

Written evidence submitted by the Ministry of Defence

HCDC Inquiry: Progress in delivering the British Army's armoured vehicle

Executive Summary

Armoured Fighting Vehicles (AFVs) are at the heart of the British Army's contribution to high intensity warfighting and therefore integral to deterrence and a vital part of an integrated defence system. We face a range of threats that includes resurgent and developing powers and violent extremism, and while these threats have diversified AFVs continue to be critical to Defence's ability to deliver hard power and underpin our credibility in the land environment. The Army's modernisation programme seeks to ensure that we retain the appropriate capabilities to meet and deter the threat. AFVs deliver persistent offensive fighting power that can directly, or indirectly through deterrence, change the actions of an adversary or enemy, alongside other land and wider defence capabilities, to impose our will. Armour provides credible deterrence and increases tactical options.

The objective of the Army's modernisation programme is to not only create a fleet of highly advanced digitised platforms able to deal with future challenges, but one that will adapt to emerging threats through iterative enhancements and upgrades. Modernised AFVs, networked and integrated into a wider system that includes precision deep fires, air defence, and layered ISR, will transform the way we fight and provide the necessary core for a world-class, credible force. Underpinned by enhanced information sharing through the digital backbone integrated Land and Joint assets will be used more safely, effectively and with greater freedom of action. In the longer term and building on current experimentation plans, upgraded, digitised and networked AFVs will be a critical link to the 'autonomous' future of armoured capability through human and machine teaming. With open architecture able to evolve as this technology matures, these AFVs will provide a springboard for the Army to effectively and efficiently harness this opportunity as it emerges.

The Integrated Review of Security, Defence, Development and Foreign Policy (the Integrated Review) will cover all aspects of our warfighting and campaigning capabilities. Focusing on the threats we face, including those in the "grey zone" and emerging domains of cyber and space, the Integrated Review will generate the right balance and composition of UK forces to meet the needs of our country and support our allies. While the Ministry of Defence's (MOD) plans for its AFVs are both well formulated and advanced, all decisions on current and future equipment capabilities are subject to the Integrated Review.

Alongside the Integrated Review, the Defence Security and Industrial Strategy (DSIS) is tasked with ensuring the UK generates and retains competitive, innovative and world-class defence and security industries that drive investment and prosperity and that underpin national security now and in the future. One element to be considered as part of the DSIS is a future "Land Industrial Strategy" in which Defence and Industry develop a more strategic relationship in this important area.

1 Does the Army have a clear understanding of how it will employ its armoured vehicles in future operations?

The Integrated Operating Concept 2025 sets out our level of ambition in terms of what the future force needs to be capable of and how we will transform the way we operate. It is based on achieving integrated advantage to provide political choice and generate credible military options as part of Defence's contribution to National Security Objectives. Critical to achieving this will be greater emphasis on agility, mobility and integration.

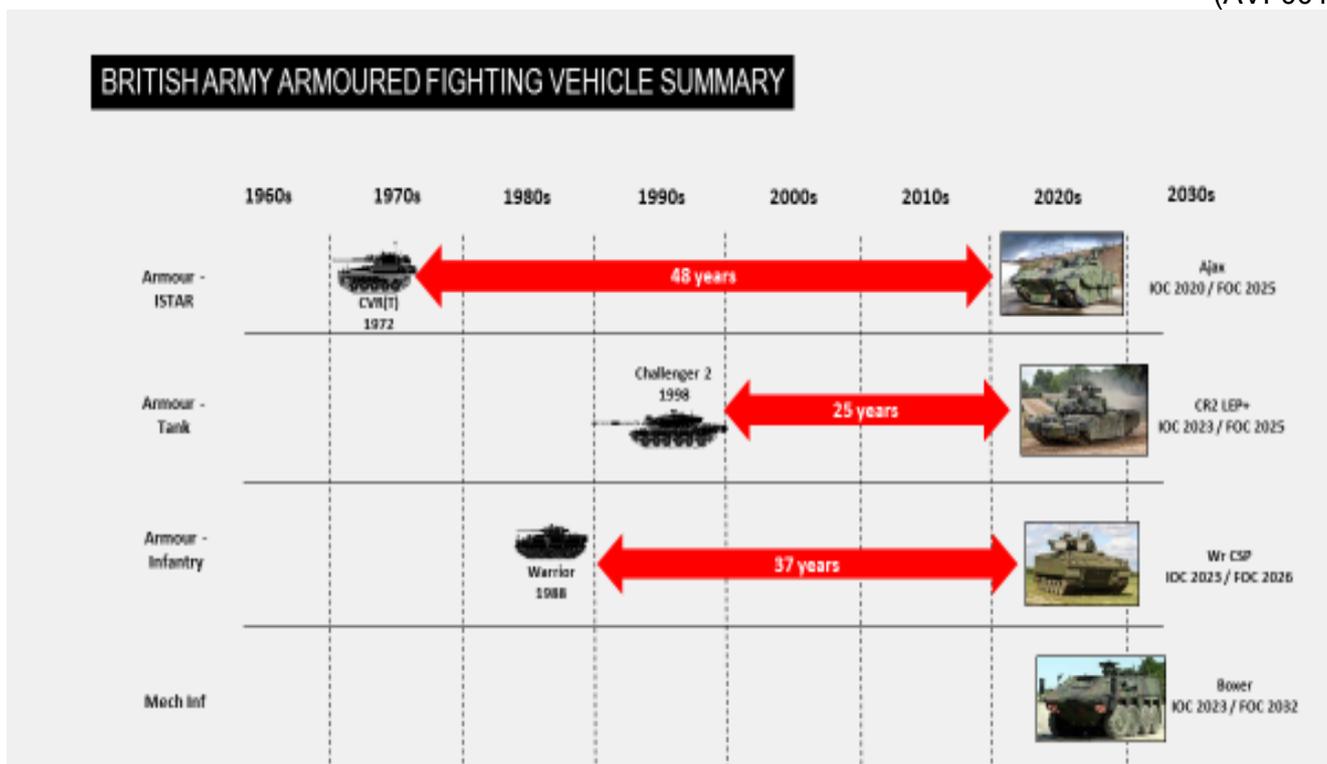
The British Army Land Operating Concept lays out the core operating concepts for the future force and how capabilities will be employed; these evolve as new capabilities are brought into service, are exploited through experimentation and as technology develops. Capability planning is being configured for this spiral development which will better enable AFVs to have greater utility across the Protect, Engage, Constrain and Fight elements of the Integrated Operating Concept 2025 operating model.

