



Metis

Study

Uncrewed systems: armaments, control and arms control

No. 28 | June 2022

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Summary

This study will reconstruct the growing importance of uncrewed weapon systems and the Bundeswehr's difficult relationship with these systems. The second part features a piece of fiction that sketches a possible future in which the Bundeswehr uses uncrewed systems innovatively, effectively and responsibly. From this scenario, the third part derives

concrete recommendations for action that take into account the three corresponding objectives of armaments, control and arms control.

The illustrations for this study were created using AI (Midjourney).

The future is unknown...crewed

Russia's war of aggression against Ukraine once more highlights the importance of uncrewed systems – in particular uncrewed aerial vehicles (UAV) – for 21st century warfare. Both sides use various types of UAV. Mass-produced and commercially procured quadcopters are used for reconnaissance and to provide target coordinates for artillery. Loitering munitions¹ are also used, including the US-made Switchblade employed by the Ukrainian side and the Lancet-3 employed by the Russians. Ukraine also hopes to receive four MQ-1C Gray Eagle systems, including guided missiles, from the US. It has been using Turkish Bayraktar TB2 drones effectively since the beginning of the war, and the resulting footage has also been skilfully employed to attract media attention. Iran, for its part, has announced its intention to supply Russia with over a thousand UAVs, including combat UAVs.

The growing military importance of uncrewed systems in general – not just UAVs – has been analysed and discussed since the early 2000s. Most recently, loitering munitions attracted a great deal of attention in the

2020 Nagorno-Karabakh conflict between Armenia and Azerbaijan.

The Bundeswehr's experience with unarmed UAVs goes back a long time. Some examples include the Canadair CL-289 artillery reconnaissance drone, which entered service in 1990 and was used until 2009; the KZO small-scale target detection aircraft, on which the artillery currently relies; MIKADO, ALADIN and LUNA with their different capability profiles in terms of range and flight time; and the tiny PD-100 Black Hornet helicopter as a reconnaissance asset for the infantry.

When it comes to loitering munitions, the story is a different one. Development of the "WaBEP" system for standoff engagement of isolated and pinpoint targets, planned as a combination of the KZO and the Israeli IAI Harop as a weapon system, was brought to a halt in 2016. A similar project, Taifun, had already failed and been discontinued in 2007. One reason for its failure was the system's inability to detect and engage targets automatically – an overambitious goal in light of the state of the art of technology at the time.

However, the range of functions of uncrewed systems has widened considerably over the past 15 years, in part because of the evolvement of new technology for object recognition and sensor data fusion using artificial intelligence. As they represent "autonomy in weapon systems", automatic target identification and engagement functions are as intensively pursued as they

¹ Precision ammunition – launched without a specific target – which waits in a specified area for targets and then, either remotely or automatically, selects and engages them.



have been controversially discussed in terms of their inherent opportunities and risks in recent years.²

After eight years of discussions, the Bundeswehr decided in 2022 to arm the Heron TP. Apart from this, there is a threefold ambition when it comes to the use of uncrewed systems (not just UAVs).

Firstly, the Bundeswehr needs to ramp up its use of uncrewed systems across all domains, from transport systems for logistics to a renewed attempt in the field of loitering munitions. Otherwise, a capability gap looms in what is seen as a critical area for the 21st century. At the same time, the notoriously wide capability gap in the *countering* of uncrewed systems at close and very close ranges must be closed. Failing this, there is a danger of “death by a thousand drones” in the event of war.

Secondly, the Bundeswehr needs an official doctrine for dealing with uncrewed systems, especially with regard to the responsible use of autonomy in the critical functions of target selection and target engagement, which some loitering munitions have long been capable of. Depending on the operational context, autonomy may give rise to security-related, legal and ethical concerns, which makes it necessary for armed forces to establish a modern paradigm of human control. The lack of such a firmly established and clearly communicated doctrine could not only spell trouble for military interoperability with alliance partners but also lead to an international loss of influence in regulatory discourse on autonomy in weapons systems.

Thirdly, Germany needs to become even more active in pursuing international arms control talks, which were already slow to progress in the UN framework even before the Russian war of aggression.

