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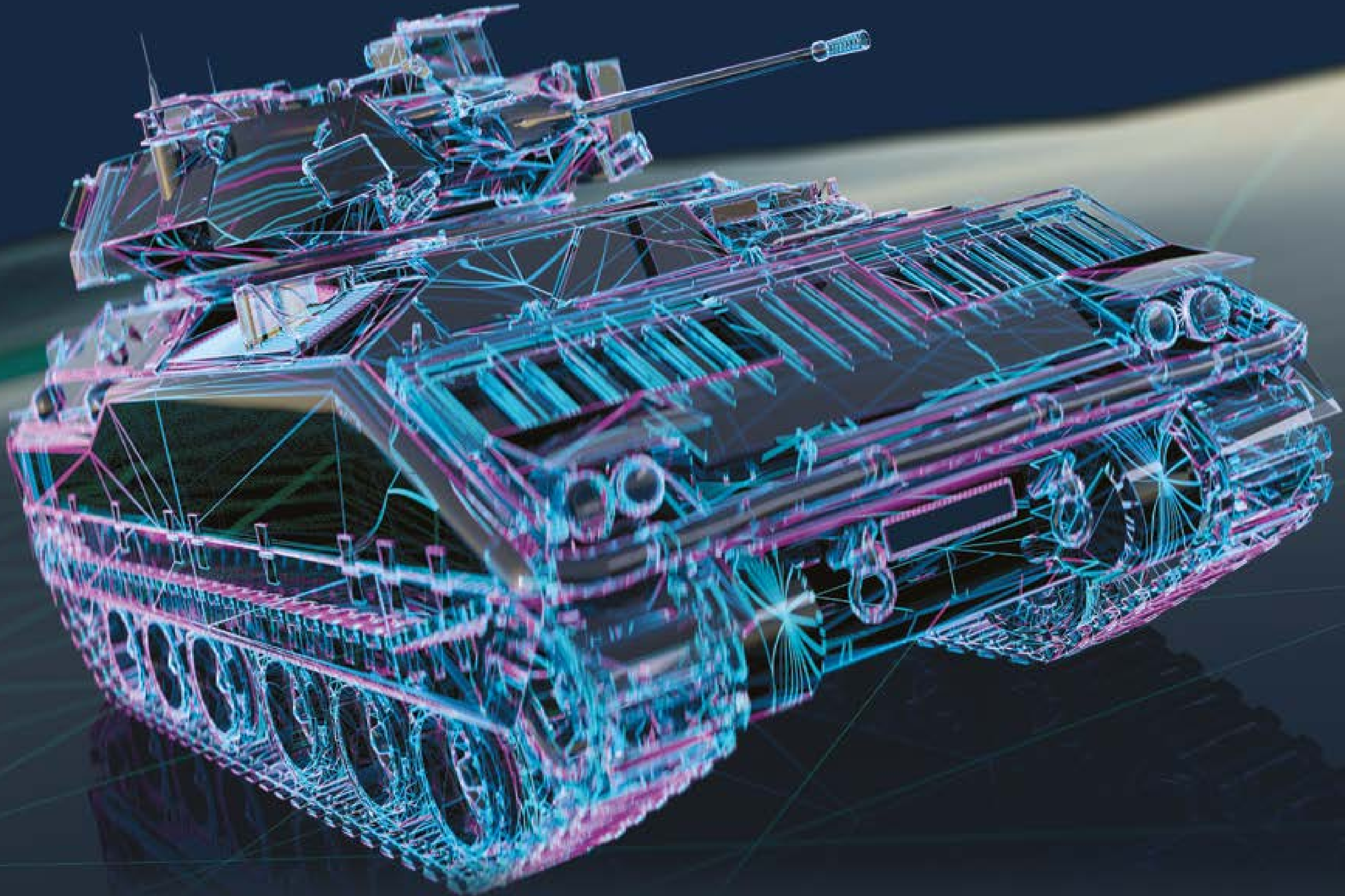


Modernising land platforms

Tracked and wheeled military vehicles have undergone a steady evolution throughout the hundred years since the first tank entered service. Performance gains have been incremental but consistent; enough to remain a credible deterrent against adversaries and their equivalent technologies.