Experience from recent conflicts in places such as Ukraine, Syria and Iraq have shown the continued utility of AFVs which are used by conventional forces but also violent extremist organisations and in a wide variety of areas; from open desert, to dense forests to complex urban terrain. The proliferation of AFVs and other advanced weapon systems and sensors has meant that the utility and effectiveness of AFVs and other anti-tank weapons and how and where they are employed is constantly evolving. Importantly, a 'like for like' for comparison potentially fails to appreciate how AFVs and other weapon systems and sensors are used as part of a system.

What are armoured vehicles? Armoured vehicles can be described as one of three types: general armoured vehicles, Protected Mobility (PM) vehicles and AFVs.

1. **General armoured vehicles.** General armoured vehicles include engineer, artillery, recovery and command and control platforms fitted with armour.
2. **PM vehicles.** PM vehicles¹ are not included as AFVs as they are not designed for mounted close combat.
3. **AFVs.** AFVs are defined as "*Land platforms designed to conduct mounted close combat*". AFVs include: Main Battle Tanks (Challenger 2), Infantry Fighting Vehicles (Warrior), Armoured Personnel Carriers (Boxer) and reconnaissance vehicles that operate in the Forward Edge of the Battle Area (Ajax). The diagram below shows the core AFVs in the warfighting division that are targeted for upgrade or coming into service and what they are replacing.

¹ Vehicles that require a crew of 2 and have the capacity to carry personnel or payloads specific to role. They can provide intimate support from a Protected Weapon Station. The platform is not an Armoured Fighting Vehicle as it is not designed for close combat but does afford a degree of protection that will improve survivability for the crew and passengers if contact with the enemy is made. They include Husky, Mastiff, Ridgeback and Wolfhound.



Does the Army need AFVs? Most of the UK's major allies and potential adversaries continue to retain and modernise armoured vehicles (including tanks and tracked Infantry Fighting Vehicles² (IFVs)). Capable armoured forces provide deterrence through the threat of physical aggression ensuring our adversaries cannot change facts on the ground and through their ability to seize and hold terrain (especially in a high threat environment). Armoured forces also offer political choice and have been deployed by the UK across the spectrum of operations, from peace support operations (such as in Bosnia and Kosovo) to high intensity conflict (such as Iraq) to counter insurgency operations (such as Afghanistan with British Warriors and Danish tanks). Beyond the ability to conduct complex combined arms, armoured manoeuvre also underpins our credibility as a 'reference' Army on the global stage. Building on the Integrated Operating Concept 2025, the focus of multi-domain operations is on influencing the will and behaviours of target audiences. AFVs influence target audiences, particularly when combined with effective information activity. This can be through the highly visible sign of the UK's commitment to deterrence of an adversary, but also by reassuring a host nation and allies, as well as the UK population.