In a nutshell, this is about the triad of *armaments*, *control* and *arms control*. The watershed moment “*Zeitenwende*” – in which we find ourselves – is both a window of opportunity and a challenge as none of the above goals can be achieved without a change in mentality, accelerated processes, and streamlined structures. As we know, more of the same is not an option.

The following look at an as-yet fictional near future illustrates a Bundeswehr approach to dealing with uncrewed systems which takes into account the three ambitions outlined above. This foresight method thus describes a specific desired future. It shows that, from Germany’s point of view, the objectives of armaments, control and arms control need not conflict with one another. This forms a basis from which to derive recommendations for action.

² See “The security-policy effects of digitisation: Future forms of conflict and conflict management”, Metis Study No. 1 (February 2018).





In the Drone Forest





Major Erkan Güler watched the Puma S4 gunner as she deftly climbed past the structures that had recently given her infantry fighting vehicle a bizarre appearance. Miika Kangaste gave him a puzzled look.

“Adversarial image insertion”, he explained. “Came in from Armed Forces Innovation Unit two days ago.”

“Installed that quickly ...?” muttered his Finnish colleague. “3D-printed?”

“Overnight, yeah. They took apart the hardware and software from those three reconnaissance drones we intercepted last week. The plastic dents on the Puma now disrupt their image recognition.”

Kangaste nodded appreciatively.

“All of it biodegradable, of course,” Güler added with a wink.

“Haha. Better leave the jokes to us Finns,” countered Kangaste. “So, does it work?”

“Looks like it. I don’t know what those things see now, but they definitely don’t recognise us anymore.”

“That’s how it should be,” asserted Miika before pointing toward the tower protruding from the infantry fighting vehicle. “But if they do, you can always use ... What do you call it? The sledgehammer.”

Not being discovered in the first place was the goal of Güler’s experimental unit. Failing that, the Puma would quickly detect enemy reconnaissance drones via sensor fusion and either disable them with a jammer or shoot them out of the sky with laser or airburst ammunition.

Some years ago, small, cheap and expendable systems had still threatened to make life extremely difficult for NATO land forces in particular. As a result, many armed forces, including the German Army, had since adapted by implementing appropriate defence measures and equipping vehicles and the infantry with compact electronic countermeasures.

Simpler, easy-to-use and expendable systems had also been introduced in NATO forces. The right lessons had been learned from the successes of the Ukrainian forces, which, in 2022, had not only fought off masses of tanks of the Russian invaders with inexpensive shoulder-launched guided missiles but also made clever use of commercial drones for reconnaissance and target acquisition, in some cases even as improvised weapon systems.

Dozens of small relay drones buzzed past Güler and Kangaste as they made their way to the command post. One after the other, they took up positions in the trees to establish laser point-to-point links for an ad hoc mesh network. Güler’s soldiers used encrypted radio only for seconds at a time, or ideally not at all. Their footprint in the electromagnetic spectrum had to remain as small as possible.

A hotwash was being held between two self-driving trucks near the camouflaged dugout. Some tempers were obviously flaring. It was clear that mistakes had been made which should not have been. Everyone got to say their piece in the hotwash, regardless of rank. Identify and analyse errors and avoid them next time round – that was what Güler had ordered his people to do. People were the all-important element in his unit, not technology. Thanks to their learning culture, they were flexible, agile and constantly improving when it came to using their assets. Most importantly, though, the constant back and forth with the enemy – the never-ending game of rock, paper, scissors – brought forth not only technological innovation but also ever new Achilles’ heels. Güler wanted his people to never rely too much on their equipment. If necessary, they would have to be able to go analogue and offline.



