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LAWS, disarmament and the case for science anticipation

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Abstract

In 2007, the roboticist Noel Sharkey warned readers of The Guardian *that the international community was "sleepwalking into a brave new world where robots decide who, where and when to kill". Almost two decades on, formal negotiations on a binding instrument governing lethal autonomous weapons systems (LAWS) have yet to begin. This article asks why the disarmament system struggles to keep pace with the weaponization of emerging science and technology. Drawing on twenty-nine interviews with State delegates and civil society representatives, an interdisciplinary workshop and the ongoing efforts to govern LAWS, it identifies three families of obstacles: the structure of the fora themselves; gaps in capacity and expertise; and a pre-emptive disarmament paradox whereby the systems most in need of anticipatory regulation are those for which the empirical case for harm is least available. Arguing that science anticipation, mediated by honest-broker networks, is an under-used corrective, the article proposes three measures: embedding standing scientific advice in fora that lack it, modernizing Article 36 reviews, and building an anticipatory issue tracker capable of putting an expert-validated picture of harm into diplomatic conversation before civilians bear its cost.*

Keywords: lethal autonomous weapons systems, disarmament, science anticipation, Article 36 weapons reviews, emerging technologies.

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Introduction

"The ultimate objective of disarmament is to save humanity and to save lives", António Guterres, the Secretary-General of the United Nations (UN), reminded the international security community in 2018 when launching his new agenda for disarmament, *Securing Our Common Future*.[1] While reiterating the priorities of the UN, Guterres spoke about the importance of bringing together scientists and engineers committed to developing "science and technology for peaceful purposes", declaring that the international community "urgently needs their insights".[2] Eight years on, the threats to civilians posed by modern weapons have only increased in frequency and intensity, while the Secretary-General's call to integrate scientific perspectives

1 António Guterres, "UN Secretary-General: An Agenda for Disarmament – Securing our Common Future", *YouTube*, 24 May 2018, available at: www.youtube.com/watch?v=EaYvr63Lfhg (all internet references were accessed in October 2026).

2 *Ibid.*

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and revitalize multilateral disarmament remains largely unanswered. Instead, amid today's deteriorating security environment, States are rushing to arm and rearm, doing so with new means and methods of warfare that integrate technology whose compliance with international law has yet to be adequately addressed. World military expenditure rose by 9.4% in 2024 – the steepest year-on-year rise since at least the end of the Cold War – and increasing portions of this spending worldwide are devoted to studying the application of emerging technologies for military purposes.[3] Underpinned by an investment surge of some $12 billion into so-called defence tech, actors involved in developing military technologies have multiplied to include small start-ups and technology companies with varying knowledge of and commitment to the rules protecting civilians.[4]

The tools of war are rapidly changing, yet the systems built to regulate them are not evolving at the same pace. This paper examines the structural causes of a slow-to-respond international system and suggests changes to make that system more effective. It takes as a starting point the decade-long multilateral debate on lethal autonomous weapons systems (LAWS), today the international community's most urgent attempt to regulate an emerging military technology. The first section tells the story of that slow process, from Noel Sharkey's first warning in 2007 to the "rolling text" on the table at the Convention on Certain Conventional Weapons' (CCW) Group of Governmental Experts (GGE) on LAWS at the time of writing (July 2026). The second section looks at what efforts to govern LAWS have revealed about the disarmament system more broadly and its ability to deal with challenges linked to emerging science and technology (S&T). Drawing on interviews conducted in mid-2025 with disarmament delegates from twenty different States and nine different civil society organizations, most of whom spoke on condition of anonymity, followed by an interdisciplinary workshop with leading academics, analysts and disarmament actors, we identify a recurrent set of obstacles that the LAWS process surfaces.[5] They fall into three families: structural problems with the fora themselves; a compounding set of capacity and expertise gaps; and the distinctive difficulty of building a case for harm that has either not yet occurred or not yet been well documented. The third section lays out avenues for ensuring that multilateral arms control will remain fit for the present – and the future – amidst an accelerating technological landscape. We

3 Xiao Liang *et al.*, "Trends in World Military Expenditure, 2024", fact sheet, Stockholm International Peace Research Institute (SIPRI), April 2025, available at: https://doi.org/10.55163/avec8366. See also UN, "Securing Our Common Future: An Agenda for Disarmament", available at: www.un.org/disarmament/sg-agenda/en/.

4 Valeriya Ionan, "What Ukraine's Wartime Tech Ecosystem Can Teach the Rest of the World", Atlantic Council, 8 April 2026, available at: www.atlanticcouncil.org/dispatches/what-ukraines-wartime-tech-ecosystem-can-teach-the-rest-of-the-world/; Sylvia Pfeifer and Ivan Levingston, "Wars Trigger $12bn Venture Capital Rush into Defence Tech", *Financial Times*, 21 June 2026, available at: https://tinyurl.com/t9jh87ph.

