ali (formerly Tallil) AB in Iraq.

The MQ-1B has a gross weight of 1022 kg and is equipped with an 86-kW Rotax 914F engine and a Raytheon AAS-52 MTS-A EO/IR turret. It can carry two

One of the most significant developments in the 20-kg category has been the Insitu Insight, which provided the basis for the 18-kg Boeing/Insitu Scaneagle and its launch and recovery system. (Insitu)

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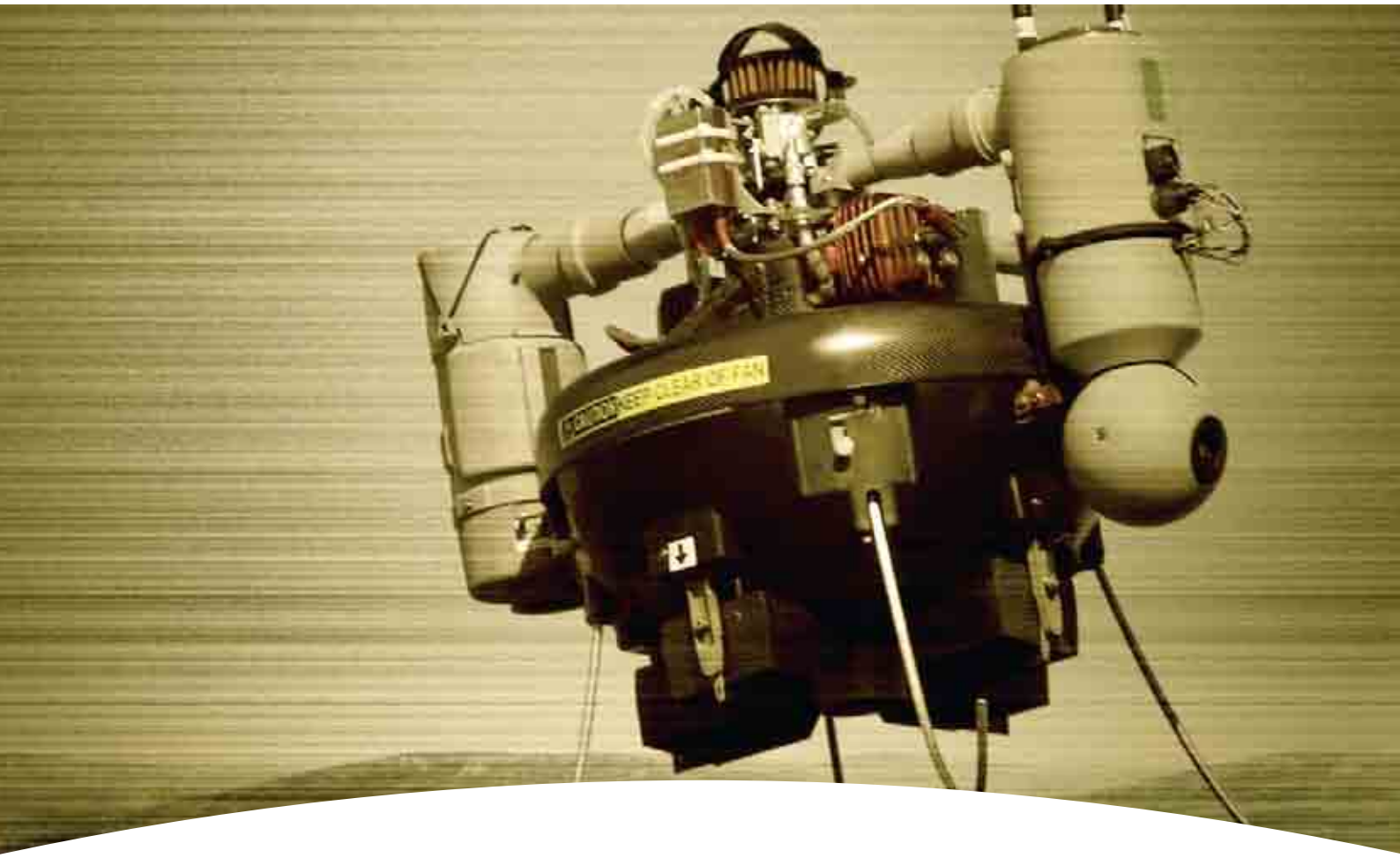

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The 9.1-kg Advanced Composites Research Silver Fox is to be purchased for the US Navy, US Marine Corps, US Army and Socom. This example was being used by the US Geological Survey. (Advanced Composites Research)

Hellfire missiles under the wings. It has a ceiling of 25,000 ft, a cruise speed of 130 km/h and a dash speed of 217 km/h. The MQ-1 requires a runway at least 23 metres wide but only 1500 metres long. It is capable of sorties of over 24 hours, or 16 hours with external stores.

General Atomics' I-Gnat-ER (Improved Gnat, Extended Range) or 'Warrior Alpha' is similar to the MQ-1 but has satcom capabilities and an improved sensor/designator. Five have been acquired by the US Army and a further dozen are being acquired. The type was first deployed to Iraq in 2004.

The US Army's production Sky Warrior is a further development of the US Air Force's MQ-1B, with a 100-kW Thielert diesel heavy fuel engine. This burns JP-8, rather than the Avgas required by the Rotax unit. A change to automatic take-off and landing (atol) reflects the fact that Army drones are not operated by qualified pilots. Unlike the Predator-A it will have a synthetic aperture radar (Sar) with moving target indicator (MTI) facility, complementing the EO/IR sensor and laser ranger/designator.

The Sky Warrior also has an airborne Ethernet connecting the vehicle's avionics, payloads and weapons, and a multi-role tactical common datalink to communicate with ground stations and other Army aircraft. Take-off weight is increased to 1450 kg, and there are two 227-kg and two 113-kg hardpoints for weapons. Each Sky Warrior system will include twelve air vehicles.

The US Army now plans to acquire eleven Sky Warrior systems with 132 air vehicles by 2015, and possibly more later. In 2007, when twelve systems were planned, the GAO had estimated a programme expenditure of $ 1.825 billion to that date.

The Sky Warrior SDD contract was awarded to General Atomics in August 2005, four air vehicles were purchased in FY06 and the manufacture of a batch of 17 SDD aircraft was funded in FY07. The low-rate production decision is scheduled for July 2008, leading to twelve aircraft per year from FY08 onwards. The FY09 dozen is budgeted as $ 174.6 million. The full-rate production decision is set for February 2010, and IOC for March 2010.

The Army reportedly asked for the Sky Warrior to be designated MQ-12A, but it appears in a May 2007 contract as the MQ-1B Block X, and has now become the MQ-1C. There is naturally pressure for the US Air Force and Army to buy and operate a common drone. The former is taking delivery of two MQ-1Cs in July and August 2008 for evaluation, presumably from the Army's FY06 batch.

In May 2007 Lockheed Martin announced that it had been selected by the US Army to provide a low-frequency, synthetic aperture Tactical Reconnaissance and Counter-Concealment Enabled Radar (Tracer) for Predator-class drones, based on the company's foliage penetration technology. The contract is valued at around $ 40 million.

Tactical American

The type that the Warrior will replace in US Army service is the Northrop Grumman MQ-5B Hunter, of which 54 remain in service with III, V and XVIII Corps. The 885-kg MQ-5B is powered by two 42.5-kW Mercedes heavy fuel engines, and is cleared to use the Northrop Grumman Viper Strike missile and Textron Defense Systems BLU-108 munition. It was deployed to Macedonia in 1999 and to Iraq in 2003.

In Iraq the Hunter serves alongside the US Marine Corps' elderly 205-kg RQ-2 Pioneer (33 still available), which is being replaced by the 170-kg AAI RQ-7B Shadow 200. The latter achieved IOC with the US Army in 2002 and is used in both Iraq and Afghanistan. The RQ-7B is powered by a 28-kW UEL AR-741 engine and has an endurance of six hours.

The US Army is already funded to acquire 85 RQ-7B systems with four air vehicles in each. In Iraq, a single system can generate up to 20 sorties per day. Some Army RQ-7Bs are being equipped with Harris PRC-152C Falcon III radios to act as communication relays. The US Marine Corps selected the Shadow in 2006 and fielded the first of 13 systems in May 2007

Other drones employed operationally by American services include: the 59-kg BAI Aerosystems Tern, the 9.1-kg Advanced Ceramics Research Silver Fox and (in the electrically-powered hand-launched category) the 3.2-kg Lockheed Martin Desert Hawk, and AV's 3.76-kg FQM-151A Pointer, 2.7-kg RQ-14 Dragon Eye and 1.9-kg RQ-11B Raven.

The Tern is an unusual design, is operated by Socom but is no longer in production. The first operational version was fitted with massive tyres to allow the use of rough runways in Afghanistan where it was used for force protection and to dispense a 9.0-kg unattended ground sensor. A naval version was developed in 2004 with skids and a tail hook to allow its use from helipads fitted with arrester wires. Socom is now believed to be operating the Viking family consisting of the Viking 100 (68 kilos, nine kg payload, 14 hours endurance), Viking 300 (144 kilos, 13.6 kilo payload, eight to ten hours endurance) and the Viking 400 (224 kilos, 27 kg payload ten to twelve hours endurance). The company is also building the Tiger shark for the Naval Air Command. The aircraft is based on the Viking design and carries L-3 BAI's serried 66 electro-optical sensor or infrared payloads.

On the USS Saipan (LHA-2) amphibious assault ship, this Boeing/Insitu Scaneagle, launched from the catapult on the left, has just been recovered by engaging a cable suspended from the Skyhook rig. (US Navy)

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AV aerovironment

Building on Scaneagle experience, Insitu sees the way ahead as a far heavier (59 kg) conventional twin-boom configuration. This Integrator prototype flew in August 2006 and a near-production aircraft appeared a year later. (Insitu)

Another one-of-a-kind is the Silver Fox, which was developed under funding from the US Office of Naval Research as a low-cost, relatively long-endurance sensor platform, and was deployed to Iraq in 2003. It is rail-launched by a compressed air catapult (which is small enough to be operated from an inflatable craft), and belly-landed in a small cleared area. The heavy fuel version has demonstrated an endurance of 21.5 hours. A total of 17 systems with 54 air vehicles are planned for the US Navy, US Marine Corps, US Army and Socom. The Canadian Forces have acquired a Silver Fox system via Thales Systems Canada for evaluation under the designation CU-167.

The US Air Force employs the Desert Hawk to protect its bases in Afghanistan. The drone is built by Aeromech Engineering under licence from Lockheed Martin Skunk Works. Since 2002 a total of 18 systems with 96 air vehicles have been delivered. It is also used by the British Army's Royal Artillery in Afghanistan. Britain has been testing the 4.5-kg Mission Technologies Buster, which serves as a tested for US Army sensors and is also operated by Socom.

