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Updated May 15, 2023

Defense Primer: U.S. Policy on Lethal Autonomous Weapon Systems (LAWS)(The Security Oracle, Inc. (TSO) comments are injected belowto demonstrate applicability and exclusiveness that is afforded TSO via the US Version of the DEFENSE and DENIAL Method and System Patentfor LAWS.)

Lethal autonomous weapon systems (LAWS) are a special class of weapon systems that use sensor suites and computer algorithms to independently identify a target and employ an onboard weapon system to engage and destroy the target without manual human control of the system. Although these systems are not yet in widespread development, it is believed they would enable military operations in communications-degraded or -denied environments in which traditional systems may not be able to operate.

TSO Comment 1: The patented TSO AI-driven systemis capable of identifyingmultiple targets and simultaneously employing onboard lethal and non-lethal weapon systems to engage and destroy the targets in priority without manual human control and does operate incommunications-degraded or -denied environments.

Contrary to a number of news reports, U.S. policy does not prohibit the development or employment of LAWS. Although the United States does not currently have LAWS in its inventory, some senior military and defense leaders have stated that the United States may be compelled to develop LAWS in the future if U.S. competitors choose to do so. At the same time, a growing number of states and nongovernmental organizations are appealing to the international community for regulation of or a ban on LAWS due to ethical concerns.

TSO Comment 2: Primary patent **claims 1 and 13** do not make a distinction between lethal and non-lethalcountermeasures so by defaultall such categories are included—particularly since in the patent spec is stated in paragraph 0010,

> "As an example, sensors may detect unauthorized presence of personnel near the premises of an electrical power substation and automatically direct cameras, initiate alarm sequences, acquire targeting signals, and aim weaponry (**non-lethal and/or lethal)** at the personnel. A user may then be able to take control of certain components (remotely or directly) to administer a non-lethal measure to repel the adversary with the benefit of time saved by actuators already being targeted on the adversaries. Non-lethal actuators may be preferred, which may exist in the form of directed emissions of light, sound, magnetic waves, chemicals, etc. …"

Developments in both autonomous weapons technology and international discussions of LAWS could hold implications for congressional oversight, defense investments, military concepts of operations, treaty-making, and the future of war.

U.S. Policy

Then-Deputy Secretary of Defense Ashton Carter issued DOD's policy on autonomy in weapons systems, Department of Defense Directive (DODD) 3000.09 (the directive), in November 2012. DOD has since updated the directive—most recently in January 2023.

Definitions. There is no agreed definition of lethal autonomous weapon systems that is used in international fora. However, DODD 3000.09 provides definitions for different categories of autonomous weapon systems for the purposes of the U.S. military. These definitions are principally grounded in the role of the human operator with regard to target selection and engagement decisions, rather than in the technological sophistication of the weapon system.

DODD 3000.09 defines LAWS as "weapon system[s] that, once activated, can select and engage targets without further intervention by a human operator." This concept of autonomy is also known as "human out of the loop" or "full autonomy." The directive contrasts LAWS with human-supervised, or "human on the loop," autonomous weapon systems, in which operators have the ability to monitor and halt a weapon's target engagement. Another category is semi-autonomous, or "human in the loop," weapon systems that "only engage individual targets or specific target groups that have been selected by a human operator." Semi-autonomous weapons include so-called "fire and forget" weapons, such as certain types of guided missiles, that deliver effects to human-identified targets using autonomous functions.

TSO Comment 3: In selected paragraphs of primary **claim 13** is described fully autonomous target(s) engagement(s) or **Human-Not-in-the-Loop** where weapons system[s] once activated, can select and engage targets without human operator intervention:

> "…wherein the application software includes fuzzy logic controller based automated

reasoning engine software programmed to automatically coordinate activation of the at least one actuator and sensor in accordance with fuzzy logic controller-based decision rules to detect, identify, and localize threats of occurrences and implement at least one countermeasure in response thereto;"

"…wherein the processor dynamically and continuously tracks and targets the threat and continuously delivers the at least one countermeasure to force a desired change in adversarial behavior of the threat that reduces or eliminates the risk to the physical asset and/or physical area presented by the threat;

The directive does not apply to autonomous or semi-autonomous cyberspace capabilities; unarmed platforms; unguided munitions; munitions manually guided by the operator (e.g., laser- or wire-guided munitions); mines; unexploded explosive ordnance; or autonomous or semi-autonomous systems that are not weapon systems, nor subject them to its guidelines.