They have succeeded because the likely nature of any potential conflict, including the role of the land platform within it, has been relatively well understood. From the Somme to the Gulf, tanks and other armoured vehicles have been called upon to provide firepower, protection and mobility in combat against peer or near-peer adversaries.

Around the turn of this century, that began to change. The familiar dangers posed by states, as experienced in the World Wars and Cold War, were overtaken by asymmetric threats from non-state aggressors like Al Qaida, the Taliban, and Daesh. These groups ignored the rules of engagement, launching attacks on civilian, government and military targets using rudimentary, but deadly, tactics such as suicide bombs and improvised explosive devices. Twentieth century land platforms, designed to counter other advanced military technologies, were suddenly powerless to protect targets against this devastating mode of primitive, unregulated conflict.

Meanwhile, another threat to global stability was rising in the form of grey zone competition. This takes many forms, whether economic coercion, deniable attacks, information operations, or the use of proxy forces – but the common thread is the ability to exert hostile influence below the threshold of war. An armoured vehicle has little role to play in defending against disinformation campaigns or aggressive diplomacy.

And yet, the familiar state threat has not disappeared. Many sovereign nations share their borders with assertive states that continue to invest in traditional military strength and may choose to exercise it at any time. To reduce land combat mass at this critical time would reopen doors to adversaries that have for decades been held shut by capability overmatch.

In this paper we examine the role of land platforms in this complex geopolitical environment; the ways in which they must be modernised to stay relevant; and the steps that must be taken for that modernisation to be successful.

Two challenges facing today's land platforms

Adapting at pace

A complex and expensive land platform, such as a main battle tank, typically evolves slowly through upgrade programmes that may take up to a decade, and is replaced every 30 to 40 years. There are two major factors governing these prolonged timelines: government procurement cycles; and reliance on proprietary technologies.

The prolonged defence procurement cycle is a relic from an era in which threats could be foreseen with greater certainty. A platform would be designed to reliably perform a consistent role throughout its long service life – at the end of which, an improved model would be introduced, and so on.

Today, a land platform can no longer afford to stay the same while the threat landscape changes all around it.

No sooner than a new platform enters service, adversaries will seek ways to undermine its effectiveness – either by developing superior offensive technologies, or by changing their way of fighting to render it redundant. Threats are becoming more adaptive, and the enemy is becoming an 'integrator' – combining multiple technologies, including those which are commercially available, to create new threats.

A platform must therefore constantly adapt – not just in response to changing threats, but in anticipation. If enemies do not know the exact nature of the platforms being deployed against them, they cannot plan strategies to defeat or undermine it. This element of surprise is essential in maintaining the upper hand against agile enemies unconstrained by the rules of engagement.

However, this brings us to the second limiting factor in the adaptability of land platforms: proprietary technology. Militaries worldwide are recognising the need to adapt and modernise their platforms mid-service-life; but may find themselves prohibited by inflexible platform design and through-life support. Imagine an Original Equipment Manufacturer (OEM) designs and builds a platform using its own components and systems. Conceived to operate as a whole, the platform meets the exact requirements specified during the tendering process – but if the requirement changes, adapting the platform accordingly can be costly and time-consuming. Introducing a new capability, such as a weapon system or command and control suite, may require the platform to be returned to the OEM for systems to be reengineered and bespoke parts manufactured. This protracted process is at odds with the agility required to outpace adversaries. It also decreases the accessibility of innovative technologies originating from Small to Medium-sized Enterprises (SMEs), academia, and other third-party developers – meaning the best solution to a problem may already exist, but be unavailable at the time of need.

The multifaceted modern threat

Closely linked to the adaptability challenge is that of versatility. If we define adaptability as the platform's capacity for change over time, versatility is its ability to perform multiple functions concurrently.

Driven by the varied and ever-shifting threat environment, today's tank must be an advanced survival system; a multifunctional weapons platform; and enhanced sensing platform; and a sophisticated command, control and communication centre.

And, as threats become yet more diverse and unpredictable, such platforms will need even greater versatility.

