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in detail

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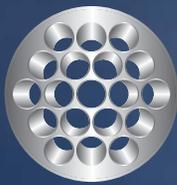
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Front cover: An MH-60R Seahawk drops a pallet of supplies on the flight deck of the LCS USS Fort Worth. (Photo: USN)

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Tony Skinner, Editor

State of the nation

Recent global events have cast the reduction in military spending across the Western world of the past six or seven years in a stark light.

Regarded as an obvious necessity by various governments as they attempted to get their houses in order after the financial crisis, the subsequent erosion of military capability brought about by deferred or cancelled defence procurements has proven a risky choice, following the posturing of China and Russia and enduring insurgencies in Afghanistan and Iraq.

Should the defence budget floodgates open around the world in 2017, however, the trends evident across the military rotorcraft sector in recent years are unlikely to change any time soon.

An under-investment in rotorcraft R&D has meant the lion's share of operations are still being carried out by helicopters of 1970s and 1980s design, with technical capability gaps easily visible across the board.

In particular, degraded visual environments – a common theme across these pages – continue to hamper operations, while newer technologies such as autonomous systems, the latest survivability suites and advances in avionics are far from being fully exploited.

US initiatives

The US has a range of programmes to address many of these shortfalls, which will soon come under the control of the incoming Trump administration, seemingly hell-bent on re-evaluating the Pentagon's flagship procurement programmes. Among the rotorcraft projects that may fall under the

immediate spotlight are: the VH-92A Presidential Helicopter Replacement programme; the USAF's Combat Rescue Helicopter and UH-1N replacement; and the longer-term Future Vertical Lift initiative.

Over the next 12 months, competing teams are expected to fly their vision of the next generation of rotorcraft under the Joint Multi-Role Technology Demonstration – Bell with its V-280 tiltrotor and Sikorsky-Boeing with the SB>1 coaxial compound.

Internationally, several key procurements will need to advance during 2017 to meet the inescapable deadline of legacy aircraft going out of service.

An RfP is expected to be issued by the German government for its heavy vertical lift requirement. Berlin is considering both the Sikorsky CH-53K and Boeing CH-47 Chinook. With the NH90 Sea Lion naval multirole helicopter currently being readied to replace the German Navy's Sea King Mk 41 fleet, the type is also in the frame for potential future selection as a Sea Lynx replacement.

For any ASW helicopter requirement, the NH90 is likely to be up against the Leonardo AW159 Wildcat, which the German Navy will see up close and personal in 2017, when the UK Royal Navy deploys the aircraft on board a German frigate in the Mediterranean.

Cancelled contract

In Poland, meanwhile, the government's helicopter renewal strategy fell into farce when it ended H225M contract talks with Airbus Helicopters in October 2016. The defence ministry then promptly announced

In the next issue

- US Army upgrades
- Scout/light attack
- Self-protection
- Avionics

several new requirements, with little detail on how these would be taken forward. Helicopter executives in Poland will be hoping for some clarity from the government in 2017, as well as several other Eastern European countries with pressing needs to replace Soviet-era rotorcraft.

Elsewhere, modernisation continues apace in many countries that have smaller overall fleets or less constrained defence budgets, with several Middle Eastern nations in particular currently seeking further US-made helicopters through the Pentagon's FMS mechanism.

The first export contract for the Bell-Boeing V-22 tiltrotor is also advancing, with the initial fuselage for Japan currently on the production line at Boeing's Philadelphia facility.

Western manufacturers are unlikely to have things all their own way in 2017, however. Russian Helicopters has been increasingly successful on the international market, Korea Aerospace Industries is marketing its Surion internationally (in conjunction with Airbus Helicopters) and China's domestic helicopter capability is now maturing to the point where it will become a contender in certain markets. ■

Myanmar Air Force bulks up on helicopters



Photo: Myanmar Air Force

The Myanmar Air Force (MAF) inducted four Airbus Helicopters H120s in a ceremony to mark the service's 69th anniversary on 15 December. These are believed to be the first Colibri types to enter service in the country.

At the same event at Meiktila Air Base in central Myanmar, the air force commissioned four Beechcraft 1900D turboprop aircraft, adding to several already in service.

Notably, Vice-Senior Gen Soe Win, the Deputy Commander-in-Chief of Defence Services, revealed at the ceremony that the MAF had received a total of 69 aircraft spread over eight batches since 2011. This figure included 14 helicopters of four types and 55 fixed-wing aircraft of six types.

On 22 August 2016, the air force officially welcomed two Y-8F-200W transport aircraft and ten Grob G 120TP trainers into service.

In June 2015, the MAF received a batch of various helicopters, including one Mi-35P, at least three Airbus Helicopters AS365 Dauphin 2s and three Bell 206 Jet Ranger IIIs. Also commissioned were examples of the Beechcraft 1900D and Grob G 120TP.

The Dauphins were assigned to SAR, medevac and maritime reconnaissance missions, while the Bells are basic trainers for pilots transitioning to the Mi-2, Mi-17 and Mi-35.

The MAF operates an eclectic rotary-wing fleet consisting of the Bell 205, Bell 206, Mi-2, Mi-8/17, Mi-35, Dauphin 2, Alouette III and W-3 Sokol, but the airworthiness of Myanmar's hotchpotch fleet is poor.

In June, *DH* reported online that Russian Helicopters had been awarded a contract to repair four Mi-35Ps. The first will be repaired in Russia, while the remaining three will be worked on in Myanmar by Russian technicians.

Myanmar has been linked with a first export purchase of the Chinese-Pakistani JF-17 fighter, although official confirmation has not yet been made. The MAF anticipated receiving three Yak-130 advanced jet trainers by the end of 2016, and it is reported to be interested in more Mi-17V-5s.

Doing business with the Myanmar military is a sensitive issue due to its human rights abuses and arms embargoes in force. However, in September, the then President Barack Obama said the US was 'prepared to lift sanctions that we have imposed on Burma [Myanmar] for quite some time'. He was presumably referring to economic sanctions. Nevertheless, US embargoes over military platforms are likely to remain for longer.

However, China has had no such compunction about selling military equipment to the Myanmar armed forces. Myanmar is known to be operating up to a dozen CH-3A UAVs, for example. Chinese-built K-8W aircraft are also being used in counter-insurgency missions.

By Gordon Arthur, Hong Kong

Germany to deploy Tiger and NH90 to Mali

On 11 January, the German government approved the deployment of four Tiger attack and four NH90 medevac helicopters to Mali to replace the Royal Netherlands Air Force (RNLAf) Apaches and Chinooks being withdrawn.

Deployment is subject to parliamentary approval for raising the ceiling on German troops in Mali from 650 to 1,000.

Based in Gao, the helicopters will support the UN Multidimensional Integrated Stabilization Mission in Mali (MINUSMA), which the Bundeswehr describes as the UN's most dangerous peacekeeping mission.

The Tigers will provide protection to the NH90s, as did the RNLAf Apaches to the

deployed Chinooks. The German helicopters will be deployed to Mali between spring 2017 and mid-2018 to fill in the gap until the UN comes up with an international rotation solution.

The Apaches have been deactivated since 1 January and are being airlifted back to the Netherlands. In December, German Defence Minister Ursula von der Leyen said that the country's helicopters would be used to build up the rescue chain.

This chain currently consists of medevac by a protected vehicle or Chinook to a Franco-German-Dutch Role 1 or French Role 2 hospital in Gao, with more seriously wounded evacuated to Europe by a Luftwaffe C-160 medevac or similar French aircraft.

Germany is also supporting MINUSMA with a Heron 1 UAS. For example, it provides real-time imagery of the routes to be taken by Bangladeshi convoys, with irregularities on the ground which could be a sign of IEDs communicated by the Heron 1 ground station to the Bangladeshis.

A total of Six Bangladeshis have died in Mali, with most of their casualties attributed to IEDs.

The heavier RNLAf Apaches have conducted reconnaissance with their onboard sensors, supported ground troops, flew shows of force and provided fire support. One of these Apaches was lost in an accident in 2015.

By Nicholas Fiorenza, Brussels

RAF Kabul crash cause revealed

An investigation into the crash of an RAF Puma HC2 in Afghanistan last year has found that the crew lost situation awareness while attempting to land, causing the helicopter to strike the tether of a surveillance aerostat.

Five crew and passengers died when the platform impacted a persistent threat detection system (PTDS) and subsequently crashed within the perimeter of NATO HQ in Kabul. The aircraft (XW229) had been flying in formation with another Puma (ZJ955), which was acting as the lead aircraft, on a sortie originating from Hamid Karzai International Airport.

As the two platforms approached NATO HQ, the crew of XW229 (A22) lost sight of the lead Puma. The report indicated that prior to this, the crew of the ill-fated aircraft had become preoccupied with ground features and restrictions that were in place to avoid flying over the Presidential Palace in Kabul. 'The sortie ran well up until the point that the crew of A22 focused their attention on ground

features to the extent that they lost sight of their leader, resulting in the formation integrity breaking down,' said the director general of the Defence Safety Authority in his report summary.

'In trying to regain visuals, the crew lost situation awareness to the point that they entered the PTDS Danger Area and struck the tether,' he added.

The PTDS was located in the southeast corner of the NATO HQ and was one of three operating in the Kabul area to provide ISR. All three PTDS had danger areas established around them. Investigators determined that the helicopter impacted the tether and damaged the tail cone as it pulled the tether along. The tether eventually snapped under force, rather than being 'cut' by the rotor blades.

Examination of the wreckage suggested that the tether had not interacted with the tail fin, tail rotor gearbox or tail rotor, but had significantly weakened the tail rotor drive



An RAF Puma HC2. (Photo: UK MoD)

shaft (TRDS), leading to a catastrophic failure and loss of power to the tail rotor itself. 'Essentially, the crew had little control of the helicopter following the TRDS failure and it was very fortunate that the aircraft came down in the street rather than on a building,' the report states.

Three upgraded Puma HC2s arrived in Afghanistan in early 2015 to support the UK's contribution to NATO's Resolute Support mission.

By Grant Turnbull, London

Thai Army puts faith in Leonardo

Leonardo Helicopters delivered six AW139s to the Royal Thai Army (RTA) in December, raising the number of units in service to ten. Additionally, the RTA has ordered five AW149s to replace ageing UH-1Hs that are being phased out of service.

The six AW139s were ordered last year for \$80 million to serve the 1st Aviation Battalion Army Aviation Centre for utility

and general transport missions. This battalion also has UH-1Hs, UH-1H gunships and H125M platforms in service.

The RTA began purchasing AW139s in 2012, with the first two units – ordered for \$37 million – now deployed on VIP transport missions in the Department of Army Transportation. A further two were later ordered.

On 19 August the RTA signed a contract with Leonardo to buy five AW149 medium helicopters with a budget of \$92.8 million, set for delivery in 2017. They will be used for utility, SAR, EMS and troop transport tasks.

Derived from the AW139, the AW149 has a larger fuselage and more powerful engines, resulting in a greater cargo volume and payload capacity. It can carry 18 troops and has a maximum speed of 169kt.

Earlier this year, the RTA received six H145Ms from Airbus Helicopters for use as VIP transport platforms. Currently, the RTA has other new types such as the UH-72A Lakota and H125M, but it still requires more than 30 new helicopters to replace a fleet of more than 100 UH-1Hs that are gradually being withdrawn.

By Sompong Nondhasa, Bangkok



AW139s are replacing ageing UH-1Hs within the Royal Thai Army. (Photo: author)

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Serbia signs for nine H145Ms

Airbus Helicopters has signed a contract with the Serbian government for the delivery of nine H145Ms (pictured above). The aircraft will be received by the Serbian Air Force and Police. The order was authorised on 28 December by the company and the Serbian MoD and Ministry of Interior, only two months after the MoU was signed.

The procurement deal will be welcome news for Airbus Helicopters, which experienced a setback towards the end of last

year when the Polish government cancelled its proposed plan to purchase 50 H225Ms.

The delivery of the nine H145Ms is slated to begin at the end of 2018 and is anticipated to continue into 2019. The 3.7t platforms will be deployed on a range of missions, including SAR, medevac and combat operations.

The contract includes associated logistics support as well as the transfer of technology for the maintenance and repair of the rotorcraft. Moma Stanojlović, the current

maintenance centre for Serbia's fleet of Gazelles, will incorporate the newly acquired helicopters into its fold for repair and overhaul work in the long-term.

The air force currently operates around 47 Gazelles within its multirole helicopter fleet and in June 2016, Serbia's MoD received two Mi-17V5 medium military-transport helicopters. The latter purchase was direct from Russian Helicopters.

By Helen Haxell, London

Russian Navy gets refurbished Ka-29s

The rotary-wing fleet of Russian Naval Aviation (RNA) has been further strengthened with the delivery of a batch of six Ka-29s on 21 December. These assault transport helicopters, originally built in the 1980s, were overhauled at the Kumertau-based KumAPE plant controlled by Russian Helicopters holding, and are set to be delivered to the Russian Pacific Fleet's 7062nd Air Base at Vladivostok.

In addition to the airframe refurbishment and repairs on an as-needed basis, the helicopters received

overhauled engines, main rotor columns and main gearbox.

The contract for the Ka-29 refurbishment and restoration into airworthy state was around \$7.14 million, according to the Moscow-based Centre for Analysis of Strategies and Technologies (CAST).

The Ka-29 is an armed derivative of the Ka-27 Helix family. The helicopter is mainly used for support of assault operations but can also be used for transport of troops and military cargo, operating from Russian Navy ships.

As of December 2016, the Russian Navy had only four Ka-29s in an airworthy state, out of about 20 units originally assigned to the four fleets and one training centre.

For example, the Northern Fleet had two serviceable Ka-29s (deployed in October 2016 on the Russian Navy's sole aircraft carrier, Admiral Kuznetsov, for operation in the eastern part of the Mediterranean Sea). Meanwhile, the Yeysk combat training and aircrew conversion centre operated two more of the type.

By Alex Mladenov, Sofia

VV-2 in Iranian helicopter market

The first flying prototype of the VV-2 light helicopter was unveiled by Softex Aero at the eighth International Iran Kish Air Show in November 2016. This latest achievement of the Ukrainian company, which also manufactures the V-52 light helicopter, is a high-speed, single-engine, two seat (tandem) platform.