Illustrating the potential of small drones, in early 2008 a 5.5-kg AV Puma (which was designed as a Pointer-replacement) achieved an endurance of nine hours (three times the figure with a standard battery) using a fuel cell/battery hybrid system.

America's leader in the two-kilo class is now the RQ-11 Pathfinder Raven from the same company. Following introduction of the RQ-11A as an interim solution to an urgent US Army requirement, the improved RQ-11B Raven-B attained IOC in 2006 and entered full-rate production in October 2007. The Raven can be remotely piloted, or fly completely autonomously, with an endurance of 1.5 hours. It is comparatively cheap and – being constructed of Kevlar – is able to survive an average of 200 belly landings.

The Raven-B is also used by the British, Danish and Italian Armies and has been adopted by the US Marine Corps as an interim 'Small UAS' to replace the Dragon Eye, and by US Special Forces to supersede the Pointer. The US Army's FY09 request is for 504 Ravens costing $ 30 million, down from a peak of 702 air vehicles for $ 33.3 million in FY08. (The $ 45.8 million US Army order placed in February 2008 includes Ravens for the US Marine Corps). The 5000th Raven has already been delivered, and at least 10,000 will be produced for the American services.

Between the US Marine Corps's Tier I 1.9-kg Raven-B and Tier III 170-kg Shadow 200, Tier II is currently represented by the 17.2-kg Boeing/Insitu Scaneagle, which has a nominal endurance of 15 hours, although 28.7 hours has been demonstrated. The Scaneagle is launched by a compressed-air catapult from a short rail and recovered by a patented Skyhook system, engaging a cable suspended from a gantry with a tip-mounted claw.

It appears that the only Scaneagle systems so far purchased by the US services are two owned by the US Air Force, with a total of 16 air vehicles. In addition, six systems are being leased by the US Marine Corps for use in Iraq and seven more are deployed on US Navy ships, based on a non-competitive contract awarded in 2004.

At time of writing a competitive follow-on contract award by the US Navy is awaited, the alternatives reportedly being the AAI Aerosonde Mk 4, Aurora Flight Sciences Golden Eye 80 (the Golden Eye 100 is terminated), MTC Technologies Spyhawk and Swift Engineering Killer Bee. This new contract (again with contractor personnel operating the systems) is expected to bridge the gap to the US Marine Corps's new Tier II, which the US Navy refers to as the Small Tactical Unmanned Aerial System (Stuas) and is due for initial operational capability in FY11. The various competitors are discussed below.

Australia's 15-kg Aerosonde Mk 3 crossed the North Atlantic in 1988 in a time of 27 hours burning less than six litres of fuel. The Mk 4 with winglets has demonstrated an endurance of 38 hr 44 min, and the Mk 4.4 has an enlarged fuselage to suit

The shape of things to come? Successful evaluation in Iraq of the Honeywell G-Mav (gasoline-powered micro air vehicle) has led to a US Navy order for 186 production RQ-16A systems. (US Navy)

increased payloads. The US Navy's Office of Naval Research has purchased several Aerosondes, and the type is also being tested by Nasa and the US Air Force.

The Goldeneye 80 is an 82-kg ducted-fan vtol air vehicle with wings that are free-floating in incidence and allow transition to conventional flight. It has an HFE, and an endurance of eight hours. It first flew in November 2006, and is regarded as Aurora Flight Sciences' 'third-generation' ducted fan drone, following the Goldeneye 100 of 2003 and the smaller Goldeneye 50 of 2005.

The 39-kg Spyhawk is a derivative of the Arturus T-16, with a Honda GX-57 piston engine. An unusual feature is a retractable ventral-mounted sensor turret (by Optical Alchemy). In November 2006 MTC Technologies was awarded a twelve-month concept demonstration contract by the Marine Corps Warfighting Laboratory to provide an air vehicle (XMQ-17A) to serve as a testbed for new technologies, and to assist in developing new tactics and procedures. However, in January 2008 MTC announced that it was negotiating a cancellation agreement. It is anticipated that by mid-2008 BAE Systems will have taken over the company.

Swift Engineering, having earlier worked with Northrop Grumman on its Killer Bee drone, has since July 2007 been teamed with Raytheon. The 62-kg Killer Bee is a flying wing design (for increased volume), with a pusher propeller and downturned winglets. It is rail-launched and recovers into a net. Maximum endurance is 15 hours.

Suggested warloads for the Killer Bee include a Rippel Effect M32 six-shot 40-mm grenade launcher, a green laser (presumably for dazzling the enemy) and the American Technology Lrad-500 long-range acoustic device. The latter was selected in May 2007 by the US Army and Navy as their hailing and warning device for small vehicles and boats. Aside from providing clear communication to 500 metres it can generate noise beyond the pain level.

The Fire Scout has been chosen as the Class IV drone component of the US Army's Future Combat Systems. (Northrop Grumman)

US Army

The US Army's Future Combat System (FCS) was originally to include four classes of drones, but in 2007 it was decided to defer Classes II and III. Following a $ 40 million Darpa technology demonstration contract in 2003, in May 2006 Boeing and SAIC (joint FCS lead systems integrator) awarded Honeywell the $ 61 million development contract for the RQ-16A Class I platoon-level drone, a ducted-fan vtol device.

In January 2008, Boeing and SAIC announced an accelerated test schedule for the Class I, requiring delivery over the following six months of eleven Block 0 prototype drones. This followed evaluation in Iraq of around 20 examples of the 8.4-kg Honeywell micro air vehicle (currently referred to as G-Mav, denoting the use of gasoline) by a US Navy-led joint explosive ordnance disposal group. Forward speeds up to 130 km/h have been achieved, but the G-Mav is operationally restricted to 93 km/h by software limitations. Endurance is only 30 minutes (against 50 required) and vtol is subject to a maximum wind speed of 28 km/h. However, these trials are evidently considered sufficiently promising to pursue development of a heavy fuel derivative of the G-Mav, possibly using a unit by RCV Engines. Initial operational capability is planned for 2015.

In a surprise move, in January 2008 the US Navy announced the intention to buy 186 two-drone RQ-16A systems with 93 ground stations for delivery between June and November 2008, evidently expanding the service's EOD mission in Iraq.

At the upper end of the FCS drone scale, the US Army's Class IV is to be the 1430-kg Northrop Grumman MQ-8B Fire Scout helicopter, which is based on the Schweizer 333 and first flew in late 2006. The MQ-8B has also been selected as the US Navy's Vtuav, and nine aircraft have been ordered for trials, with deliveries running from November 2007 to the end of 2008. IOC is scheduled for early 2009. The US Army programme alone is worth 560 drones, with IOC around 2014. The US Coast Guard is considering a radar-equipped development of the MQ-8B as a substitute for the Bell Eagle Eye tilt-rotor, which the service abandoned in 2007.

The MQ-8B is powered by a Rolls-Royce 250-C20W turbo-shaft, and equipment fit includes a Flir Systems Brite Star II thermal imager. Maximum endurance is eight hours, and a four-aircraft system can provide continuous 24-hour operation. Shipboard atols have already been demonstrated.

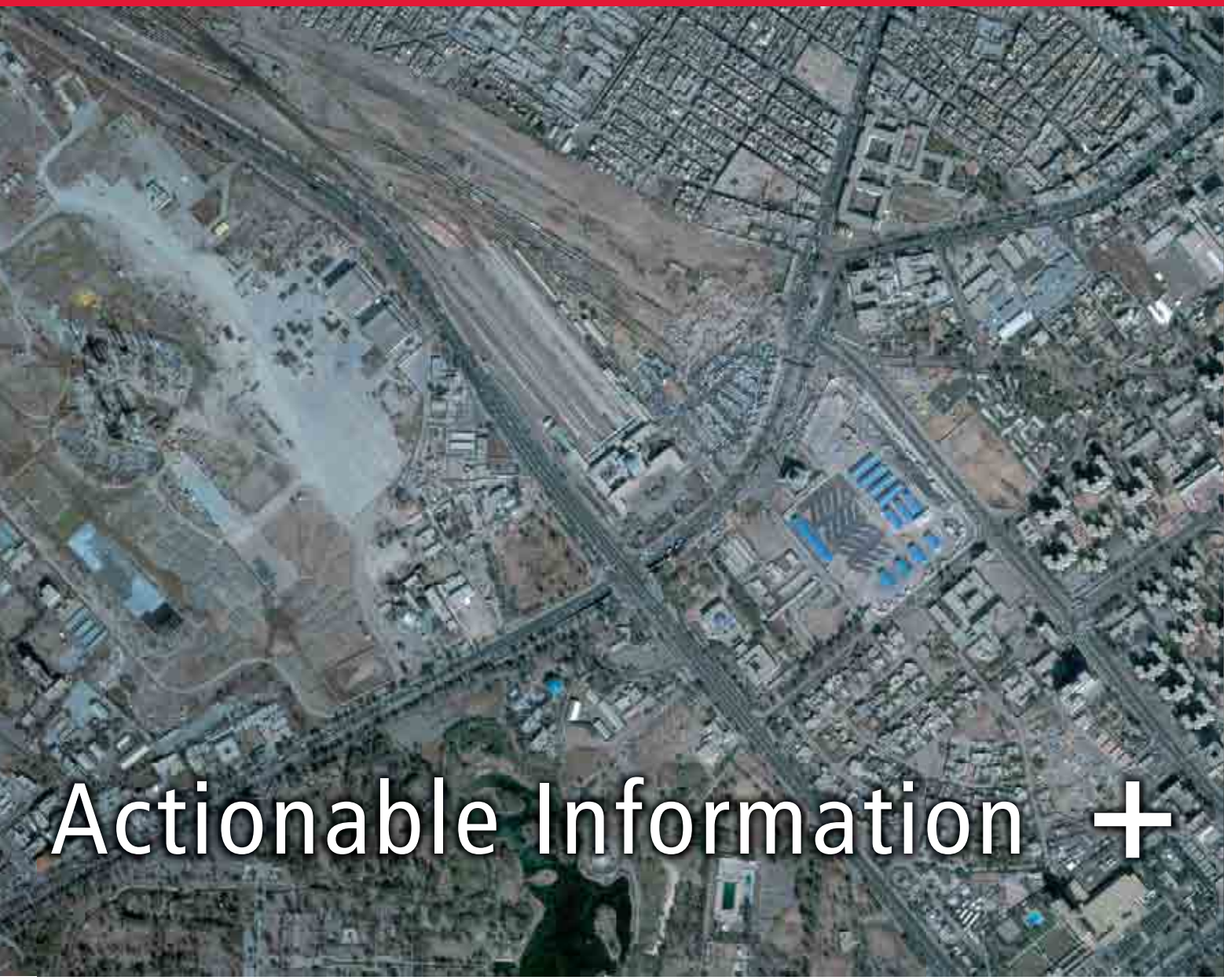
Developed with Lockheed Martin in view of the Bams programme, the General Atomics Mariner has also been evaluated by Australia as a possible anti-smuggling observation platform on the North-West Shelf. (General Atomics)

Micro

The most important development in the micro air vehicle (Mav) category is the 454-gm AV Wasp III, another fruit of Darpa funding. The lithium-ion battery also serves as the structure for the 72.4-cm span wing. An endurance of 107 minutes has been demonstrated, but a more typical figure is 45 minutes. In late 2006 the US Air Force selected the Wasp III for its Batmav (Battlefield Air Targeting Mav), and in January 2008 authorised full-rate production, leading to the procurement of 314 systems.