Future adversaries' weapons may not look or behave like the ones land platforms were historically designed to defend against. Knowing that an armoured vehicle is impervious to rockets and mortars, adversaries may instead launch swarms of cheap drones laden with explosives to overwhelm threat identification systems and overload operators' cognitive capacity. Or, unable to destroy a platform, the adversary may instead seek to disrupt its operations through other means – by jamming its navigation systems; cutting off its fuel supply chain; or targeting its operators with deception and distraction. All these approaches have the same aim – to render the platform ineffective.

The need to simultaneously protect against multiple threats creates a challenge for platform designers. When considering the trinity of firepower, protection and mobility, an increase in one often necessitates a compromise in another. For example, more protective armour means more weight and therefore less mobility. The platform's weakest quality will inevitably be the one exploited by adversaries to their own advantage. Optimising a platform to maximise all three requires new and innovative methods, many of which will appear radical and even challenge existing concepts of what defines a land platform.

Key technologies for land platform modernisation

Technologies capable of addressing these challenges exist today – many of which can be retrofitted to platforms already in service to alter or augment their capabilities.

In this section we examine some of the best available technologies for modernising land platforms:

Autonomy

Uncrewed platforms are already finding their way onto the battlefield, mostly in the form of robotic vehicles weighing less than a metric ton. Applications include last mile resupply, reconnaissance, bomb disposal, and fire support (although a human must remain in the loop to make firing decisions). It is entirely possible that larger uncrewed vehicles, even main battle tanks, will follow – but in the short term there is more to land platform autonomy than just robotics.

Selectively automating functions of an existing platform, rather than automating the whole thing, reduces the workload for its operators. For instance, the crew may switch a vehicle to self-driving mode to concentrate on target identification and acquisition. Such options enable the crew to devote their attention to tasks that demand human decision-making. As an extension of this, multiple robotic 'wingmen' will flank the crewed vehicle, increasing deployed combat mass, widening the main platform's operating footprint, and further reducing the burden on the crew. In a chaotic, multifaceted threat environment, the ability to focus on the things that matter can make the difference between life and death.

Information advantage

Faced with a complex and changing threat environment, the ability to understand what is happening is paramount. Only by detecting, identifying and characterising threats is it possible to counter them. This principle is not new, but the technologies to implement it have advanced rapidly in recent years.

In addition to collecting information from a land platform's own onboard sensors, crews can receive it from remote sensors fitted to satellites, drones, crewed aircraft, or other land vehicles. This provides a much higher-fidelity picture of the battlespace, but also creates new challenges. The first is cognitive overload. With so much data being received from different sources, the human recipient may struggle to process it, leading to overlooked information and decision-paralysis. Between the points of data collection and delivery, there must be means of condensing and prioritising it for ease of interpretation.

A data fusion engine can perform this task, bringing together information from multiple sources; identifying the most relevant or urgent; and presenting it to the recipient in a way that can be interpreted quickly and accurately. The second challenge is that data from remote sensors must be transmitted wirelessly to the platform at volumes that may exceed available bandwidth.

Processing it may also require more computing power than the platform can provide. These challenges can be mitigated using edge processing, where the sensor makes decisions about what data to capture and transmit. A rudimentary example already widely in use today is a CCTV camera equipped with a movement sensor, which records only when activity is detected.

Stealth and counter-surveillance

If advantage is gained by observing the enemy, it stands to reason that it is lost by being observed. It is therefore vital to understand the ways in which enemies may use sensors to observe a platform, and equip it with appropriate means of evading detection. The most obvious way to detect a large platform is visually. The very earliest tanks were painted to blend in with their surroundings, and covered using camouflage nets to avoid being seen from the air.

Camouflage nets became less relevant as western forces increasingly operated in theatres with tightly monitored and controlled airspace – but are now increasing in relevance again due to adversaries' use of small drones equipped with cameras for aerial surveillance. But optical sensing is not the only way to detect an object. Enemies may use multiple parts of the electromagnetic spectrum, such as radar, to find the platform's reflective surfaces, or infrared to locate its heat sources.