The VV-2 has drawn the attention of a private Iranian company and two governmental Iranian companies – Iranian Helicopter Support and Renewal (IHSRC) and Iranian Aircraft Manufacturing Industries (IAMI), both of which are under subordination of the Iranian Aviation Industries Organization. Negotiations have taken place regarding investment at the R&D phase of the VV-2. Interest has been shown in the establishment



Photo: author

of a domestic production line for under-licence production of the helicopter at the IAMI facility in Shahin-Shahr, or for assembly at the IHSRC facility in Tehran.

If these talks come to fruition, then the manned version of the platform will have the capability to be procured by Iranian Army Aviation, which currently operates 132 AB206s, and by the Iranian Police Aviation as a replacement for its ageing 206 JetRangers.

Replacement has been stalled by the army due to budgetary constraints and sanctions.

The aircraft has been designed for either piloted or unmanned flight missions and is equipped with a TS100 ZA turboshaft engine by PBS. The VV-2 can produce 190shp continuous power in cruise speed and 245shp take-off power, equating to five minutes.

The VV-2 can undertake various missions, from surveillance to reconnaissance, and the unmanned variant can be used as a light scout/attack helicopter for counter-insurgency, counter-narcotics and counter-terrorism missions in the east and southeast of the country.

Its aerodynamic shape bears some resemblance to the AH-1 attack helicopter. However, the company claims it has been developed for the civilian market, with a range of usage from leisure activities to aviation sports.

By Babak Taghvaei, Ankara

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The USN will be in receipt of the final batch of MH-60Rs in 2018. (Photo: Lockheed Martin)

MODEL MASTERPLAN

The USN's MH-60R programme is looking ahead to mid-life upgrades and an eventual successor to help the platform move with the times. **By Gerrard Cowan**



The USN first deployed the MH-60R Seahawk in 2009, and will receive its final scheduled deliveries of the helicopter in the summer of 2018. While the aircraft has been in service for some years now, it continually receives upgrades and modifications to allow it to adapt to an evolving operational environment.

The Romeo variant is primarily focused on ASW and ASuW, with secondary missions including SAR and medevac. According to manufacturer Lockheed Martin, the platform – along with its sibling, the MH-60S – has flown more than 650,000 hours across a 500-plus fleet. It is deployed with both the USN and a number of export customers.

The most recent batch for the service was procured in FY2016, making a total of 280 platforms, said Capt Craig Grubb, manager of the navy's H-60 programme. The final set of 29 MH-60Rs is known as Lot 14, and will be delivered in June 2018.

The acquisition is part of a rotorcraft masterplan, designed to take seven different types and replace them with the two MH-60 variants, and the programme is almost complete. According to Grubb, the SH-60F retired in the spring of 2016 and the SH-60B retired in 2015.

There are still a few HH-60Hs remaining in the fleet, which he said will be in service through FY2019 and possibly longer. 'They're pretty valued by the fleet, so

there's a lot of consideration being given to keeping those aircraft in service longer,' he told *DH*.

Lead role

Lockheed Martin is the lead industrial partner in the MH-60 programme, having acquired manufacturer Sikorsky in November 2015. In addition, the company has long contributed to the helicopters in its own right.

Lockheed Martin Mission Systems and Training equips the model with sensors and advanced mission systems, while it also produces the common cockpit avionics. There have been various changes to the aircraft over the years, said Tom

Kane, director of naval helicopters at Lockheed Martin.

'As the aircraft get delivered, [the navy has] incorporated upgrades along the way, so the configuration of aircraft that we're delivering now is very much different [compared with] the ones we first delivered,' he said.

The biggest change with the Lot 14 aircraft will be the introduction of a moving map capability, said Grubb, which would enable bottom topography mapping for ASW use.

Kane said that a moving map capability has been desired by the fleet for some time and is likely to be seen in Lot 14 aircraft. The introduction of this would boost situation awareness. 'The crews can see a bottom topography of the ocean... they know at what depths they're operating,' he commented.

The MH-60R has evolved over the years to address emerging threats. One of the most significant recent changes was the addition of the BAE Systems Advanced Precision Kill Weapon System (APKWS).

'[The APKWS] turns a standard unguided 70mm rocket into a precision laser-guided rocket to give warfighters a low-cost surgical strike capability,' said the UK company.

APKWS has now been fielded for both the MH-60R and MH-60S, said Grubb. He believed this would augment the

helicopters' Hellfire missile capability and was aimed at addressing the threat posed by clusters of small vessels.

'That's one of the primary weapons to help combat the fast attack and fast inshore attack craft threat – large groups of small boats heading towards a high-value unit or some other surface vessel,' he explained.

Kane echoed this, saying the APKWS would allow a significantly greater volume of fire. 'Typically, what would happen is a number of small boats would congregate, with MANPADS, weapons, guns, whatever the threat might be, and they'll approach a large-value target. So this gives the navy better fire capability.'

In addition to moving map and APKWS, the third major element from a development standpoint is software modernisation, Kane said. The original software that was delivered with the aircraft is becoming obsolete. The modernisation programme that Lockheed Martin is currently working on with the navy modifies language codes and processing.

'[It] updates some of that language and modularises the codes, so it breaks the code into smaller processing elements that makes it cheaper to maintain and upgrade.' This would make modifications much simpler in the future, he explained.

“ The navy is looking ahead to a mid-life upgrade of the helicopters, which is scheduled for the mid-2020s. ”

Typically, if new capability is added to the code, it requires a significant amount of testing across the code base to avoid any unforeseen impacts. 'By modularising the code, it makes that job to test new code much easier, because you only really need to test the specific area of the code that you're changing. So we're in the process of doing that as well.'

Accepting the future

Part of the drive behind the software modernisation is to make the aircraft more adaptable to future changes, Kane said. 'They recognise that as threats evolve... There will be added capability that will be required to address those threats.'

A more modern software architecture makes upgrades generally more affordable and less time-consuming, he said. 'Modernising software architecture absolutely gives the navy capability to add future upgrades. And future weapons, future IR countermeasure systems... Those are things that the navy looks at from a roadmap standpoint.'

Kane said the navy had been successful at developing roadmaps for the helicopters, to enable it to evolve as needed. 'They recognise that the platform itself will be out there for a number of years... They certainly have been forward-looking, recognising they're going to need to continue to invest in the platform.'

The commonalities between the Sierra and Romeo – such as their common cockpit – would save the service money on training and sustainment costs, said Kane.

If a system becomes obsolete across both aircraft, he explained the next steps: 'We pay for that one time, the navy pays for it one time, and they can get the benefit of that upgrade or capability or solving that ▶

In recognition of future threats, there has been a push on software modernisation on board the aircraft. (Photo: CAE)





International customers of the MH-60 variant have benefitted from the USN's investment in sensors and weapons for the platform. (Photo: Lockheed Martin)

obsolescence problem across the entire fleet,' as opposed to Sierra having one set of problems and Romeo having another.

The scale of the MH-60 product line also spread these advantages more broadly, Kane said, including internationally.

'As obsolescence issues occur, which they always will, you can solve that with an upgrade and offer that to the entire international community that participates in the Romeo, versus just having a small country maybe deal with that issue all by themselves, because it's budget prohibitive.'

The MH-60R currently has three major export customers – the Royal Saudi Naval Forces, the Royal Australian Navy and the Royal Danish Navy.

Individual customers naturally have differing requirements for the helicopter. However, maintaining the same basic software lowers the development costs for partners, a particular advantage for countries that may only require a handful of aircraft, Kane pointed out.

The common software makes it easier and less expensive to add on new capabilities. 'Say there's a new joint air-to-surface missile available, that we want to integrate on the platform... It could be offered to the other international partners and developed and tested once, because it's on the same software.'

This meant that the development of a new capability did not have to be paid for multiple times across multiple international partners, Kane said. 'We pay for it once, and the cost of that non-recurring development is really shared across all international partners,' he explained.

The company thinks of it as a production line. Each partner, depending on how many aircraft it has or other factors, will have to pay for a certain percentage of the development cost, rather than the entire capability.

This is particularly beneficial for smaller countries that might only have between five and 20 aircraft, he said. 'They're really participating in the larger product line, and it makes it much more affordable for them to get that capability.'

Investment leverage

The MH-60R and MH-60S are enduring platforms that are likely to be around for decades, said Chris Stellwag, director of marketing communications at CAE Defence & Security, which provides the USN and international customers with simulators and other training devices for the aircraft.

'One of the advantages for foreign militaries when they acquire a platform like that is they're getting the benefit of the significant investment the USN is making in the continual upgrades and enhancements to a fleet of 500-plus helicopters,' he told *DH*.

This meant that international customers were able to leverage the investment the USN is making in enhancing the aircraft, through new sensor suites, weapon systems or countermeasures, for example.

Additionally, it boosted interoperability with their US ally. Stellwag said the helicopter was an attractive, low-risk and cost-effective platform. 'We're always conscious of maintaining strong positions in platforms that we think are enduring, and that's what we've successfully been

able to do so far with the Seahawk,' he said.

'We definitely see opportunities over the next decade with other countries, and continued improvements and enhancements to the suite of training systems that the USN uses.'

CAE provides simulators and trainers for a number of roles for the USN's MH-60R fleet. The primary focus is the Tactical Operational Flight Trainer (TOFT), which is made up of two separate devices.

The first is what the navy calls an operational flight trainer, Stellwag said – a flight simulator to train the pilot and co-pilot on all they needed to know to operate an aircraft: 'All the kind of things you'd normally train a pilot and co-pilot for: emergency procedures and tactics.'

The second element is a rear crew trainer, or a weapons tactics trainer, which is designed to train the sensor operators on the variety of equipment that is included in the aircraft. 'In many respects, that's the real mission of the helicopter: finding submarines, prosecuting them, ASW, that sort of thing.'

The two training devices can be networked together to form a TOFT, 'so the full crew can practice and rehearse the type of mission that they're going to do together', he explained.

However, they can be used separately, as required. The navy does this to provide routine training for those learning to fly the helicopter, or rear crews practising with their different sensor packages.

Separately, CAE also provides equipment designed to train the maintainers of the helicopter's avionics suite. ▶

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WHEN RESULTS MATTER

Simulators like these are necessary, Stellwag explained, because carrying out training on the actual aircraft is very expensive and takes the helicopter out of use. 'A simulated or virtual environment is a great learning environment, because you can make mistakes and practice different procedures,' he added.

Refreshing change

As with the helicopters themselves, work is under way to upgrade the navy's equipment on the training side of the Romeo, as well as the Sierra, Stellwag said. He pointed to the MH-60R/S Tech Refresh programme, which was announced in February 2016. Under this contract, CAE will perform a 'technology refresh' on a variety of simulators and training systems associated with the helicopters, including TOFTs and weapons tactics trainers at NAS Jacksonville, NAS North Island, NS Norfolk and NS Mayport.

According to a release at the time of the award, the upgrades and updates include a common hardware/software baseline for over 20 MH-60 Seahawk training devices, converting an SH-60B helicopter simulator into an MH-60 TOFT, and extending the visual FoV on MH-60S operational flight trainers.

Additionally, the company will be responsible for the networking, interoperability, and integration of the

navy's suite of MH-60 training systems, including training devices used for door gunnery training and hoist operations, the release stated. The deal also covered the supply of two new MH-60R TOFTs.

The aim of the refresh programme is to bring all the training devices to a common baseline, on both the software and hardware side, Stellwag explained. If the navy exercises various options, the programme will be valued at about \$100 million over several years.

'Over the last decade, that helicopter has gone through various upgrades and enhancements and additional capabilities, so one of the important things in training military aircrews is you want the training devices as closely as possible to be concurrent with the aircraft you're training them for,' he said.

'The tech refresh programme is really designed to upgrade that suite of MH-60 Seahawk training systems so that [they are] concurrent with the fleet of helicopters that the navy's now operating.'

Training devices need to be modified and upgraded over time, Stellwag explained, as with any piece of equipment. The simulators are typically in service for 25 to 30 years or even longer. As with the aircraft, over such a lengthy time period they do need and enhancements.

It was necessary to address the 'obsolescence of technologies, circuit boards and different things that go out of production'. Most militaries realise when acquiring both aircraft and training devices that there is a life-cycle support cost involved, he added.

Looking ahead, Grubb said that a service life assessment programme would be carried out on both the Romeo and Sierra, with the MH-60S pencilled in for FY2017 and the MH-60R coming a few years after that.

The navy expects to follow this with a service-life extension programme, which will look at a number of areas of the equipment, such as the airframe and the components associated with the aircraft, hydraulics, electrical systems, etc.

'It also has an interest in how you are doing from a performance standpoint, both from an aircraft performance, mission systems and avionics backbone standpoint.'

In addition to this, the navy is looking ahead to a mid-life upgrade of the helicopters, which is scheduled for the mid-2020s, around the same time as the life extension work. It would therefore be convenient to carry out both at once, as the life extension may include actual structural modification to the aircraft. For example, it could upgrade the avionics suite as part of the mid-life upgrade while work is being carried out on the life extension programme, Grubb said.

Pulling these different strands together made sense on a number of levels. 'The challenge associated with that is that it's a very large effort once you put that all together. But it makes sense from a timing perspective, as well as... [the] efficiency of doing the work in combination.' The Seahawk was designed to be flexible for the remainder of the life of the aircraft.

While the navy is in only the very early phases of exploring what a successor to the MH-60 might look like, there is an interest in being able to migrate the work done on the mid-life upgrade onto another platform at a later date.

