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Aimpoint selection: the UK's SPEAR Cap 3 air-to-surface weapon

The UK Ministry of Defence is weighing up the options for its Selective Precision Effects At Range Capability 3 air-launched precision-guided weapon programme. Richard Scott reports

Advanced air-launched guided weapon procurements have historically presented the UK government with all manner of political and industrial dilemmas. Policymakers, planners, and budget holders alike have been vexed by the struggle to balance competing arguments regarding performance, cost, programme and technical risk, interoperability, sovereign technology ownership, sustainment of indigenous knowledge and industrial capacity, and relationships with partners and allies.

Most often the choice came down to military-off-the-shelf (MOTS)/modified MOTS solutions based on US-developed weapon systems and requirements-led solutions originating from the United Kingdom or developed as part of pan-European collaborations. The procurement of a new-generation beyond-visual-range air-to-air missile (BVRAAM) to meet Staff Requirement (Air) 1239 was a classic case in point, resulting in a protracted battle between MBDA's 'clean sheet' Meteor solution and rival AIM-120 Advanced Medium-Range Air-to-Air Missile (AMRAAM)-derived Future Medium Range Air-to-Air Missile/Extended Range Air-to-Air Missile designs proposed by a Raytheon-led team. Meteor was eventually selected in May 2000.

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Sovereign capability

The subsequent establishment of Team Complex Weapons (Team CW) appeared to mark a significant shift in this direction. Team CW gained its initial momentum from the December 2005 Defence Industrial Strategy (DIS), which set out a roadmap for the transformation of the sovereign enterprise. The DIS noted that, while the United Kingdom needed to "retain the capability within industry to design, develop, assemble, support, and upgrade complex weapons", future demand and investment would simply not support industrial capability, as then configured, from 2007 onwards.

The DIS continued, "The fragility of the wider UK industrial base is such that unmitigated open international competition will put the sustainment of key industrial capabilities at risk."

Team CW was formed by industry in July 2006, with MBDA UK at the head of a collective that includes QinetiQ, Roxel, and Thales UK. It defined an approach to delivering the United Kingdom's complex weapons requirements in an affordable manner, while at the same time ensuring the maintenance of a viable industrial capacity.

The UK Ministry of Defence (MoD) subsequently signed a long-term bilateral partnering agreement - known as the Initial Portfolio Management Agreement (PMA-I) - with MBDA in March 2010. This

framework agreement covers a complex weapons pipeline valued at about GBP600 million (USD905 million) per year and containing a 'portfolio' of different programmes.

Alongside the PMA-I, the MoD and MBDA signed a through-life enabling contract that included a first work package valued at GBP330 million. One part of this non-competitive package was to undertake the assessment phase for a new air-to-surface precision guided weapon designed to meet the MoD's 100 kg-class Selective Precision Effects At Range (SPEAR) Capability 3 (Cap 3) requirement.

SPEAR is characterised by the MoD as a capability "focused on the enduring requirement to engage mobile and fixed targets in hostile and complex environments", delivered through "a range of weapon solutions, which address the diverse target set". An evolution of Raytheon's Paveway IV precision-guided bomb is intended to meet the SPEAR Cap 1 requirement, while MBDA's Dual-Mode Brimstone air-to-surface missile forms the basis for SPEAR Cap 2.

The requirement for SPEAR Cap 3 in fact began to gestate around the turn of the century, when the Royal Air Force (RAF) and the MoD identified the requirement for a standoff air-to-surface weapon able to strike static, mobile, and armoured targets accurately in all weathers at any time of day. This need reflected shortfalls identified during operations over Kosovo in 1999, particularly with regard to the prosecution of time-sensitive targets with the ability to move and manoeuvre.

Subsequent work to evolve and finesse the understanding of SPEAR Cap 3 has shaped a requirement for a highly accurate, low-collateral-effect 100 kg-class weapon able to receive target updates via datalink in near real time; able to destroy/defeat fixed, mobile, and re-locatable targets in complex, hostile environments, in all weathers, day and night, amid restrictive rules of engagement (RoE); and with sufficient range to enable the launch aircraft to 'stand off' outside the effective envelope of the latest integrated air defence systems (IADS).



A rendering of MBDA's SPEAR Cap 3 solution following launch from the internal weapon bay of an F-35. (MBDA)

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Furthermore, SPEAR Cap 3 has been conceived with the specific characteristics and internal weapon carriage constraints of the F-35B variant of the Lockheed Martin Lightning II Joint Strike Fighter (JSF) in mind, being optimised for carriage and launch from the F-35B internal weapons bay. At the same time SPEAR Cap 3 remains an option for integration onto the Eurofighter Typhoon (as an external weapon store).

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Fifth generation

MBDA describes Spear - its proposed SPEAR Cap 3 solution - as a 'fifth-generation weapon for a fifth-generation fast jet', reflecting the optimisation of the weapon to suit integration with the low-observable F-35.