In November 2007 the US Marine Corps placed a $ 19.3 million order for Wasps to complement the larger Raven.

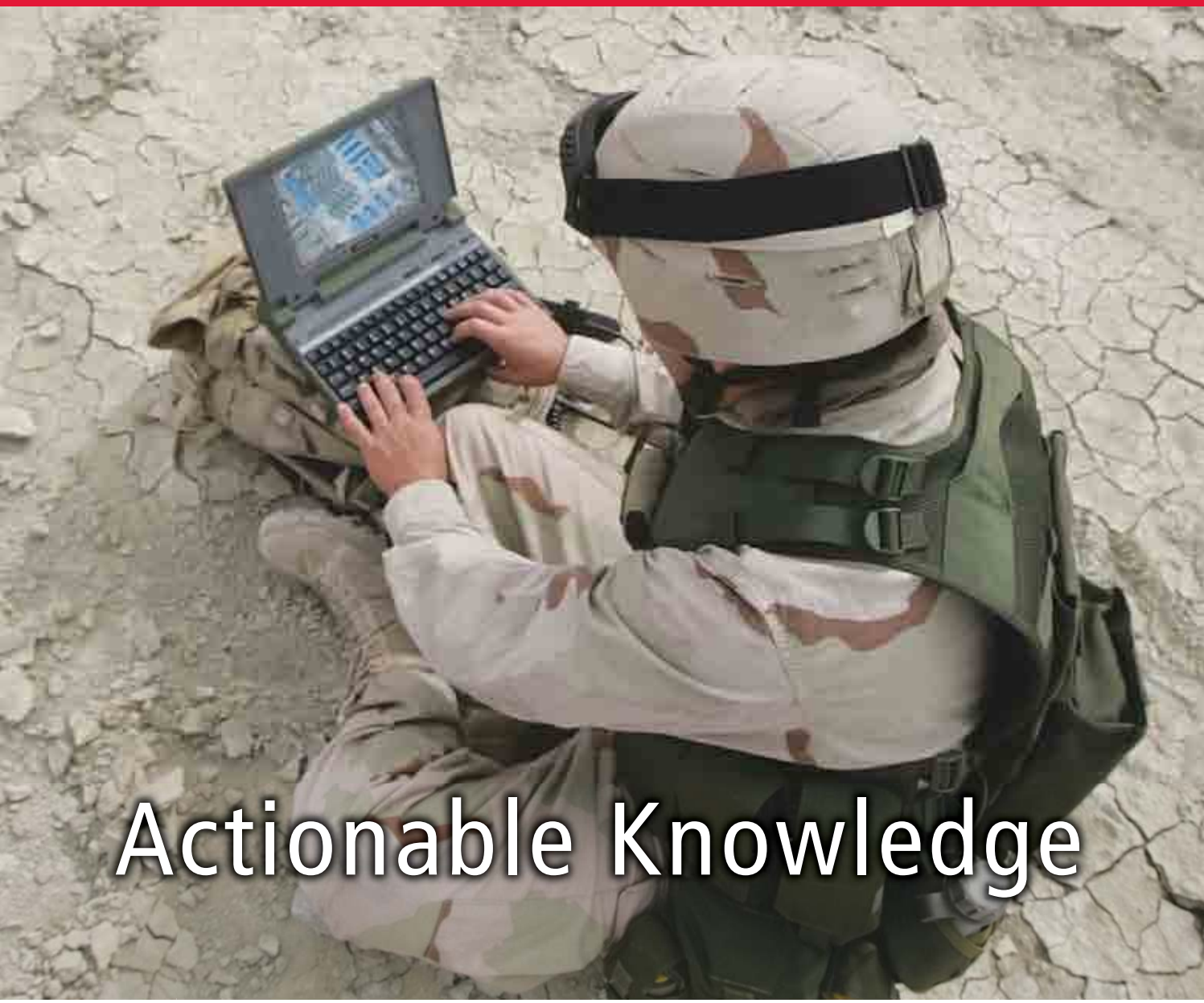
Actionable information in real time



Actionable Information +

www.raytheon.com

Actionable Intelligence



Actionable Knowledge

Knowledge to act. Warfighters need access to accurate information and intelligence to gain operational advantage. Raytheon's extensive domain expertise and technical innovation combine to deliver complete situational awareness. Our fully integrated persistent surveillance solutions gather and disseminate actionable information globally, in real time. Without delay. Without compromise.

Raytheon

Customer Success Is Our Mission

A160T Hummingbird

Frontier Systems-Boeing

10.67 10.97 n/a	1x 572 hp P&WC PW207D	24.0+ 30.0 2540	300 kg Sar, EO/IR	vtol

Aerolight

Aeronautics

2.56 4.00 ~0.50	8 hp (type undis-closed)	4.00 10.0 40	8 kg hi-resolution CCD or night camera	cat/parafoil

Aerosky

Israel Aerospace Industries

n/a 4.48 n/a	(type undis-closed)	5.00+ 15.0 70.31	Cots EO (manufacturer not determined)	conv/conv

Aerosonde Mk 4

AAI-Aerosonde

2.10 2.90 n/a	H-Type 24 cc EFI	30.0 15.0 15.20	5 kg various stabilised EO/IR BLOS imagery meteo sensors	hand/belly

Aerostar

Aeronautics

4.50 6.50 ~0.50	Zanzottera 2-piston 490ia 38 hp	14.0 18.0 200	200 kg stabilised EO	conv/conv

Aladin

EMT

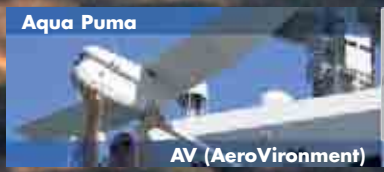
0.60 1.46 n/a	1x electric	0.75 low ~3.0	Day or IR	hand/belly

Apid 55

CybAero

3.20 3.3 dia n/a	2-stroke 2-piston 55 hp	6:00 9.00 105	Stabilised electro-optical	vtol

Aqua Puma



AV (AeroVironment)

1.80 2.59 n/a	600 W	2:50 2.50 6.35	E-O	hand/belly

Bateleur

Denel

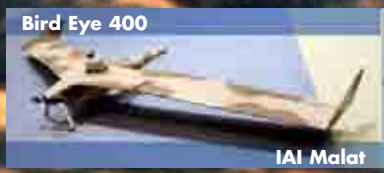
~10.0 15.0 ~0.80	1x Rotax 914 or Subaru EA-82T	24.0 25.0 1000	200 kg Denel Argos or Goshawk/ Avitronics elint or Sar	conv/conv

Bekas

Granit-NPO Mash.

2.97 3.20 n/a	not yet defined	5:00 15.0 ~250	Project for target recce (imaging infrared) and RF jamming	conv/conv+para

Bird Eye 400



IAI Malat

0.80 2.20 n/a	n/a	1:00 n/a 5.60	Day or IR	hand or cat/belly

Buster

Mission Technologies

1.04 1.24 n/a		4+ 10.0 6.35	1.3 kg, IR	hand or cat/belly

Camcopter S-100

Schiebel

3.09 3.40 ~0.80	1x 55 hp Diamond	6:00 18.0 200	Day/IR/elint /comint	vtol

Carapas

Eads-Galileo

4.07 2.30 0.40	16 daN Microturbo TRS 18-1 tf	0.90 40.0 750	60 kg Eads passive esm-elint, stabilised e-o and infrared	cat+rato/para

Carolo P50

Mavionics-Eads

0.47 0.49 n/a		0.30 na 0.53	Day	hand/belly

Changhong IC

People's Republic of China

8.47 7.53 0.58	1x WP6	0.75 na 2450	R/C (NAI)	acft/para

CL-289 Piver

Bombardier-Eads

3.51 1.37 0.40	1x BMW RR T117 +s/b	125 2.00 240	Infrared line scanner	rato/para

D-1A SR

Dara Aviation

1.75 3.28 n/a	QA400, 37cc 2.5 hp	4:00 na 25.0	-1A recon or weather sample -1D geophys. survey	car-top/conv

Desert Hawk

Lockheed Martin

0.82 1.31 n/a		2:50 1.00 3.20	Colour day or IR	cat/belly

Dragon Eye RQ-14A

AV (AeroVironment)

1.73 1.16 n/a	2 x Aveox 1005/6Y	1:00 1.00 2.04	Day TV	hand/belly

Eagle 1

Eads-IAI Malat

4.00 16.3 n/a	1x Rotax 914	24.0 25.0 1150	250 kg EO or EW	conv/conv

Eagle 2

Eads-IAI Malat

13.0 22.0 n/a	1x 1200 hp P&WC PT6A-67A	24.0 45.0 3600	~500 kg EO, EW or Sar (based on Heron TP, development on back-burner)	conv/conv

Eagle Eye

Bell Helicopter Textron

5.46 4.63 0.76	1x P&WC 200-55	8:00 20.0 1290	Flir Safire III + Telephonics RDR-1700B radar	stovl

Euro Hawk

Eads-Northrop Grumman

14.53 39.90 1.46	1x R-R AE3007H	30+ 60.0 14,628	Sigint, Elint, Comint, Satcom, Sar MTI (Imint)	conv/conv

