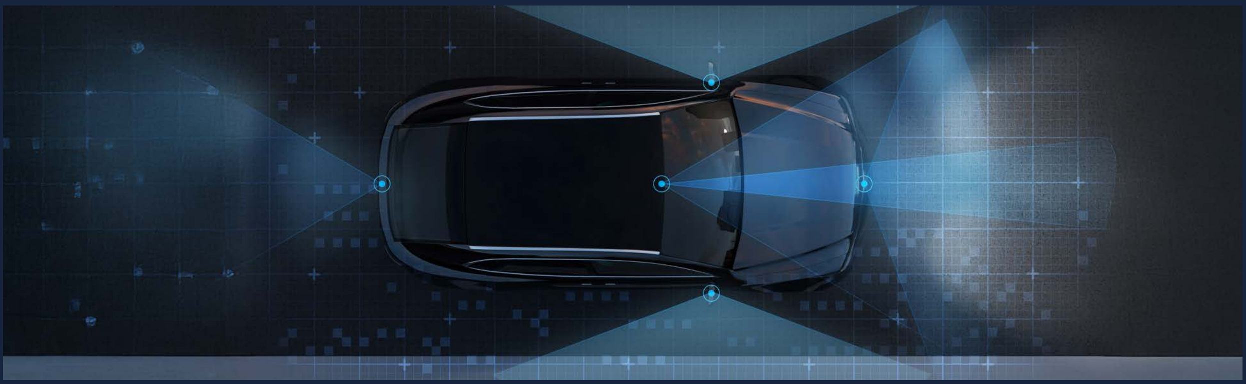
Uncrewed Ground Systems



Welcome to part two of our Primer series on autonomous systems, where we explore the developing area of uncrewed ground systems (UGVs) - drones on terra firma. Much has been made of the UGV's aerial counterpart - UAVs - but alongside the evolution of UAVs, we've seen significant development in autonomous systems operating on the ground.

As with many technological innovations of the 20th Century, the UGV's genesis came about from a military need, and it can trace its roots back to the Second World War. In the 1940s, German military engineers developed one of the first known UGVs, with the conception of the Goliath Tracked Mine, which was a tethered remotely controlled vehicle used to deliver an explosive payload to enemy targets. Since then, UGVs have been developed to tackle a much wider breadth of problems, in areas beyond defence, such as bomb disposal, transport, and logistics.

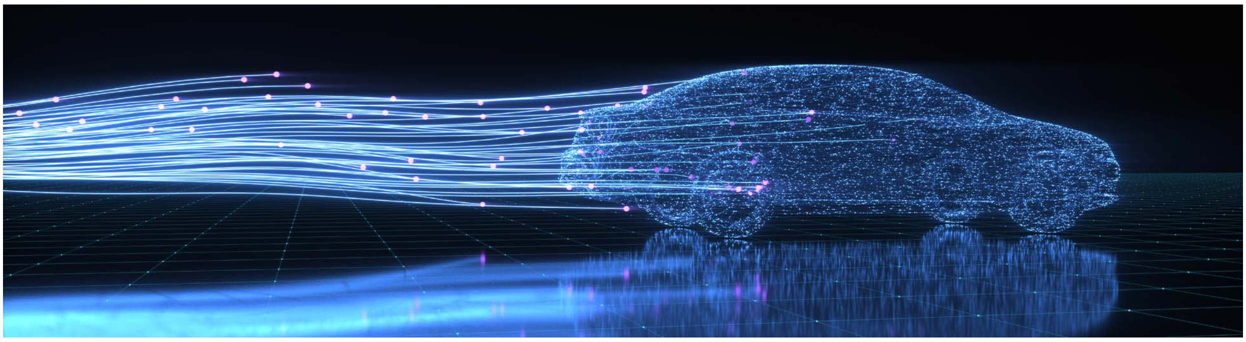
Whilst the strict definition of a UGV encapsulates "any terrestrial vehicle that operates without a human onboard," and therefore counts remotely controlled vehicles in this classification, advancements in AI, sensing, and robotics have driven the emergence of vehicles able to operate under even greater levels of autonomy – think self-driving cars. So, what makes a UGV? Well, we've already established their uncrewed and ground-based nature. On top of this, a UGV is typically equipped with an array of sensors, to enable navigation and/or target acquisition (whether the UGV is remotely operated by a human or is fully autonomous), as well as equipment to allow it to communicate to an operator, ground station, or to other systems (crewed or uncrewed). With a payload, such as weapons, robotic arms, or cargo, these systems are able to tackle a variety of use cases, as we'll explore further.