Stealth materials can absorb radio waves or distort their reflections to evade radar, while insulating and heat-reflecting materials can shield the platform's heat sources from infrared. Sound can equally give away a platform's location, so noise reduction is an important factor in evading detection. The combustion engine is a significant source of both thermal and acoustic signatures, making electric drive systems an attractive option for silent running and watch. Finally, data sensing and transmission are themselves potential signatures that can be used to locate a platform. Data transfer via light-based Lidar presents a less observable alternative to radio-based sensing and communication.

Enhanced effects

Land platforms are normally equipped with traditional kinetic weapons – but these have drawbacks in the face of certain types of threat. A large-calibre high-velocity gun may be effective against enemy tanks, but no use against a swarm of small drones.

Directed energy as a secondary weapon system could redress the balance in asymmetric conflict, with its low cost-per-round, high accuracy, and magazine limited only by its power source making it better suited to tackling high volumes of low-value targets. Kinetic weapons also emit significant thermal, visible, and acoustic signatures, which can reveal the location of the host platform. By contrast, directed energy can be invisible and silent, making it much harder to trace back to its source.

Directed energy may also form part of a platform's active protection suite. Active protection systems shield against incoming fire, either by changing the platform's signatures to 'confuse' the threat's tracking and sensing systems (soft-kill), or physically intercepting the threat using kinetic effects or directed energy (hard-kill). These provide an alternative to burdening the platform with heavier armour that would restrict mobility.

Mobility and survivability

Land platforms, out of necessity, have always been designed around the internal combustion engine and its associated components. This creates a couple of significant challenges for platform evolution and adaptation.

Firstly, it places strict limitations on vehicle architectures. The need to accommodate the engine's volume and distribute its weight leaves few options for its placement within the vehicle. Secondly, in wheeled vehicles, the mechanical moving parts, such as axles and driveshaft, must run along the underside of the vehicle to the wheels.

This not only further restricts design options, but presents a risk to the vehicle's occupants by limiting the available space for armour on the underside. Consequently, a detonation beneath the vehicle can blast the components into the occupied space above.

Electric drive systems have the potential to revolutionise platform design by finally addressing these age-old issues. Motors contained within the wheel hubs or track drives are joined to their power source by flexible wires. Unlike the traditional rigid metal components, these can be routed virtually anywhere within the vehicle, creating options for additional protection, firepower, or situational awareness capability without sacrificing mobility.

Existing tracked and wheeled vehicles can be retrofitted with hybrid electric drive systems, although future platforms designed specifically around electric drive will be even more revolutionary. Prototypes have been produced of wheeled military vehicles with novel suspension configurations, including independent long-travel models with six degrees of movement (up, down, forward, backward, inward, outward). These enable manual or automated placement and torque adjustments to each individual wheel, greatly increasing mobility and performance.

Power sources

Many of the above technologies, such as sensors, processors, and directed energy, consume electricity. As power demand increases, it must be serviced by reliable, secure energy storage and delivery. On a traditional land platform this may mean adding dedicated generation and storage, which occupies valuable space and increases weight – but in a platform with hybrid electric drive, power can be supplied from the generator to anywhere on the vehicle, either directly or via battery storage. It can increase the available onboard power from tens of kilowatts to up to a megawatt. Further to servicing increasing power demands, running a platform on electrical power has the added advantage of reducing fossil fuel dependency. Aside from the obvious environmental benefits, this may directly contribute to preserving the lives of servicemen and women.

Over 3,000 American soldiers or contractors were killed in attacks on fuel supply convoys between 2003 and 2007 in Iraq and Afghanistan. A 2009 report by the US Army Environmental Policy Institute puts the estimate at one casualty for every 24 convoys. The ability to power a platform using onboard or localised energy generation and storage would minimise the logistical burden inherent in the fossil fuel supply chain, significantly reducing the associated casualties. Any energy surplus produced by a platform's generator can also act as a 'micro-grid', recharging soldiers' equipment while in transit, or operating a field-deployed power source in remote regions.

Enabling platform modernisation

How can these capabilities be applied safely, quickly and effectively to existing platforms currently in service?