This would lead to 'risk mitigation, at least, by doing some of that work early, if not being able to take that avionics suite, maybe mission systems from [the mid-life upgrade] and then migrate them to a follow-on air vehicle platform in the future'. ■

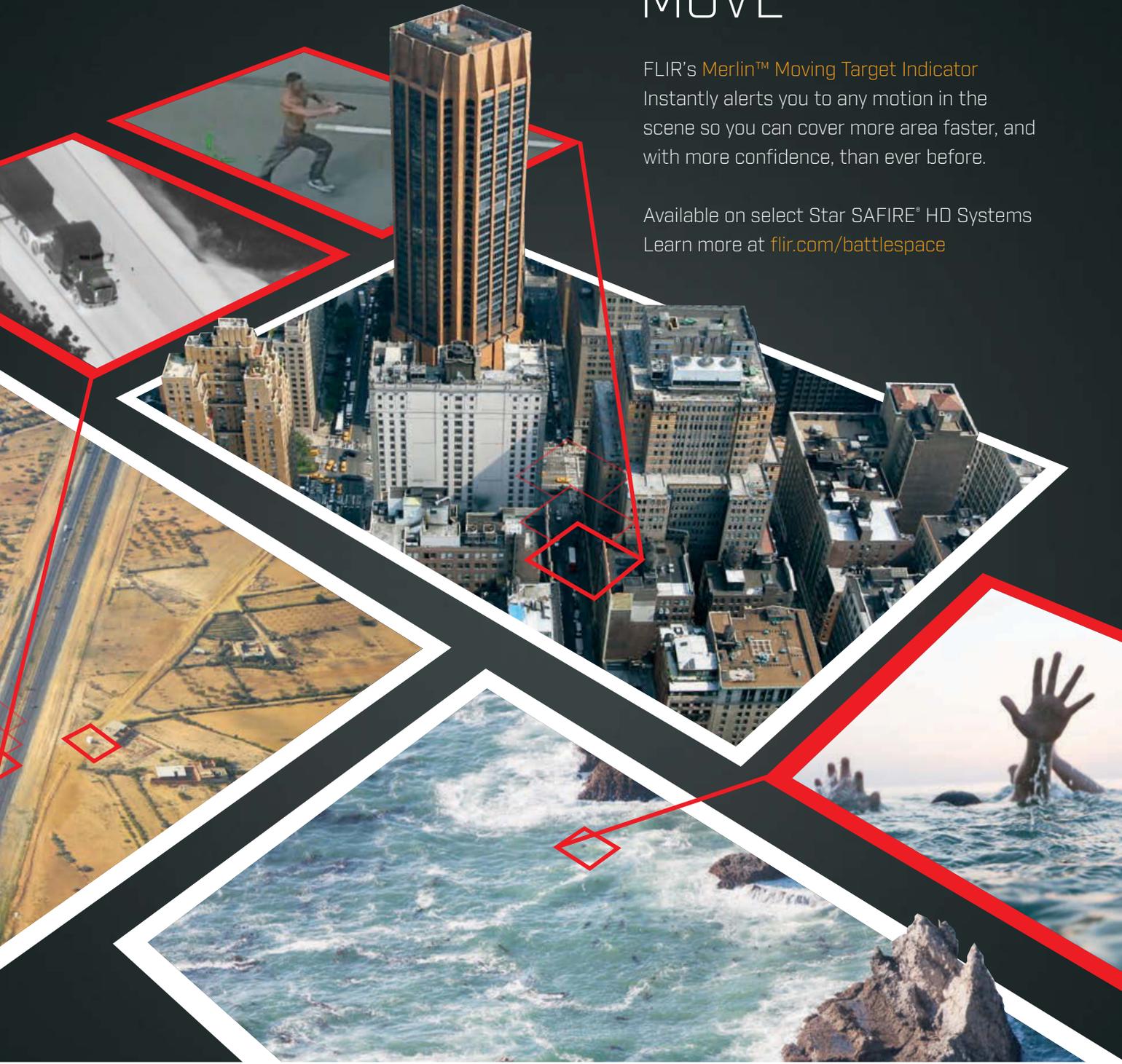
The commonalities between the Sierra and Romeo – such as their common cockpit – will save the navy money on training and sustainment costs. (Photo: CAE)



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The World's *Sixth Sense™*

China has struggled under Western embargoes to raise its rotary game and is casting off foreign assistance to produce models domestically. **By Gordon Arthur**

China's military, the People's Liberation Army (PLA), is the largest in the world, and such a force requires a considerable number of helicopters. However, the PLA is still in the process of building up its rotary-wing fleet to suitable levels.

Although still reliant on Russian-built aircraft, the country is now focusing predominantly on indigenous manufacture. For a long time, the PRC has done so with licensed or copied designs from overseas, although in recent years, China has amassed the experience and confidence to develop more independent designs.

The table on p15 illustrates the range of helicopter types employed by the ground forces of the PLA, as well as by the air force (PLAAF) and navy (PLAN). The listed numbers are estimates only, due to the opaqueness surrounding China's military.

Foreign assistance

In consideration of China's attack helicopters, in the 1980s the country acquired a handful of Aérospatiale Gazelles armed with HOT missiles, to study how to utilise helicopters to defeat enemy armoured formations.

China even evaluated the Leonardo A129 Mangusta, and had agreed to purchase Bell AH-1 Cobras from the US. However, the Tiananmen Square massacre in 1989 and subsequent embargoes by the West immediately halted these efforts.

The Z-10 from Changhe Aircraft Industries Corporation (CAIC), entered the stage rather furtively after the project kicked off in 1994. Although trumpeted as an indigenous project, in fact it was Kamov in Russia that helped design, test and verify the Z-10's airframe and propulsion.

Since China initially cloaked it as a civilian project – the China Medium

Helicopter – it was initially able to garner COTS technology from Western companies despite arms embargoes. This point is underscored by the fact that US authorities charged United Technologies in June 2012 for selling controlled items that aided the Z-10's development.

Subsidiary Pratt & Whitney Canada provided ten PT6C-67C turboshafts in 2001-02, plus another subsidiary, Hamilton Sundstrand, allowed six versions of military electronic engine control software to reach China in 2002-03. The company paid a fine of more than \$75 million for 'making false and belated disclosures to the US government about these illegal exports'.

The furore forced China to re-engine the Z-10 with twin WZ-9 turboshafts producing 1,340hp (meaning the Z-10 is somewhat underpowered), a process that considerably delayed the programme.

Indigenous drive

The Z-19 is a tandem-seat attack helicopter that offers a lighter capability than the Z-10. These examples are from the army's Thunder aerobatic team pictured in Tianjin. (All photos: author)



However, as the WZ-9 engine is indigenously developed, China need not fear foreign-imposed embargoes. There is talk that the 2,010hp WZ-16 engine, a Chinese-built Turbomeca Ardiden 3C to be used on the AC352, could one day find its way onto the Z-10.

The Z-10's maiden flight occurred in April 2003, and first deliveries to army aviation units took place around 2009. Due to the PLA's secretive nature, it is impossible to know how many Z-10s are in service, but it could be around 90 units. The service confirmed last September that it was being operated by every major army aviation unit, for example, six brigades and four regiments designed to support the five theatre commands.

Public unveiling

The Z-10 was the first Chinese helicopter to adopt hands on throttle-and-stick and a holographic helmet-mounted sight is also standard fare. A stub wing either side of the fuselage has two hard points capable of carrying four missiles each. Alternative weaponry able to be fitted includes rockets

Current inventory of the PLA helicopter fleet

PLA		PLAAF		PLAN	
Z-10	91	Z-10K	3+	Z-18/Z-18F/Z-18J	n/a
Z-9W/Z-9WA/ Z-9WZ	52+	Mi-171	10	Z-8/Z-8J/Z-8JH	24+
Z-19	105	Z-8K/Z-8KA/Z-8KH	28	Ka-28	14
Z-8A	53	AS332/EC225	8	Ka-27PS	3
Mi-17/Mi-17V-5	44	Z-9/Z-9B/ Z-9WZ/Z-9ZH	55+	Ka-31	9
Mi-171/Mi-171E	204			Mi-8	8
S-70C-2	20			Z-9C/Z-9D	29
AS332 L1	6				
Z-9B/Z-9ZH/DZ-9	50+				
H120 Colibri	34				
Z-11	46				

(90mm or 57mm), missiles or gun pods (7.62mm, 12.7mm, 14.5mm or 23mm).

Under the nose is a cannon, presumably of 23mm calibre. A Norinco subsidiary has developed a mast-mounted optronic system and millimetre-wave fire control radar, although its development was too late to be fitted on early Z-10s.

The next phase of the Z-10's development was made patent at the 11th

China International Aviation & Aerospace Exhibition in Zhuhai November 2016. A Z-10K of the PLAAF, cloaked in a three-colour camouflage scheme, was shown to the public for the first time.

It is believed that the 15th Airborne Corps of the PLAAF has flown the Z-10K since 2014, with development kicking off around 2011. The PLAAF stated the Z-10K's missions were 'mainly for attacking



The Z-9C is a navalised, look-alike version of the Dauphin. It is the primary helicopter embarked aboard major warships of the PLAN, and it is seen here on a Type 054A frigate.

The Z-8 is an important platform, despite it being only a reverse-engineered copy of the decades-old Super Frélon. This is a Z-8KA of the PLAAF, on this occasion being used to carry parachutists.



ground targets such as hostile tanks and armoured vehicles, and [it] can provide direct fire support to ground troops'.

Other functions specific to the PLAAF include escorting CSAR helicopters, supporting airborne operations by paratroopers, and patrolling important air force bases and sites to prevent infiltration or ground attack.

The Z-10K in Zhuhai was exhibited alongside Blue Arrow 7 and AG-300M air-to-ground missiles, plus Norinco BRM1 90mm guided rockets.

The PLAN Marine Corps does not currently possess any organic air support, instead relying on the PLAN. It is possible that the navy could eventually adopt the Z-10 too, with the type known to have conducted deck trials about a landing ship in 2014.

Under a January 2015 agreement, the Pakistan Army took receipt of three Z-10s gifted by China. China's 'donation' helicopters served two purposes. If the Z-10 proves successful in counter-insurgency operations, it could encourage Pakistan and other potential operators to order more examples. Secondly, it provides the Chinese military important feedback from actual combat to inform future developments.

Light attack

The Z-10 has a sidekick in the shape of the Z-19 light attack helicopter (see feature on

p37), which made its public debut at Airshow China 2012 in Zhuhai. It emanates from the Harbin Aircraft Industry Group (HAIG) and its lineage reveals direct descent from the armed Z-9W, although it was completely redesigned with a tandem-seat cockpit.

This connection is most obvious in its fenestron tail, which has the advantage of dampening noise levels but the drawback of a higher power requirement and maintenance cost and greater aerodynamic resistance and weight.

The Z-19 was deliberately developed as a light attack helicopter, as an alternative to the more expensive Z-10. Essentially, it gives the PLA a high-low mix of attack helicopters. First confirmation of the new Z-19 platform occurred in 2010, while its maiden flight was supposedly achieved in 2011.

The Z-19 is protected by armour in key areas but, unlike the Z-10, there is no chin-mounted weapon system. Instead, weapons are mounted on two stub wings containing two hardpoints each. The Z-19 is powered by twin WZ-8A (some sources say WZ-8C) engines, these being a licensed version of the Turbomeca Arriel unit.

It can operate by day or night and under all weather conditions. The Z-19 performs scout and observation missions while the Z-10 would be responsible for countering enemy armoured vehicles. However, with its range of armaments, the Z-19 offers a decent amount of fire support.

In January 2014, a Z-19 fitted with a mast-mounted active millimetre-wave radar was witnessed, probably allowing anti-tank missiles to be launched in fire-and-forget mode.

An estimated 105 Z-19s have entered PLA service to date. A modified Z-19 variant broke cover at the 3rd China Helicopter Exposition in Tianjin in September 2015. HAIG is squarely targeting this aircraft, designated the Z-19E, at the export market. Positioned as a lower-cost alternative to Western and Russian rotorcraft, it may appeal to countries with limited defence budgets. At the time of writing, no Z-19E sales had been recorded.

Tantalising but vague news appeared on Chinese websites last November, promising the rollout of a new attack helicopter that is more advanced than the Z-10. It is supposed to appear within two years, although no further details are known.

Stepping stone

A backbone of the PLA inventory is HAIG's Z-9, used for both multirole and light attack missions. The Z-9 was the result of a commercial venture with Aérospatiale that began in 1980, enabling China to license-produce the AS365 N Dauphin 2.

The updated Z-9B first flew in 1992, using upgraded engines and 70% Chinese components. This programme was a key stepping stone that gave China access ▶

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to dual-use technology, and the Z-9 soon become a key military helicopter for the PLA. The Z-9 differs from the AS365 N in that the tail rotor has 11 blades rather than the latter's 13. It is indisputable that China's pathway to establishing a viable helicopter manufacturing industry has been greatly aided by France.

The Z-9B is the standard utility version employed by the PLA and PLAAF, but a number of other variants have been added over the years. For example, a completely new type debuted in Hong Kong in May 2011. Designated the Z-9ZH, this C2 platform received a longer, bulbous nose with a FLIR system from Luoyang Electro-Optics.

The other main difference is in the cabin, where standard seat rows have been modified to accommodate a digitised command console with radio sets and multifunction display. The Z-9ZH's endurance is listed by the PLA as being three hours 40 minutes, or with a range of 770km.

There are armed versions, too. The Z-9W entered service in around 1989, while the improved Z-9WA inducted in 2004 offered night-fighting capabilities and a nose-mounted FLIR. These armed platforms can carry 57mm or 90mm rocket pods, 12.7mm machine guns, HJ-8 anti-tank

missiles, 23mm cannon and TY-90 air-to-air missiles.

The Z-9WA has a greater weapon carriage capacity than the preceding Z-9W, although it was still a stop-gap measure until the Z-10 and Z-19 entered service. The Z-9WZ is yet further improved, with a better fire control system and laser designator that enables it to fire newer missiles.

Export success

The DZ-9 model, of which there are only a small number, is modified for electronic warfare missions, particularly communications jamming. The Z-9C is a shipborne version used by the PLAN. Equipped with a nose radar and having the ability to carry torpedoes, the navalised Z-9C commonly operates aboard Chinese warships. The follow-on Z-9D can carry four light anti-ship missiles such as the C-701 on external pylons.

Harbin has exported more than 50 Z-9s to Bangladesh, Bolivia, Cambodia, Cameroon, Ghana, Kenya, Laos, Mali, Mauritania, Namibia, Pakistan and Zambia.