Role of human operator. DODD 3000.09 requires that all systems, including LAWS, be designed to "allow commanders and operators to exercise appropriate levels of human judgment over the use of force." As noted in an August 2018 U.S. government white paper, "'appropriate' is a flexible term that reflects the fact that there is not a fixed, one-size-fits-all level of human judgment that should be applied to every context. What is 'appropriate' can differ across weapon systems, domains of warfare, types of warfare, operational contexts, and even across different functions in a weapon system."

TSO Comment 4: Per **claim 13**the fuzzy logic AI controllers are programmed (or embedded) with levels of human judgement (policy) that form parameters to automatically implement and constrain actions for what is appropriate for specific situations and locations.

"wherein the fuzzy logic controller-based decision rules are parameters programmed into the application software to identify the threats based on a probability of the occurrences creating a risk to a physical asset and/or a physical area and to direct activation of the at least one actuator and sensor during implementation of the at least one countermeasure;"

"wherein each countermeasure includes a probabilistic outcome of accomplishing: a) a reduction in the probability that the threats will cause the risk; and/or b) a delay in the time required for the threats to become the risk, wherein the probabilistic outcome for each countermeasure is determined by failure analysis modeling and the threat's response to the countermeasure;"

"wherein the response is the at least one countermeasure that will be carried out by the at least one actuator that has the highest probabilistic outcome of accomplishing the reduction and/or delay;"

"wherein the processor dynamically and continuously tracks and targets the threat and continuously delivers the at least one countermeasure to force a desired change in adversarial behavior of the threat that reduces or eliminates the risk to the physical asset and/or physical area presented by the threat;"

"transmitting, by the computer network using the at least one fuzzy logic controller, countermeasure data representative of the response to at least one actuator;"

"activating, based on the countermeasure data, the at least one actuator to implement the response;"

TSO's patented software engine is/arefuzzy logic constraint-based automated reasoning AI controller(s) that inhibit activation of countermeasures based on an analysis of context factors including political, environmental, technological, and social context factors per **claim 18**, which is subordinate to primary **claim 13**.

One major reason TSO selected fuzzy logic AI (constraint-based automated reasoning) as the overarching software control system is that it operates within the parameters intended by humans, whereas, other types of AI may create its own policy and act in conflict with human intentions.

Furthermore, "human judgment over the use of force" does not require manual human "control" of the weapon system, as is often reported, but rather broader human involvement in decisions about how, when, where, and why the weapon will be employed. This includes a human determination that the weapon will be used "with appropriate care and in accordance with the law of war, applicable treaties, weapon system safety rules, and applicable rules of engagement."

To aid this determination, DODD 3000.09 requires that "[a]dequate training, [tactics, techniques, and procedures], and doctrine are available, periodically reviewed, and used by system operators and commanders to understand the functioning, capabilities, and limitations of the system's autonomy in realistic operational conditions." The directive also requires that the weapon's human-machine interface be "readily understandable to trained operators" so they can make informed decisions regarding the weapon's use.

Weapons review process. DODD 3000.09 requires that the software and hardware of covered semi-autonomous and autonomous weapon systems, be tested and evaluated to ensure they

function as anticipated in realistic operational environments against adaptive adversaries taking realistic and practicable countermeasures, [and] complete engagements within a timeframe and geographic area, as well as other relevant environmental and operational constraints, consistent with commander and operator intentions. If unable to do so, the systems will terminate the engagement or obtain additional operator input before continuing the engagement.

Systems must also be "sufficiently robust to minimize the probability and consequences of failures." Any changes to the system's operating state—for example, due to machine learning—would require the system to go through testing and evaluation again to ensure that it has retained its safety features and ability to operate as intended. The directive also notes that "the use of AI capabilities in autonomous or semi-autonomous systems will be consistent with the DOD AI Ethical Principles."

TSO Comment 5:Ourrobust patented system [per **claim 13**] was fielded and its fuzzy logic AI control units self-maintained 99.99% uptime in 200,000+ hours of continuous operation. No hardware repairs or maintenance were required either over 5 years.