In the dugout, Güler and Kangaste took a look at the common operational picture in the JADC2S. Originally developed by the US Army as part of Project Convergence and by the US Navy as part of Project Overmatch, the now mature Joint All-Domain Command and Control System was on its way towards becoming NATO standard. Güler's and Kangaste's mission was to practice and further develop standardised tactics, techniques, procedures and interfaces. Every system and every sensor in the Alliance was to be able to "talk" with all the others in real time. The focus was on interoperability and speed, on identifying and pursuing enemy targets quickly and engaging them with the most suitable weapon. In short, on running through their own kill chain faster than the enemy. Güler and Kangaste were part of the generation that was beginning to leave behind the concept of separate services, traditional command structures, and individual weapon platforms. Officially, the desired end state was a lean, integrated, platform-agnostic command and control process based on decentralised communication infrastructures, which, supported by machines where necessary and appropriate, would make it easier for people to make faster and better decisions. At least that was the theory. The two of them were very aware that the PowerPoint slides in the ministries and their everyday military reality were still worlds apart. Some of the intended benefits were obvious to them, but despite having grown up with technology from an early age, years of experience had taught them to have a healthy dose of scepticism towards expensive and vulnerable technical solutions touted as a panacea. On this point, Güler would reliably quote Clausewitz and the "persistent fog of war", which Kangaste would reliably roll his eyes at.

"Jackpot!" shouted Kangaste when, a few minutes later, a change in the operational picture drew their attention.

"There they are!" confirmed Güler, who immediately began to study the weapon prompt generated by the system.

Two uncrewed ground vehicles had reconnoitred the enemy's artillery position. The fictitious enemy had indeed interrupted the electromagnetic spectrum, but this did not prevent the silent four-legged recon robots from fulfilling their mission because the machines used quantum magnetometers to navigate based on the earth's magnetic field. The command and control information system was now suggesting suitable weapon systems. During the exercise, it was up to Güler to issue the command to engage the target.

"It's Senkaku time", commented Kangaste, looking towards Güler.

He was alluding to the Senkaku Agreement, so named after the island group in the East China Sea, close to which, four years previously, a software error had caused a swarm of US Navy LOCUSTs (Low-Cost UAV Swarming Technology) to enter into battle with Chinese uncrewed fast patrol boats. At the very last minute, the two navies had managed to avoid skidding into a cascade of further automated strikes and counterstrikes, but the incident had given Beijing and Washington a real fright. Just three years later, an autonomy protocol was adopted within the UN framework which committed signatory states to self-restrictions on the use of autonomy in weapon systems and to regulating the human-machine relationship on the battlefield. Initiated by the rivalling United States and China and effectively promoted and driven forward by the EU, with Germany and France as the main drivers of progress and compromise, the agreement was eventually supported by an overwhelming majority of the international community and the permanent members of the UN Security Council – with the exception of Russia.



Güler and Kangaste now implemented the relevant requirements from the NATO doctrine, both fully aware that people had to retain the necessary level of control over critical decisions in all operational contexts. Machines were not able or allowed to do everything even if the technology were to develop to the point where that would technically be possible. Legal and ethical frameworks were one thing. But security policy also demanded prudence and common sense in light of the Senkaku incident: it was the stated intention of all responsible stake holders to prevent machines from ever accidentally triggering a war.

Güler checked the system's "airspace deconflicted" message. He then focused on finalising the last necessary steps. His time advantage and detailed knowledge of the situation on the ground in this simulated operational context allowed him to review each target individually before confirming engagement. Just 34 seconds later, four virtual self-propelled howitzers began firing precision-guided artillery grenades, while six loitering munitions darted for their targets.





Food for thought and recommendations for action

The above narrative once more illustrates the three central motives of this study.

Firstly, armaments: The Bundeswehr of the future is innovative and uses uncrewed systems in numerous contexts and for various purposes. It will also have widely deployed soft and hard kill capabilities to defend against them.

Secondly, control: The Bundeswehr of the future focuses on people and has developed a doctrine and context-dependent procedures for the responsible use of uncrewed systems, i.e. in compliance with legal, ethical and security policy frameworks.

Thirdly, arms control: Within the European framework, Germany will have actively used a window of opportunity and its influence to set a global standard and to thus help the rule-based world order to prevail.

If the future outlined here can be considered both possible and desirable, then we must consider what needs to be done to achieve it. The following three recommendations for action can point the way.

Armaments

Exploitation and communication of the full range of opportunities afforded by uncrewed systems and faster exploration of potential applications.

Much ink has been spilled and many a lively discussion has been had about the use of uncrewed systems as weapon carriers, in particular in the context of the German drone debate. The Bundeswehr and the Federal Ministry of Defence took their time to join this discussion. As part of the change in mentality in the wake of the "Zeitenwende", the Bundeswehr must be in a position to express its requirements clearly in the debate, which will undoubtedly continue, and also has to be willing and able to take on board justified criticism and objections.