How do future AFVs differ from their predecessors? Defence's plans for upgrading current AFVs (Challenger 2 and Warrior) and introduction into service of new AFVs (Ajax and Boxer) is not about replacing 'like for like'. The MOD's current procurement and capability upgrades targeted the creation of highly advanced, digitised, sensor enabled systems connected to an operational picture via secure fast networks. They will gather and share vital information to ensure Defence has an accurate land, air and littoral picture. They will provide 24/7 intelligence and effect in all weathers and can operate indefinitely in the most hostile environments and, when needed, can deliver overwhelming precision lethality, from a protected position using verified data and operator information to avoid collateral damage. In the longer term upgraded, digitised and networked AFVs will be a critical link to the 'autonomous' future of armoured capability through human and machine teaming.³ They will transform the way we operate and fight. They provide the best opportunity to generate mass by augmenting our forces and may enable us to increase the dispersion of manned platforms whilst remaining self-sufficient for longer. Army Warfighting Experiment 2019 was a £4 million world-class experiment that saw six industry partners test unmanned air and ground systems as autonomous 'wingmen' to manned equipment, such as Wildcat and Ajax. There are also experiments with 'Joint Tactical Autonomous Resupply and Replenishment' and a 'Robotic Platoon Vehicle' to support sustainment tasks. These experiments will play a critical role in the further development of armoured vehicles and how they will

² Of our key allies only FR and CAN have wheeled IFVs but maintain MBTs; the rest use tracked IFVs alongside MBTs.

³ For example, use of unmanned surveillance systems and autonomous re-supply of ground vehicles.

be used in the future. Other nations are also investing in autonomous systems; Russia is apparently developing Autonomous Weapon Systems trialling and developing capabilities on operations in Syria for tasks such as ISR, logistic resupply and combat missions.⁴

How does Defence assess what future operations are likely? Due to the need to evaluate future threats and requirements, and the time required to bring complex capabilities in to service, it is imperative that capability development for AFVs is based on a sufficiently detailed and consistent articulation of likely future operations. An assessment of likely future operations⁵ is conducted regularly to ensure that the assumptions upon which capability development is based are appropriate and remain relevant. This assessment is supported by continual Defence Intelligence and the Defence Science and Technology Laboratory (Dstl) analysis of current and potential future threats and vulnerabilities of both Army and potential adversary capabilities.

How does the Army inform longer term capability planning? Force Output Concepts have been produced for the primary outputs of the Army (for example the warfighting Division, Strike Brigade and Armoured Infantry Brigade) and are based on Defence Policy. These documents define the operating environment, threat, operational requirements, and structure for each of the primary outputs within a future context and provide an aiming mark to drive and inform capability development. They also inform the development of 'Concepts of Employment' for future capabilities which describe how they will be employed within a range of operations and scenarios. Higher level Allied (NATO), Joint, and Land doctrine provide the necessary detail of how current and future operations will be conducted. This provides a clear understanding of how AFVs will likely be employed on future operations.

How does the Army ensure that these documents are accurate and relevant? Regular analysis is conducted to inform these documents. This includes: assessment of current operations around the world (for example the Dstl Ukraine Study); detailed analysis of current and future capabilities (such as the Dstl 'Need for Armour Study') and war gaming based on likely scenarios, geographic locations and threats in a Combined, Joint, Inter-agency, Multi-national context. This analysis is used to ensure that future capabilities are relevant and appropriate and to identify critical gaps to inform decision making on risk and affordability, as well as how Defence will deal with future physical and virtual (e.g. cyber) threats. As an example, the Dstl Ukraine study analysed the use of armour and artillery in the Donbass to determine what had changed and what the implications for the effectiveness of armoured vehicles were. Many different types of AFVs were used by both sides and the study concluded that armour provided a significant advantage especially when used alongside other capabilities. Operational Analysis is also a key part of the scrutiny 'Gate' process that is required for Treasury approval for AFVs and is necessarily based on a clear understanding of how they will be employed on potential future operations. This approach ensures that the Defence's capability requirements for AFVs and how they will be employed are both relevant and appropriate.

2. Given the delays to its programmes, will the Army be able to field the Strike Brigades and an armoured division as envisaged by the 2015 SDSR?

What did the 2015 SDSR and subsequent Defence direction envisage? The 2015 SDSR articulated the Army's contribution to the new Joint Force 2025⁶ in terms of a land/warfighting division (but not specifically an armoured division) "*capable of undertaking high-end operations....of up to three combat brigades*". As shown in the diagram below, Army 2020 envisaged that the Strike and Armoured Infantry Brigades would be generated from a standing Army structure of two Armoured Infantry Brigades and two Strike Brigades (and the necessary divisional enablers). Defence Strategic Direction 2016 gave further detail and articulated that, as part of this Joint Force 2025 package, the warfighting division should comprise of two Armoured Infantry Brigades and a single Strike Brigade, plus divisional enablers, able to face a peer/peer+ threat.

⁴ <https://warontherocks.com/2019/07/russian-ai-enabled-combat-coming-to-a-city-near-you/>

⁵ The Defence Scenarios Booklet 2016, a Secret document.