The patented software engine is/are constraint-based automated reasoning fuzzy logic AI controller(s) that inhibit activation of countermeasures based on an analysis of context factors including political, environmental, technological, and socialcontext factors per claim 18, which is subordinate to primary claim 13.

So regardless of inputs from machine learning AI, the system's behavior is automatically controlled within preprogrammed boundariescoded into the patented constraint-based fuzzy logic AI controllers governed by context factors.

Senior-level review. In addition to the standard weapons review process, a secondary senior-level review is required for covered autonomous and semi-autonomous systems. This review requires the Under Secretary of Defense for Policy (USD[P]), the Vice Chairman of the Joint Chiefs of Staff (VCJCS), and the Under Secretary of Defense for Research and Engineering (USD[R&E]) to approve the system before formal development. USD(P), VCJCS, and the Under Secretary of Defense for Acquisition and Sustainment (USD[A&S]) must then approve the system before fielding. In the event of "urgent military need," this senior-level review may be waived by the Deputy Secretary of Defense. DODD 3000.09 additionally establishes the Autonomous Weapon System Working Group—composed of representatives of USD(P); USD(R&E); USD(A&S); DOD General Counsel; the Chief Digital and AI Officer; the Director, Operational Test and Evaluation; and the Chairman of the Joint Chiefs of Staff—to support and advise the senior-level review process.

International Discussions of LAWS

Since 2014, the United States has participated in international discussions of LAWS, sometimes colloquially referred to as "killer robots," under the auspices of the United Nations Convention on Certain Conventional Weapons (U.N. CCW). In 2017, these discussions transitioned from an informal "meeting of experts" to a formal "Group of Governmental Experts" (GGE) tasked with examining the technological, military, ethical, and legal dimensions of LAWS. In 2018 and 2019, the GGE has considered proposals by states parties to issue political declarations about LAWS, as well as proposals to regulate them.

In addition, approximately 30 countries and 165 nongovernmental organizations have called for a preemptive ban on LAWS due to ethical concerns, including concerns about operational risk, accountability for use, and compliance with the proportionality and distinction requirements of the law of war. The U.S. government does not currently support a ban on LAWS and has addressed ethical concerns about the systems in a March 2018 white paper, "Humanitarian Benefits of Emerging Technologies in the Area of Lethal Autonomous Weapons." The paper notes that "automated target identification, tracking, selection, and engagement functions can allow weapons to strike military objectives more accurately and with less risk of collateral damage" or civilian casualties.

Although the U.N. CCW is a consensus-based forum, the outcome of its discussions could hold implications for U.S. policy on lethal autonomous weapons.

Potential Questions for Congress

- What is the status of U.S. competitors' development of LAWS? Is the United States adequately investing in counter-autonomy capabilities?
- To what extent, if at all, should the United States initiate or accelerate its own development of LAWS?
- How should the United States balance LAWS research and development with ethical considerations? What, if any, restrictions should there be on DOD's development or employment of LAWS?
- If the United States chooses to develop LAWS, are current weapons review processes and legal standards for their employment in conflict sufficient?
- What role should the United States play in U.N. CCW discussions of LAWS? Should the United States support the status quo, propose a political declaration, or advocate regulation of or a ban on LAWS?

CRS Products

CRS In Focus IF11294, *International Discussions Concerning Lethal Autonomous Weapon Systems*, by Kelley M. Sayler.

CRS Report R45178, *Artificial Intelligence and National Security*, by Kelley M. Sayler.

CRS Report R45392, *U.S. Ground Forces Robotics and Autonomous Systems (RAS) and Artificial Intelligence (AI): Considerations for Congress*, coordinated by Andrew Feickert.

Other Resources

Department of Defense Directive 3000.09, "Autonomy in Weapon Systems," Updated January 25, 2023, https://www.esd.whs.mil/portals/54/documents/dd/issuances/dodd/300009p.pdf.

U.S. Government, "Humanitarian Benefits of Emerging Technologies in the Area of Lethal Autonomous Weapons," March 28, 2018.

U.S. Government, "Human-Machine Interaction in the Development, Deployment and Use of Emerging Technologies in the Area of Lethal Autonomous Weapons Systems," August 28, 2018.

United Nations Office at Geneva, "Background on Lethal Autonomous Weapons Systems in the CCW."

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