To this day, there has also never been much focus on the enormous leverage that uncrewed systems – be they remotely controlled by humans or autonomous, at least in certain uncritical functions – can provide in areas such as logistics. Developments in defence technology have been ongoing in industry, institutes of applied research, and the Bundeswehr's universities for years. Partially and highly automated systems for trucks driven in military convoys are just one example of the support and protection that technology can provide in this context. More agility, more "living labs", and more eagerness to experiment are needed to shorten the procurement cycle, implement useful technology more quickly, and to explore and publicise a range of potential applications of uncrewed systems.

The German Cyber and Information Domain Service Headquarters is working on the extensive digitalisation of processes across all domains and is thus laying the foundation for a future digital architecture in which legacy systems will merge into a common situation picture for

command and control, reconnaissance, effects, and support and which will also incorporate uncrewed systems. This process also needs to be accelerated.

Control

Development and publication of a doctrine for the responsible development and use of uncrewed systems, particularly those with autonomy in the critical functions of target acquisition and engagement. The French Ministry of Defence specifically set up an ethics commission to deal with autonomy in weapon systems and the resulting report has been adopted as French national policy. The Pentagon is already revising its 2012 Directive 3000.09 on the development and use of autonomy in weapon systems for the third time. To date, Germany has nothing comparable. This is bad for communication with civil society actors, some of whom have justified concerns about risks. It is bad in terms of alliance partners and interoperability. It also impedes joint standard setting and the development, testing, certification, procurement and use of future systems such as FCAS.

Using weapon system autonomy responsibly means taking advantage of its opportunities while addressing its risks effectively by not unnecessarily delegating decisions over life and death to machines, by keeping legal accountability chains intact whenever military force is used, and by not accelerating all military processes to machine speed so as not to risk uncontrollable escalation cascades.

A policy document for the Bundeswehr that establishes effective human control over the Bundeswehr's weapon systems could do all this. As proposed by the International Committee of the Red Cross (ICRC), this document should also reject weapon systems that are aimed specifically at people (by means of target profiles that include facial features, body temperature, gait or other biometric human characteristics).

Arms control

Planning for the ice age of European arms control and developing new verification tools.

Conventional and nuclear arms control were already in a precarious state before 24 February 2022.³ In the context of the UN Weapons Convention in Geneva, a forum that is particularly relevant for this study, Russia was already well known as a spoiler state and major factor in the slow progress of talks on weapon system autonomy. With the war of aggression against Ukraine, the recent years of winter in arms control in Europe and with regard to Russia is now, unfortunately, not being followed by the expected spring but by an arms control ice age.

³ See "Nuclear arms control in crisis", Metis Study No. 18 (August 2020).



Arms control is not only plagued by political setbacks, however, but also by technological progress. It thus faces a double dilemma. On the one hand, many developments in the field of emerging and disruptive technologies defy traditional verification approaches and proven quantitative routines of counting, weighing and measuring.⁴ On the other hand, the war of aggression against Ukraine has caused trust in Russia to hit rock bottom, which has only made effective verification all the more vital, of course.

For the time being, arms control in Europe must once more be considered and practiced as a necessary and

complementary partner to deterrence and defence – as two sides of the same coin. Secondly, more efforts need to be made to develop new qualitative verification tools. And thirdly, more efforts need to be made to achieve “softer standards” in areas where binding agreements are currently not within reach. With a clear doctrinal position on uncrewed systems and weapon system autonomy, Germany, which now has the largest defence budget in Europe, would be more capable of setting standards in international forums as far as the latter is concerned.



⁴ See “Conventional arms control and emerging technologies”, Metis Study No. 20 (September 2020).

IMPRINT**Publisher**

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Image credits

Cover photo:
Christoph Ph. Nick / midjourney
p. 4 / 5 & 10: Christoph Ph. Nick / midjourney
p. 8: Frank Sauer / midjourney

Original title

*Unbemannte Systeme:
Rüstung, Kontrolle und Rüstungskontrolle*

Translation

Federal Office of Languages

ISSN-2627-0609

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