5 Most interviews took place in June and July of 2025. See Annex 1 for a list of representatives of States and organizations interviewed; notably, these did not include some of the major States leading the development of artificial intelligence (AI)-integrated weapons. The workshop, entitled "Revitalizing Disarmament through Science Anticipation: How Multilateralism Can Contend with the Rapid Weaponization of Emerging Technology", took place at the October 2025 GESDA Summit, in collaboration with the Geneva Centre for Security Policy. See Annex 1 for list of States and organizations present.

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set out three recommendations: integrating scientific expertise more systematically; modernizing Article 36 reviews; and leveraging science anticipation to prevent the most important risks to civilians. While some obstacles to disarmament stem from broader geopolitical tensions, the current system also lacks anticipatory capacity: it is not able to systematically identify or act upon the weaponization of emerging S&T before harm is visible. Underlying the analysis is what we call the pre-emptive disarmament paradox: systems that need pre-emptive regulation are the ones for which the traditional machinery of humanitarian advocacy – which requires building an empirical case – is least available. Remaining fit for purpose requires a more proactive approach. Fortunately, many of the required tools already exist.

Before we proceed, a word on terminology is warranted. "Science anticipation", as we use the term, denotes the practice of identifying and scoping the major scientific advances most likely to reshape society and translating those projections into actionable insights for policy-makers before disruptions arise. The Geneva Science and Diplomacy Anticipator (GESDA), which produces an annual Science Breakthrough Radar® across five-, ten- and twenty-five-year time horizons, is one institutional example, but the principle is broader, encompassing any structured effort to bring forward-looking scientific judgement into deliberation before crises materialize, thereby maximizing the benefits of scientific breakthroughs while mitigating the risk that they will widen inequalities or contribute to conflict.[6] The relevance of science anticipation to disarmament challenges is becoming more widely acknowledged: in consultations for the International Committee of the Red Cross's (ICRC) Global Initiative to Galvanize Political Commitment to International Humanitarian Law (Global IHL Initiative), Colombia, for example, equated anticipatory governance with "an essential humanitarian responsibility" that enables the humanitarian disarmament community to prevent foreseeable harms.[7]

Efforts to govern LAWS

On 17 August 2007, roboticist and professor Noel Sharkey warned readers of *The Guardian* that the international community was "sleepwalking into a brave new world where robots decide who, where and when to kill".[8] Sharkey had discovered the use of military robots through his research on the ethics of robotics and emerging technologies. He was damning in his condemnation of the US, South Korean,

6 GESDA, "GESDA's Approach to Science Anticipation 2026", 2026, available at: https://radar.gesda.global/science-anticipation/gesd-as-approach-to-science-anticipation-2026/. See also GESDA, *Anticipatory Science Diplomacy: A Framework for Global Action*, Geneva, 2025. Of note, while science anticipation is of course anticipatory in nature, science diplomacy is the practice of using scientific collaboration and knowledge to address global challenges and improve international relations.

7 Colombia, "Colombia Interventions", statement presented at the Global IHL Initiative Third Consultation with States on IHL and Peace, 5 February 2026, available: www.upholdhumanityinwar.org/sites/default/files/2026-03/COLOMBIA%20-%20Global%20IHL%20Initiative%20-%20WS3%20IHL%20and%20Peace%20-%203rd%20state%20consultation%20-%20statement.pdf.

8 Noel Sharkey, "Robot Wars Are a Reality", *The Guardian*, 18 August 2007, available at: www.theguardian.com/commentisfree/2007/aug/18/comment.military.

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Israeli, Chinese and UK militaries for handing over "decisions on human fatality to machines not bright enough to be called stupid".[9] Sharkey ended with a call to action for diplomats to immediately "create international legislation and a code of ethics on autonomous robots at war before it is too late".[10] In doing so, he was the first to sound the alarm on autonomous weapons.

As of July 2026, LAWS – also called "killer robots" – have been in public discourse for almost two decades. The term refers to systems that can select and attack targets with differing levels of autonomy.[11] From 2007 to 2013, the issue of LAWS was raised continually by civil society actors, who advocated for their prohibition and regulation in various multilateral fora, from State parliaments to civil society spaces to the UN in Geneva and New York. In April 2013, non-governmental organizations (NGOs) launched the Stop Killer Robots campaign to work for an international ban on autonomous weapons systems. Under this pressure, in November 2013, States party to the CCW agreed to a mandate to begin informal discussions on LAWS, promising to discuss their implications for international humanitarian law (IHL).[12]

According to Mary Wareham of Human Rights Watch, founding coordinator of the Stop Killer Robots campaign, it was Sharkey, Peter Asaro and their colleagues at the International Committee for Robot Arms Control who brought concerns over autonomous weapons systems to civil society's attention.[13] These "activist academics" were pivotal not only in anticipating the dangers raised by removing human control from the use of force but also in working in cooperation with civil society to jointly address this challenge, an example of science anticipation in action.[14] As of July 2026, almost two decades after Sharkey's initial call to action and over a decade since the initial mandate to discuss the LAWS issue, discussions at the CCW moved to formal talks in 2016, but States Parties have yet to agree on a mandate to negotiate a legally binding instrument on LAWS.[15] A draft "rolling text" working document produced by the Dutch chair of the CCW's GGE on LAWS has articulated the main elements of a possible instrument, but discussions have