QinetiQ has identified **four principles** that will ease the transition to modernised platforms; maximise the resulting capability; and ensure the greatest possible return on investment for governments and their defence departments:

1 Take a holistic view

Individual technologies do not provide competitive advantage by operating in isolation, but by working together to produce a greater combined effect. At a micro-level, the technologies aboard an individual platform must clearly be compatible with each other; but at a macro-level, different platforms must also be capable of sharing information and tasks. Given that today's threats are not constrained to specific fighting domains or fixed operating concepts, land platforms should be interoperable not just with each other, but with other capabilities, including some not traditionally associated with land warfare.

Information advantage is dependent on gathering and combining data from across all of the defence domains; land, air, maritime, space and cyber. Integrating these capabilities will require the formation of a 'digital backbone', which gives different platforms and assets access to a common communications, command and control architecture. This will allow them to communicate, share data and distribute tasks effectively. The value of all future capabilities will come from their ability to work collaboratively with other assets. The way in which a land platform is positioned within the defence picture as a whole, and its ability to cooperate with the things around it, will be critical.

2 Adopt iterative development

Responding to new threats and providing deterrents against emerging ones requires a platform to adapt quickly and in real time. Waiting years for the start of a new procurement cycle to update a platform is no longer realistic; the capability must be available where and when it is needed. For defence, this represents a cultural shift that may feel uncomfortable and alien to some. Defence procurement has historically been built on precision and certainty; the customer's need is precisely defined, and a precise solution developed and procured. However, as the future defence environment and the platform's role within it become less certain, these existing processes become unworkable.

A platform may be designed for 30 years of desert warfare based on the geopolitical priorities at the time of inception – but an unexpected shift to asymmetric urban conflict ten years into its service life could leave it ill-equipped for the next two decades. Land platforms and associated capabilities must evolve iteratively, both in response to the changing needs of the end-user, and in anticipation of shifting geopolitical circumstances. At times this may mean not procuring perfection, but the minimum viable product capable of fulfilling the requirement. Delivery of an 80%-ready solution at the time of need is better than a 100%-ready solution several years too late.

3 Nurture a collaborative ecosystem

Since the end of the Cold War there has been a shift in the primary source of technology and innovation. Where technologies developed by state-owned defence and aerospace organisations were once most commonly spun out into commercial applications, today the reverse is true.

Big technology companies, Small and Medium-sized enterprises (SMEs) and academia are producing innovations that have the potential to revolutionise defence capability – so it is vital that defence is not denied access to these innovations by prohibitive procurement practices and contracting models. Instead, a collaborative ecosystem must exist in which any partner can find and adopt the best available solution to a new challenge, whether it comes from an SME, a university, or a commercial technology giant. A technology-agnostic integration partner must be nominated to ensure capabilities can be combined safely and effectively without generating risk. As platforms continually adapt and are combined to create new capabilities, collaborative experimentation and testing must persist throughout the development cycle to ensure compatibility and develop new use cases.

4 Know your mission

Above all, modernisation must be mission-led, putting the needs of the end-user first. Coupled with a knowledge of current user requirements is a need for horizon-scanning, to understand what the platform will be required to do in the future and how it must be equipped to perform those duties. We must be ready to embrace new technologies, but should equally be wary of innovating for innovation's sake, remembering that there are still duties that traditional land platforms perform exceptionally well.

The conversation on modernisation should not be framed as a competition between industrial-age and digital-age capabilities; it is about the combination of capabilities that will give our armed forces the best chance in both a fight against a peer adversary, and in asymmetric conflict against small-state or non-state actors. We need to create the conditions for industrial and digital capabilities not just to coexist, but to complement each other to the extent that they become greater than the sum of their parts.