⁶ "A war-fighting division optimised for high intensity combat operations. The division will draw on two armoured infantry brigades and two new Strike Brigades to deliver a deployed division of three brigades. We will establish these two Strike Brigades to be able to deploy rapidly over long distances using the new Ajax armoured vehicles and new mechanised infantry vehicles. They will double the number of brigades ready for operations. With these, and 16 Air Assault Brigade's very high readiness forces, we will improve our ability to respond to all likely threats."



What is the difference between a warfighting division and an armoured division? Both can conduct high tempo operations against a peer/peer+ enemy. The armoured division is focussed on defeating the enemy armoured threat, hence it consists primarily of main battle tanks and IFVs. A warfighting division contains other brigade level capabilities to deal with a broader range of threats and tasks. The exact composition of the division is determined by several factors including threat, task and geography.

What are the different elements that could be in the warfighting division and what AFVs do they use?

1. **Divisional Headquarters.** This provides the command and control for the warfighting division.
2. **Armoured Infantry Brigade (Challenger 2, Warrior).** An Armoured Infantry brigade consists of armoured capabilities such as tanks and IFVs, armoured engineers, armoured artillery and signals assets. It is designed to counter enemy armoured forces through greater levels of protection and firepower.
3. **Strike Brigade (Ajax and Boxer).** The Strike brigade is a new concept designed to be more mobile than the Armoured Infantry brigade, to allow rapid deployment and re-deployment, while still possessing sufficient firepower to deal with the enemy's less well protected assets and threats that do not include heavy armour or where direct confrontation with heavy armour can be avoided. The Strike Brigade will also gather information and intelligence for the divisional commander, manoeuvre critical assets into a position of advantage and disperse widely, to seek to cause uncertainty in the mind of the enemy.
4. **Air Assault Brigade.** The Air Assault brigade can move at very high readiness using transport aircraft or heavy lift helicopter aviation. It provides the means to demonstrate intent ahead of the divisional main body's deployment, and secure vital battlespace for the division until it can link up with other forces.
5. **Combat Aviation Brigade.** The Combat Aviation brigade is anticipated, by 2025, to include upgraded Apache Attack Helicopters grouped with Wildcat reconnaissance helicopters, providing vital air support to troops on the ground.
6. **Divisional enablers.** Divisional enablers comprise a significant part of the warfighting division (c. 40% of the troops) and consist of: Signals, Artillery, Air Defence, Engineers (including Explosive Ordnance Disposal), Aviation, Royal Military Police, Medical, Logistics and REME.

Will the Army be able to field these ambitions as envisaged by the 2015 SDSR?

SDSR15 envisaged that Army would be able to field a 'division with three brigades including a new Strike Force'. The division described in SDSR15 drew on two armoured infantry brigades and two new Strike Brigades to deliver a deployed division of three brigades. The two Strike Brigades were envisaged to be able to deploy rapidly over long distances using the new Ajax armoured vehicles and new mechanised infantry vehicles.

By 2025, the Army will be able to field a war-fighting division optimised for high intensity combat operations, consisting of a single Manoeuvre Brigade (Armoured Infantry) and an interim Manoeuvre Support Brigade (from Strike and Light Infantry). The Interim Manoeuvre Support Brigade will be

equipped with Ajax, the first Boxer (Mechanised Infantry) platforms and the in-service Protected Mobility vehicles. Boxer will be at full operating capability in the early 2030s allowing the remaining protected mobility vehicles to be replaced and the full Strike Brigade ambition to be achieved.

Why is it only partially possible?

The 2015 SDSR, and subsequent planning round decisions, did not fully resource the Army to achieve this output within this timeframe. In the face of ongoing departmental financial challenges, subsequent programming decisions have kept the modernisation programme alive but placed it under increasing pressure and resulted in an inability to fully meet the 2015 SDSR ambitions.

3. How much has the Army spent on procuring armoured vehicles over the last 20 years? How many vehicles has it procured with this funding?

What are procurement costs? The term 'procurement costs' include money spent on Concept, Assessment, Design and Manufacture phases for new armoured vehicles. The cost of procurement of other systems fitted to armoured vehicles (for example communication systems) are not included here. While Capability Sustainment Projects (CSP) and Life Extension Projects (LEP) are not procurements they have been included.

AFV procurement and upgrades. Following the introduction into service of Challenger 2 in the late 1990s relatively little money has been spent on armoured vehicles procurement until the contract award for Ajax in 2014 and Boxer in 2019. The table below shows that over the last 20 years⁷ the MOD has spent a total of £3.004 billion on the procurement of AFVs.

Armoured vehicle name	Procurement cost 01/04/00 to 31/03/19	Number procured	Remarks
Ajax	£2.395 Bn	589	Army formally took delivery of the first six ARES vehicles in 2019 for trials
Boxer	£4 Mn	508	Design work and trialling currently taking place prior to delivery commencing.
CR2 LEP	£57 Mn	TBC	Approval target end 2020
WR CSP	£491 Mn	TBC	Approval target end 2020
Multi Role Armoured Vehicle	£57 Mn	0	MRAV was the predecessor to Boxer and was cancelled in 2003.