Export versions are believed to be typically powered by Safran Arriel 2C turboshaft engines, while rotorcraft for the PLA are powered by locally produced WZ-8 engines developed via the Turbomeca (Beijing) Helicopter Engines Trading Company.

Given the EU embargo on supplying military equipment to China, *DH* asked Safran Helicopter Engines about the use of licensed engines on PLA helicopters. The company responded: 'These rotorcraft are powered with a WZ-8 variant, which is a licence-built Arriel engine.'

'This licence was established before the export control measures were put in place, and the WZ-8 engine is now a 100% Chinese-built engine, with no Safran Helicopter Engines content inside.'

A spokesperson pointed out: 'Safran Helicopter Engines strictly complies with all regulations concerning its import and export activities for military and dual (civil/military) technologies.'

DH also asked for an explanation from Airbus Helicopters about continued production of the Dauphin-derived Z-9 for the PLA. The company responded: 'Airbus Helicopters is strictly adhering to the EU arms embargo on China, and Airbus Helicopters has no licence production agreement in place for military helicopters in China.'

This explanation implies that the Z-9 is completely indigenised and that it is not licensed any more. Airbus Helicopters thus denies any contribution to its production.

Transport and rescue

The medium-weight Z-8 from CAIC is another obvious copy of a French design, this time *Aérospatiale's* SA 321Ja Super Frélon, of which China bought 13 in the 1970s. Despite being certified back in 1999, the PLA refused for a long time to accept the Z-8 into service, owing to its poor reliability.

Nevertheless, it began to enter widespread service in 2007 with the introduction of the improved Z-8K and Z-8KA – SAR and transport variants respectively. They are thought to be powered by WZ-6G engines. Since 2011, the PLA ground forces have adopted a number of Z-8Bs for transportation roles.

The Z-8KH is another version, operated by the Hong Kong Garrison since 2011. A rescue hoist and under-nose FLIR system are fitted. The model has an endurance of three hours 55 minutes and a combat range of 720km. Its top speed is 130kt and its maximum payload is 5,000kg.

The PLAN has several other Z-8 transport and SAR variants in service, but these ►

A mainstay of the PLA rotary-wing inventory is the Harbin Z-9, originally a licensed copy of the AS365N Dauphin 2. Pictured here is a Z-9ZH command variant in Hong Kong.





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are expected to be replaced by the Z-18.

During an ASEAN exercise last September, the PLAN pushed a burning Z-8 off the deck of *Changbai Shan*, a Type 071 landing platform dock ship, and into the sea. The helicopter with a fire on board had made a forced landing, and when fuel started leaking the decision was taken to jettison it overboard.

Training platform

Another debut at Zhuhai was Changhe's Z-11WB multipurpose reconnaissance/attack helicopter, even though it achieved its maiden flight back in September 2015. Intended roles include ground support, battlefield reconnaissance, counterterrorism and policing tasks.

The 1,274kg exhibit was armed with a plethora of weapon systems. The example shown at Zhuhai had a door-mounted 40mm automatic grenade launcher and 7.62mm six-barrelled Gatling-style gun.

On pylons either side of the fuselage were a quad launcher with TL-2 missiles, an AG-300M air-to-ground missile, an 18-tube 57-1 rocket launcher and a folded-up SW6 UAV. An EO sensor is mounted under the Z-11WB's chin. The model can carry a 976kg payload, its maximum take-off weight is listed as 2,250kg, and its 535l fuel tank offers a 680km range.

The Z-11 is a Chinese copy of the AS350 Écureuil, with the first flight occurring back in 1994 and initial military deliveries in 1998. It is primarily employed as a training platform by the PLA, a role it shares with the H120 Colibri, the result of a 2004 co-production agreement between Harbin and the then Eurocopter. One source estimated about 34 H120s are currently serving as primary trainers.

The fact that the Z-11WB is powered by a Turbomeca Arriel 2B1A engine suggests it cannot be adopted by the PLA in its present form. Nevertheless, news emerged last October that the People's Armed Police would acquire the type.

The Z-18 from CAIG will gradually replace many Z-8 variants. This is a new family based on the civilian AC313, essentially an upgraded commercial version of the Z-8. Equipped with a glass cockpit, the AC313 can lift a 4t payload and uses 50% composites in its airframe.

In addition to an army Z-18A transport variant, naval Z-18J AEW and Z-18F ASW subtypes exist. The Z-18F can carry four sonobuoy launchers, a dipping sonar and four 324mm torpedoes or light anti-ship missiles on two external pylons.

The rotorcraft also has a nose-mounted surface surveillance radar, plus a FLIR camera. The existence of a data link would allow it to target anti-ship cruise missiles fired by warships.

As China spools up its aircraft carrier fleet, it also needs helicopters to populate them. At this point, a typical air wing is estimated to contain four Z-18J AEW rotorcraft, six Z-18F ASW types and two Z-9Cs for SAR duties.

US copy

A second major development project still under way is HAIG's new-generation Z-20, unashamedly copied from Sikorsky's S-70C-2, of which China purchased 24 examples in 1984.

The medium-lift platform achieved its maiden flight in December 2013, and while technical specifications remain shrouded, there are differences to the Black Hawk. For instance, it has a five-blade main rotor compared to the Black Hawk's four blades, plus the tail wheel is mounted farther aft. It could become a future mainstay of the PLA fleet, with the military needing a twin-engine platform in the 10t class that is able to operate at high altitudes.

DH was intrigued to hear what Sikorsky thought about such a blatant S-70 replica coming from China. Unfortunately, the company could only respond: 'We decline to comment on this one.' It is assumed that a number of S-70C-2s are grounded because of a shortage of spare parts.

One of the PLA's most popular and long-serving types is the Mil Mi-17/171 family, of which more than 250 are thought to be in service. Rosoboronexport completed delivery of 52 Mi-171Es in July 2014, following a deal signed with Poly Technologies in 2012. The latter was also the Chinese agent in a contract for 32 Mi-171Es signed in 2009, with all handed over by 2011.

Prior to that, China has ordered various batches of Mi-17, Mi-17-1V, Mi-171,

“ A backbone of the PLA inventory is HAIG's Z-9, which is used for both multirole and light attack missions. ”

Mi-171V-5 and Mi-171V-7 platforms from Russia since 1991. Notably, there exists a Sino-Russian joint venture in Chengdu to repair Mi-17s.

China desperately wants to beef up its heavy-lift capacity, after this weakness was exposed by the 2008 Sichuan earthquake. At the 2015 Tianjin show, Avicopter unveiled a scale model of the proposed Advanced Heavy Lift (AHL) design, possessing a maximum take-off weight of 38t, a 160kt cruise speed, 630km range and 5,700m service ceiling.

Internally it will carry 10t of cargo, or 15t on an external sling. The ability to operate in high-altitudes is critical for the PLA, as it must fly in areas such as the Tibetan Plateau. Russian Helicopters and AVIC signed a preliminary framework agreement in May 2015, which was later confirmed on 25 June 2016.

The AHL bears some similarity to Mil's Mi-46 concept of the early 1990s. It has a seven-blade main rotor with paddle-shaped anhedral blade tips and a rear loading ramp. While the AHL will be built in China, it will employ Russian engines. The partners hope demand could stretch to 200 units by 2040.

The PLAN also uses Kamov helicopters. The navy received nine Ka-31 AEW types fitted with retractable E-801M solid-state radars in 2010-11.

The navy also operates the Ka-28 family, with six ASW and three SAR variants (the latter's nomenclature being the Ka-27PS) received in 1999-2000. An additional eight Ka-28 helicopters were ordered in 2009. ■



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TAKE BACK THE NIGHT

Developments in night vision goggles have allowed African, Eastern European and Central American countries to reap the benefits of the technology once enjoyed only by Western nations. **By Jim Dorschner**

An AH-64 Apache departs from a base in Afghanistan to conduct a security and reconnaissance mission at night. (Photo: US DoD)

When night vision goggles (NVGs) were first introduced to military rotorcraft aircrew in the late 1970s, the US and a few Western allies enjoyed a virtual monopoly on the advantages afforded by more effective and robust night operations.

Indeed, it was the application of advanced NVG technology more than any other factor that permitted the US Army's ground-breaking 160th Special Operations Aviation Regiment to earn the iconic name, Night Stalkers.

As Harry Hewson, senior director for rotorcraft airborne solutions at Elbit Systems of America told *DH*: 'NVGs provide an excellent night vision solution at a very low cost across the great majority of conditions.'

By the 1990s, this increasingly routine ability to operate freely in darkness offered US and Western special operations forces

(SOF) and conventional forces previously unimaginable operational flexibility.

Furthermore, it added security not available to other armed forces or to the enemy in conflicts such as the Gulf War, or military interventions such as Britain's in Sierra Leone or Australia's in East Timor. SOF teams, or even entire infantry battalions, could be safely inserted at night into landing zones to seize key objectives, conduct strikes and raids, or perform critical reconnaissance deep in enemy territory.

Casualties could be swiftly evacuated and critical supplies delivered using landing zones considered too dangerous during daylight. Secure, quick-reaction night CSAR of downed aircrew and clandestine personnel recovery missions from otherwise denied territory became established doctrine and repeatedly saved lives in the Balkans and elsewhere.

Changing landscape

Over the past 15 years or so, this operational monopoly steadily disappeared, as countries such as China, Israel and Russia developed and marketed NVG technology. At the same time, American and European NVGs were exported around the world, particularly to allies battling Islamic terrorism after 2001.

As a result, affordable and effective helicopter systems have proliferated far and wide, accompanied by the now mature skills and doctrine required to successfully exploit the advantages afforded by almost unrestricted night flying.

While *DH* previously examined in detail the developing technologies and what lays ahead for military helicopter night vision systems (see Sep-Oct 2016, p30), equally important is the changing operational landscape produced by NVG proliferation.

Worth noting for comparison are the arguably more important parallel effects of unmanned aerial vehicle (UAV) proliferation beyond the original US and allied technology developers and users.

During the long, hard years of combat since 2001, the employment of UAVs for surveillance and strike missions exclusively by the US and allies such as the UK fundamentally altered the operational landscape for all sides in theatres like Afghanistan, Libya and Somalia.

Just as Russia now relies on UAVs to support operations in Ukraine and Syria, while China and Iran develop their own indigenous capabilities, the proliferation of military helicopter NVG technology is incrementally expanding the operational envelope for armed forces that previously flew at night only rarely.

As we move into 2017, the new normal is represented by Cameroon Air Force pilots employing Chinese-made HY-07 NVGs, while flying Harbin Z-9WE attack and reconnaissance helicopters in preparation for combat operations against Boko Haram in the north of the country. The HY-07 is thought to be similar to the AN/AVS-6 Generation 3 ANVIS night vision systems fielded to the US Army rotary-wing aviation from the late 1980s.

Another variation on this theme is the 30 NVG-capable Bell 412EPs supplied to Pakistan Army Aviation by the US since 2007. Although unconfirmed, it is believed that AN/AVS-6 systems were included in the

transfer for use by 412 crews supporting the special operations task force on counter-terrorism operations.

Similarly, boosting operational night flying skills is an established priority for the Afghan Special Mission Wing (SMW), which supports Afghan special forces throughout the country with 30 Mi-17V5s and 30+ Afghan crews.

The Kabul-based 1st and 2nd squadrons, established in 2006, are the most experienced NVG-qualified aircrew. Declared operational in 2016, both 3rd Squadron in Kandahar and 4th Squadron in Mazar-e-Sharif, are steadily building capability. Along with refining mission planning, tactics and logistics, a mostly American cadre of foreign advisers is focusing on building up the roster of NVG-qualified aviators.

The SMW's Mi-17V5s were purchased new from Russia by the US and received a number of modifications before delivery to Afghanistan, including NVG-compatible Western avionics. Despite an excellent operational history since 2013, the SMW Mi-17s may be replaced by an equal number of either UH-60Ms or upgraded V-model Black Hawks at some point in the future.

Iraqi improvement

Shifting to Iraq, army aviation attack helicopter and special operations aviators rely on NVG technology to conduct high-intensity combat operations at night against Daesh. Aircrew were trained and qualified on NVGs by American instructors on OH-58s

from February 2008, before moving on to Bell Huey IIs and Mi-17s.

When the programme started, there were no Iraqi NVG-qualified pilots. Now, many of the young aviators trained earlier are old hands leading night surveillance and attack missions, and serving as instructors training the next generation.

Iraqi Army Aviation training, operations and logistics are complicated by a mixed inventory. In addition to Huey IIs and Mi-17s, this includes the Bell IA-407 and Airbus H135M reconnaissance and attack rotorcraft, as well as Russian Mi-35M and Mi-28NE attack helicopters. Each type was presumably delivered with different NVG systems from the US, Europe and Russia.

Despite the challenges, the ability of Iraqi Army Aviation to operate successfully at night has proven critical in efforts to retake territory from Daesh, including the ongoing campaign against Mosul.

North by night

North African countries also rely on the ability to operate helicopters at night as they battle local Daesh franchises and other threats. In 2014, the US agreed to provide Tunisia with 12 UH-60M Black Hawks for the air force, deliveries of which commenced in 2016. The \$700 million FMS deal included 30 sets of AN/AVS-9 NVGs and 15 Wescam MX-15Di or Brite Star II EO/IR laser designators to facilitate night operations.

In May 2016, the US government approved the transfer of 24 excess Bell OH-58D Kiowa Warrior scout helicopters to Tunisia, along with 50 additional sets of AN/AVS-6 NVGs. Prior to delivery of the first batch of OH-58Ds in late 2016, 24 pilots and 50 technicians trained under a US Army Security Assistance Training Management Organisation contract with Integration Innovation Inc (I3) at Roswell, New Mexico. Today, the Tunisian Air Force has the foundation for a well-balanced, modern rotary-wing combat force with effective night capability.

Neighbouring Algeria has led helicopter NVG capability in the region, contracting with Russian state armaments export agency Rosoboronexport in 2003 for the delivery of 42 night-capable Mi-171AMTSh 'Terminator' assault helicopters, with deliveries completed by the end of 2016.