Planning for the next generation

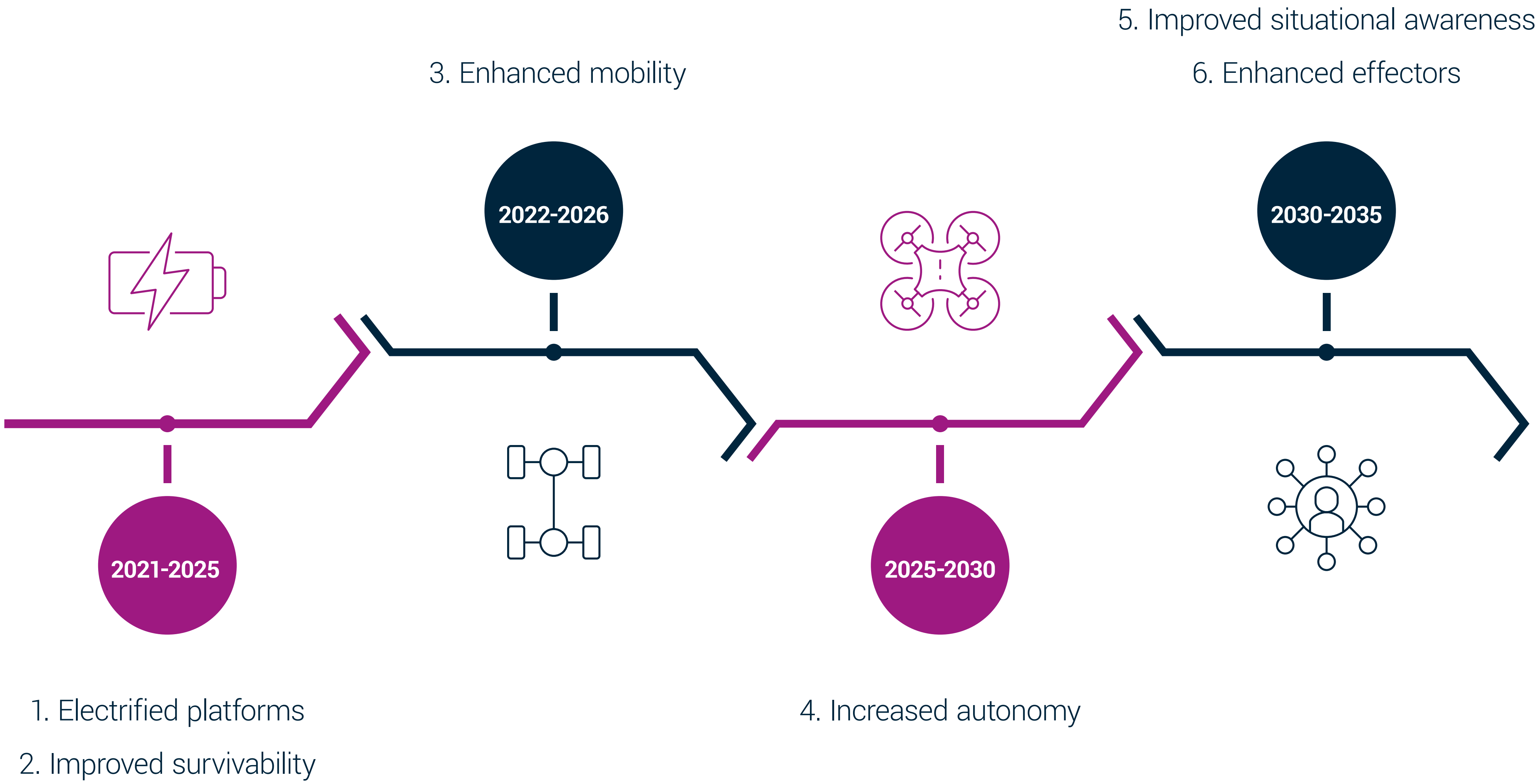
While modernising the platforms of today, we must also consider how we intend to get the best from the platforms of tomorrow. To avoid the integration challenges associated with current capabilities, we must procure platforms that are designed specifically to evolve throughout their service lives.

The key to building an adaptable platform is modularity; a reliable and versatile base to which capabilities can be introduced or removed at pace as threats evolve.

These must be based on open architecture that allows technology from multiple partners to be plugged in. This ensures the best solution to an urgent requirement is available at the time of need. It also makes economic sense, as it gives SMEs a route into the global defence supply chain, fostering innovation and supporting employment.

The land platform still has a vital role to play in global defence and security – but maintaining its relevance over time will depend entirely on its ability to adapt as the world changes quickly and continually around it.

Ready for deployment



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