Furthermore, the MOD has spent £1.014 billion on general armoured vehicles, including Terrier, Titan, Trojan, Viking and Warthog. The procurement of PM platforms for operations in Iraq and Afghanistan have not been included as these were funded through the Urgent Operational Requirement process, funded directly by HMT.

4. What other capabilities has the Army sacrificed in order to fund overruns in its core armoured vehicles programmes?

Overruns are due to both financial decisions (to balance the budget) and unforeseen programme risks materialising that affect performance. It would therefore be inaccurate to say that 'other capabilities' have been 'sacrificed in order to fund overruns'. Defence and the Army continue to make difficult balance of investment decisions, creating capability gaps due to several factors. This includes financial pressure as well as cost overruns due to financial decisions and programme performance. These capability gaps and risks have all been articulated in the annual Land Environment Capability Assessment Register which is regularly reviewed against the ever-developing threat and classified as Secret.

5. How flexible can the Army be in adapting its current armoured vehicle plans to the results of the Integrated Review?

⁷ Figures as at 31 March 2019

The MOD's ability to be flexible depends on the extent to which the Integrated Review changes the Army's required outputs; however, the current vehicle plans provide a strong basis from which to evolve new capability priorities whilst investing in the UK industrial base to meet future needs. Their modernisation, including new platform and network architectures, provides a next generation of digitised platforms that can exploit autonomy, human and machine teaming and integrate into a multidomain network and battlefield to meet future threats and technology opportunities. In a future scenario with a significant cyber threat, every platform is a sensor that is constantly networked across land, air, sea and space, and able to operate as a system of systems. But this still requires a protected presence under armour in the close battle to deploy firepower or soldiers onto targets where stand-off intervention cannot be guaranteed and where engagement with the population is essential. This will transform the use of AFVs to complement their role of hard power and provide the critical steppingstone to the future.

Some of these potential future capabilities are already being developed and experimented with. The Army Warfighting Experiment 2018 (AWE 18) tested technologies in surveillance, long-range and precision targeting, enhanced mobility and the autonomous resupply of forces, urban warfare and enhanced situational awareness. Experimentation with unmanned aerial and autonomous ground vehicles also demonstrated the remote operation of a Warrior IFV. A range of concept and technology demonstrators are underway including autonomous robotic surveillance, use of hybrid-electric drives on existing platforms, Electronic Warfare and Signals Intelligence (EWSI) delivering enhanced situational awareness and Cyber and Electromagnetic Activities (CEMA) to exploit technology opportunities and enable human machine teaming in manned and unmanned platforms. These will become enablers for data fusion across the battlefield and the Integrated Operating Concept.

If there was a need for more fundamental changes to current programmes already on contract (e.g. Ajax and Boxer) or already underway in the commercial process preparing to go on contract (e.g. the Challenger 2 Life Extension Project currently being negotiated and Warrior Capability Sustainment Project currently under tender) then this could cause significant delay and/or increased cost with a negative impact on UK suppliers. Where possible long-term investment provides a good opportunity for our industrial base to have the confidence to invest in design, manufacture and the integration of future capabilities.

One area where there is potential flexibility is the mission or sub-systems that are fitted to AFVs (for example sighting systems, sensors, weapons systems, protection systems, automotive systems) and the ability to take advantage of Generic Vehicle Architecture that will support these on-platform upgrades. Programmes such as Land ISTAR, Cyber and Battle Group Organic Anti-Armour will be integrated with our armoured vehicles in the future. The intent of the Land Industrial Strategy, as part of the DSIS, is to ensure that the Army's capabilities, especially armoured vehicles, remain competitive through life. This means developing long-term plans to iteratively upgrade these sub systems so that they can be prioritised when funding is available, adapt to emerging threats and exploit advances in technology, thereby maintaining their relevance and utility to Defence and providing value for money.

LE TacCIS is key to these initiatives in order to be able to fully exploit Mission System Integration and enable the seamless passage of information on and off platforms. The key is influencing new capabilities at the design stage to avoid costly contract amendments, ensuring platforms are an integral part of the network and for in-service capabilities when can interventions be made.

6. By 2025 will the Army be able to match the potential threat posed by peer adversaries? ⁸

The MOD would always seek to 'over-match' threats, rather than match them, (both physical and virtual) by seeking asymmetric advantage, potentially via novel offset strategies and by the development and co-ordination of a whole range of capabilities. The threat must be considered in terms of both quality and quantity and the Army's modernisation and transformation programmes, and the iterative upgrades envisaged in the Land Industrial Strategy, seek to achieve over-match as part of our contribution to the Joint and Allied force. Feedback from recent experimentation (including using a synthetic training environment to replicate planned capability enhancements) has been positive.