The boosting of operational night flying skills is an established priority for the Afghan Special Mission Wing. (Photo: Russian Helicopters)

These feature Geofizika-NV GEO-NVG-1 goggles from the Russian Federal Research and Production Center, which uses high-sensitivity night-vision technology based on third-generation image converters and spectral filtration techniques. The Mi-171 upgrade was followed by an order from Rostvertol for 42 night-capable Mil Mi-28NE attack helicopters, the first four of which were delivered in May 2016.

Algeria has battled armed Islamist insurgent factions since 1992, beginning with the Armed Islamic Group, which morphed into the Salafist Group for Preaching and Combat in 1998, and later linked to Al-Qaeda in 2003 to become Al-Qaeda in the Islamic Maghreb (AQIM) in 2007. AQIM remains a serious threat to the national oil industry, particularly in southern Algeria, where it operates across the lawless border regions with Mauritania, Mali and Niger.

The fall of Muammar Gaddafi in 2011 created a new swath of lawless territory along Algeria's eastern border with Libya, and introduced additional threats from Daesh and other well-armed extremist groups operating in the area. Survival of the Algerian state depends on containing these threats, and a key component in doing so is the ability to operate attack, reconnaissance and assault helicopters at night.

Further south, Nigeria struggles to counter the Boko Haram insurgency in the north of the country in the Niger, Chad and Cameroon tri-border area. The Nigerian Air Force (NAF) had already obtained four night-capable Mi-171Sh helicopters from Russia in 2003, but was clearly in need of more capability.

In response, six additional Mi-171Sh models were reportedly ordered from Russia, along with six Mi-35 attack helicopters, although no evidence of delivery has surfaced. According to the UN Register of Conventional Arms, Nigeria previously acquired three Mi-24s from Ukraine in 2008 and two more from Belarus in 2010.

Given Nigeria's rather chaotic and inept military response to Boko Haram thus far, coupled with a general lack of professionalism in the NAF, it will be a hard slog to develop the skills and doctrine required to turn these platforms into a functional night-capable force. Unlike in neighbouring Cameroon, there is no evidence of aircrew building capability with NVGs.

OH-58 Kiowa Warriors are kept mission-ready on the tarmac even as night falls. (Photo: US DoD)



Eastern capability

In East Africa, Kenya Air Force (KAF) and army helicopters have been at the forefront of coalition operations against Al Shabab in Somalia since 2011, although with only limited night capability. This is principally provided by the army's 50th Air Cavalry Regiment, relying on around 40 MD 500 armed scouts originally acquired from the US in the 1980s and six armed Harbin Z-9s obtained from China in 2010.

The former were modernised by Israel over the years and augmented by transfers of upgraded former IDF airframes. MD 500 aircrew probably use Israeli NVGs and have benefitted from training by Israeli and American advisers. The more modern, night-capable Z-9s are equipped with FLIR systems and were probably delivered with HY-07 NVGs.

Until recently, the KAF relied on around 11 surviving SA 330 and IAR-330 Pumas for battlefield helicopter support. These aircraft date from the late 1970s and 1980s and were never upgraded for NVGs. Two Mi-171s obtained in 2010 may be NVG-compatible, but have been grounded for extended periods with maintenance issues.

In December 2016, the KAF took delivery of the first six of eight upgraded UH-1H Huey II helicopters transferred from the US. These are night-capable, with a number of AN/AVS-9 systems probably included in the package. The Huey IIs will be heavily used for troop lift and medevac missions in Somalia and northern Kenya.

While the Huey IIs offer an urgently needed capability boost, the KAF eventually requires a more capable

replacement for the ageing Pumas. This will most likely take the form of around 12 Black Hawks from the US, either new UH-60Ms in a package similar to Tunisia, or upgraded UH-60Vs.

To replace the air cavalry MD 500s, Kenya is another prime candidate for excess US Army OH-58D Kiowa Warriors, new MD 530G scout attack helicopters or Boeing AH-6i light attack helicopters, all of which feature robust night capability.

In terms of night-capable Mi-17 variants, the Indian Air Force (IAF) is a major user, with around 140 Mi-17V-5 models in service or on order. Along with new VK-2500 engines, these feature advanced avionics with a KNEI-8 glass cockpit compatible with the latest Russian Generation III NVGs.

The new helicopters are popular with the IAF, providing significantly improved support to special forces and to frontline operations in the demanding mountainous terrain and harsh weather conditions along the borders with Pakistan and China.

In 2015, India concluded contracts with Boeing and the US government for 22 AH-64E Apache Guardian attack helicopters and 15 CH-47F Chinook heavy lift models. These will also be operated by the IAF and will come with the latest US NVG technology.

Meanwhile, Republic of Korea Army (ROKA) aviators are steadily building night capability with indigenously produced Korea Aerospace Industries KUH-1 Surion tactical helicopters. Complex night operations are being conducted using Elbit Systems' Aviator's Night Vision/Head-Up display. The ROKA has over 40 Surions in service, with plans for around 200. ▶

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ROKA Aviation Command has benefitted from decades of close cooperation with US Army aviation in South Korea, including extensive night operations employing NVGs.

The command employs some 130 UH-60P Black Hawks, 25 CH-47D Chinooks, 50 AH-1 Cobra attack helicopters and a similar number of MD 500 scout attack helicopters. These will be joined in 2017 by the first of 36 Boeing AH-64E Apache Guardian attack helicopters on order.

Balkan requirements

Turning to the Balkans, Serbia received two new Mi-17V-5s from Russia in June 2016, with follow-on deliveries expected. These have NVG-compatible analogue cockpits and modern Russian NVG systems were likely included in the transfer.

The helicopters' primary role is providing an all-weather national SAR capability. Serbia has requirements for at least 12 new Mi-17V-5s. In Macedonia, Israel's Elbit Systems completed the upgrade of ten Soviet-era Mi-8MT, Mi-17 and Mi-24V rotorcraft in 2014.

The upgrade included compatible cockpits and Elbit NVGs, new internal and external lighting systems, and the installation and integration of modern day/night ANVIS/HUD-24 systems.

In Croatia, the US agreed to the transfer of 24 OH-58D Kiowa Warrior scout attack helicopters in May 2016. Similar to

the Tunisia transfer, the package includes 50 pairs of AN/AVS-6 NVGs and an extensive training programme. The final batch of Kiowa Warriors were delivered in December 2016, with training set to begin in early 2017. Five instructors from US contractor I3 will conduct the programme at the Zadar base of the new squadron, with full operational capability expected by 2020.

The world's largest operator of UH-60 Black Hawks after the US Army is also one of the most experienced at night operations using NVGs. Colombian Army Aviation operates 56 Black Hawks, in addition to 24 UH-1H Huey IIs, 16 UH-1Ns and 20 Mi-17s, all of which are NVG-capable.

Decades of counter-insurgency operations in Colombia have produced a highly capable force. While a recently concluded peace agreement will likely mean some reductions in fleets of older types, Colombia will remain engaged with global peace missions, including aviation contributions.

Army aviation will also continue to play an important role in formalising the armed forces of Central American countries. El Salvador, Guatemala and Honduras are struggling to cope with powerful transnational organised crime elements and need all the help they can get, including enhanced night helicopter capability.

According to Elbit's Harry Hewson, as industry works to further reduce pilot

workload and improve flight safety in degraded visual environments, there is a lot of focus now on pilot-machine interface.

'Testing in simulators and in limited flight tests has shown that when the visibility really starts to shut down, particularly during take-off and landing, pilots want to keep their heads up and eyes outside the cockpit to search for even the smallest outside visual cue to aircraft position and drift,' he said.

Having to come back inside to focus on a small head-down display 'is not just counter-intuitive, it gets dangerous if you don't see obstacles that are in close to the landing point'.

Steady improvement

Given the nature of global threats and requirements, the market for increasingly capable, affordable and available night vision systems will remain strong. While a range of even more advanced next-generation night vision systems, particularly for helmet display and tracking, are in development or entering service in China, Europe, Israel, Russia and the US, the use of traditional NVG technologies will continue to expand around the world.

The proliferation of military helicopter night vision systems has significantly changed the operational landscape with strategic effects. The US and allies such as the UK and France now rely on local forces to confront security threats including Daesh, the Taliban, Boko Haram and AQIM.

The employment of NVGs by increasingly professional helicopter aircrews, coupled with proven doctrine, good intelligence and advanced skills is crucial to denying these enemies the operational freedom and security provided by the hours of darkness.

Since emerging in the 1970s, military helicopter NVGs have steadily improved and become more affordable even as the tactics, techniques and procedures required to integrate them into operations have matured.

Given the enormous operational benefits derived from NVG use, they will become standard kit for a growing number of military helicopter operators. However, on a cautionary note, some of these operators will inevitably be bad actors using the same technology to counter the advantages gained by similarly equipped good actors. ■



ROKA Aviation Command employs 130 UH-60Ps, 25 CH-47Ds, 50 AH-1 Cobras and a similar number of MD 500s. (Photo: US DoD)

Eyes on the sky

Widely used by commercial operators, automatic helicopter flight tracking technology is increasingly emerging into the military domain. **By Helen Haxell**

Tracking systems for aircraft provide commanders overseeing military operations with peace of mind.

Whether it is an MH-60R Seahawk landing on board a ship, or a UH-60 Black Hawk on a reconnaissance mission in a hostile environment, tracking solutions are the eyes, and in some instances the ears, for unit commanders.

For companies providing tracking solutions to the military sector, many offer a portfolio of products comprising a mixture of handheld, installed and portable devices. For example, Blue Sky Network's HawkEye 7200 is a portable tracking system and the installed version is known as the HawkEye 7200A.

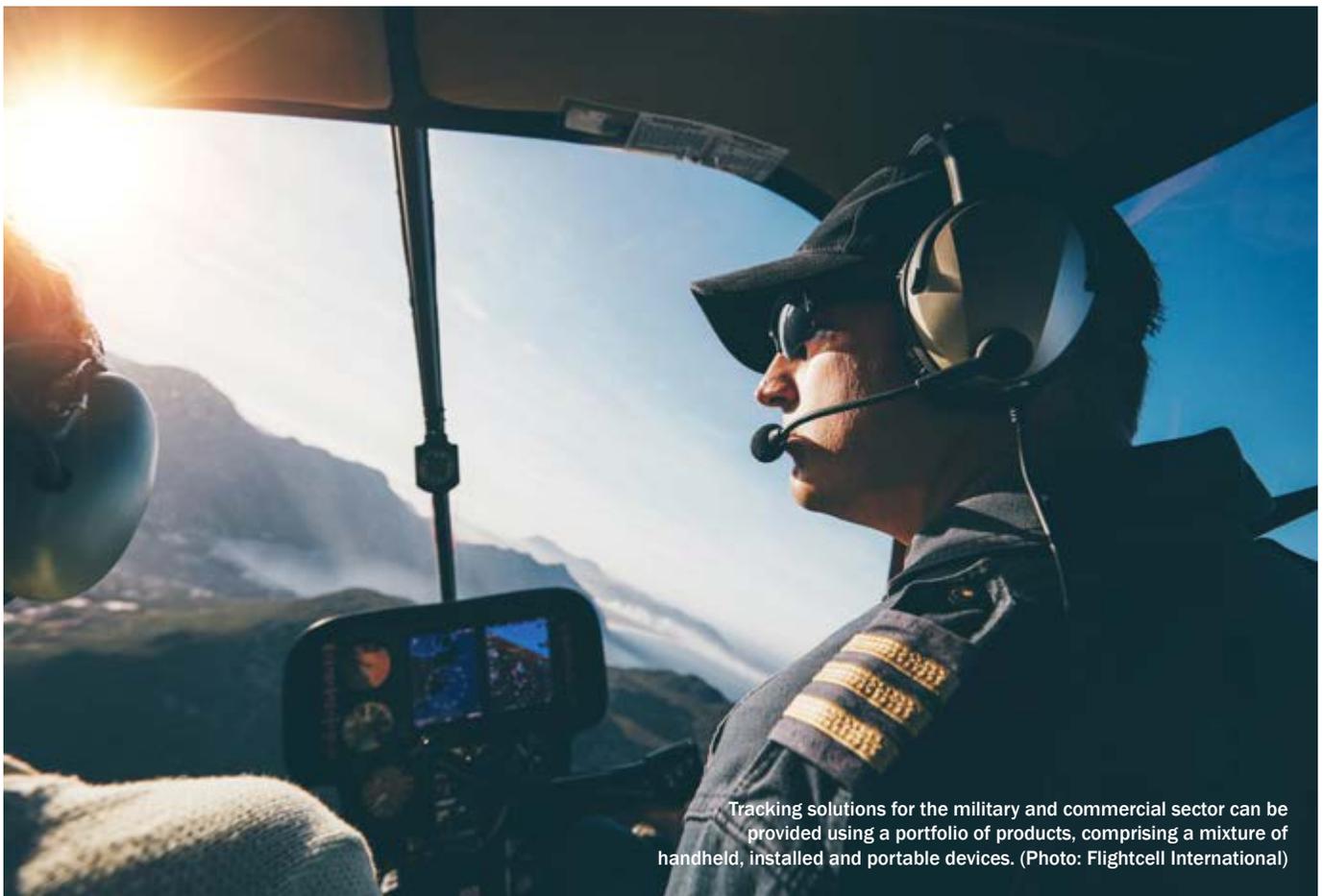
The company's CEO Kambiz Aghili told *DH* the tracking devices work through satellite media that retrieve location data and subsequently transmit it via a network.

'The HawkEye 7200A collects location data from GPS and GLONASS satellites and uses an Iridium transceiver to transmit this data over the Iridium satellite network,' he said. The device can then provide almost instant reports on its whereabouts and a

ground team can monitor its journey through the coordinated data it provides.

Aghili said that the operator can determine the timing of the reports, detailing how the information is presented: 'These position reports are typically transmitted at a regular interval that you can define as every 15 seconds, or every minute, whatever that [need] might be, and that contains minimal four-dimensional location data that includes latitude, longitude, altitude and time,' he explained.