9 *Ibid.*

10 *Ibid.*

11 Stop Killer Robots, "The Story so Far", available at: www.stopkillerrobots.org/the-story-so-far/.

12 CCW, *Meeting of High Contracting Parties to the Convention on Prohibitions or Restrictions on the Use of Certain Conventional Weapons Which May Be Deemed to Be Excessively Injurious or to Have Indiscriminate Effects, 2013 Session: Final Report*, UN Doc. CCW/MSP/2013/CRP.1, 16 December 2013, para. 32, available at: https://digitallibrary.un.org/record/3856236?ln=en&v=pdf.

13 Interview with Mary Wareham, then Deputy Crisis, Conflict and Arms Director, Human Rights Watch, 18 June 2025. The other co-founders of the International Committee for Robot Arms Control are Rob Sparrow and Jürgen Altmann, chair of the German Research Association for Science, Disarmament and International Security.

14 Interview with Mary Wareham, above note 13.

15 The GGE did produce guiding principles in 2019: see GGE, "Guiding Principles Affirmed by the Group of Governmental Experts", in *Meeting of the High Contracting Parties to the Convention on Prohibitions or Restrictions on the Use of Certain Conventional Weapons Which May Be Deemed to Be Excessively Injurious or to Have Indiscriminate Effects: Final Report*, UN Doc. CCW/MSP/2019/9, 13 December 2019, Annex III.

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not yet crossed into formal negotiations.[16] At the time of writing, a legally binding instrument still lies just out of reach.

The political ground, however, has moved as the push for regulation has gained momentum. At the September 2025 GGE session, Brazil delivered a joint statement on behalf of forty-two States declaring that the rolling text was a sufficient basis from which to begin negotiations.[17] In November 2025, the UN General Assembly's First Committee on Disarmament and International Security (First Committee) adopted its third consecutive resolution on autonomous weapons systems with 156 States in favour, calling on High Contracting Parties of the CCW to "work towards completing the set of elements for an instrument being developed within the mandate of the Group of Governmental Experts, with a view to future negotiation".[18] With the GGE's mandate running until the Seventh CCW Review Conference in late 2026, the Conference is the decisive juncture: States can either authorize negotiations on a new protocol or watch the opportunity slip away again. For the first time since Sharkey's warning, both options are on the table. Either way, the LAWS talks are the clearest test of whether multilateral disarmament can regulate an emerging technology before it matures. However, the obstacles that these discussions have exposed, as the next section argues, are not unique to LAWS.

Challenges with (pre-emptive) disarmament

The arc from Sharkey's warning to today exposes several systemic weaknesses of the disarmament ecosystem. In this section, we briefly go over how that ecosystem is structured and then lay out the recurrent set of obstacles that emerged from our conversations with many of the actors involved in the ongoing LAWS discussions. These obstacles fall into three families: structural problems with the fora themselves; a compounding set of capacity and expertise gaps; and specific challenges for pre-emptive disarmament. "Pre-emptive disarmament", as we use the term, denotes the practice preventing the deployment of certain weapons before they reach the battlefield. Of note, many of these points are best read as compounding factors: for example, thin delegation capacity widens the expertise gap, which no standing scientific mechanism exists to close.

How the system is structured

Within the complex and layered ecosystem of multilateral disarmament, each body serves a particular purpose depending on its scope, membership and mandate. These

16 See GGE on LAWS, *Report of the 2024-2025-2026 Sessions of the Group of Governmental Experts on Emerging Technologies in the Area of Lethal Autonomous Weapons Systems*, UN Doc. CCW/GGE.1/2026/CRP.1/Rev.1, 3 September 2026, available at: https://docs-library.unoda.org/Convention_on_Certain_Conventional_Weapons_-Group_of_Governmental_Experts_on_Lethal_Autonomous_Weapons_Systems_(2026)/CCW-GGE.1-2026-CRP.1-Rev.1_-_03_September_.pdf.

17 "Joint Statement to the September 2025 Session of the CCW GGE LAWS", available at: https://tinyurl.com/496stppz.

18 Stop Killer Robots, "156 States Support UNGA Resolution on Autonomous Weapons", 6 November 2025, available at: www.stopkillerrobots.org/news/156-states-support-unga-resolution/.

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fora are generally split between New York and Geneva, with some additional ones in Vienna and The Hague. Location is largely a historical proxy for an underlying division in function: political deliberations usually take place in New York, whereas negotiations on binding legal instruments have historically tended to be in Geneva. It is also correlated with how high the threshold for agreement is set: negotiations in Geneva are generally carried out by consensus, whereas majority support is typically sufficient in New York. Treaty implementation bodies – weapon-specific fora where States having ratified the respective treaties meet – are largely Geneva-based. Decision-making rules vary by treaty.

