

# Merlin's second coming

A comprehensive capability sustainment programme is intended to bring the bulk of the Royal Navy's Merlin helicopter fleet up to a new HM2 standard, **Richard Scott** reports.

**T**he last decade has seen the Royal Navy (RN) progressively get to grips with the immense capability and versatility afforded by the Merlin HM1 helicopter.

Based on the AgustaWestland EH101/AW101 platform, but delivered as an integrated weapons system under the prime contractorship of Lockheed Martin UK Integrated Systems (LM UKIS), Merlin was originally procured to operate from aircraft carriers and Type 23 frigates and to directly replace the venerable Sea King HAS6 in the open-ocean anti-submarine warfare (ASW) role.

History has seen things turn out rather differently. For a start, the fast, deep-diving Soviet submarine threat that the Merlin was conceived to counter largely disappeared before the aircraft had even completed its protracted development programme.

Instead, Merlin has found itself re-cast by the Fleet Air Arm (FAA) as a multi-mission maritime patrol helicopter, tasked to take on a much wider range of duties on the front line, including surface search, littoral ASW, anti-surface warfare (ASuW), force protection, vertical replenishment and intra-theatre lift.

In doing so, the HM1 has proved itself to be both adept and agile. The combination of the Selex Galileo Blue Kestrel surveillance radar, Orange Reaper electronic support measures



(ESM), Link 11, Sonar 2089 active dipping sonar, AQS-903A acoustic processor and, aboard selected aircraft, the L-3 Wescam MX-15 EO/IR device, means it can 'swing' roles in flight and truly multi-task to meet the demands of the force commander.

## DESIGN SATURATION

Yet while the Merlin mission system has been described as giving its two rear-cabin crew capabilities tantamount to those of an 'airborne frigate', its early 1990s origins – right at the end of the bespoke mil-spec computing era – have seen it increasingly left behind by accelerating technological change.

As a result, the mission system has reached 'design saturation', being encumbered by a tightly coupled hardware/software design,

vintage 80x86 processors, obsolete programming languages, an outdated human-machine interface (HMI) and an inability to easily accept new functionality and plug-ins.

The corollary is a high premium to introduce change, and progressively higher spares and support costs. This reflects the difficulties associated with maintaining 35 separate processor types, eight legacy software languages and a highly bespoke operating system.

To address this situation, plans began to take shape at the end of the 1990s for a Merlin Capability Sustainment Programme (MCSP) to resolve obsolescence issues in the HM1 airframe, avionics and mission system to ensure availability and sustainment of the aircraft out to its nominal 2029 out-of-service date. →



**Left: Merlin HM2 will introduce brand new tactical mission consoles featuring 60cm widescreen colour displays. (Photo: Lockheed Martin)**  
**Right: Compare and contrast with the existing mission displays. (Photo: Richard Scott/NAVYPIX)**

In addition, it was planned at the outset to embody a number of 'aspirational' enhancements as part of the programme, chief amongst them being a defensive aids suite (DAS), a permanent EO/IR fit and the integration of an anti-surface guided weapon.

An 18-month assessment phase kicked off in June 2002, with LM UKIS and AgustaWestland evaluating obsolescence issues and capability upgrades for the aircraft in order to improve performance and reduce through-life costs.

This work, by then known as 'Merlin Capability Sustainment Plus', culminated in a proposal for demonstration and manufacture submitted to the Ministry of Defence in late 2004.

## FINAL CONTRACT

One outcome of this exercise was to prioritise what could and could not be implemented within the programme budget. The wished-for capability enhancements constituting the 'Plus' element of the project did not make the final cut – rather, the MCSP would

emphasise sustainment by introducing a more open system architecture to mitigate existing and manage future obsolescence impacts, substantially reduce through-life costs, and offer a growth path to future technology upgrades.

Following exhaustive and, in their later stages, somewhat fraught negotiations, LM UKIS, as MCSP prime contractor, was in December 2005 awarded a \$1.15 billion contract by the MoD to bring 30 Merlin HM1 aircraft up to an improved HM2 standard.

The contract included an option for the modernisation of up to eight additional aircraft and mission systems. Although the RN was keen to exercise this option, budget pressures ultimately conspired against it.

Lockheed Martin claims that the investment in MCSP will deliver an overall cost saving in excess of \$770 million through the avoidance of obsolescence, and is also forecast to lead to savings in support costs in excess of \$115 million. At the same time, it will leave the RN with an aircraft offering the intrinsic adaptability and flexibility to accommodate future capability insertions.

At the point of contract, the first re-worked aircraft was due for delivery in 2012, with entry into service following in 2013. Four years on, LM UKIS's MCSP programme director Trevor Watkins says the programme 'remains firmly on track to deliver against the schedule set out in 2005'.