'So once the data passes through the Iridium gateway and it reaches our servers, we have our own advanced cloud-based web portal... called SkyRouter. It will utilise this data in a variety of mapping ways to display the aircraft's



Tracking solutions for the military and commercial sector can be provided using a portfolio of products, comprising a mixture of handheld, installed and portable devices. (Photo: Flightcell International)

real-time movement on the end user's personal account.'

SkyRouter is a centralised web portal that enables the operator to visualise, speak with and track its aircraft or fleet.

The 7200 series is being used by military operators around the world and on board aircraft such as the S-70i Black Hawk, *DH* has learnt.

Real-time insight

New Zealand-based company Spidertracks has developed a tracking service that is designed to give rotorcraft operators enhanced real-time operational insight into their fleet.

Replacing an earlier version of Spidertxt, used for two-way communication – aircraft-to-ground, ground-to-aircraft – Spidertracks has built its 2.0 system to encompass all communication through one channel.

It works independently of local infrastructure, so even if there is no telephone or internet communication, messages to the helicopter or ground station can still be delivered. Spidertxt now allows messaging between aircraft, ground-to-ground and aircraft-to-ground.



The DZMx is a satellite transceiver, a cellular transceiver and a tracking device all in one box. (Photo: Flightcell International)

'Spidertxt 2.0 is for an operator that does not know where they are going to be in ten minutes' time. They might need to change their mission at the last minute... when a mission isn't just taking the aircraft from one spot to another,' Todd O'Hara, marketing manager at Spidertracks, and a helicopter pilot, told *DH*.

Another tracking device that can be applied to military fleets is Flightcell

International's DZMx. This has recently been advanced with new cellular tracking technology, which can provide positions of the aircraft at 15-second intervals in high definition.

Michael Eddy, marketing and communications manager at Flightcell, explained that the system has the capacity to utilise cellular data and IP delivery and automatically switch between cellular and satellite. When operating over satellite, the technology fills in the gaps between position points and maps the flight path.

'The DZMx is a satellite transceiver, a cellular transceiver and a tracking device all in one box. Where our competition has many different units, it's just one tiny box that fits in the palm of your hand. It's built to Mil-Spec standards and it's night vision-compliant, so it's perfect for the military,' Eddy said.

Regarding the new capability of the DZMx, Eddy explained that the latest feature – cellular IP tracking – was a second-generation technology: 'The product can switch automatically between cellular and satellite. The new technology, instead of being every minute on a position recording, [populates on the screen] every 15 seconds. So, it shows you almost in real time exactly where the aircraft is.'

Another feature of DZMx is the fact that the tracking feature is joined with Iridium push-to-talk (PTT), which allows secure global walkie-talkie-style communications between aircraft and ground units.

AIRBORNE AWARENESS

Military helicopters on missions far from base can use a range of technologies to help them operate at long distances and over challenging terrain.

With the chopiness of the ocean waves and difficult environmental conditions added to the mix, aircraft crews and ship operations rooms alike want to ensure a safe flight and approach to a vessel's deck.

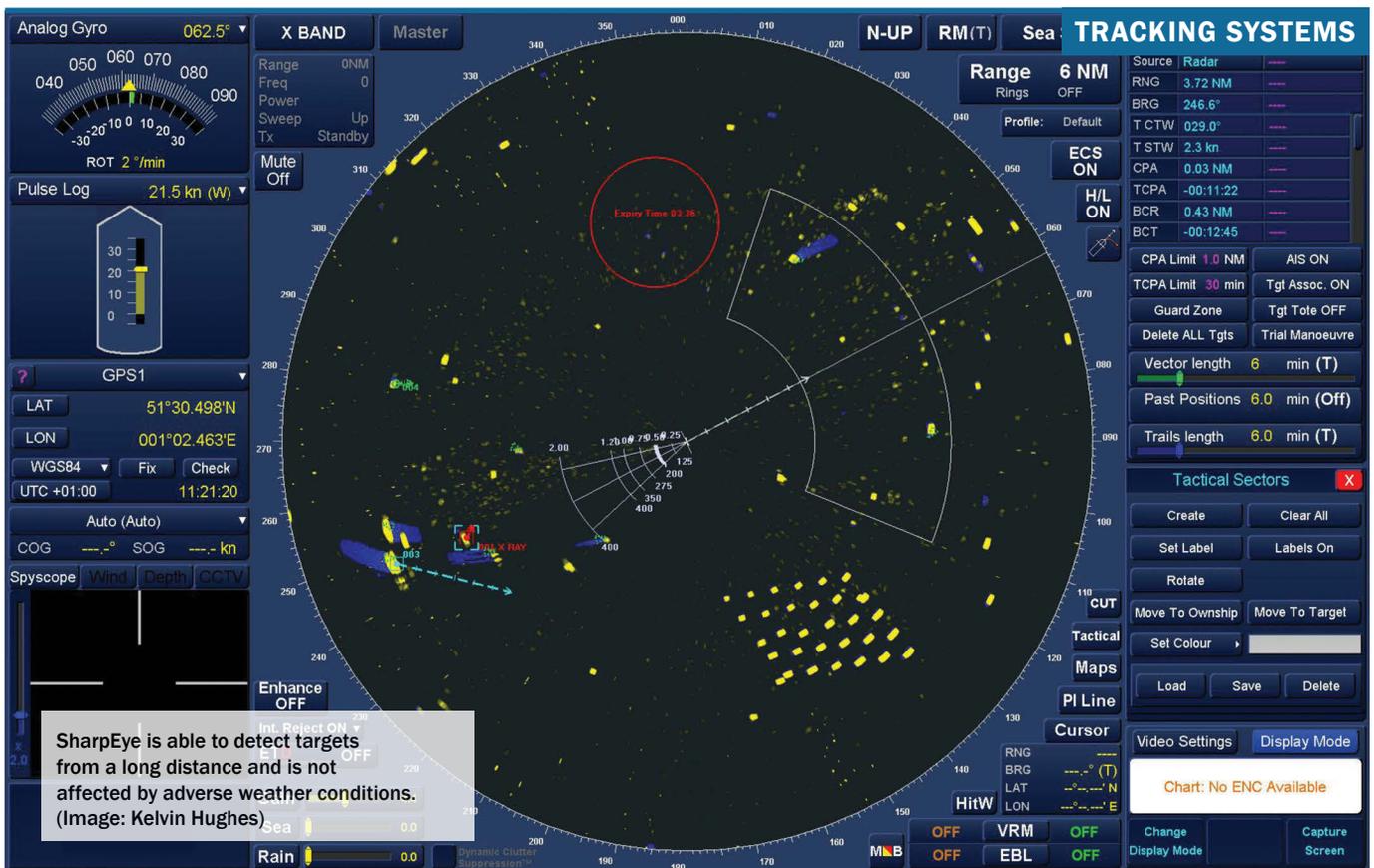
Currently, Kelvin Hughes' SharpEye radar is being used by 27 navies throughout the world. This includes the UK RN and Royal Fleet Auxiliary (RFA). The company received a contract in March 2016 for more than 60 radar sets for RN and RFA ships, submarines and shore facilities.

At least ten navies utilise SharpEye to control aircraft and the airspace around a ship as a helicopter tracking function. One of the main capabilities of SharpEye is its capacity to eradicate the necessity of a

second radar/transponder system. SharpEye is able to detect targets from a long distance and is not affected by adverse weather conditions, using a combination of algorithms, moving target detection and the Doppler processing technique, Mark Bown, group marketing manager at Kelvin Hughes, explained to *DH*.

'The algorithms enable target information to be resolved as targets [radar contacts], or not. They can be optimised for specific, harder to detect targets such as helicopters,' he said.

Rohan Dearlove, Kelvin Hughes' maritime sales director, UK and France, commented: 'The Doppler processing techniques we deploy within the system filters out the effects of the rain and the clutter. So, you'll have a very clean picture. Essentially you are seeing through the clutter.'



Privacy needs

A common thread throughout military users is the necessity for security and privacy in relation to the usage of tracking devices.

Fundamentally, these systems hold key data that in the wrong hands could have devastating effects, leading militaries to develop some specific requirements outlining what they need from the technology.

'We have seen some militaries that like to have their own private server. In addition to the privacy and security of data that we set, we offer very private data endpoints for the client,' explained Aghili.

'They [the military] want to have their own strict physical access... For instance, we worked with a military operator around the Middle East and they were really interested in a very specific improvement. They want to know if an aircraft goes down and if the enemy gets their hands on the cockpit.

'They don't want any memory to be left on the device. So, they need specific solutions to purge the data and... securing that data with physical access keys in addition to what we offer,' he added.

'Also, [they want the capacity to be] able to broadcast a purge signal as well as having an internal [component] where intelligence

within the device detects if the helicopter crashes, and it will self-purge itself.'

Similarly, O'Hara said that the important thing for the military is not just the security of knowing the fleet's location but ensuring data is private and protected.

'Military operators largely have the same requirements as commercial aircraft operators. They need to know where their people and assets are, and that they're safe. Spidertracks' suite of features provides situational awareness about what an aircraft is doing, not just where it is.

'Unlike other technologies like ADS-B, the key capability for Spidertracks for military aircraft is the secure nature of our system. Data is encrypted from the aircraft to the same standard that banks use, and the data is only available to whoever the operator chooses,' he stated.

One level of protection for tracking devices is encoding the Iridium packet in the first instance with the additional layer of a company's own protocol, *DH* has learnt.

Getting connected

Honeywell also provides a tracking system for many helicopter fleets, including that of the Mexican Navy.

Iain Ronis, project manager for the Sky Connect product line at the company, told *DH* that the navy utilises the Sky Connect Tracker system, which provides simultaneous automated tracking, text messaging and voice communications.

'[Sky Connect] is deployed throughout the world with about 3,000 helicopters in operation... We have been working with the Colombian military on army and air force aircraft as well as the paramilitary - their national police force - in support of their drug interdiction campaigns,' Ronis said.

'We also have deployments with the Mexican Navy again on helicopters, and some units are deployed on their naval vessels.'

The systems have been operated in the depths of the Colombian jungle on ageing Hueys. A major capability that has been developed after customer feedback and grown organically through research and development is a button quite literally marked 'under fire'.

All the crew has to do is press the button, and Sky Connect emits a discreet signal that passes through the satellite to the user's operating centre. An alert then highlights the aircraft on the map and indicates its status, Ronis explained to *DH*. ▶

Talking away

Eddy noted how the heightened capability of tracking projections helps the end user. Situation awareness for command centres is achieved by having real-time tracking combined with live PTT voice at the same time.

Another component of DZMx is its capability to allow communication between the helicopter and the ground team.

'It's higher resolution – so [military operators] can see exactly where their helicopters are, but coupled with the Iridium push-to-talk they can also hear what's going on in a walkie-talkie group conversation network. This allows full operational situational awareness of what's happening, and it provides a global reach if they are out of a typical radio frequency,' Eddy said.

Likewise, O'Hara in a statement to *DH* noted how the Spidertracks tracking technology now knows no geographical boundaries.

'With Spidertxt 2.0, operators are able to send and receive secure communications anywhere in the world. In some cases, aircraft are operating in airspace that isn't their own. Whether this is on exercise or deployment, being able to have command and control over your assets from anywhere

in the world is extremely valuable for any aircraft operator,' he said.

The future of tracking systems could be shaped by the analytical data collated by the devices and most importantly, how this is presented to operators.

'We're on the cusp of a data revolution. Current tracking products focus almost exclusively on where an aircraft is and where it has been,' O'Hara noted. 'But there's so much data that surrounds this that rarely gets used; information that, if processed correctly, can deliver tangible efficiency improvements to operators.'

Satellite boost

The Iridium NEXT service is anticipated to be available for commercial operators in 2017 – although dependent on the success of the launches this could move into 2018. The latter possibility is due to the project undergoing a setback when SpaceX's Falcon 9 exploded in September during a test. Ten Iridium satellites were expected to be launched by January 2017.

This will be of interest to developers and operators alike, as most tracking systems benefit from the incumbent Iridium service.

The upgraded Iridium NEXT will be a constellation with worldwide coverage. In essence, there will be 66 cross-linked low-

earth orbit satellites which will work to produce high levels of data coverage regardless of weather and even natural disasters.

'In space, each Iridium NEXT satellite will be linked up to four others – two in the same orbital plane and one in each adjacent plane – creating a dynamic mesh network that routes traffic among satellites to ensure a continuous connection, everywhere,' according to company literature.

This technological development will aid connectivity for military helicopters with no fears of communication drop-outs, especially when the crew is on a humanitarian mission in a tsunami-struck area, for example.

In a similar vein, Aghili said that this could help with the processing power for tracking systems. 'This [tracking] technology has a way to go. For instance, you can use our product to communicate a ton of data back to the ground and back up again. I think that has some limitations... thankfully Iridium NEXT will increase our processing power and capacity,' he explained.

'Its operating data will allow some broadband at 1.4Mbps speeds and this would allow us to leverage our solutions to really create a big data and analytics [solution],' he said.

Ronis further explained how this technology will benefit operators: 'This new constellation will fully support everything that is already on operation with Iridium. So, there's continuity of service that is assured. The new satellites will offer new capabilities, higher-speed data rates.'

More specifically, Ronis noted how the advancement will help military and commercial operators with fluidity in transferring information through the increase in upload speeds and improved bandwidth rates.

'For military applications, as well as commercial helicopters, all pilots face the same situation, and that's access to data. The additional bandwidth, the higher data speed that the new Iridium network is going to offer will bring a lot of capability to improve that data exchange.'

While Iridium may not be the only service available to SATCOM users for tracking, it is clear that the development will be aiding the eyes in the sky with a sharper and faster flow of data and information to help all missions. ■



HawkEye 7200 is a portable tracking system, while the installed version is known as the HawkEye 7200A. (Photo: Blue Sky Network)

A number of the world's militaries are on the cusp of more advanced attack capabilities as their helicopter fleets adopt the latest in missile technology.

By Beth Maundrill

When discussing missiles for military rotorcraft, many will be inclined to think first of the Lockheed Martin AGM-114 Hellfire.