The use cases

In policing and emergency response, UGVs support search and rescue teams access dangerous, inaccessible environments after catastrophes such as earthquakes. When equipped with thermal imaging sensors, they are able to locate survivors in poor visibility, with greater sensitivity to signals of life than humans. In addition, they have found use in firefighting, handling of hazardous materials, and have been used for years by bomb disposal experts – all of these use cases capitalise on UGV's innate resilience to harsh environments and remove the need to put a human 'on the line.'

In the defence and national security arena we see the US and Russia developing autonomous ground combat vehicles, equipped with weaponry and AI-assisted targeting systems, which match the lethality of any crewed variant currently in service. We also see developing use cases in a variety of other tasks on the battlefield including casualty evacuation and supply delivery – all of which again aim to remove humans from harm's way. Many of these defence applications are currently being developed and battle-tested on the frontlines of Ukraine, with an ecosystem of hundreds of innovative SMEs riding the wave of military investment in the country. The Brave1 cluster spearheads this ecosystem, supporting these SMEs in accessing funding and championing their cause to overseas investors. On top of this, a drastic overhaul of Ukraine's military procurement process has seen technologies, including autonomous UGVs, move from concept to design to deployment at breakneck speed. The conflict in Eastern Europe, which has cost tens of thousands of human lives, is driving the speed of development in UGVs, as is the boost in European sovereign defence spending, which will inevitably support the roll out of autonomous ground vehicle technology in civilian use cases.

From the perspective of civil applications, we've been hearing for years of the development of autonomous vehicles (AVs). A subset of UGVs, AVs are fully self-driving cars, which promise to revolutionise our lives, frequently hailed as being on the brink of commercialisation. But where are we with that, and what other uses could UGVs have outside of defence and national security? Whilst traction has been slow in the UK, AVs are being used extensively in US cities to transport people from A to B. Leading the way with this offering are firms like Waymo (owned by Alphabet, Google's parent company) and Cruise (owned by General Motors), with these 'robotaxis' increasingly being deployed to more and more urban areas – 2025 looks to be a pivotal year for robotaxis state-side. However, despite their popularity, adoption en masse remains relatively limited, with trust in the technology often cited as a barrier to uptake, despite road collision data pointing to human error in 88% of all incidents. Furthermore, we've seen the utility of UGVs in logistics (Asda has commissioned a trial to autonomously deliver groceries to over 170,000 residents), agriculture (think autonomous tractors ploughing fields), and infrastructure inspection. And for those of you that already own a Tesla, the company is increasingly looking to transition from driver-assist features to full autonomy across its growing fleet.