## ADVANCED INSTALLATION

In terms of embodiment, the key features of the MCSP comprise the installation of new

NVG-compatible cockpit avionics (based on seven 1024x768 pixel XGA multifunction flat-panel displays), a new navigation suite (with dual attitude, heading and reference system, embedded GPS/inertial navigation system, standby GPS and a new air data computer), an open architecture mission system, a substantial uplift in tactical management system processing capability, and new tactical management software.

In parallel, the Merlin HM2 is receiving an improved Blue Kestrel surveillance radar (incorporating a new digital signal processor conferring SAR/ISAR modes and improved track-while-scan performance), a revised sonics processing suite from Thales (featuring new shallow-water detection and tracking algorithms, a common acoustic processor to handle both active dipping sonar and sonobuoy processing, and a digital VHF sonobuoy receiver), and a new solid-state DiRECT HR mass storage and recording system from Saab Avionics.

New tactical mission consoles are installed in the rear cabin, using large flat-panel colour screens, drop-down menus and Windows-style display formats to reduce operator workload and provide a far more intuitive HMI.

'The dual 30cm displays used in the current HM1 consoles are being replaced by a Barco 60cm (1920x1200 pixel) widescreen colour display, a 30cm (1024x768 pixel) interactive display unit and a 30cm (1024x768 pixel) touch-screen control unit,' Watkins said.

'We want the operator to benefit from a much richer HMI. Avoiding operator overload is a key issue – given the power of modern





processing, the operator is the bottleneck. Our aim has been to engineer a system where it is far more straightforward for the observer or crewman to access and interpret actionable information.'

To that end, an RN observer has been embedded with the contractor's development team. 'This was enormously beneficial,' said Watkins, 'because rather than have engineers design the interface, we had a front-line user telling us how the operator would want the HMI menu sequences and display formats to function.'

Lockheed Martin's Owego operation is supplying a new tactical management computer with embedded digital map, based on multiple PC/104 processor cards communicating via a tactical Ethernet switch. This runs applications software, atop CORBA middleware, on Green Hills' Integrity secure real-time operating system.

MCSP also covers modifications to the Merlin Training System, centred on the type's

main operating base at RNAS Culdrose in Cornwall. CAE is under contract for the upgrade of the full mission cockpit dynamic simulator, the cockpit procedural trainer and two (out of the three existing) Merlin HM1 rear crew trainers.

**FEELING THE HEAT**

One change to the MCSP programme since contract award has seen the shelving of plans to retrofit helicopter electro actuation technology (HEAT) to replace existing hydraulic systems.

Originally developed by AgustaWestland and industry partners BAE Systems and Claverham using a mix of MoD and corporate funding, the HEAT system was planned to introduce brushless electric motor actuators for both the main and tail rotors. According to AgustaWestland, the replacement of simplex mechanical flying controls with quadruplex electronic/mechanical systems would allow complex hydraulics to be removed from the



The Merlin HM1 – seen here during the RN's 'Orion 08' deployment to the Indian Ocean – has seen its mission remit broadened since it entered operational service in March 1999. (Photo: Richard Scott/NAVYPIX)

aircraft, reducing weight and maintenance costs and improving safety.

A ground rig was built at AgustaWestland's Yeovil factory in early 2005 for component testing, and Merlin air vehicle RN01 was subsequently modified for HEAT trials. However, technology demonstration efforts

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## UORs bring enhancements to Merlin force



The Merlin DAS capability, developed to meet a UOR for operations in the Northern Arabian Gulf, was introduced to service in early 2009. (Photo: Lockheed Martin)

### IN ADVANCE OF THE MCSP

programme, recent operational demands have resulted in a number of the RN's existing Merlin HM1 helicopters becoming the beneficiary of enhancements introduced as urgent operational requirements (UORs) to reflect the current pattern of operations.

Concern over the man-portable surface-to-air missile threat in the Northern Arabian Gulf (NAG) operating area saw a UOR raised in 2007 for the integration of a DAS in a pool of four aircraft modified for NAG operations.

### CONTRACT AWARD

LM UKIS was in January 2008 awarded a \$10.8 million contract to design, develop, trial and certify the DAS system, incorporating the BAE Systems AN/AAR-57 Common Missile Warning System, the same company's AN/ALQ-157 IR jammer and an AN/ALE-47 Countermeasures Dispensing System to eject IR flares.

The DAS development and proving programme was supported by AgustaWestland (EMC and flight testing), QinetiQ (which performed flare carriage, release and jettison trials, RF environment generator testing and effectiveness trials), the Defence Science and Technology

Laboratory, Petards Joyce-Loebl and the UK Air Warfare Centre. All test and evaluation activities were completed in December 2008, and following release to service, the first DAS-equipped aircraft was delivered to the RN just 13 months after contract award.