⁸ Detail of the threat is not available at this classification

7. Is the Army still confident that the Warrior CSP can deliver an effective vehicle capability for the foreseeable future?

The planned Warrior CSP upgrade will be considered against alternate options in the forthcoming Full Business Case and has recently been reviewed and confirmed as the recommended best value for money route to enduring competitive advantage out to 2040 in terms of lethality, electrical power growth and communications technology. Warrior 2 is a significant enhancement and will ensure that Defence has an IFV that can remain competitive out to 2040. Warrior 2 will provide a genuine close combat advantage against current and future adversaries, especially when teamed alongside Challenger 3.

Warrior 2 will be one of the first IFVs able to fire 40mm on the move. The armour piercing round is much more lethal, and the point detonating air burst round is highly effective in dealing with enemy combatants located behind cover. Due to the upgrade to the electronic architecture it can automatically hand off targets between vehicle commanders, improving tempo.

Unlike other AFVs, the Warrior offers significant weight growth potential, enabling the rapid fitting and removal of the latest range of reactive and passive applique armours now and in the future. This, along with active protection systems tailored to the threat will be coupled to automotive improvements to address the associated weight growth.

A key aspect of the Army's armoured vehicle modernisation is the digitalisation of the battlefield through the introduction of the Land Environment Tactical Communications and Information Systems Programme and specifically MORPHEUS. This programme will create a digital backbone within the Army's Brigades and Division to enhance tempo, increase situational awareness, deliver functional applications (for example engineering data, fires and targeting) and improve decision making (including through the use of Artificial Intelligence). This backbone will also enable the integration of new sensors, effectors and means of electronic force protection, while also enhancing interoperability with our allies. The programme is synchronised with the armoured vehicle programmes and the electronic architecture of these platforms is an important part of 'future proofing' our armoured vehicles in the Information Age. In the future, the introduction of new technologies such as Human Machine Teaming will further enhance Warrior 2.

8. To what extent does poor contractor performance explain the delays to the Warrior and Ajax programmes?

As in any complex acquisition there are several risks and challenges that materialise in the demonstration and pre-production phases which the MOD look to manage and mitigate against through analysis and by learning from previous programmes and experiences. In the case of Warrior CSP and Ajax, there have been a number of challenges which have not been experienced previously due to the nature of such new capabilities. These have been worked through with the contractor. It should be noted that such delays are not always technical in nature; some are programmatic as realistic spending profiles often have to be adjusted to reflect contract performance and balanced with the Department's annual planning round and affordability challenge over the 10-year cycle.

Significant steps have been taken leading to increased confidence going forward. In the case of Warrior three significant milestones have been achieved on time in 2019 and a comprehensive suite of further rigorous tests is continuing throughout 2020 and into 2021. The Ajax project is now in its production and support phases with the Army having taken formal delivery of the first six ARES vehicles in March 2019 into trials, and the first vehicles going to the Household Cavalry and ARMCCEN in July 2020. Deliveries of further vehicles continue, with driver and crew training systems being installed.

9. Should the UK have a land vehicles industrial strategy, and if so what benefits would this bring?

The UK would derive significant benefit from having an industrial strategy for land vehicles, including the cross cutting sub-systems and mission systems that are integrated into them. The Army is currently

developing a proposition for a Land Industrial Strategy as part of the cross-Whitehall DSIS review. The analysis conducted so far indicates that the UK could derive greater value from its procurement activity by adopting a national industrial strategy for future land capabilities. In addition to creating and maintaining competitive capabilities for the Army, the most obvious gains are operational advantage (in terms of technology) and freedom of action (in terms of security of supply), but there are also fiscal, national prosperity and foreign policy benefits to be gained from more strategically shaping approaches between Defence and Industry to better target investment, the cycle of procurement and support, and balance requirements for UK capability and export opportunities.

Why adopt an industry strategy now? The Army's modernisation programme has catalysed investment in the UK's onshore industrial capability and provides a once in a generation opportunity; previous attempts over the last 20 years to develop and adopt a strategy have not had a modernisation programme to build on. Over the next decade, the Ajax, Boxer, Challenger 2 LEP and Warrior CSP programmes will sustain and grow a workforce across the UK's nations and regions that is skilled in research and experimentation, high tech engineering design and complex systems integration. These skills underpin our ability to innovate and provide solutions to counter evolving threats. They also provide a springboard for the next generation of land capabilities while simultaneously building industry confidence and increasing the likelihood of longer-term investment. With the Integrated Review and the DSIS, there is an opportunity to consolidate these gains and establish a more sustainable, long term portfolio of investment in the UK's future land capabilities.