What the company also acknowledges is the strategic significance of SPEAR Cap 3 from both corporate and technology standpoints; Steve Wadey, UK managing director of MBDA, told journalists in March 2013 that the programme represented "the equivalent step change to Meteor in air-to-surface capability and a step change in complex weapons capability in the global market".

The Spear concept developed by MBDA against SPEAR Cap 3 is a powered, medium-range (circa-75 n mile [139 km]) mini-cruise missile designed for internal carriage by the JSF (four missiles can be accommodated on a dedicated launcher in each of the F-35B's two internal weapon bays). Furthermore, it is compliant with both MIL-STD-1760 and UAI interface standards for both Typhoon and F-35 integration.



MBDA's Spear concept to meet SPEAR Cap 3 is a winged, turbojet-powered weapon that combines a GPS/inertial navigation subsystem with a two-way datalink (enabling mid-course updates, re-targeting, and mission abort) and a dual-mode (millimetric wave radar and semi-active laser) terminal seeker. (MBDA)

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MBDA revealed initial details of its 100B thinking design approach in mid-2011, showing a turbojet-powered baseline characterised by a box-shaped airframe with high-mounted flip-out wing surfaces, a cruciform tail, and a flush intake in the lower body. By mid-2012, however, MBDA was showing a substantially evolved missile design featuring a new circular cross-section airframe (the same diameter as Brimstone), dorsally mounted flip-out wings (folding rearward for stowage), a revised intake arrangement with twin side inlets, and three folding tail surfaces in an inverted 'Y' configuration.

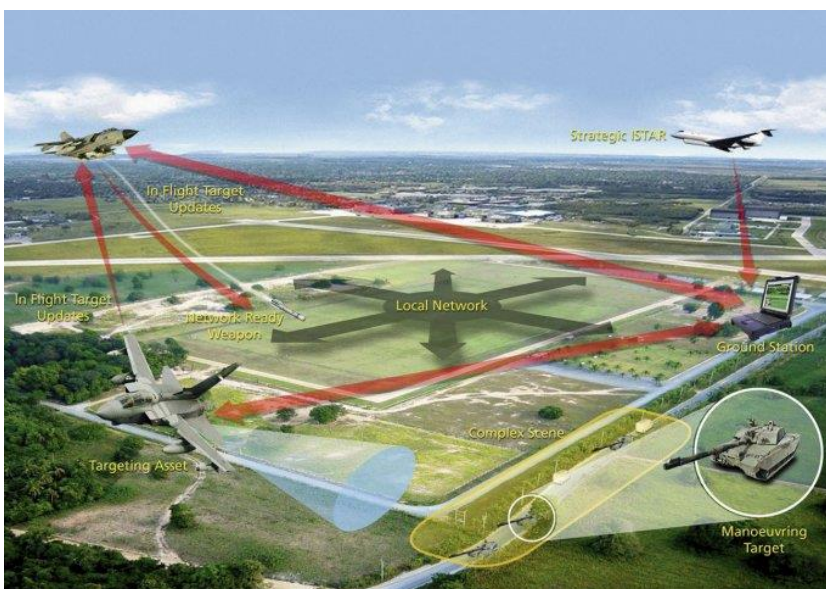
Mid-course guidance will be via a combined GPS/inertial navigation subsystem, with a two-way datalink enabling mid-course updates, re-targeting, and mission abort functions. To deliver the high level of selectivity required in complex, RoE-constrained scenarios, MBDA has baselined a dual-mode seeker - combining millimetre wave (mmW) and semi-active laser (SAL) channels - for terminal homing; according to

the company, Spear will be suitable for use in 'fire-and-forget' and SAL designation modes, as well as being fully network enabled.

To address this diverse range of targets and minimise collateral effects, MBDA has settled upon what it describes as a "multi-effect warhead with multiple fuzing options, allowing tuneable effects to target".

Turbojet propulsion provides for high subsonic speed and extended range, "providing operational flexibility and increased weapon and platform survivability", according to MBDA. A contract was placed with Pratt & Whitney AeroPower in early 2012 for propulsion technical assistance; the company is supplying a derivation of its off-the-shelf TJ-150 turbojet to support the SPEAR Cap 3 assessment phase programme.

MBDA's design and development effort has pulled technology through from a number of MoD and corporately funded research and technology programmes. In parallel, several other risk reduction and integration threads are being pursued under assessment phase funding.



The UK's S2E2 programme has prototyped a networked weapon system to enable precision guidance of a weapon at ranges only limited by a weapon's fuel payload, along with the range of communications and targeting systems employed in the engagement. S2E2 included the participation of the Defence Science and Technology Laboratory, MBDA, and QinetiQ. (MBDA)

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One key MoD research effort that has informed SPEAR Cap 3 is the Sensor to Effect Phase 2 (S2E2) programme, which has prototyped a networked weapon system to enable precision guidance of a weapon at ranges only limited by a weapon's fuel payload, along with the range of communications and targeting systems employed in the engagement. Under S2E2, which included the participation of the Defence Science and Technology Laboratory (Dstl), MBDA, and QinetiQ, a Brimstone missile shell was used as a surrogate airframe to host a new datalink, GPS system, and data fusion processor capable of delivering the missile from range with the precision of a laser designator but without the range constraints that the laser presents.