In New York, the main deliberative disarmament body is the UN General Assembly First Committee, where all disarmament topics can be discussed, all UN member States are included and decisions are made by majority vote. The UN Disarmament Commission (UNDC) is also situated in New York and operates as a deliberative body with a broad mandate to discuss questions pertaining to disarmament. It strives to make decisions based on consensus.[19] States have the option to vote for or against, or abstain from, any decision; no State can directly veto decisions in any of these fora. Although these bodies impose no binding substantive obligations, their decisions nonetheless carry real institutional force. The UN General Assembly can establish subsidiary organs, mandate negotiating conferences and apportion their costs over the objection of any State.[20]

Geneva hosts the Conference on Disarmament (CD), the single standing multilateral forum mandated to negotiate binding disarmament treaties, whose restricted membership of sixty-five includes all nuclear-armed States.[21] Decisions are made by consensus. Geneva is also where most of the implementation support units for other specialized humanitarian disarmament treaties are based, including the Anti-Personnel Mine Ban Convention (APMBC), the Biological Weapons Convention (BWC), the Convention on Cluster Munitions (CCM) and the CCW – the body where ongoing discussions on LAWS are taking place. The Hague hosts the Organization for the Prohibition of Chemical Weapons (OPCW), while the Comprehensive Nuclear-Test Ban Treaty Organization (CTBTO) is located in Vienna. Membership in these bodies is comprised of States that have ratified the respective conventions.

The principle of consensus is defined in a 2005 UN legal opinion as "the absence of objection rather than a practical majority".[22] This principle was designed to give a voice to smaller delegations who, due to serious national security concerns,

19 In theory, the UNDC can turn to a majority vote; in practice, however, it has not resorted to this option and has consequently struggled for years to reach consensus on substantive agenda items. See *Report of the Disarmament Commission*, UN Doc. A/33/42(Supp), 1978, p. 2, "Rules of Procedure", available at: https://docs.un.org/en/A/33/42(SUPP).

20 UN General Assembly, "Functions and Powers of the General Assembly", available at: www.un.org/en/ga/about/background.shtml.

21 UN Office at Geneva, "Disarmament", available at: www.ungeneva.org/en/about/topics/disarmament.

22 UN, "Selected Legal Opinions of the Secretariats of the United Nations and Related Intergovernmental Organizations", in *United Nations Juridical Yearbook 2005*, 2009, p. 457, available at: https://legal.un.org/unjuridicalyearbook/pdfs/english/volumes/2005.pdf.

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might disagree with the majority. Treating the principle of consensus as a veto was intended to be a last resort.[23] In practice, the consensus rule has been used to block meaningful progress on substantive regulation, leading to deadlock. In response, States and civil society actors seeking more protective regulation have bypassed consensus bodies to negotiate the APMBC, the CCM and, in 2017, the Treaty on the Prohibition of Nuclear Weapons (TPNW) – the first two through the Ottawa and Oslo processes, and the third through a First Committee-mandated negotiating conference. The trade-off concerned the participation of possessor States: no nuclear-armed State participated in the negotiations for the TPNW, for example,[24] and none has joined the treaty. There is an underlying disagreement between the arms control and humanitarian disarmament traditions, visible in the LAWS debate, about whether binding possessor States is worth weaker treaty provisions.

A list of different disarmament conventions and their characteristics is provided in Table 1. For a more comprehensive list, see Annex 2, which includes an overview of ratification numbers.

Recurring challenges

The fora themselves

a. *Where debate happens.* In our interviews, many States and NGOs expressed frustration at how the issue of LAWS has been dealt with in the CCW. The principle of consensus has meant that a single State can stall even the beginning of substantive discussion by debating any element of the agenda. Scrutiny of agenda or procedural items has been known to derail sessions of the GGE, preventing States from producing tangible outcomes and resulting in a "lowest common denominator" product that makes little to no substantive progress on the issue at hand.[25] Wareham noted that the first multilateral forum to consider the challenges raised by LAWS was the Human Rights Council in May 2013, but major military powers insisted on opening discussions in the CCW later that year.[26] She believes that the issue has since stagnated because of the abuse of the consensus by certain military powers as well as a fixation on technical, legal and military minutiae. While some States expressed appreciation for the

23 Anonymous interviews with European delegates, 14 and 16 July 2025.

24 UNGA Res. 71/258, "Taking Forward Multilateral Nuclear Disarmament Negotiations", 23 December 2016, adopted by 113 votes to thirty-five with thirteen abstentions. The TPNW was adopted on 7 July 2017 by 122 votes to one, with one abstention; there was no participation by any nuclear-armed State.

25 Interview with Bonnie Docherty, Harvard Law School International Human Rights Clinic, 27 June 2025. The phrase "lowest common denominator" appeared in multiple interviews with State actors: anonymous interview with European State delegate, 19 June 2025; anonymous interview with European State delegate, 1 July 2025.

26 Interview with Mary Wareham, above note 13; Stop Killer Robots, above note 11. See also Christof Heyns, *Report of the Special Rapporteur on Extrajudicial, Summary or Arbitrary Executions*, UN Doc. A/HRC/23/47, 9 April 2013, available at: https://digitallibrary.un.org/record/755741?v=pdf.