Falco Selex Galileo	5.20 7.20 0.74	75 hp AR682	14:0 na 350	Flir, colour TV laser rangefinder	conv-cat/conv	**Heron** IAI Malat	8.60 16.61 0.85	1x Rotax 914 115 hp	50:0 30:0 1100	TV and IR, custom (IAI Tamam)	conv/conv
Fire Scout (RQ-8B) Northrop Grumman	7.01 8.22 n/a	1x R-R 250-C20W	8:00 20:0 1430	EO/IR, laser designator, SAR, GMTI, Radar	vtol	**Heron TP/Eitan** IAI Malat	14.00 26.00 n/a	1x 1200 hp P&WC PT6-67A	36:0 45:0 4650	TV and IR, custom (IAI Tamam, various) 245 kg	conv/conv
Global Hawk (RQ-4A Block 10) Northrop Grumman	14.53 39.90 1.46	1x R-R AE3007	28:0 65:0 14628	Sigint, MP Rtip plus extra power unit/Sar, EO, IR, Satcom	conv/conv	**Hunter MQ-5B** Northrop Grumman	7.01 10.44 n/a	2x 57 hp dual	20:5 18:0 885	TV and IR (IAI Tamam)	conv/conv
Global Hawk (RQ-4B Block 20) Northrop Grumman	13.41 35.35 1.46	1x R-R AE3007 H tf	36:0 65:0 12111	Satcom + Sar, EO, IR	conv/conv	**I-Gnat** General Atomics	7.01 10.44 0.76	1x Rotax 914	23:0 40:0 635	EO, IR or Sar (Wescam)	conv/conv
Global Observer GO-2 AV (AeroVironment)	25.4 78.94 n/a	Fuel cell 8 motors	168+ 65:0 4127	450 kg	conv/conv	**I-Gnat-ER Warrior Alpha** General Atomics	8.00 17.00 n/a	1x Rotax 914F 115 hp	30:0 25:0 1043	Flir, TV, Lynx Sar, Ku Satcom	conv/conv
Gnat-750 (Tier I) General Atomics	5.49 10.67 0.76	1x Rotax 582	40:0 20:0 513	Day TV, flir (Wescam)	conv/conv	**I-View 250** IAI Malat	4.10 7.10 ~0.25	(type undis-closed)	8:00 20:0 250	30 kg Mosp EO or EL/M-2055B Sar	cat/para
GoldenEye 80 Aurora Flight Sciences	0.70 1.40 n/a		1:00 5.00 11.0	Day/IR 1 kg Athena GuideStar 111m nav. & ref. system, IR, Flir	vtol	**Killer Bee KB4** Swift Engineering-Raytheon	1.91 3.05 n/a	15 hp	15:0 10:0 74	Laser designator, TV, IR, payload 10 kg	cat/conv
Hermes 180 Elbit	4.43 6.00 ~0.50	1x UEL 38 hp	10:0 15:0 195	EO, IR, laser designator, GMTI UK: Athena GuideStar 411 nav. & ref. system	conv, cat/ para,ab,conv	**KZO** Rheinmetall	2.26 3.41 0.37	1x 30 hp Schrick SF2-350S	3:50 11:5 161	Flir (Rheinmetall Defence Electronics)	rato/para
Hermes 450 Elbit	6.10 10.52 0.52	1x UEL AR-80-1010 52 hp	20:0 20:0 449	Tesar Sar, DSP EO, compass flir and CCD	conv/conv	**Luna X-2000** EMT	2.26 4.24 n/a	2-cyl 2-s 6.70 hp	4:00 10:0 29.9	CCD camera (various manufacturers) Athena Guide-Star 311 nav. & ref. system	cat/para
Hermes 1500 Elbit	9.39 15.0 ~1.00	2x Rotax 914, 100 hp	24:0 25:0 1496	EM, TV, Sar (various manufacturers)	conv/conv	**Mariner** General Atomics	10.97 26.21 n/a	1x Ase TPE331-10T tp	49.0+ 52.0 4763	Internal 363 kg, external 1361 kg various	conv/conv

Drone Name Dem Manufacturer	Length wingspan ⌀ payload bay all sizes in meters	Electric motor	Sensor packages, in many cases maximum sensor payload weight launch/recovery

turbine or t-prop engine | piston engine | Wankel engine

endurance [hours]
max altitude [feet x 1000]
take-off weight [kilograms]

Where no information is given, either the information was not made available or it has not been decided for that specific portion of the system. **Dem** signifies the drone is a demonstrator.

Powerplant abbreviations

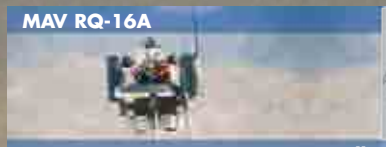
2-s	2-stroke	elec	electric engine	tf	turbo fan
hp	horsepower	gas	gasoline engine	tj	turbo jet
tp	turboprop	s/b	solid booster	pj	pulse jet
Rx	Rotax engine	-cyl	-cylinder		

Launch/Recovery abbreviations

conv	conventional	**rato**	rocket-assisted take off
cat	catapult	**hand**	hand launched
para	parachute	**vtol**	vertical take-off and landing
belly	belly landing	**stovl**	short T/O vertical landing

Unmanned Aircraft

MAV RQ-16A



0.40 / 0.33 / n/a | 2-stroke 3W engine 4 hp | 0:70 / 10:5 / 6.80 | 0.45 kg Sony FCB-IX11A E/O DRS E3500 IR cameras

Honeywell | vtol

Mini-UAV

1.05 / 1.50 / n/a | 1x 300W type n/a | 1.00+ / low / 3-4 | 0.50 kg TV or flir Photon, gas sensors

Patria | hand/belly

Mirach 20

3.60 / 4.15 / 0.34 | 1x 26 hp | 4.00+ / 12:0 / 170 | TV or flir/elint (Meteor)

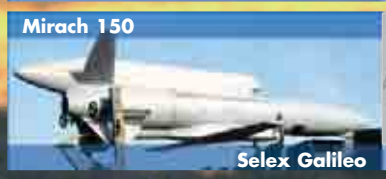
Selex Galileo | rato/para

Mirach 26

3.78 / 4.72 / 0.37 | 1x 28 hp | 7:00 / 13:0 / 200 | TV, LLTV, flir, elint (various manufacturers)

Selex Galileo | rato/para

Mirach 150



4.69 / 2.10 / 0.37 | 1x Micro-turbo TRS 18-1 tj | 1:30 / 30:0 / 345 | TV, IR, EW, Sar (various manufacturers)

Selex Galileo | rato/para

Muas

4.00 / 6.00 / n/a | n/a | 14:0 / 20:0 / 200 | 50 kg IR and TV

Irkut | conv/conv

Neptune RQ-15

2.13 / 1.83 / n/a | 1x 15 hp 2-stroke | 4:00 / 8:00 / 36.3 | IR or TV or 9 kg droppable

DRS Technologies | cat/belly, para

Neuron

9.30 / 12.5 / n/a | 1x Adour | n/a / 35.0 / ~6000 | Radar, IR + guided bombs in 2 internal bays

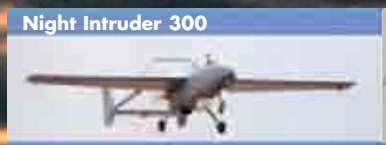
Neuron | conv/conv

Nibbio

4.07 / 2.30 / 0.40 | Micro-turbo TRS18-1 tf | 0:90 / 40 / 740 | Flir, ESM, IR, TV, ECM 60 kg

Selex Galileo | cat/para

Night Intruder 300



4.70 / 6.40 / n/a | 50 hp | 6:00 / 15:0 / 290 | IR, Sar, payload 45 kg

KAI | cat/para + conv

Orbiter

1.00 / 2.20 / ~0.35 | brushless | 1:50 / 2:00 / 650 | Max. 1.2 kg hi-resolution CCD from Controp

Aeronautics | hand/belly

Pchela 1

2.77 / 3.26 / 0.30 | Samana /Trud P-032 32 hp | 2:00 / 8:20 / 130 | TV or LLTV or elint

Yakovlev Design Bureau | cat/conv

Pioneer

4.24 / 5.12 / 0.37 | 1x 27 hp Sachs SF2-350 | 6:50 / 15:0 / 210 | TV and flir (IAI Tamam, Versatron)

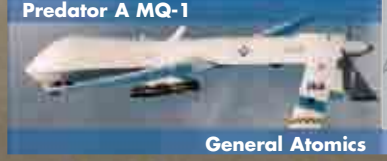
IAI-AAI | conv, rato/conv

Pointer

1.80 / 2.70 / ~0.10 | 1x electric | 1:00 / 0.6+ / 3.60 | 0.9 kg CCD camera or IR

AV (AeroVironment) | hand/belly

Predator A MQ-1



8.23 / 14.84 / 1.22 | 1x Rotax 914 115 hp | 24:0+ / 25:0 / 1043 | EO, IR, Sar (Northrop Grumman, Wescam)

General Atomics | conv/conv

Predator B

10.36 / 20.12 / n/a | 1x Ase TPE331-10T tp | 30:0+ / 50:0 / 4536 | Eo, IR, Sar (General Atomics, Wescam)

General Atomics | conv/conv

R90

1.42 / 2.56 / ~0.25 | 1x Enics M44D pulse jet | 0:50 | Day/IR

Enics | rato/expend

Ranger

4.60 / 5.70 / n/a | 1x Goebler-Hirth 38 hp | 5:00 / 14:8 / 274 | EO/IR sensor (IAI Tamam)

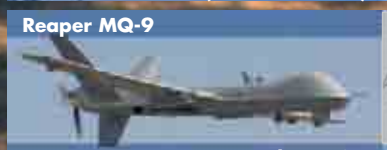
Ruag | cat/conv

Raven RQ-11

1.04 / 1.31 / 0.10 | 1x Aveox 27 | 1:50 / 14:0 / 1.82 | IR/EO

AV (AeroVironment) | hand/belly

Reaper MQ-9



10.36 / 20.12 / n/a | TPE331-10T 900 hp | 24.0 / 50:0 / 4763 | 340 kg internal, 1360 kg ext. AN/APY-8 Sar, EO/IR turret, AN/AAS-52(V) MTS

General Atomics | conv/conv

RemoEye 006

1.55 / 2.72 / ~0.12 | 1.50+ / na / 6.00 | Day or IR

Ucon | hand/belly

RemoEye 015

1.80 / 3.20 / ~0.20 | 4:00 / na / 15.0 | Day or IR

Ucon | conv/conv

ScanEagle

1.19 / 3.05 / 0.18 | 1x 1.5 hp 2-stroke | 15.0 / 16:0 / 18.0 | Stabilised day or IR

Boeing | cat/cable

Searcher II

5.85 / 8.56 / n/a | 1x 73 hp | 16:0 / 19:0 / 426 | TV and flir (IAI Tamam)

IAI Malat | conv/conv

Seeker II

n/a
7.00
n/a

1x 4-cyl 2-stroke 50 hp

10:0
18:0
280

Colour camera, multi-sensor, electronic survey

Denel

conv/conv + arrestor

Sky-X

~7.00
~6.00
n/a

1 turbine

na
30:0
1100

200 kg not defined Athena GuideStar 311 nav. & ref. system

Alenia

conv/conv

Sentry

2.57
1.90
n/a

1x 2-stroke 28 hp

6:00
10:0
150

35 kg Various

DRS Technologies

conv/conv-para

Sojka

3.81
4.08
n/a

2-cyl 2-stroke 29.5 hp

2:00
7:00
145

CCD camera, IR (various manufacturers)