What could the UK expect from a Land Industrial Strategy? By shifting to a more selective approach to acquisition and a longer-term approach to investment planning, the UK could create a more virtuous relationship between Defence and its suppliers. Open electronic architectures (a key feature of new and upgraded armoured vehicles) enables the use and upgrading of novel sensors and effectors as well as enhancing command and control. This could also foster: increased investment in UK intellectual property (especially in areas of national technological advantage); growth of the UK's high-tech Defence industrial capability (including the generation of jobs and skills); closer collaboration with our unique network of international allies and partners (building on the lessons from programmes like Boxer and F-35); and greater support to UK land system exports (tapping into the clear opportunity to achieve a greater share of the global land systems export market).

What are the potential benefits to the Army? Principally, a Land Industrial Strategy would target the sustained development and acquisition of competitive land capabilities that can be rapidly adapted to counter current and emerging threats while exploiting advances in technology. This offers the UK greater advantage on operations, but with increased investment in the UK industrial base, it also enhances freedom of action and creates national resilience.

What are the potential benefits to the UK? The UK could also derive wider benefits that would help attend to the Government's priorities. Revenue from increased export sales or levies from international user group memberships would contribute to national prosperity. By way of example, the UK is now a member of the Boxer user club and benefits from a percentage levy on Boxer exports. The Challenger 2 LEP digital turret has been built with exportability in mind. Land systems exports currently make up approximately 7% of total UK Defence exports and it is assessed that Army modernisation offers a considerable opportunity for growth. In addition, securing and generating jobs and STEM skills in the UK's devolved nations and regions supports the Union and assists with levelling up. Greater international collaborations, in which we can showcase the best of Britain, promotes UK influence and Global Britain. There is an opportunity for the UK to be a land equipment supplier (with all the benefits of national resilience, jobs and investment, access to data and ability to enhance international co-operation rather than a consumer (and having to pay for access to new technology). Finally, investment in high end dual use technology research and development, such as hybrid-electric drive and power generation, could support the sustainability agenda.

10. What sovereign capability for the design and production of armoured vehicles does the UK retain?

As the UK has not independently designed and produced an AFV for some time, its industrial base has reduced in terms of sovereign capability and capacity. This has shrunk over recent decades with a

trend towards more global supply chains to collaborate with Allies and benefit from wider economies of scale, as the UK no longer procures the volumes required to sustain its historic levels on its own. However, across the wider definition of armoured vehicles the UK does retain an active and competitive industrial base supporting and upgrading a range of in-service vehicles which is spread across the UK, including the devolved Nations, at prime and sub-supplier level. This maintains freedom of action for the UK and has enabled a positive role in recent design, integration and production whilst general armoured vehicles including military engineering and logistics vehicles continue to have an active UK industrial base.

The UK was a founding member in the design of Boxer which it is now benefiting from rejoining the programme; in the UOR years prioritising Protected Mobility capabilities, the UK designed and produced vehicles including Foxhound, Jackal and Coyote, whilst integrating UK systems into existing off the shelf base platforms for Mastiff and Husky. Ajax is also a UK designed vehicle based on an existing base platform (ASCOD – Austrian Spanish Cooperation Development), whilst its 40mm CTA cannon was developed jointly between the UK for Ajax and Warrior, and France for its Jaguar. The UK is now re-establishing the ability to conduct complex upgrades (for example the Challenger 2 Life Extension Project and Warrior Capability Sustainment Project) and the assembly, integration and testing of complex digital vehicles such as Ajax.

The UK now has an active supply base for complex armoured vehicle sub-systems such as sensors, survivability technology and secure communications. Within the Boxer Programme, the UK is creating new onshore production lines and intends to expand this further with the Challenger 2 Life Extension Project. Where it is not cost effective for the UK to have specific onshore sub-system facilities (for example large calibre weapon manufacture), the UK will ensure continued access through international partnerships, participation in collaborative programmes and by seeking to use commercial based products where economies of scale are much greater (for example engines). This approach to acquisition and support will create the opportunity to build a longer term, broader and mutually beneficial relationship with Industry.

This has retained a reasonably strong UK industrial base to collaborate with Allies for our future capabilities. The Army's modernisation programme presents opportunity for the UK to now re-establish and enhance its sovereign onshore capability for the design and production of ground combat systems including armoured fighting vehicles, wider armoured vehicles, key mission systems and future unmanned systems. A Land Industrial Strategy could complement and secure this approach for the longer-term planning of key skills and facilities to enable subsequent upgrades and create new capabilities for future systems and platforms.

11. Does it make sense to upgrade the Challenger 2 when newer, more capable vehicles may be available from our NATO allies?

Although Leopard 2 and Abrams main battle tanks have been subject to several iterative upgrades, they entered service in the late 1980s. The Challenger 2 Life Extension Project will be the first significant upgrade since it entered service in 1998; once in service it will be comparable – and in certain areas superior – to the latest version of Leopard 2 and Abrams. It will have the same level of lethality, better survivability, similar levels of mobility and more capable surveillance and target acquisition systems. Enhanced lethality is vital given the proliferation of reactive protection systems that are unable to defeat high velocity ammunition that can currently only be fired from a main battle tank. The upgrade to Challenger 2 will make it world leading while the provision of an open electronic architecture and the potential for lethality upgrades will promote NATO interoperability.