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Table 1. *Existing disarmament instruments and their characteristics*

Instrument/forum name	Location	Decision-making	Forum type	Key characteristics
UN General Assembly (First Committee)	New York	Majority vote	Deliberative forum	Politically inclusive; adopts non-binding resolutions that shape norms and creates mandates that lead to treaty negotiations.
UN Disarmament Commission	New York	Consensus	Deliberative forum	Universal membership; broad participation; builds common positions without binding outcomes.
Conference on Disarmament	Geneva	Consensus	Negotiating platform	Deadlocked for decades; any State can block progress under consensus rule.
Convention on Certain Conventional Weapons	Geneva	Consensus	Treaty framework	Flexible through protocols; constrained by consensus on new issues.

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Instrument/forum name	Location	Decision-making	Forum type	Key characteristics
Anti-Personnel Mine Ban Convention	Geneva	Majority vote	Treaty framework	Membership by signatory and ratification status.
Biological Weapons Convention	Geneva	Consensus	Treaty framework	Membership by signatory and ratification status.
Convention on Cluster Munitions	Geneva	Majority vote	Treaty framework	Membership by signatory and ratification status.
Organization for the Prohibition of Chemical Weapons	The Hague	Soft consensus – allows for two-thirds majority vote	Treaty framework	Membership by signatory and ratification status.
Comprehensive Nuclear-Test-Ban Treaty Organization	Vienna	Soft consensus – allows for majority vote	Treaty framework	Not in force; supported by science and technology conference.

Source: compiled by the authors from the constitutive instruments and rules of procedure of each body. For further information, see UN Office for Disarmament Affairs, "Our Work", available at: https://disarmament.unoda.org/en.

CCW's technical focus in helping actors from non-technical backgrounds grapple with the concept of LAWS, even they admit that this utility has run its course.[27] Some State and civil society actors expressed a belief that it will take a move to the UN General Assembly, where every UN member has a vote and majority decision-making takes precedence over consensus, or removal from UN structures entirely, to see a successful multilateral written agreement on LAWS – especially if the hope is to produce a legally binding treaty.[28]

b. *No systematic integration of credible and trusted scientific expertise.* Each disarmament body and convention takes a different approach to the integration of scientific expertise.[29] While some disarmament bodies have embedded scientific advisory boards (SABs),[30] others lack a mechanism through which to equip delegates with the required expertise to effectively regulate emerging S&T. Geneva is home to the CCW, and despite the intrinsically technical nature of the content discussed in the CCW, it does not have a SAB of independent technical advisers or a conference to otherwise integrate the scientific community into its disarmament efforts – let alone a mechanism for anticipating and flagging emerging developments of relevance.[31] Since 2021, discussions have been taking place within the BWC to establish an S&T review mechanism, but they have not yet been successful.[32] Switzerland's 2016 proposal and its subsequent collaboration with India to champion the CCW as the appropriate host of conversations on S&T have made progress possible through individual States' efforts, but the absence of a formal mechanism leaves S&T

27 Anonymous interview with African State delegate, 18 June 2025.

28 Anonymous interview with Latin American State delegate, 16 June 2025; interview with Nicole Van Rooijen, Executive Director, Stop Killer Robots, 18 June 2025.

29 See Annex 2 for further detail on integration of scientific expertise.

30 The TPNW built science advisory into its institutional architecture at the first Meeting of States Parties in 2022, establishing a fifteen-person Science Advisory Group. The OPCW contains its own embedded SAB, which every five years prepares a large report on developments in S&T relevant to the Chemical Weapons Convention (CWC) for submission to Review Conferences of the CWC. The CTBTO invites the international scientific and technological community to a CTBT: Science and Technology Conference, and has done so every two years since 2009. See International Campaign to Abolish Nuclear Weapons (ICAN), "Scientific Advisory Group: Informal Intersessional Work", available at: www.icanw.org/tpnw_scientific_advisory_group; OPCW, "Scientific Advisory Board: Keeping Pace with Scientific and Technological Change", available at: www.opcw.org/about/subsidiary-bodies/scientific-advisory-board; CTBTO, "CTBT: Science and Technology Conferences", available at: www.ctbto.org/news-and-events/science-and-technology-conference.

31 The text of the CCW does not include a mandate to create a SAB entity. Convention on Prohibitions or Restrictions on the Use of Certain Conventional Weapons Which May Be Deemed to Be Excessively Injurious or to Have Indiscriminate Effects, 1342 UNTS 137, 10 October 1980 (entered into force 2 December 1983), available at: https://treaties.unoda.org/t/ccw.

32 James Revill, Aditi Anand and Giacomo Persi Paoli, *Exploring Science and Technology Review Mechanisms under the Biological Weapons Convention*, UN Institute for Disarmament Research (UNIDIR), Geneva, 2021, available at: https://doi.org/10.37559/SECTEC/2021/SandTreviews/01.