VTULaSTV

cat/pata

Shadow 200 RQ-7B

3.75
4.27
0.34

1x UEL AR 741 38 hp

6.00+
15:0
170

27.3 kg Tamam EO/IR Athena GuideStar 211e nav. & ref. system

AAI

conv-cat-rato/para

Sperwer B

3.50
6.20
n/a

1x 70 hp 2-stroke

12:0
20:0
350

50 kg Sagem 410 TV, Sagem Matis (3-5µ) or Iris(-12µ) + weapons (Spike)

Sagem

cat/para

Shadow 400

5.00
3.82
n/a

1x UEL AR 741 38 hp

5:00
12:0
201

30 kg EO/IR (various manufacturers)

AAI

conv/conv

Sperwer/Ugglan

3.51
4.21
n/a

1x 70 hp 2-stroke

8:00
17:0
250

50 kg Sagem Olosp

Sagem

cat/para

Shadow 600

5.18
7.47
0.46

1x UEL AR 801 50 hp

12:0+
17:0
265

Micro-flir, CCTV (various manufacturers)

AAI

conv-cat-rato/para

Tracker (Drac)

1.40
3.60
~0.10

1x electric

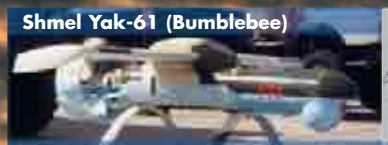
2:00
6:50
7.50

Day or IR, 1.8 kg

Eads

hand/belly

Shmel Yak-61 (Bumblebee)



2.77
3.26
n/a

(type undis-closed)

2:00
10:0
129

Day/night imager (various manufacturers)

Yakovlev Design Bureau

cat/conv

Tu-243 (VR-3 Reys-D)

8.21
2.26
n/a

1x Izotov TR-3-117 tj

na
17:0
1397

TV, IR, radiation detection

Tupolev ANTK

rato/para

Silver Fox

1.46
2.38
n/a

4-cycle JP5 or FP8

10:0
16:0
9.1

2.7 kg colour/CCD cameras, flir

ACR

cat/para

Vulture

3.11
5.21
0.70

1x TTL-Wae 342

3:00
16:0
125

Optronic day sight (M-Tek)

ATE

cat/para

Skeldar V-150

4.00
3.30
n/a

2-stroke 2-piston 55 hp

n/a
11:0
150

25 kg, types not yet defined

Saab

vtol

Wasp

0.28
0.40
n/a

1:00
10:0
0.32

Video + IR

AV (AeroVironment)

hand/belly

Skylark

2.20
5.50
~0.15

2:00
6:00
na

Day or IR

Elbit Systems

hand/belly

X-47B (Ucas-D)

11.58
18.90
n/a

P&W F100

40.0+
40.0+
20.865

2040 kg EO/IR/Sar/ GMTI/ESM/IO

Northrop Grumman

conv/conv

Skylark II

n/a
4.2
n/a

5:00
15:0
35

8 kg stabilised EO not defined

Elbit Systems

cat

Yabhon-M

4.30
5.70
~0.30

1x 60 hp ME 684

30.0
na
330

Day/IR

ATS

conv/conv

Skylite-B

1.25
2.40
0.12

1x electric

1:50
low
6.40

CCD camera

Rafael

tube/belly

Yarara

2.47
3.98
n/a

6 hp

6:00
10:0
30

EO, payload 5 kg

Nostromo Defense

conv/conv

Sky Warrior MQ-1C

8.53
17.07
n/a

Thielert diesel 135 hp

40:0
25:0
1450

363 kg internal, 227 kg external AN/APY-8 Sar, EO/IR turret

General Atomics

conv/conv

Zala 421-12

0.62
1.2
n/a

2:00
10:0
3.9

1 kg GPS, EO

A Level Aerosystems

cat/para

The service plans to acquire 21 systems and about 80 drones. Since late 2005 trials of the Wasp's suitability for jungle operations have been run jointly by Darpa and Singapore's Defence Science & Technology Agency.

The US Navy and US Marine Corps are using the USS Philippine Sea (CG 58) to evaluate the water-landing version of the Wasp, which is 50 grams heavier. Maritime operations would clearly be facilitated by a vtol version, studies of which are being jointly funded by AV and Darpa. Concepts under consideration include tilt-rotors, buried fans and a tail-sitter configuration.

In 2004 the US Army's Rapid Equipping Force acquired six Applied Research Associates (ARA) Tacmav systems for evaluation, and subsequently purchased 78 under a $ three billion programme for use in Afghanistan and Iraq. User criticism led to an improved version, now marketed by ARA as the 725-gram Nighthawk. The Nighthawk has folding propeller blades and a carbon-fibre wing (increased to 66-cm span) that wraps around the fuselage for transport. The drone is stored in a tube of 15.25-cm diameter, and the wing snaps back to flight position as it is pulled out of the tube. It has a ceiling of 11,000 ft, and an endurance of up to 90 minutes.

Non-American

Only current rival to the MQ-9 Reaper is the IAI Heron TP

In the non-American league of drone manufacturers, Israel's (who incidentally offered a stepping stone to America by supplying the first Hunters through TRW) take the lion's share, although a number of other nations have put their foot in the door, especially during the former-Yugoslavia conflict.

Amongst the first European manufacturers to have entered the observation drone market were Sagem with the Crecerelle (itself based on a Meggitt target drone) and EMT with the Luna. Since, other manufacturers have joined the dance, like Thales, Ruag (with Israeli-based airframes), BAE Systems (lately with the Herti), Selex, Galileo, Saab and Schiebel to name but a few. Given the large range of drones that this nation alone can supply, we shall begin the second section of this survey with Israel.

Israel

The development and operation of tactical drones was pioneered by Israel, although America was soon to achieve dominance in larger and more expensive systems. However, some nations are unwilling to buy military equipment from the United States, hence Israel's drone industry can still thrive, selling advanced systems free of political strings.

Heron TP: The top of the Israel Aerospace Industries/Malat range is now the 4650-kg Heron TP or Eitan (Strength), which is powered by an unspecified 895-kW turboprop. In the same weight category as the General Atomics Reaper, it has more power and wingspan.

It carries a 1000-kg payload at up to 45,000 ft and has an endurance of 36 hours.

Hermes 1500: Before the Heron TP, the heaviest Israeli drone was the 1650-kg Elbit Systems Hermes 1500 powered by two 75-kW Rotax engines. It has an endurance of 26 hours and a ceiling of 33,000 ft. The 1200-kg IAI Heron I has an 85-kW Rotax, an endurance of 45 hours and a ceiling of 30,000 ft. The Heron I is operated by the Israeli Air Force under the names Machatz (Strike) and Shoval (Trail), presumably in different roles. Two Shovals have recently been equipped with maritime surveillance sensors to replace crewed IAI Seascans (modified Westwind bizjets). The Heron is flown by all three Indian services, the Turkish Army and the French Army (as the Eads Sidm).

Hermes 900: The 970-kg Rotax-engined Hermes 900 is the latest member of Elbit Systems' Male family, featuring an 'independent' atol system that allows it to use alternate non-instrumented runways. Unveiled at the 2007 Paris Air Show, the Hermes 900 was to fly in the first quarter of 2008. Near-term potential markets include Canada.

Hermes 450: The 550-kg Elbit Hermes 450 is the first drone certified to fly in Israeli civil airspace. It has been operated under the name Zik by the Israel Defense Force since 2000 and is reported to have been

This recent photograph of an IAI Heron I shows it camouflaged light blue on the undersurfaces and painted white on top, presumably to reduce the heating produced by solar radiation. (IAI)

The 970-kg Elbit Systems Hermes 900 is a larger, retractable-gear, mid-wing derivative of the 550-kg Hermes 450. Unveiled at the Paris Air Show in 2007 it was to fly in early 2008. (Elbit)

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Cyber Aerospace has also recently developed and flight demonstrated the CyberScout, a small vertical take-off and landing UAV that is capable of carrying flexible payload packages where other systems are unable to operate. Its cruise speed of 250 knots and wide-area 30 km range coupled with its hover-and-stare capability and modular configuration provide a platform of unequalled surveillance/reconnaissance potential in urban, desert, jungle and mountainous environments.

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This impression of the British Army's Thales Watchkeeper shows some differences from the Elbit Hermes 450: the shoulder-mounted wing, retractable nose gear and twin sensor turrets. (Thales UK)

used as a missile platform over the Lebanon in 2006 to give a quick reaction to rocket launches. Other customers include Botswana and Singapore.

The Hermes 450-B forms the basis for the British Army's Thales Watchkeeper system, with UAV Tactical Systems (a joint venture by Elbit and Thales UK) as prime. Watchkeeper is scheduled for IOC with the Royal Artillery in 2010, fitted with the Thales Magic atol system, the I-Master radar and Elop Compass IV EO/IR turret. Modifications from the Hermes 450 include a shoulder wing-mounting, a retractable nose gear and wing de-icing. A number of standard 'H-450' drones owned by Thales UK have been leased under a $ 110 million contract as an interim measure for use by 32 Regiment Royal Artillery in southern Afghanistan and Iraq. In early 2008 Elbit unveiled its uprated 52-kW R902(W) engine for the Hermes 450.

Searcher II: The 425-kg IAI Searcher II, equipped with Elta EL/M-2055 radar, is being phased out of Israeli Air Force service in favour of the Heron I, but it has been exported to India, Indonesia, Singapore and Spain. The Spanish Army was due to deploy its Searcher IIs to Afghanistan in April 2008.

I-View: The 250-kg IAI I-View 250A has been selected by the Australian Army, with deliveries to begin in 2009. The 210-kg Aeronautics Defense Systems Aerostar is used by the Israel Defense Force and has been sold in small numbers to the US Navy, Angola and Nigeria. The canard-configuration 180-kg Emit Blue Horizon 2 has been used by the Sri Lankan Air Force, two being lost in a Tamil Tiger attack in late 2007.

Mini-Falcon: In the 50 to 100-kg category Israel offers the 80-kg Innocon Mini-Falcon, the 65-kg IAI I-View 50, the 45-kg Emit Sparrow and the 43-kg Elbit Skylark II. The Blade armed version of the Sparrow has been purchased by the British Army, reportedly linked to development of a loitering attack weapon concept. The Skylark II, a relatively heavy electric-powered drone, has been adopted by South Korea. It is rail-launched and recovered by parachute and airbag.

Skylite B: The eight-kg, rail-launched Rafael Skylite-B is believed to have been used over Lebanon in 2006, operated by contractor personnel. In the hand-launched category, the six-kg Aeronautics Defense Systems Orbiter has been ordered by Ireland, Poland and an undisclosed CIS nation. The 5.5-kg Elbit Skylark I was used on a small scale by Israeli ground forces in Lebanon in 2006, but the service is reportedly also considering the Skylite-B and the 5.6-kg IAI Bird Eye 400 in selecting a future mini-drone. The Skylark is also operated by the armies of Australia, Canada and Sweden. Other drones of around five kg include the ITL Optronics Lightener and Top-I-View Casper 250.