Another research strand, the Weapon Datalink 2 programme, has integrated Link 16 terminals into a Time Sensitive Target Test Bed (TST-TB). The TST-TB is a real-time environment for the experimentation of networked weapon systems, which permits experimentation and proof-of-principle demonstrations of the Link 16 net to support SPEAR Cap 3 engagement.

The culmination of the current assessment phase programme will be a flight test from a Typhoon aircraft, now planned for early this year. This airframe and propulsion demonstration is intended to prove safe separation, initiation of control (the 100B/Spear missile is launched inverted, then rolls and deploys wings to commence free flight), and propulsion and flight dynamics.

At the conclusion of the SPEAR Cap 3 assessment phase, MBDA expects its Spear weapon to be at or about technology readiness level (TRL) 6. This, the company has told *IHS Jane's*, would provide a high level of maturity from which to transition into demonstration and manufacture.

However, it is by no means certain that SPEAR Cap 3 will be sourced via the sovereign complex weapons pipeline. The non-recurring costs associated with developing a bespoke 'clean sheet' missile, plus the additional expenditure for its integration with the F-35, are now coming under intensive scrutiny by the MoD. Informed sources suggest that, on rule-of-thumb calculations, the combined cost of development and integration will be in the GBP750-800 million bracket. That represents a significant investment, the justification for which needs to be tested - hence the IAC's direction last April that further work was required to understand all potential options to meet SPEAR Cap 3 requirements.

What has followed has been an eight-month 'deep dive' - led by the WECA team, but with the additional participation of Air Command, Defence Equipment and Support's Surface Attack project team and Dstl - to refresh the MoD's understanding of the requirement, and evaluate MOTS options.

While other options have been evaluated, it is Raytheon's GBU-53/B SDB II that has really come under the microscope: the MoD has engaged on both a government-to-government and government-to-industry basis to better understand the SDB II concept of operations (conops) and access data on performance, status, price, and availability.

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SDB II integration on the F-15E Strike Eagle has been under way since 2010. Flight testing has already demonstrated the weapon's ability to hit both moving and stationary targets. (Raytheon)

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Raytheon has completed SDB II fit checks on the F-35, validating the capability to carry four weapons (plus an AMRAAM missile) in each F-35 weapon bay. (Raytheon)

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Compare and contrast

Superficially, at least, SDB II and MBDA's Spear bear a strong resemblance to one another. However, there is one key difference in that, while SDB II is a glide bomb, MBDA's newly designed Spear is a powered weapon, so enjoying the benefits of longer range, reduced time to target, and greater flexibility in terms of launch altitude, aircraft heading, and mission planning.

According to Barrie, this is a significant discriminator, given the range performance that the MoD is looking for, and he questions how much the United Kingdom can afford to concede on attributes of range and time to target. "The SPEAR Cap 3 range requirement is driven by an advanced 'double digit' IADS [integrated air defence system] threat, most probably the SA-21 'Growler'/S-400 Triumf," he said. "You want a weapon that allows the launch aircraft to maximise standoff range, a weapon that offers tactical flexibility in its routing and approach, and a weapon that can get to the target fast.

"Also, you have to consider that the UK has, compared to the US, a far more limited number of offensive air enablers and effectors, so it needs a weapon that can go up against a much broader target set."

Barrie added, "To my mind, SDB II in its current form falls short of the MoD's aspirational requirement for SPEAR Cap 3. As a glide weapon, it is slower, and has much reduced range. Moreover, it does not have the off-axis performance of a powered weapon, or the means to prosecute a complex multi-axis attack at range.

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Next steps

According to the MoD, "work exploring potential options to satisfy the SPEAR Cap 3 requirement is on track, with a decision expected in the first quarter of 2015".

It is understood that the programme will go back to the IAC for review at the end of this month. One industry source close to the programme suggested to *IHS Jane's* that there were four potential choices open to the committee. "First, maintain the current non-competitive route, with MBDA continuing to deliver SPEAR Cap 3 through the complex weapons pipeline. Second, abandon the MBDA solution and instead pursue an off-the-shelf buy of SDB II through US Foreign Military Sales.

"Third, run some sort of formal competition between the two solutions. And fourth, extend the current assessment phase into 2016 to keep both options on the table, and so give the MoD breathing space as it negotiates an election, a spending review, and the subsequent SDSR."

According to Barrie, the final decision will potentially have major ramifications. "I think SPEAR Cap 3 is a 'need to win' for MBDA," he said. "We're at a crossroads on the course to sustain a UK complex weapons capability within a European context.

"Any decision to go off the shelf from the United States [for SPEAR Cap 3] will certainly raise questions about how committed the UK government is to that policy in the future.

"The MoD will need to choose very carefully ... this is going to be an important choice in terms of where the UK guided weapons sector is going."

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