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conversations *ad hoc* and sponsor-dependent.[33] The result is a disarmament space in which the diplomats who most need trusted technical advice cannot access it systematically.

Capacity and expertise gaps

c. *Uneven capacity and under-represented voices.* In our conversations, delegates from under-represented States, often from the global South, described being sole representatives for disarmament while juggling several other responsibilities; lacking ready access to technical experts from their home countries; depending on already stretched NGO support; and seeing other priorities (trade, health, education) claim limited resources first.[34] These constraints are exacerbated by the infrequent pooling of human resources, information and coordinated stances at the regional level. Faced with the foreign policy machinery of heavily armed States, individual voices from smaller delegations are routinely sidelined in negotiations. The default vehicle for collective positions on disarmament remains Cold War-era coalitions such as the Non-Aligned Movement, which can be a powerful voice for the global majority, but whose broad membership can pose coordination challenges in highly specialized negotiations. As a result, the very States whose populations are most likely to suffer the harm of emerging weapons have the least capacity to shape the rules governing the use of those weapons; civilians from these affected States play no role in developing the rules, yet are historically the first to bear the costs.[35] In an interview, Wareham noted that this historic imbalance has been and can continue to be challenged. There is precedent for both civilian and State actors from these affected countries to play a prominent role in developing norms to address these weapons, as was done by, for example, Cambodia and Mozambique during the Ottawa Process to ban anti-personnel landmines or Laos and Lebanon during the Oslo Process to prohibit cluster munitions.[36]

d. *Technical complexity and the expertise gap.* The capacity gap becomes more salient when it relates to highly technical topics of emerging S&T, such as LAWS. Even today, as LAWS enter their thirteenth year of discussions,

33 Anonymous interview with Swiss delegate, 23 February 2026; see also Fifth Review Conference of High Contracting Parties to the CCW, *CCW: Consideration of Developments in Science and Technology that May Be Relevant to the Work of the Convention on Certain Conventional Weapons*, UN Doc. CCW/CONF.V/WP.4, 5 December 2016, available at: https://docs-library.unoda.org/Convention_on_Certain_Conventional_Weapons_Fifth_Review_Conference_(2016)/CCW_CONF.V_WP.4.pdf.

34 Anonymous interview with Latin American State delegate, 16 June 2025; anonymous interview with African State delegate, 19 June 2025; anonymous interview with African State delegate, 7 July 2025; anonymous interview with European State delegate, 25 June 2025; anonymous interview with European State delegate, 14 July 2025.

35 Anonymous interview with African State delegate, 19 June 2025; anonymous interview with African State delegate, 16 July 2025.

36 Interview with Mary Wareham, above note 13.

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there is a wide disparity in levels of understanding of the technical complexity of these systems. Owing in part to frequent diplomatic rotations and differences in delegate profiles,[37] many States admitted to finding it incredibly difficult to keep up with the conversation on weapons of such technical complexity.[38] Importantly, this expertise gap undermines delegates' ability to productively challenge assumptions about the capabilities of these new technologies. While LAWS are framed by some as presenting an indispensable strategic advantage, for instance, the importance and reliability of their military benefits are debated.[39] Even Anthropic, the first artificial intelligence (AI) developer to deploy its models on US military networks, notably stated that "frontier AI systems are simply not reliable enough to power fully autonomous weapons".[40] In war-game simulations, AI decision-support models also lead to undesirable and often catastrophic outcomes, such as inadvertent escalation,[41] and they exhibit a propensity to threaten or resort to nuclear strikes at alarming rates.[42] Unchallenged assumptions on LAWS' military benefits and overconfidence in their effectiveness have contributed to an arms race dynamic which might not have unfolded in the same way if States had more immediately been confronted with these systems' limitations.

Specific challenges for pre-emptive disarmament

e. *Establishing a credible pattern of harm.* The most distinctive challenge of regulating emerging weapons is what we call the pre-emptive disarmament paradox: the very systems that most need pre-emptive regulation are the ones for which the traditional machinery of humanitarian advocacy, which requires building an empirical case, is least available. Milestone treaties and resolutions on weapons have been propelled by powerful victim advocacy: the International Campaign to Ban Landmines (ICBL) and the International Campaign to Abolish Nuclear Weapons (ICAN) relied heavily on victim testimony to create issue salience, and many of our interviewees credited documented patterns of harm with pushing humanitarian

37 For example, some delegations bring members of their ministries of defence to discussions on LAWS, while others exclusively bring delegates from their ministries of foreign affairs.

38 Anonymous interview with African State delegate, 19 June 2025; anonymous interview with European State delegate, 19 June 2025.

39 Anonymous interviews with two European State delegates, 19 June 2025; Anna Hehir, Future of Life Institute, comments given at an informal workshop hosted by the non-profit organization Article 36, 13 June 2025.

40 Anthropic, "Statement from Dario Amodei on Our Discussions with the Department of War", 26 February 2026, available at: www.anthropic.com/news/statement-department-of-war.