The Israel Defense Force is developing a requirement for an unmanned combat resupply and medevac system. Relevant projects include a new IAI helicopter, the 450-kg Emit Butterfly powered parachute with a Rotax 582 engine and the Urban Aeronautics 'Mule' powered by two Turbomeca Arriel engines driving ducted fans.

The parasol-wing, fixed-gear Hermes 450 entered service with the Israel Defense Force in 2000. It has also been purchased by Botswana and Singapore, and has been leased by the British Army. (Elbit)

Selected by the Israel Defense Force in 2004, the Elbit Systems Skylark has since been adopted by the armies of Australia, Canada and Sweden. The Canadian Skylark is used in Afghanistan. (Canadian Forces)

Upper End

Soar Dragon: At the upper end of the spectrum – and outside Israel – the only potential near-term competitor for the Global Hawk appears to be China's Chengdu/Guizhou Soar Dragon, which may be running ahead of the Mitsubishi and Alenia Aeronautica Molynx Hale projects. Oddly enough, the development of these appears to be more advanced than Russian projects announced much earlier, notably the Sukhoi Zond 1, 2 and 3.

Molynx: The 3000-kg Alenia Aeronautica Molynx has two 186-kW car engines and is designed for an endurance of 30 hours at up to 45,000 ft. It may produce useful experience for the Alenia Black Lynx, a tailless armed Male project.

Barracuda: The Eads Barracuda technology demonstrator crashed in 2006, but it is hoped to develop from this (in a joint Franco-German-Spanish programme) a modular twin-turbofan type. With long-span wings this will serve in the Male role. With short wings it will be a high-speed penetrator, like the smaller 360-kg Selex

The Eads Modular Advanced UAV will consist of a single 10.3-metre backbone fuselage cum engine and tail unit to which 25.25-metre span wings can be fitted for 46,000-ft altitude missions. Endurance would be around 17 hours. The 'canopy bay' would receive a Ku-band satellite aerial. The shorter set of wings (about nine meters) will provide high-speed low altitude (1000 ft) dash missions. (Eads)

Galileo Nibbio based on the Meteor 100/5 target, which presumably also forms the basis for the Eads Carapas demonstrator.

Modular Advanced UAV: Unveiled at the 2007 Paris Air Show, the Eads Advanced Modular UAV design has recently moved a step forward in its development, having been awarded a € 60 million contract by the German Government to cover its share in a 15-month study conducted with France (Thales) and Spain (Indra). As reported in Armada 2/2008 and clearly seen on our current cover, the system is modular at various levels. Not the least aspect is the ability to tailor cut the aircraft's wings to enable it to carry out high-speed penetration missions with shorter wings, or above-male missions with long-span wings, the wings being totally interchangeable. Likewise, the underbelly and 'cockpit' payloads will be interchangeable, the whole idea being to achieve a plug-and-play concept enabling an aircraft to be configured within anything between 30 minutes to a couple of hours. The aircraft will be powered by two external rear-mounted engines.

Herti: As remarked in his Dubai Show report (Issue 2/2008), Armada's Editor highlighted the fact that, «the Herti is pretty much a unique system, which brings the word 'unmanned', somewhat abusively used in the drone community, slightly closer to a certain truth», since it not only has the ability to fly totally autonomously without transmitting or receiving to remain as 'quiet' as possible, but also to judge, select the required sensors depending on the requirement of the moment and identify points of interest without any commands from the ground and then send bursts of data only when necessary. As manufacturer BAE Systems puts it, it is «task driven» and remains fully autonomous except for the first click on the mouse to get it started, as explained by a company official. Developed under a cloak of secrecy in Australia under the codename «Morrigan», first signs of its existence appeared in 2006 through press releases, but tangible proof was given at Dubai 2007 with one of two prototypes exhibited. It is based on a motor-glider design from J & AS Aero Design in Poland and powered by a Rotax 914 engine. Still few details are divulged regarding the payloads, but the aircraft is able to detect people walking across a border between two countries, fly a surveillance pattern at 80 knots at 9000 ft using its fixed electro-optical sensor, then switch to a higher-resolution turreted sensor upon which these are confirmed by a ground operator.

Sperwer Mk II: Following on from recent deployments in Afghanistan and the Balkans, Sagem is turning its sights towards the future for the Sperwer drone. Purchased by the Canadian, French, Dutch, Swedish, Danish (later abandoned) and Canadian armed forces, this 'Sparrow hawk' (the drone's name translated from French) has become the standard unmanned aerial vehicle for several Nato members.

Sagem notes that the combat hours racked up to date by the drone have already given the company tangible experience in real operations, in addition to the flying hours notched up in military exercises. However, the company has now developed a new version of its aircraft, which is available for purchase, according to official Sagem literature. The new aircraft will «incorporate several improvements based on feedback from the field and the latest technologies».

Known as the Sperwer Mk II, the new drone picks up from where the original left off, and features a host of modifications. For example, Sagem has obtained a significant reduction in logistics requirements and hence easier deployment in foreign theatres of operation. At present, it takes around two C-130 flights to transport an entire Sperwer system, which includes three aircraft, a ground control station, a catapult and a ground data terminal.

The Mk II model will have a greatly enhanced operating envelope in terms of altitude and temperature, although as yet no figures are available on what these improvements may constitute. Moreover, Sagem will enhance the electro-optical payload by installing new state-of-the-art systems. The company is also looking at how the drone's datalinks can be made compatible with Nato command and control structures via the French Army's Rapid Reaction Corps. This unit has been raised as a quick response partner for the Alliance's Rapid Reaction Force.

Night Intruder: Following its 290-kg Night Intruder 300 drone for the South Korean Army and Navy, Korea Aerospace Industries (KAI) is developing the 6500-kg turboprop-engined Kus-9, which is heavier than the MQ-9.

Yabhon: In a much smaller category, the Abu Dhabi-based Adcom Military Industries flew its new Yabhon RX-6 tac-

A successful programme, the Sagem Sperwer has seen extensive deployment in former Yugoslavia and now in Afghanistan. The French manufacturer is now looking into the development of a Mk II with extender range and a sharper electro-optical sensor. (Armada/EHB)

Complete Guide

by armada

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Russia's principal hand-launch drones appear to belong to the A-Level Aerosystems Zala 421 family. The 2.1-kg Zala 421-08 is used by the Interior Ministry, and this 421-04 weighs up to 7.9 kg. (A-Level Aerosystems)

tical drone in September 2006, to serve as the basis for the 1250-kg Yabhon RX-18 Male, now in development.

Tiha: Turkish Aerospace Industries is developing the 1500-kg Tiha-A, which is to fly in 2009 and provide a basis for the much larger (3500 kg) Tiha-B, to meet a Turkish Air Force requirement. Other TAI drone projects include the 85-kg Gozcu and the Tuma target.

Mid-weight

Falco: In the mid-weight category, the new 420-kg Selex Galileo Falco (reportedly sold to Pakistan) aims to follow the success of the 310-kg Sagem Sperwer, the 280-kg Denel Seeker and the 275-kg Oerlikon Contraves/Ruag Aerospace Ranger.

Harop: Rheinmetall is now working with IAI on a system that would combine the KZO with a loitering munition – presumably the new Harop, which has an EO sensor – a 23-kg warhead and an endurance of six hours. The IAI Harop, which is currently being evaluated in India and Turkey, is a larger derivative of the 135-kg IAI Harpy, which has been sold to China, India, South Korea and Turkey.

Ababil and Mohajer: Iran has at least two drone manufacturers. Iran Aircraft Manufacturing Industries (Hesa) makes aluminium airframes in Shahinshehr, and Qods makes composite airframes in Tehran. Hesa's 200-kg Ababil (Swallow) has been in production since 1986 and is used by the Iranian Revolutionary Guards and by Hezbollah in Lebanon, as is Qods' 85-kg Mohajer-2 (reportedly under the name Mirsad-1). Qods also produces the 60-kg Saegheh-2. The Toufan is an anti-radiation attack drone, like the IAI Harpy.

Latin American developments are evidenced by Mexico's 54-kg Hydra Technologies S4 Ehécatl (Wind), which first flew in 2006 and made its debut in Paris in 2007. Argentina's Nostromo Defensa is reported to be in small-scale production with the 30-kg Yarará, and is scheduled to unveil the electrically powered 3.5-kg Carbure 2 at Fidae-2008. Chile's air force Aeronautical Academy has a Project Vantapa, based on its X-02 air vehicle. Brazil's air force is purchasing the locally developed three-kg Flight Solutions FS-01 Watchdog.

Other hand-launched drones in the three-kg category include France's Technisolar Seni, Germany's EMT Aladin and South Africa's ATE Kiwit (Plover).

Malaysia's Sapura has exhibited its ten-hour endurance Cyber Eye and the Cyber Shark helicopter drone. At the recent air show at Langkawi a joint venture by Composite Technology Research Malaysia, Ikramatic and System Consultancy Services showed its MX-05 Aludra drone, which had just made its first flight in Malacca.

Singapore Technologies Aerospace has produced the hand-launched, piston-engined Skyblade II for the Singaporean Army, developed the electrically powered Skyblade III and is working on the much heavier (50 kg) Skyblade IV. The latter has been partly funded by the Singapore Ministry of Defence,and is due to fly around the end of 2008.

Australia's DSTO (Defence Science and Technology Organisation) is now funding development of the turbofan-powered Jandu, a joint project by ADI and Western Australia's Global UAV Organisation.

Notwithstanding its undoubted technological capability and its many advanced drone concepts (including the Sukhoi BAS-62 and Zond series), Russia has so far made little impact on this market.

In the last century the Soviets were best known for jet-powered reconnaissance drones, notably the 35.6-tonne, Mach 2.5 Tupolev Tu-123/139 Jastreb (Hawk), which was superseded by the manned MiG-25, and the 5370-kg high-subsonic Tu-141 Stritzh (Swift), of which 152 were built.

The 1230-kg Tu-143 Reys (Trip) was used by the Soviet forces in Afghanistan, and by Syria over Israel. It was also sold to the Czech Republic and Romania. The stretched 1600-kg Tu-243 Reys-D entered service in 1999 and is available through Rosoboronexport. The latest known version is the Tu-300 Korshun.

More recently the emphasis has been on providing target data for artillery rockets, notably the 40-km-range Grad, with further development aimed at the 80-km Smerch, likewise made by Splav. It may be noted that at Idex 2005 Splav exhibited the R-90 tandem-wing sensor-equipped drone that can be launched from a Smerch tube.