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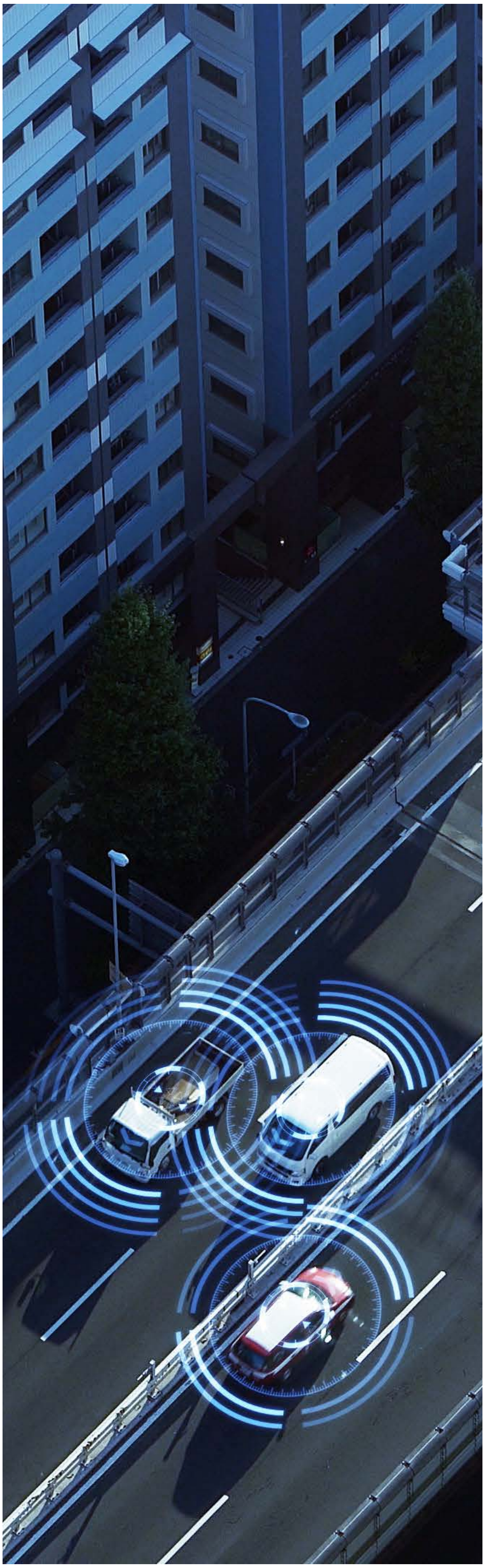
Acknowledging that we have some way to go to developing fully autonomous UGVs, the UK government, led by the Department for Transport (DfT), established the UK Connected & Automated Mobility (UK CAM) Testbed in 2017 – a consortia of CAM innovation and test facilities, geographically centred on the Birmingham to London corridor. £200m has been aligned to UK CAM, with Heligan's industry insiders predicting a market value upwards of £40bn by 2035 and an industry supporting over 38,000 skilled jobs. It is our assessment that whilst the US leads the way, the UK is well-placed to work with international partners to develop international standards centred around safety, licensing, and liability (holding insurers and/or manufacturers accountable where necessary in incidents of collisions).



The future

With self-driving vehicles touted to be operational on UK roads as early as 2026, what opportunities and challenges lie ahead for fully autonomous UGVs? Firstly, the opportunities and challenges are numerous, so for the purposes of this Primer we'll examine those at the top of UK CAM's agenda. Starting with the challenges, we see challenges in enhancing the civil populace's appetite to adopt such technology. The government, through UK CAM, and private businesses operating in the AV sector, will need to work together to address public concerns around safety, congestion and job displacement before we'll see large-scale uptake of autonomous UGVs. In addition, the interconnected nature of AVs will pose cybersecurity challenges, and opportunities for cyber criminals – the AVs of the future need to be 'secure by design,' which will require cross-collaboration between the AV industry and cybersecurity sector.

Opportunities for the industry lie in the UK's leadership in key enabling technologies such as AI and space technology. The development of advanced AI will fuel advancements in hazard perception and deep learning will make AVs more reliable in complex environments – as is the nature of built-up urban areas, particularly in the UK. Additionally, AVs currently rely on reliable high-bandwidth, low-latency 5G networks – often the preserve of urban areas – to navigate and communicate with other vehicles, which enhances safety, minimising the risk of collision. Therefore, the democratisation of space-based communication technology, and integration with AVs, will support the deployment of vehicles in more remote, less connected, regions. Lastly, the next generation of sensors for AVs, such as LiDAR, with higher resolution, will enable more accurate motion prediction which will be crucial for high-speed, long-range hazard perception and collision avoidance.

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The bottom line

UGVs have a surprisingly long history, rooted in their military genesis. As key enabling technologies in AI, sensors, and communication links have matured, we have seen the emergence of highly sophisticated, autonomous systems with real-world civilian applications and the potential to revolutionise the way we live. Recognising this promise, the UK has invested heavily and sits at the forefront of autonomous UGV development, which must be sustained in order for us to keep pace with our American counterparts and earn a seat at the 'regulatory development table.' There is also no doubt that such systems will begin to be used in anger on the battlefields of the future, but civil applications will require the industry to overcome public concerns primarily centred around safety. From an investment standpoint, the growing sector, coupled with its connections into a flourishing defence industry, make it an attractive proposition. However, the dual use nature of UGVs presents complications around the potentially kinetic nature of such technology – a UGV used for humanitarian work could be repurposed with weaponry to undertake military operations. These are critical questions that investment committees must address decisively – and without delay – or risk losing out on a potentially high-value opportunity.