The Hellfire has become the go-to missile for a number of AH-64 Apache customers, as well as for UH-60 Black Hawks, OH-58D Kiowa Warriors and French and Australian Tigers, among others.

While there have been a range of Hellfire variants over the years, the most common are currently the AGM-114L

Longbow and AGM-114R Hellfire II. The former is a radar-guided, fire-and-forget, adverse weather anti-armour missile system, while the latter incorporates semi-active laser guidance.

Put to the test

The US Army successfully completed testing of the AGM-114R missile in 2016 against a new, more representative masonry target at high temperature. The weapon can be launched from high or low altitudes and has an enhanced guidance system with improved navigation capabilities.

It includes a three-axis inertial measurement unit, which enables properly equipped launch platforms to engage targets to the side and behind them without having to manoeuvre the aircraft into position, according to Lockheed Martin.

The Hellfire is nevertheless not the only player in the game. As Boeing rolls

out the latest iteration of the Apache, the AH-64E, missile manufacturers are working with the aircraft's OEM to integrate new weapons.

The US Army is looking to replace the AGM-114 with the Joint Air-to-Ground Missile (JAGM); the UK MoD is exploring options through its Future Attack Helicopter Weapon (FAHW) endeavour; and products such as the Rafael Spike-ER and MBDA PARS 3 LR are also providing alternatives.

Open market

With Raytheon also gaining more customers for its air-to-air Stinger solution, the market for missiles is as open as it has ever been.

JAGM is a next-generation air-to-ground missile designed to replace both the Hellfire and air-launched TOW families of missiles for joint use on rotary-wing aircraft for the US Army, USN and USMC. ▶

The UK is equipping its AW159 Wildcats with the new Future Anti-Surface Guided Weapon – Heavy. (Image: MBDA)

Targeting strategies



Any system that currently uses Hellfire will be able to utilise JAGM and, indeed, the army plans to implement the AGM-114R warhead on the new munition.

The missile combines an onboard radar with a semi-active laser sensor to enhance its capability against stationary and moving targets for precision point or fire-and-forget targeting.

The army awarded a contract with low-rate initial production (LRIP) options to Lockheed Martin in 2015 for the JAGM engineering and manufacturing development phase.

More recently, on 7 December 2016 JAGM was fired from an AH-64D Apache for the first time, successfully targeting a moving maritime asset.

'This was the tenth of our risk-reduction flight tests,' explained Lt Col Phil Rottenborn, product manager for JAGM, Program Executive Office Missiles and Space. 'This most recent one was the first ever manned platform launch of a JAGM... Some of the ones prior to this [were] required to get a safety release [before] a manned release. It was also the first against a boat, and a manoeuvring boat at that.'

Experimental approach

The Apache was operated by an experimental test pilot from the Redstone test centre. It flew at 15,000ft above the target, which was a 30ft-long remotely controlled boat travelling at 30kt, Rottenborn explained.

The main purpose of this test firing was to demonstrate target handover from the laser to the radar.

'We provide the missile with targeting information by putting a laser on or near it,' he continued. 'And on purpose the experimental pilot ceases lasing a few seconds into flight – about 10% into the missile flight – and then the radar, exclusively without any help from the laser, guided it to the centre of the target and destroyed it.'

'A missile that has a radar sensor will perform very well against moving targets especially when you consider the difficulty to maintain a laser spot on a moving target,' he added.

This is one of the advantages of the JAGM compared with Hellfire. The capabilities of the latter's laser limit its ability to see reflective energy from the target in challenging environments, such as maritime. 'JAGM affords the pilot and the platform more

survivability in that the pilot can lock-on before or after launch in conditions in which you would not want to expose the platform to any longer than [needed],' Rottenborn said.

'It has great capability against high-speed manoeuvring targets, more so than any missile out there now. These independent sensors can play off of each other in case there is a vulnerability to one, whether that is weather-induced or battlefield condition-induced.'

In the future, at least 50 further tests are planned, including some simulated. These have all been developed by a DoD independent test agency.

'It's up to us to go out and execute that to show this missile can meet those requirements,' concluded Rottenborn (for more on the development of JAGM, see p40).

Primary resources

Meanwhile, weapons manufacturer MBDA is offering a derivative of Brimstone for the UK's FAHW requirement. If successful, this would become the primary armament on the nation's AH-64E Apache fleet.

Brimstone is already operational with the RAF on various fixed-wing platforms and has been used in both Syria and Iraq.

In July 2016, MBDA completed a series of physical trials and firings of Brimstone from the AH-64E. These were part of a UK MoD contract with MBDA and Boeing which confirmed integration of the missiles would be low-risk.

These firings demonstrated the capability of the weapon to navigate using its semi-active laser (SAL), dual-mode SAL/millimetric wave (mmW) and fully autonomous mmW guidance modes.

Throughout the trials, aviation services company Amber Tiger assisted MBDA in integrating Brimstone with the Apache.

'Until now, Hellfire has been the prime choice for operators of the Apache around the world,' said Andy Furness, CEO of Amber Tiger. 'But now there is a UK option to support the national prosperity agenda, and the RAF have the operational experience as proof to show that Brimstone is an overall better solution.'

Two versions of Hellfire are currently used on the British Army Apache helicopters, the Longbow Hellfire and the Hellfire II.

'Above all else, the missile firings from the AH-64E debunked the myth that integrating

“ On 7 December 2016 JAGM was fired from an AH-64D Apache for the first time, successfully targeting a moving maritime asset. ”

Brimstone onto the Apache wasn't feasible,' Furness argued. 'Brimstone onto Apache has been seen by some as the underdog – from two years ago, many would not have taken this project seriously due to the strong historical connection of Hellfire and the Longbow Apache, to now with the successful Brimstone firings.'

'Ultimately, it shows the MoD and other militaries that there is now an alternative to Hellfire and its successor, JAGM.'

Individual differences

While on the surface Brimstone may look similar to Hellfire, there are a number of differences.

Brimstone is able to utilise laser guidance, followed by a transfer to mmW radar for the terminal phase, which is known as 'dual mode'. This aims to greatly increase the probability of hitting a target, especially moving ones.

'There are second-order effects of this too,' said Furness. 'Firstly, training burden can be minimised, as the difficult and latent skill of manually tracking a target can be reduced. Secondly, it allows the operator to engage a target sooner, without having to wait for the perfect engagement profile. This means the operator can engage whilst the platform is dynamically manoeuvring or for the target to move to an area that is clear of obstructions.'

Following recent demonstration trials, Dan Girardin, a Boeing flight test engineer in Mesa, Arizona, stated: 'The mmW autonomous shot from a moving and banking platform against an off-axis target with the missile hitting the MBT turret ring was the most aggressive shot I have ever seen in my 30 years of the Apache programme.'

Another advantage for the UK MoD investing in Brimstone is the issue of sovereignty, having a British-made weapon on a UK platform.

'The nation's enemies for the next 20-plus years are not yet known, and so having a



US soldiers load Hellfire missiles on the Apache attack helicopter. (Photo: US DoD)

missile and manufacturer who can easily adapt to meet the requirements in an uncertain future holds a significant appeal,' said Furness.

'The UK MoD is very conscious that more than ever before there is a need to provide greater capability with fewer resources. By selecting Brimstone for Typhoon, Protector and the AH-64E, the MoD aims to maintain consolidated stockpiles rather than have to hold different missiles for each platform, which provides significant cost, logistical and even training reductions,' he said.

Future weapons

The UK is also equipping the Royal Navy's AW159 Wildcats with the new Future Anti-Surface Guided Weapon - Light (FASGW(L)), with the Thales Lightweight Multirole Missile (LMM) selected for the requirement.

FASGW(L) will have a five-barrel launcher and laser guidance system. The LMM will complement the new MBDA Sea Skua II, also known as Sea Venom, which is the new FASGW (Heavy). LMM can potentially be deployed on any helicopter, manned or unmanned.

'A key feature of the LMM on Wildcat is the ability to engage fast inshore attack craft threat,' said James Keown, product line

manager, surface attack solutions at Thales UK. LMM employs precise laser beam riding guidance to accurately fly over water, has a dual-effect shaped charge and blast fragmentation warhead, plus laser proximity sensors, and a sealed canister with a debris-free launch to protect the aircraft.

'These threats represent a very difficult target for other missiles due to their small size, agility and low thermal signature in a very cluttered environment due to waves and spray,' explained Keown.

'Due to the laser beam riding guidance, the LMM can be precisely guided to defeat these targets at long range without threat to friendly forces. The compact and lightweight nature of LMM enables up to 20 LMM missiles to be deployed on the Wildcat - enabling a single helicopter to defeat a swarm attack,' he added.

Thales is also actively pursuing a number of sales campaigns outside of the UK.

Customer requirements

Keown said that precision, weight and cost of ownership are some of the most important requirements for customers when looking at new missile integration.

'In today's warfare environment, where rules of engagement, preservation of evidence and proportional effect are all

key considerations in the engagement approval chain, guaranteed accuracy can be a defining operational advantage,' said Keown.

The LMM enables operators to select specific aim points and Thales offers a mission denial capability rather than only target destruction by selecting a specific point on the target.

The weight of a weapon must also be carefully considered, as it means a reduction in fuel that can be carried. Lighter weapons systems are more desirable because a heavy missile can limit the endurance of an air platform.

Operational commanders can then decide between increasing endurance or enhancing lethality, depending on the number of rounds carried on a platform.

Multipurpose missiles are also being utilised on helicopters in order to meet these requirements. For instance, a ground-launched missile could be mounted on aircraft, with the right modification and launcher capability.

Israeli company Rafael has noted that weight is just as important to aircraft as it is to infantry forces. The company believes there will continue to be a demand for lightweight weapon systems for attack helicopters.

The manufacturer also notes that because ▶

budgets are typically lower now, it becomes cost-effective for a customer to use the same ammunition on the ground and in the air.

As an example, the company's Spike family of anti-tank missiles has been integrated onto various helicopter platforms.

The company has integrated the Spike Extended Range (ER) onto Italian aircraft, with the country already using the Spike Medium Range (MR) and Long Range (LR). Italian AH-129Ds have been equipped with the Toplite III targeting pod and Spike ER.

Transformative approach

The company has also worked with the Colombian Air Force to transform the UH-60 Black Hawk into an attack helicopter. It is now able to launch Spike LR and ER as well as the latest version of the missile, Spike NLOS, which is a multipurpose EO-guided system with a real-time data link for ranges up to 25km.

UH-60Ls have become AH-60L gunships through the addition of weapons pylons and a Toplite II EO sensor turret. The AH-60L is now capable of carrying 16 Spike NLOS missiles.

Elsewhere, South Korea's AW159s have also been equipped with the Spike NLOS, while Rafael has also worked with OEM PZL Świdnik to increase the firepower of the Polish W-3PL Głuszec with the use of Spike missiles.

The W-3 was on display at MSPO 2016 in Kielce, Poland, with both Spike NLOS and ER missiles. The addition of these armaments will assist the Polish Land Forces in increasing its capabilities.

Another missile that started out life as a ground-launched munition is Raytheon's air-to-air Stinger, which is now being chosen by many operators of the AH-64E.

'When we use MANPADS or ground-based air defence, most of those slewing activities and getting launched and locked on are all controlled by a human,' explained Jack Elliot, director of Stinger mission systems at Raytheon.

'So what we had to do is create within our launcher an electronic and software capability in order to perform all of those functions traditionally performed by a human. We had to convert all of those activities and place them in the launcher.

'The Stinger programme has got those over the last four or five years perfected to the



A Polish W-3PL Głuszec displayed at the 2016 MSPO event equipped with Spike missiles. (Photo: Tony Skinner)

point where it is now a relatively simple mission to perform and train for.'

Digital switchover

The air-to-air mission requirement pushed Raytheon to move Stinger from an analogue missile to a digital one, and it has now been qualified on Apache for about seven years. The current production version of the Stinger is the RMP Block 1.

'Today, the Stinger is qualified on the Apache, but is not being performed on US Apaches. There is a plan in the first quarter of 2018 that the US Apache will have a fully released version of air-to-air Stinger that it takes delivery of. That will be for the AH-64E version,' added Elliot.

'Every Apache leaving the production facility at Boeing at that point will have Stinger fully integrated on it, whether that be US or Foreign Military Sales.'

The company has already secured contracts from South Korea, with deliveries beginning in May 2017. The \$35 million agreement will supply 28 launchers and 63 missiles and associated maintenance and support equipment to fit up 14 AH-64 aircraft.

'We attained a contract in December 2016 for both India, to put air-to-air Stinger on the Indian Apache order, and we will also deliver an air-to-air package for Qatar,' Elliot announced.

India will acquire 58 air-to-air launchers and 240 missiles. Qatar will be fitted out for 12 Apaches, 24 launchers and 288 missiles.

'In the case of India and Qatar, we fully expect India to continue on a frequent basis to buy additional air-to-air Stinger capability as they take delivery of their future aircraft,' Elliot added.

The air-to-air system comprises a launching unit and an adapter. The latter allows Raytheon to mechanically adapt the missile to an aircraft at a desired location. Typically on rotorcraft this will be on pylons, but Elliot said there have been instances where the system has been clipped directly to the fuselage for select special operations helicopters.

The Stinger air-to-air launcher does most of the targeting calculations and other functions that bring the missile on target and lock on to the fire unit.

Today, the air-to-air mission is not only about combating other manned aircraft, as the proliferation of UAVs has brought with it new threats and targets. The Stinger can be used against all classes of helicopters, UAS, cruise missiles and manned fixed-wing aircraft.

With the threat from adversaries as prominent as ever and the ongoing delivery of new aircraft, the missile market is as vibrant as ever. ■



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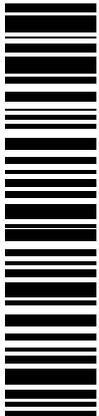
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China appears to have developed two helicopters simultaneously, taking both the Z-10 and Z-19 models into service within a short time of each other.