The Kulon Stroy-P system based on the Yakovlev Pchela-1T (TV-only) was used operationally over Chechnya in 1995 before it attained formal IOC with the Russian Army in 1997. One system with twelve drones had previously been supplied to North Korea. The Pchela-1K with day/night capability followed with the Stroy-PD, now in production. The shorter range Kulon Stroy-BP is based on the 25-kg Osa air vehicle.

In 2005 the Vega group, including the Kulon Scientific Production Institute in Moscow and KB Luch in Rybinsk, was given the lead in further Russian drone developments. Luch is developing the very conventional 60-kg BLA-05 Tipchak artillery reconnaissance drone, which has

The Selex Galileo Falco was cleared following 18 flight tests made by the end user (believed to be Pakistan) during which it carried out a surveillance mission at maximum payload which lasted 9 hours and 15 minutes, demonstrating, by using an auxiliary fuel tank, maximum endurance could exceed the 14 hour mark earlier anticipated. (Selex Galileo)

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The writing is on the door: the letters stencilled on this G-Wagen gives a clue as to which theatre of operations this EMT Luna is being deployed from. (EMT)

the military designation 9M62 and appears to aimed at supporting the 300-km Iskander rocket. The first state test series was concluded in late 2006.

Also funded by the Russian Ministry of Defence, the Luch BLA-07 is a 35-kg canard-configuration with a shrouded pusher propeller. The 500-kg Kulon BLA-06 Aist is an unusual design with a retractable undercarriage, a V-tail, and two piston engines on over-wing pylons. Although ordered by the Russian Ministry of Defence in 2005 it is also intended for commercial use.

At ParcAberporth, Wales in 2007 Russia's A-Level Aerosystems demonstrated the 2.1-kg Zala 421-08, as used by Russia's Ministry of Interior Affairs. The company also makes the somewhat larger Zala 421-04, which weighs 6.95 kg in electric form and 7.9 kg with a piston engine.

The Verticals

The Schiebel Camcopter S-100 during recent trials

The ideal of usefully sized drones that can be operated without runways or catapults, and can be recovered safely without nets or parachutes, is encouraging widespread interest in advanced helicopters and other vtol concepts.

The age-old struggle to convert a helicopter into an aeroplane in flight is illustrated (inter alia) by Spain's Hada (Helicopter Adaptive Aircraft) project, part of the Platino national drone research programme. Partly funded by Spain, the 380-kg Hada will take off like a conventional two-blade helicopter, then for forward flight the rotor will be fixed fore-and-aft, while a six-metre wing is unfolded from under the fuselage. Thrust is provided by a tail-mounted pusher propeller.

One of many ducted-fan vtol concepts, the Selex Damselfly follows the well-proven Harrier/Pegasus four-nozzle thrust-vectoring arrangement. An electrically powered small-scale model flew in April 2007, paving the way for a 100-kg full-scale Damselfly in 2009.

The Damselfly may compete for an anticipated Royal Navy order against the MQ-8B and Austria's 200-kg Schiebel Camcopter S-100, which is being marketed in co-operation with Thales. More than 100 S-100s have been ordered by three countries. Following trial on frigates in March, Schiebel announced in mid-April 2008 that the S-100 had been tested in conjunction with a much smaller vessel, namely the Guardia Civil's 51-metre Rio Miño off the

One of the most advanced is the 2540-kg Boeing A160T Hummingbird, powered by a 425-kW Pratt & Whitney Canada PW207D turbo-shaft. With the A160T it is hoped to achieve a 30,000 ft ceiling and an endurance of over 18 hours, this by virtue of a patented Optimum Speed Rotor (OSR), a clean airframe and a high fuel fraction. The OSR reduces the rotational speed of the blades in forward flight, to delay compressibility effects on the advancing tip and inboard stalling on the retreating blade. A piston-engined A160 flew in 2002, having been developed by Frontier Systems, which was taken over by Boeing in 2004. June 2007 marked the first flight by the turbine-engined A160T, the first of ten being built for Darpa and the US Special Operations Command.

Unlike tail-sitter ducted fan projects, the Selex Galileo Damselfly is a flat-riser using four rotating nozzles (as in the Rolls-Royce Pegasus), with the aft nozzles raised to avoid interaction of the jets. (Selex)

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by armada

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coasts of Grand Canaria. A former tuna trawler, the *Rio Miño* was converted to a coastal patrol ship with, inter alia, a 10.5 × 8.5-meter helipad sans landing grid (which would have facilitated operations since the S-100 can be fitted with a harpoon decking system. According to the Austrian manufacturer the S-100 took off on a one-hour mission, spotted a Spanish Armada frigate from a range of about ten nautical miles, returned to the hosting 'mother ship' and displayed its capability to hover above the helipad and follow the ship's heaving and sinking motion to perform a smooth touchdown. In the tests mentioned above, the S-100 was operated from a Pakistan Navy Type 21 frigate in the Arabian Sea. The weather allowed takeoffs and landings at a maximum ship speed of 13 kt with 15-kt crosswinds.

The Boeing A160T Hummingbird is a turbine-engined development of the piston-engined A160 designed by Frontier Systems. It is hoped to produce a breakthrough in rotorcraft speed, ceiling and endurance. (Boeing)

Sweden's 160-kg Cybaero Apid 55 is in service in the United Arab Emirates. It provides the basis for the new Saab Skeldar-150, which has a modified airframe and a variety of sensors. (Cybaero)

A four-hour mission was carried out, the S-100 taking off from the helipad in daylight and landing at night. The tests were concluded by another night flight with a total flight time about six hours at a maximum altitude of 6000 ft.

Depending on the timescale, other drone helicopter contenders for the Royal Navy order may be the Saab Skeldar V-150 M and the Eads Sharc or Orka. The Skeldar is a derivative of Sweden's Cybaero Apid 55, a 160-kg drone powered by a 41-kW Wankel engine. Seven Apid 55 systems were sold to the United Arab Emirates in 2004. The Skeldar first flew in April 2006, but for naval applications a Skeldar M is being developed. Cybaero is now working with the US Naval Research Laboratory on the latter's new 172-kg Vantage drone, which flew in early 2008, powered by a 31-kW UEL 801 rotary heavy fuel engine.

The 190-kg Sharc (Scouting and Hunting Autonomous RotorCraft) has a coaxial rotor, and represents a further development by Eads Military Air Systems (part of Defence & Security Systems) of the earlier Seamos. The Sharc first flew in July 2007. The Orka, for its part, is a joint drone development by Eads' Eurocopter division and Hélicoptères Guimbal, based on the latter's two-seat Cabri. The Orka is being offered to both the French Army and Navy.

In 2005 an agreement was signed by Eurocopter and Guimbal, paving the way for the latter's two-seat Cabri helicopter to be developed as the Orka drone, aimed initially at an anticipated French requirement. (Eads).

Targets and Decoys

Eads DO-DT25 carrying a rocket-powered DO-DT55

The well-established targets produced by companies such as Meggitt Defence Systems, Northrop Grumman, Raytheon and Selex Galileo require no introduction.

Jet engines developed for aero modellers are making possible small high-speed targets such as Eads-Dornier's single-engined 144-kg Do-DT25 and the 50-kg Do-DT35 and 70-kg Do-DT45 twins. All are in production for the German Army and Navy. The 22-kg Do-DT55 is launched from the Do-DT25 to simulate an anti-radiation missile. Selex Galileo is likewise developing the 20-kg Locusta target, to be released from a 330-kg Meteor 100/5.

Another in the Do-DT25 class appears to be the 150-kg Iris Jet, developed by the Greece-based Eads 3 Sigma, which produces a wide range of targets. Spain's Inta has its own Diana project, with a similar payload capacity. The California-based Xcelaero is developing the 80-kg NXT-400, with two model jet engines. Air Affairs Australia is promoting the Phoenix Jet, equipped with an AMT engine.

The Beijing-based Black Buzzard Aviation Technology has exhibited the 45-kg single-engined HFT-40A and the 90-kg HFT-60A twin, both powered by the indigenous VWP-60.

One of the main thrusts of future developments appears to be on low-cost targets to simulate anti-ship missiles: high-subsonic weapons such as the

The swing-wing Raytheon AGM-160B Mald (Miniature Air-Launched Decoy) has a range of 925 km and been cleared for use on the Lockheed Martin F-16 (shown here) and the Boeing B-52. (Raytheon)

MBDA Exocet, and Russia's supersonic SS-N-22 and -27.

The US Navy has an emerging need for a Multi-Stage Supersonic Target (Msst) to simulate 'Threat D', thought to be the Novator 3M54E (SS-N-27). This cruises subsonically, but in the terminal phase detaches a sea-skimming supersonic penetrator. Although the Mach 2.3 Orbital Sciences GQM-163 Coyote (which received the first US Navy production order in late 2007) can represent Threats A, B and C, it evidently cannot cruise subsonically for 170 km and reach Mach 2.2 at a height of 16 ft. The Msst SDD award is due in late FY08.

The US Navy also has a requirement for a high-subsonic target, which is being competed by the Northrop Grumman BQM-74F and the Orbital Sciences BQM-167X, a development of the BQM-167A Skeeter used by the US Air Force.

In the full-scale target category the US Air Force's QF-4 is expected to be replaced by the QF-16, with the contract to be awarded competitively in April 2009.

Little has been published on Russian targets, beyond the fact that Sokol began production of the turbofan-powered, 280-kg Dan in 1993. The Dan-Baruk search-and-attack variant with KBP Vikhr anti-armour missiles has been proposed.

Turning to decoys, the 135-kg swing-wing Raytheon AGM-160B Miniature Air-Launched Decoy (Mald) successfully completed flight testing in January 2008, and is set to enter Lrip. It has a range of 925 km, and will be launched from the B-52 and F-16.

The use of a drone to launch mini-targets is represented by this 330-kg Meteor Mirach 100/5, carrying two 20-kg Selex Galileo Locustas, as used to test German Air Force Patriot missiles. (Selex Galileo)

Combat Drones

Dramatic montage of the Northrop Grumman X-47 on its future home: a flight deck

The ideal of usefully sized drones that can be operated without runways or catapults, and can be recovered safely without nets or parachutes, is encouraging widespread interest in advanced helicopters and other vtol concepts.

Turning drones into light bombers was an obvious step in the recent history of drone development. However, the creation of 'proper' strike aircraft, by removing not only the crew but also all the items that go with them is a far more ambitious undertaking.

One often overlooks what are the implications of having one or several crew members onboard an aircraft in terms of weight, cost and volume taken away; just a few items: avionics, ejection seat, obogs, canopy, controls. The comes the crew itself, which without even looking at the human value aspect, but through the lengthy training process end up costing more than the machine they fly.