41 Future of Life Institute, *A Diplomat's Guide to Autonomous Weapons Systems*, 2024, available at: https://futureoflife.org/wp-content/uploads/2024/08/AWS-Guide-for-Diplomats_17-September-2024.pdf.

42 Kenneth Payne, *AI Arms and Influence: Frontier Models Exhibit Sophisticated Reasoning in Simulated Nuclear Crises*, arXiv Preprint No. 2602.14740, 17 February 2026, available at: https://arxiv.org/pdf/2602.14740.

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disarmament efforts over the finish line.[43] Even the pre-emptive CCW Protocol on Blinding Lasers came about after an ICRC campaign that used photographs of soldiers blinded by poison gas during the First World War to show the inhumanity of permanently blinding soldiers.[44] A recent joint investigation by Airwars and *The Independent* identified what may be the first civilian death officially acknowledged as occurring in an AI-assisted strike,[45] but the opacity of AI systems makes attribution exceptionally difficult, and the systems envisioned by the LAWS debate have not yet been deployed at scale. Without a face and a name attached to the consequences of unregulated weapons, pre-emptive disarmament needs authoritative voices that can speak credibly about harm that has not yet occurred. Scientists' anticipated use cases, grounded in technical understanding of what these systems can and will do, are one candidate; they cannot replace victim testimony, but they can put a credible, expert-validated picture of the consequences into the diplomatic conversation.[46] Waiting for catastrophic harm to catalyze action – which is sometimes portrayed as an alternative – is simply not an option given the stakes.

f. *Balancing focused progress with a sufficiently broad overview.* As detailed above, making progress on a legal instrument on LAWS requires sustained and focused attention from civil society and States alike for over a decade. Multilateral negotiations require specificity to gain traction and concreteness to become actionable. Focus is therefore essential, although it also comes at a cost. Nicole Van Rooijen, campaign director for Stop Killer Robots, drew our attention to a "missed step" in the disarmament response to war over the past two decades: drones. When drones first transitioned from surveillance craft to surgical strike weapons "and the international community blinked", she explained, modern war took a massive step into a more dispassionate, clinical and automated form.[47] This happened again as the broader tendency towards the removal of human control from war through the operationalization of AI decision-support systems (AI-DSS) became a reality with little scrutiny from multilateral arms control. Of

43 Interview with Beatrice Fihn, Founder, Lex International, and Magnus Løvold, Adviser, Lex International, 17 June 2025; interview with Nicole Van Rooijen, above note 28. See also e.g., ICAN, *Catastrophic Humanitarian Harm*, August 2012, available at: www.icanw.org/catastrophic_humanitarian_harm; ICBL, "Real-Life Stories: Dejan Ivanovic", 21 May 2025, available at: www.icblcmc.org/our-impact/real-life-stories-dejan-ivanovic.

44 Human Rights Watch and Harvard Law School International Human Rights Clinic, "Precedent for Preemption: The Ban on Blinding Lasers as a Model for a Killer Robots Prohibition", 8 November 2015, available at: www.hrw.org/news/2015/11/08/precedent-preemption-ban-blinding-lasers-model-killer-robots-prohibition.

45 "The First Civilian Confirmed Killed in an AI-Assisted Strike?", *Airwars*, 10 March 2026, available at: https://airwars.org/the-first-civilian-confirmed-killed-in-an-ai-assisted-strike/.

46 To be sure, this substitution might be more effective in some cases than in others: the blinding-laser precedent worked partly because the harm mechanism was bounded and well understood.

47 Interview with Nicole Van Rooijen, above note 28.

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> note, recent efforts are under way to address broader concerns of autonomy and AI in warfare, for example through the Responsible AI in the Military Domain (REAIM) Summit – although they have not resulted in any regulation.[48]

The obstacles surfaced here recur across the disarmament ecosystem and become more acute wherever the weaponization of emerging S&T is concerned. Interviewees discussing the CD, the BWC and the CCW more broadly described similar dynamics: consensus wielded as veto, an absence of trusted technical advice, the difficulty of building political momentum without a face to put to the harm, and smaller delegations unable to participate meaningfully in negotiations due to constraints on resources and subject-matter expertise.

These challenges also surface when it comes to getting emerging S&T onto a disarmament agenda. While the convergence of AI and other fields is vastly accelerating developments that will heavily impact peace, security and humanitarian outcomes, disarmament bodies lack the ability to anticipate and act upon their weaponization.[49] Quantum technologies, for example, have the potential to deeply disrupt current encryption systems and data security in the coming five years, but they are not currently addressed by any dedicated UN process.[50]

While a technology is still emerging, governance options remain broad, because no State yet has a stake in protecting sunk investments in weaponized capabilities. Once a capability is fielded, positions harden and protection becomes a matter of rollback rather than design. By then, the opportunity to prevent harm has been squandered.