By Alexander Mladenov and Krassimir Grozev

China has developed several types of combat helicopters of late, and the country has gained a wealth of experience during the protracted works on the Z-10. However, this armoured attack machine was shortly followed by the much lighter and more affordable – but less capable – Z-19 model, also fielded in mass service concurrently with the Z-10. The Z-19 light attack/reconnaissance helicopter is based on the Z-9, a mass-produced light twin-engine model, and is fielded in frontline service with the Chinese military.

As is typical with the country's helicopter industry, little is known about the aircraft's development history, and the true extent of its efforts to design, test and produce

dedicated combat rotorcraft. It is believed that the Z-19 made its maiden flight in May or June 2010. The first set of blurred images appeared on the Chinese Internet in January 2011.

The Z-19 has been described as similar to the Bell AH-1 Cobra series. The evolution of the UH-1 to AH-1 could be repeated for the Z-9 and Z-19. Therefore, the new Chinese combat helicopter is perhaps not as new as initially supposed.

The model has been developed by Harbin Aircraft Industry Group (HAIG), which started the licensed manufacture of the Aérospatiale SA 365 Dauphin in the early 1980s. The 4.3t twin-engine helicopter is still in production at HAIG,

and is available in several versions including combat.

Familiar design

The Z-19 is in fact a distant cousin of the SA 365, retaining the characteristic tail boom with the Fenestron design, in addition to the main rotor system and engines. The Z-19 utilises the entire rotor system, unchanged from the Z-9, in addition to its propulsion.

The new light attack/reconnaissance machine was shown for the first time publicly at the Zhuhai Air Show 2012, accompanying the debut of the Z-10. Its next airing was at the military parade in Beijing in September 2015, which saw as many as 18 Z-19s flying in formation. Beyond these public events, there has been much speculation regarding the Z-19's true role within the Chinese military machine.

The Z-19 has a conventional gunship scheme with non-retractable undercarriage with its tail wheel unit. The main rotor



Chinese Army Aviation has fielded the Z-19 as a lightweight anti-tank and close air support asset. (All photos: via authors)

Parallel lines

system has four blades and its diameter is 11.9m, while the Fenestron tail rotor uses 11 blades. The powerplant consists of two WZ-8C turboshafts, each rated at 940shp. The WZ-8C is actually a Chinese copy of the Turbomeca Arriel 2 used to power the original Dauphin.

The Z-19's fuselage is very different to the Z-9. It has been designed to be narrow towards the front to accommodate slightly stepped tandem cockpits for the two crew members in crashworthy seats. The pilot sits at the front while the gunner occupies the rear cockpit. Both cockpits are equipped with large colour displays and the pilot is also provided with a head-up display for flight/navigation information and sighting of the forward-firing weapons.

It has been suggested that the Z-19 crew can use a helmet-mounted display and cueing system, which is simpler and lighter than that developed for the Z-10, but it is unknown if the system has already been commissioned into regular service. Crew members use NVGs that are compatible with the lighting in both cockpits.

The model retains the traditional hydro-mechanical controls inherited from the Z-9. There is no credible information about the presence of armour protection on board. The cockpit glazing appears to be non-armoured and this goes for the crew seating as well. The Z-19 has a simplified self-protection suite, with a laser warner, radar warning receiver and chaff/flare dispenser units.

However, the engine exhaust ducts are not provided with devices for reducing the

temperature of the exhaust gases. There is also no IR jammer installed on board. The targeting system installed on the nose has a chin turret incorporating a FLIR, TV camera and laser rangefinder/target designator device.

There are photos from early 2012 that show the Z-19 being tested with mast-mounted millimetric-wavelength radar, although there is no information on whether the aforementioned radar has been planned for installation on the production-standard helicopters. It is assumed that there is only one production standard, which has been commissioned in service with the People's Liberation Army (PLA) Army Aviation branch.

In September 2015, during the International Helicopter Exposition held in Tianjin, HAIG demonstrated an export version designated the Z-19E, externally identical to the baseline model. As yet, information is not available regarding potential export customers.

The Z-19 carries its weapons on short stub-wings with a total of four hardpoints, and has no gun or machine-gun turret installed, unlike most – if not all – modern attack helicopters in the world. The main weapon is an HJ-10 anti-tank guided missile. The designation covers a large family of missiles developed in China for both helicopters and combat UAVs.

All missiles in the HJ-10 family share the same general design, but feature a variety of warheads, guidance systems and rocket motor sizes. The Z-19 uses the KD-9, one of the smallest derivatives, weighing around

Z-19 in figures

Length:	12m
Height:	4m
Main rotor diameter:	11.9m
Empty weight:	2,350kg
Maximum gross weight:	4,500kg
Maximum speed:	151kt
Cruise speed:	132kt
Rate of climb:	9m/s
Service ceiling:	19,685ft
Range:	700km

26kg and with a 6km range and semi-active laser seeker. The Z-19 has never been seen carrying the much heavier KD-10, which weighs 46kg.

During the 2016 Zhuhai Air Show, the Z-19E was demonstrated on static display with a new guided missile designated AG-300M. It appeared to resemble a derivative of the YJ-9 anti-ship missile employed by the Z-9D helicopters of the PLA Naval Aviation branch, although it featured a semi-active laser seeker. There is no information regarding whether this missile has already been integrated on the PLA Z-19s or is set to be ordered for export only.

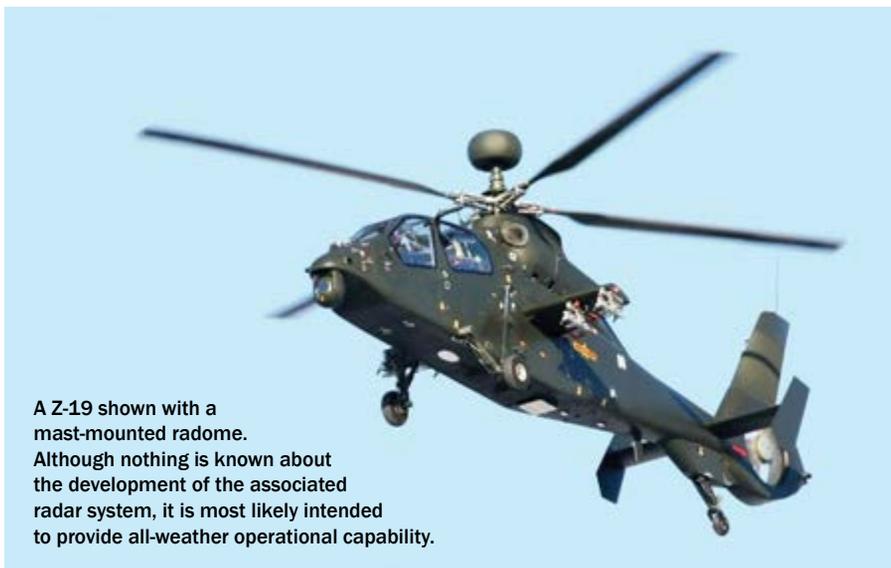
Main missile

The PL-90 (TY-90) air-to-air missile is another guided weapon in the Z-19's arsenal. Featuring a dual-wavelength IR seeker, it weighs only 20kg, with a warhead weight of 3kg and a range of 6km. The Z-19 can carry four such missiles.

However, so far the KD-9 and PL-90 missiles have been seen on the outer hard points, while the inner ones were left empty or used for carrying a rocket pack, most likely due to weight restrictions. The Z-19 can use the standard Chinese-made 90mm rockets fired from seven and 19-round packs, although only seven-round ones have been seen suspended on operational helicopters.

The Z-19's arsenal is complemented by pods with 12.7mm machine guns and it is assumed that the platform can also carry 23mm gun pods. There are also photos showing it with two external fuel tanks.

The Z-19 was formally commissioned in service with the PLA Army Aviation arm in late 2012, with the official name Black Whirlwind. Its production has reached a rather high tempo, and it is believed that the



A Z-19 shown with a mast-mounted radome. Although nothing is known about the development of the associated radar system, it is most likely intended to provide all-weather operational capability.

The Z-19 resembles the Bell AH-1 Cobra and was developed by altering the design of a utility transport helicopter.



annual rate is at least 25 units. In late 2016, the total Z-19 fleet was fielded in service with nine of the PLA Army Aviation regiments and brigades, and accounted for 100 to 120 production-standard helicopters.

The PLA Army Aviation has currently embarked on a serious expansion move, hitting a strength of 12 regiments and brigades. All regiments have between three and five squadrons in their structure, while the brigades have six and more. There is a trend for the regiments to transform into brigades, which will further increase the numerical strength. Currently, the army aviation structure incorporates at least nine helicopter brigades and only three regiments.

The Z-19 has been incorporated into the PLA Army Aviation service as a replacement for the Z-9WA armed model, used mainly in the anti-tank role. Initially, it was anticipated that the Z-19 would be used in the armed scout role, due to the mass fielding into service of the heavier and more capable Z-10, thus broadly replicating the US Army concept of utilising the OH-58D Kiowa Warrior armed scout and the AH-64D Apache Longbow.

So far, there is no confirmed information that the Z-19 and Z-10 operate in an integrated manner, and it is more likely that the Z-19 comes as a direct replacement of the anti-armour Z-9WA, with secondary roles of close air support and escort of assault transport helicopters.

Back-up model

The Z-10 plays a similar role and this leads us to question why the Chinese military has fielded two types for the same roles? The answer could be found in the development timeframe of the platforms. The Z-19 made its maiden flight in mid-2010 and its development was initiated in 2007 or 2008. This is the period when the Z-10 development fell into crisis due to the withdrawal of the engine supplier, Pratt & Whitney Canada.

This occurred after the discovery that the PT-6C-76C turboshaft with FADEC controls had been used to power the prototypes of a Chinese-made combat helicopter, in a clear violation of the US-imposed arms export embargo. As a consequence, the Z-10 was modified in a crash manner to use the Chinese-made

and less-powerful WZ-9 engine, which took a lot of weight-reducing design efforts.

So it is highly likely that the Z-19 was launched as a back-up project to ensure that PLA Army Aviation would receive a new-generation attack helicopter in case of failure in the Z-10's redesign effort. After all, the Z-19 programme offered low risk at the time and promised to be quick and affordable.

The Z-10 team succeeded with the redesign effort and both the Z-10 and Z-19 entered service at the same time, despite the former being in development since the late 1990s and having its maiden flight in April 2003.

The wide introduction of the Z-10 and Z-19 shows that PLA Army Aviation currently relies on a varied mix of attack helicopters. The Z-10 still suffers from being underpowered due to the low rating of its engines, which in turn reduces its war load and therefore its overall battlefield performance. The Z-19's complementary role on the battlefield is therefore necessary to keep the numerical strength of the attack assets available to PLA commanders. ■

Colonel David Warnick, US Army Project Manager for Joint Attack Munition Systems within the Program Executive Office Missiles and Space, speaks to Beth Maundrill about the Joint Air-to-Ground Missile programme.

Missile management



As the Joint Air-to-Ground Missile (JAGM) project moves forward through the engineering, manufacturing and development phase (EMD), the Pentagon is eyeing the benefits the missile will have over the widely used Hellfire alternative.

Warnick told *DH* that to date, ten 'risk reduction' shots have been carried out and some of the EMD hardware has been received.

'We are very encouraged by what we have seen, everything seems to be tracking very nicely. I don't want to jinx my programme, but if we continue with the way things have been going, we will be able to deliver the capability as soon as possible,' he said.

The programme office awarded a competitive, fixed-price contract with low-rate production options to Lockheed Martin in 2015 for the EMD phase. This followed a restructure after some previous delays. As a result, the programme is now leveraging the AGM-114R 'Romeo' Hellfire II warhead in order to reduce risk within the project. This lowers the cost of the missile compared to the development of a new warhead and motor.

On track

Warnick felt that the programme was currently on track to demonstrate low-rate production readiness after completion of production line qualification and flight testing. 'Under the [low-rate production] we have already got, we will be doing 50 or so more tests under the limited user test. It will be over the next couple of years that you will see that transition take place to a full-rate production.'

The testing stage ensures that the system is designed to withstand the full life cycle, from production to executing a target.

'The missile is designed to be utilised with all the systems that currently fire the Hellfire missiles. We have threshold programmes right now where it will be on the Apache and it will be on the Marine Corps AH-1Z Viper,' explained Warnick. '[Other] platforms we will get to as the resourcing and requirements drive it and the user needs demand it.'

JAGM has now been tested from both manned and unmanned platforms. The latest test firing, carried out in December from an Apache AH-64D, demonstrated its capabilities in maritime conditions against a moving target. This demonstration highlighted the differences between JAGM and Hellfire.

'The limitations of the Hellfire are essentially the capabilities in the laser and the ability to see reflected energy from the target. Given the different environments, it will not get a return off of water,' Warnick said.

Combination benefit

'Keeping a laser on a boat or using a laser-guided system in a cloudy, smoky or dusty environment, where a good laser return is not possible or is difficult or reduced in its signature, is why the radar capability is essential to being able to prosecute these types of target.'

'The biggest benefit that a JAGM will provide to the warfighter is the mission flexibility that it offers where you have a semi-active laser system in Hellfire and a

“ I don't want to jinx my programme, but if we continue with the way things have been going, we will be able to deliver the capability as soon as possible. ”

millimetre-guided system in Longbow – this combines those capabilities into a single missile,' he said.

There are around 26 international customers of Hellfire that could be interested in JAGM when it has fully developed. 'It is premature to speculate on what other countries may see the value proposition of integrating JAGM,' Warnick noted.

Nevertheless, JAGM does not mean the immediate end of Hellfire, as the missile's shelf life is such that it will be in the US inventory for the 'foreseeable future', according to Warnick.

'From my perspective, you are always seeing missile technologies being pushed to the limits. There has been a proliferation throughout the world of precision munitions and as technologies mature, they become less costly. I think that's where most of the focus has been – on the cost portion of missiles. We will continue to push the technologies as the threats change, but as those threats evolve, we obviously will have to take actions with the missile technologies.' ■



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A precision strike rocket is shown in mid-air, trailing a bright yellow laser beam from a helicopter below. The helicopter is a heavy-lift model, possibly a Chinook, with its rotors blurred from motion. The background is a dramatic sunset sky with orange and yellow clouds. The rocket is dark green and white, with a long, slender body and a conical nose.

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