Under a second UOR, selected aircraft have received a naval full motion video (FMV) capability which enables EO/IR imagery from the L-3 Wescam MX-15 system (a pool of which are rotated across the Merlin fleet) to be downlinked to remote platforms. This capability, also introduced to service in early 2009, is believed to have been led by LM UK working together with Cobham Aviation Services (electrical installation), Ultra Electronics (data link) and QinetiQ (test and trials activities). RN sources suggest four FMV kits have been delivered.

Other UORs introduced to the front line over the last 18 months include a two-way Bowman radio communications system, additional armour protection for aircrew, a fast roping system, and the M3M 0.50 calibre heavy machine gun for force protection. In addition, Teledyne Reynolds was in late 2008 contracted to manufacture a quantity of fittings to allow for the mounting of the MX-15 EO/IR system across the Merlin HM1 forward fleet.

using RN01 revealed issues concerning the reliability of the main rotor actuators, and as a result of attendant concerns over technical maturity and risk, the decision was taken in late 2007 to drop HEAT from the MCSP programme.

Instead, an alternate solution to flight control computer obsolescence has been adopted that retains the existing computer, but manages obsolescence through a programme of new design, qualification and production embodiment. Meanwhile, money saved by cancelling the HEAT upgrade has been re-appropriated for initial spares provisioning.

### INTENSIVE INTEGRATION

According to Watkins, the MCSP programme is now well into an intensive systems integration phase.

'In the key areas of software development we now have both air vehicle management and tactical management software releases coming out onto the rigs,' he said. 'We have also started to receive early phase subsystem deliveries – either "B" models or functional equivalent units – to support system integration activities.'

The integration task is distributed across nine separate land-based development facilities: four software development test facilities (SDTFs) at Lockheed Martin's Havant premises; a further three SDTFs at BAE Systems Ael in Yeovil (the former Aerosystems International business is taking responsibility for parts of both the aircraft management computer and tactical management computer software); one tactical system integration rig (TSIR) at Havant; and a full system integration rig (FSIR) at AgustaWestland in Yeovil. A common test system is employed across all of the lab-based rigs, ensuring a high level of repeatability.

'Software is developed and tested on the SDTFs before being brought together on the TSIR, which is very much at the core of the mission system integration work,' explained Watkins. 'It then migrates to the FSIR, which came on line at the end of 2009, for full integration with the aircraft's avionics.'

Tactical mission software – re-coded in Ada but making use of many existing algorithms from the HM1 – is being developed in three iterations, with various point releases in between. 'We now have Release 2.0 on the rigs,' said Watkins, 'with an



initial issue of Release 3.0 – which will deliver full capability including acoustics – planned for August 2010.'

**UP IN THE AIR**

AgustaWestland is meanwhile progressing avionics integration and qualification, together with the Merlin air vehicle modification programme. Production-standard avionics are in test, and wiring looms are now being installed on RN06, the first Merlin to fly in MCSP configuration.

'RN06 is now fully instrumented and will be the first aircraft to fly in December 2010,' said Watkins. 'Our aim is that it flies with a full-up mission system on board.'

Ahead of this, preparations are ongoing for a radar de-risking trial in the second quarter of 2010 using one of the Merlin HM1 aircraft resident at the MoD's Boscombe Down flight test centre for trials and evaluation purposes.

'Installed performance is a risk, so we're investing in a precursor trial to get the system



**The Havant-based tactical systems integration rig is very much at the core of MCSP mission system integration activities. (Photo: Lockheed Martin)**

airborne early on,' Watkins explained. 'We are then looking to extend this de-risk trial to test the acoustics suite.'

To date, the MCSP programme has adhered to its schedule and hit key anchor milestones. 'We completed the system critical design review [CDR] in October 2008, the aircraft test readiness review in April 2009 [four months

early], and the training system CDR in October 2009,' said Watkins.

The 30 Merlin HM1 helicopters slated for the HM2 upgrade will be progressively put through the MCSP modification cycle. An initial four airframes, including RN06, are now at AgustaWestland's Yeovil facility in various stages of MCSP strip-down and build.

'The series retrofit programme commences in 2011, with each aircraft taking approximately nine months to upgrade,' said Watkins. 'There will be a staggered entry and exit to ensure that the forward fleet can maintain the requisite force elements at readiness, and we're already working alongside various RN stakeholders to ensure the synchronisation of the aircraft modification programme with the introduction of the upgraded training system. At the same time, we're working closely with the Integrated Merlin Operational Support contract to understand the condition and status of each aircraft as it comes in for upgrade.' **DH**

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