The new modular armour systems designed in Porton Down have already been tested and proven to be state of the art and competitive with other Nations. The turret is brand new, with a fully digitised architecture, with enhancements to the powertrain and suspension. The enhancements within the hull will also be shared across the heavy armour fleet (CRARRV, TITAN, TROJAN) including a common engine and improved suspension. This will result in a reduction in heavy armour automotive through-life costs.

Challenger 2 will also benefit from the same Land Environment Tactical Communication and Information Systems Programme and advances in technology as Warrior CSP. Not only will these upgrades create new capabilities, but they will provide the critical steppingstone to develop future technologies including autonomy, human and machine teaming, electric drive propulsion and advanced protection and weapon systems.

A detailed comparison of costs, both unit price and through life, will be made in the Full Business Case that will be presented to the Investment Approval Committee in November 2020. Challenger 2 LEP will provide a step change in capability for the Army, especially in conjunction with Warrior CSP, and will enable the Army to operate and fight differently in order to gain advantage and win. The investment also represents good value for money and will support UK prosperity and the levelling up agenda.

12. What other key gaps are emerging within the Army's armoured vehicle capability?

The current assessment of armoured vehicle capability gaps includes the requirement for a Mobile Fires Platform, a Future All-Terrain Vehicle (a multinational collaboration alongside the German, Dutch and Swedish armies), a mortar variant and a repair (crane) variant of Boxer and an Armoured Support Vehicle (to replace a number of platforms including Bulldog which has been in service since the 1960s).

In addition, armoured vehicles are also dependent on other capabilities which the Army intends to bring into service. This includes a Wide Wet Gap Crossing capability (bi-lateral co-operation with the German Army) and a Protected Patrol Vehicle.

As highlighted, the LETacCIS programme will transform our ability to leverage information by incorporating individual AFV 'nodes' into the wider information network to increase operational tempo, optimise our current and future capabilities and protect our armoured vehicles against cyber threats. In terms of protection and lethality systems, Defence is funding Electronic Counter Measure enhancements and planning to develop new and novel protection methods and weapon systems. While main battle tanks are the most effective way of countering the threats posed by enemy armoured vehicles there continues to be a requirement to fit effective anti-armour weapon systems to other platforms, including Ajax and Boxer, and the Army is developing plans to bring these systems into service on these, and other, platforms.

The most significant capability opportunity is Human Machine Teaming. Unmanned vehicles will transform the way the Army operates and fights, and the Army is determined to take advantage of the opportunities that this technology will provide.

13. Has the Army learned from previous failures such as FRES to ensure new vehicles are acquired effectively?

The Army, DE&S and the MOD have continued to improve Defence acquisition including learning lessons from FRES. The broad and demanding requirement of FRES could not easily be met and required complex commercial arrangements, whilst also facing significant planning round savings, changing global threats and evolving requirements. Many of the 2011 NAO "*cost effective delivery of an armoured vehicle capability*" observations and recommendations have been implemented in the Army's delivery approach including trading requirements, pursuing off the shelf solutions with growth potential and longer-term incremental acquisition.

Capability requirements have been refined and many of the core elements of FRES that remain relevant today are now being delivered through current programmes. Ajax will meet the specialist recce platform requirement. Boxer is on contract with a more agile off the shelf approach and the Multi-Role Vehicle Protected (MRVP) packages are progressing. These have more realistic performance cost and time requirements and are based on existing and proven vehicles. In addition, we have invested in open systems and generic vehicle architectures while also prioritising power, weight and space growth potential to ensure these vehicles are future proofed.

This longer-term focus will allow improved incremental technology insertion and better whole life cost management. This, combined with the Army's increased focus on Future Force Development and experimentation, will allow the MOD to keep capabilities contemporary and partner more strategically with the industrial base and key allies through the proposed Land Industrial Strategy.

The MOD acquisition system has also evolved significantly in the past decade with various initiatives across the Army, DE&S and the MOD which are supporting improved approaches. The Army Operating Model has embraced Programme, Portfolio and Project Management as a professional business approach over the last 5 years creating a more robust and disciplined approach across requirement setting, delivery management and governance. DE&S transformation has delivered stronger functional management and project controls in its delivery and a more disciplined business relationship with Front Line Commands, whilst its commercial and improved market engagement has, for example, accelerated the procurement of Boxer saving time and resource and providing a stronger understanding of products that best meet the requirement. The Army has also contributed to the MOD's acquisition and approvals transformation initiative with several pathfinders and exemplar approaches applying previous lessons to future approaches.

28 September 2020