America's Joint Unmanned Combat Air Systems (J-Ucas) programme was terminated in FY07 after the expenditure of $ 800 million. Out of the ashes came the US Navy's Ucas-D demonstrator, paving the way for a stealthy 'F/A-XX' Ucas to replace the Boeing F/A-18 in 2025.

In August 2007 Northrop Grumman was awarded the $ 650 million Ucas-D

A wind tunnel test model of the Neuron is here seen being put through its paces at Onera's facilties in France. As for its American counterpart, low radar signature is a mission prerequisite. (Dassault)

In contrast, China's Shenyang Anjian (Invisible Sword), which was shown in model form at Zhuhai in 2007, is a supersonic configuration allegedly intended for the air-to-air role.

Europe's principal Ucas effort is the Dassault-led, six-tonne Neuron, for which France's DGA signed a € 405 million contract in 2006, and which is to have its maiden flight in 2011. Others involved include Alenia Aeronautica, Hellenic Aerospace Industries, Ruag Aerospace, Saab Aerosystems and Thales. National efforts include Britain's BAE Systems eight-tonne Taranis (to fly in 2010), Italy's 1300-kg Alenia Aeronautica Sky-X, Russia's Yakovlev Proryv (Breakthrough) and the lightweight Voron as well as Sweden's Saab Aerosystems Filur.

contract to construct two X-47Bs. The first is scheduled to fly in November 2009, and the first carrier operations in late 2011. Derived from the X-47A tested in J-Ucas, the X-47B has wing extensions and a non-afterburning Pratt & Whitney F100-PW-220U turbofan. It has a designed launch weight of 20,200 kg and a maximum landing weight of 10,567 kg.

Russian Ucas thinking appears to be following similar (though land-based) lines, aiming for a subsonic stealthy Sead drone. At Maks 2007 RAC-MiG unveiled its tailless Skat (Skate) in mock-up form. The Skat is a ten-tonne vehicle with a Klimov RD-5000B engine.

Paving the way for the US Navy's next strike aircraft, Northrop Grumman's unmanned, subsonic X-47B demonstrator will rely heavily on its low radar signature, shown here under test. (Northrop Grumman)

Brains and Eyes

Sagem is working on a hi-res Euroflir sensor

Manning a drone from the ground is easy, but on paper only. What the people behind the controls really lack is not only the pants-and-seat feeling, but also the environmental assessment. We tend to forget the incredible benefits we get from stereoscopic vision and the incredibly fast and automatic ability of the eye and brain to adjust or focus on a point of interest.

Eric H. Biass

Except for unbelievably irresponsible designs (and yet some made it to active service level) and mechanical failure, drones more often crash for two main reasons: bad handling and loss of environmental reference.

Bad handling is a common occurrence, this because the ground crews are rarely aviators themselves and often lack the aviation spirit generally acquired at light aviation club level by pushing an aircraft out of a hanger to start with. Some footage of army soldiers unloading drones from a lorry clearly show that they wouldn't handle wings in such a manner, for example, if they had to board the aircraft themselves. This has only recently

The Tacmet II, from Climatronics, is seen here used in conjunction with a PDA. The solid-state Tacmet II can also be used on a tripod to provide a nearby mobile control station for wind, temperature, relative humidity and barometric pressure data. (Climatronics)

Innosuisse has developed a pilot helmet called Peyelot to help the operator to virtually slide into the skin of a drone. Linked to the ground control system, the helmet is equipped with a display and the onboard camera is slaved to the helmet's movements. (Innossuisse)

been corrected with adequate training to seed the 'this is an aeroplane' notion.

Even the smallest aero clubs either have their own weather station or at least a direct link to one. Meteorology is part and parcel of flight safety. Several companies offer 'met' kits, like Climatronics, that provide wind, temperature and pressure data (see picture herewith).

Turning to drone attitude control, and particularly those that are flown beyond the pilot's range of view, one must not forget that their 'flyability' depends on a number of sensors that not only constantly correct the aircraft's attitude (straight and level) but also altitude. This is very important as thermals and downdrafts may not change their attitude or heading but dramatically alter their height above the ground without the pilot immediately noticing the change. Heading is now usually provided by satellite navigation receivers. This is the reason why ground control stations are usually manned by a pilot and sensor operator.

One of the major players in the field of navigation and control systems is Athena. The company offers a wide range of products. One that probably best provides a yardstick to the state of the art is the Gus. This unit packs accelerometers, rate gyros, magnetometer, air pressure data sensors and meets shock, vibration, temperature and humidity requirements – all in a case that is about the size of a portable telephone for a weight of 114 grams, which also happens to be the weight of the authors cell phone. When one is in the flight instrumentation and avionics business and in need of widening one's range of activities, a short cut method is to acquire a drone avionics manufacturer. This is exactly what Rockwell Collins did earlier this year (2008). Other drone autopilots manufacturers include Cloud Cap with its Piccolo series, UAV Navigation and Micropilot.

The Star Safire HD uses a 3-5µm 640 × 512 InSb focal plane array to provide a true resolution of 1280 × 720. It also packs a similar resolution colour camera, laser rangefinder, illuminator and pointer. (Flir Systems)

Drone capabilities are almost proportional with their size (for systems of a same generation of course). The farther they need to go, the more fuel they have to carry, the bigger the engine, the larger the airframe volume and the more accurate the navigation systems need to be. Thus, at the opposite end of Athena's spectrum of products is the 4.5-kilo Guidestar 611 with a 0.003°/hour inertial measuring unit. Microstrain is another producer with the 3DM-GX2 and the Inertia-Link.

Quite apart from a new tend to use drones as radio relays (an interesting development using hand-held radios is explained in "The Hand-held Uprising" article in the main issue of Armada with which this supplement has been despatched) drones also need to communicate. This too has opened up a new field of specialisation to cope with range, size and weight requirements of datalinks. Typical suppliers here are firms like Microhard Systems, Free-wave and Advanced Microwave Products.

Eyes and Ears

The primary electronic system of a drone is its optical sensor. Depending on the type; from mini drones all the way up to the male types, the range covers simple miniature black-and-white pen-sized cameras (available in video shops) to the large, multiple-channel, fully-stabilised turret.

The largest players in stabilised systems are Flir, Elbit, Denel, DRS (which was about to be bought up by Finmeccanica at the time of writing) and Sagem, but newcomers providing smaller and lighter stabilised systems have emerged and include Cloud Cap and Optical Alchemy.

Flir Systems is probably the largest producer of stabilised mounts due to the fact that it also manufactures stabilised turrets for fixed and vehicle-mounted land surveillance applications. During the last DSA exhibition in Kuala Lumpur, the company told the author that there were 65 Flir systems operated in Malaysia alone and approximately 200 in the region. In fact, Flir is now aiming at opening a maintenance centre in Malaysia and is currently looking for partners.

One of Flir's latest systems is the Star Safhire HD, where the HD suffix stands for high definition. The sensor is not interleaved and thus offers a true 720-line picture while most other so-called high-definition devices do not offer 1080 lines but in fact 420.

Another recent Flir development is the Mep (Mission Equipment Package) of which a first batch of three has been delivered to the US Army's Night Vision and Electronic Sensors Directorate. The system has been integrated into the Directorate's UH-1 test helicopter, but is in a first stage aimed at the US Army's Tier II drone programme. The Mep incorporates no less than five sensors: two infrared cameras, a colour television camera, a laser rangefinder and a laser designator. A key feature of the system is its secondary steering system that provides a co-operative wide field-of-view (WFOV) and narrow field-of-view (NFOV). The WFOV IR is mounted on an internal gimbal. This scheme significantly enhances the operator's situational awareness by allowing the WFOV IR to be pointed separately from the other four sensors. The WFOV IR is used to detect potential targets of interest and the NFOV IR with its improved range performance is used to identify, track and designate the targets. The Mep thus supports simultaneous acquisition and tracking in both the wide and narrow fields of view.

An autopilot is a boring to look at as its capabilities are fascinating. This AP04 unit is from UAV Navigation (who also supplies to the Red Bull Air Race), and is capable of fully automatic takeoff, flight plan following and landing. (UAV Navigation)

Elbit's Compass IV is now becoming the company's optical payload flagship, being installed on the Hermes 450. This carries a third-generation 3-5µm 320 × 256 infrared camera, a colour or black-and-white television camera, an eye-safe 1.54µm laser rangefinder with minimum

The Compass IV is Elbit's top-of-the-range gimballed sensor for drone applications. It weighs 38 kilos and is here seen under a Hermes 450 from the same company. (Elbit)

and maximum operational ranges of 100 and 2000 metres respectively, a diode-pumped 1.064µm, 80 mJ/pulse laser target designator and a night vision-compatible ten-kilometre range laser target illuminator which, with all the gimbals and turret put together, tips the scales at 38 kilos.

The Emos from the same company weighs less than 6.5 kilos but carries an 8-12µm infrared sensor and day colour television camera and can optionally carry a night camera a laser target illuminator or an eye-safe laser rangefinder.

Sagem has recently released news that is so fresh that little is known of the Euroflir that the company is developing. Basically the new infrared sensor, destined for the longer-range Mk II version of the Sperwer, is to offer a higher resolution.

In total contrast in terms of size and weight, Optical Alchemy's KJ600 is being developed to offer maximum capability for drones with limited payload capacity. An Optical Alchemy official explained, «Unfortunately, most gimballed systems address providing the warfighter imagery of the target of interest, but do a poor job of getting co-ordinates (i.e. locations of the target). OAI [Optical Alchemy] payloads have been designed from the ground up to be provide both imagery of the targets (ISR) as well as high accuracy targeting information (Fires support)/(location of targets). This is accomplished by having the sensor fully geo-referenced with the ability to slew to co-ordinates instantly. This is the big difference between existing payloads and OAI payloads as well as the fact that we do this in 1/10 weight of existing systems». The 2.3-kilo KJ600 carries an 8-12µm infrared sensor, daylight camera and a laser marker. The larger 5.9-kilo KJ800 is still at laboratory development stage and adds a laser rangefinder.

In a sphere of only 12.7 cm Cloud Cap's latest offering is the Tase Duo, which houses a Flir Systems Photon sensor and a Sony day camera. It only weighs 1060 grams. (Cloud Cap)

Seen here under the Raytheon experimental Cobra, the KJ600 has also been tested in the Swift Killer Bee, the Arcturus T-16 and the Snow Goose. (Optical Alchemy)

Turning to radars, particulary those able to provide synthetic aperture, inverted synthetic aperture and moving target indicator modes, recent articles in Armada International have extensively described state-of-the-art systems, particularly from Elbit and General Atomics. Joining the band is now Thales UK with the 30 km Coastmaster, officially announced in September 2007. The coastmaster is targeting a potential requirement for counter-piracy capabilities as it is, according to Thales UK, suited for the detection of small and fast-moving targets on land or offshore.

Index to Advertisers

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