Recommendations for a fit-for-purpose arms control ecosystem

This section focuses on addressing the challenges described above that are particularly relevant for the weaponization of emerging S&T. These recommendations do not claim to resolve the problem of consensus set out above; science anticipation cannot dissolve geopolitical disagreement, but it can widen the space for agency around it. They instead focus on challenges linked to capacity and expertise, as well as to pre-emptive disarmament. We argue that given the implications of emerging technologies for peace, security and the protection of civilians, arms control and

48 The first REAIM Summit was established in 2023. The third REAIM Summit, held in A Coruña, Spain, in February 2026, illustrated both the platform's reach and its limits: its *Pathways to Action* outcome document was endorsed by only around thirty-five States, with the United States and China, both founding participants in earlier summits, declining to sign.

49 Emilia Javorsky and Hamza Chaudhry, "Convergence: Artificial Intelligence and the New and Old Weapons of Mass Destruction", *Bulletin of the Atomic Scientists*, 18 August 2023, available at: https://thebulletin.org/2023/08/convergence-artificial-intelligence-and-the-new-and-old-weapons-of-mass-destruction/.

50 UNDC, "UNDC Working Group II: Chair's Summary", 23 April 2025, p. 3, available at: https://docs-library.unoda.org/United_Nations_Disarmament_Commission_-_%282025%29/Final_Chair%27s_summary_dated_2025-04-23.pdf.

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disarmament efforts simply cannot wait for these technologies to be deployed before acting. Anticipation has become essential. Below, we detail how it could be put into practice.

Of note, mobilizing scientific expertise into arms control does not presume that individual scientists are neutral; rather, what matters is the objective and the process through which their input is gathered and conveyed. An honest broker, in GESDA's definition, works to expand and clarify the scope of available options to decision-makers.[51] Science helps to show what the socio-technical possibilities really are, and how they are likely to evolve in the coming years (the science anticipation angle). For this, honest brokering strives to surface the best available science and puts forward the claims that have survived the discipline's established mechanisms of scrutiny, such as peer review; the point, in other words, is not to relay every opinion a scientist might hold.

Three safeguards keep such brokering honest. The first is the quality control internal to science itself. The second is the objective: brokering must increase rather than restrict the possibility of action; it must enrich the policy alternatives. The third, importantly, is epistemic diversity when discussing the impacts and uses of emerging technologies, because who selects the experts and what they bring can tilt advice in one direction. The boards and networks we recommend must be deliberately diverse, cutting across geographical, disciplinary, political and private–public divides, so that no single agenda can capture the "scientific" position and diversity itself operates as a check on stealth advocacy. The goal is an arms control process that can focus on reaching political agreements based on the best available science.

Integrating scientific expertise more systematically in disarmament efforts

The foremost step is to build a stronger interface between, on the one hand, diplomats and civil society working on arms control, and on the other, experts, scientists, technologists, academics and industry players developing or studying relevant scientific and technological applications. Integrating scientific expertise within disarmament efforts – mediated through the honest-broker process outlined above – aims to inform and educate without lobbying for any specific political aims. The following recommendations offer three concrete additions to the current landscape of multilateral disarmament in this domain.

Establishing scientific advisory boards to address the expertise gap

Arms control fora that currently lack SABs should develop them.[52] At a minimum, they should establish an annual conference of scientists and technologists working in fields related to questions facing the CCW and CD. The exact shape of this network is

51 GESDA, "Acting as an Honest Broker", available at: https://radar.gesda.global/science-anticipation/acting-as-an-honest-broker.

52 See Annex 2 for an overview of which bodies do and do not have SABs.

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secondary; what is of utmost importance is the creation of a durable space or format which ensures that the relevant expertise is consistently available to diplomats. This will help to ground governance discussions in technical and largely agreed-upon definitions.[53] As noted above, to be seen as trusted touchpoints in this context, SABs must have a diverse composition, cutting across geographical and political divides.[54] Climate scientists have had success in a similar venture, offering galvanizing expert testimony with their tacit knowledge as "trustees" of climate.[55] The disarmament space needs equivalents to this.

Tailoring resources to address the expertise and capacity gap

There must be a concentrated effort to streamline access to information, expertise and resources on emerging science and technology relevant to arms control and disarmament discussions. These resources should include tailored briefs to State delegates on relevant emerging topics in S&T such as advanced AI, space sciences, quantum technology, synthetic biology and neurotechnology. These could, for instance, begin as short documents translating complex technical issues into relatable points, produced by an honest-broker party, replicating the success of resources produced by climate scientists.[56] By tailoring these to specific discussions or negotiations, they would help address the limited available expertise and capacity of smaller delegations, enabling them to engage with technically complex topics, give detailed statements, ask more pointed questions in discussions and better advocate for their positions.[57] This may ultimately help to amplify the voices of traditionally under-represented States and keep them engaged in disarmament.[58]

Creating new spaces for structured science–policy dialogues to address current fora limitations

New spaces for informal discussions on emerging technologies should be established to allow diplomats and scientists to exchange information freely, identify areas of

53 Note that complete agreement on definition is not a prerequisite for action – progress was made on the BWC and CCM without precise definitions. See "Myths vs. Fact: Autonomous Weapons and the Global Effort to Control Them", *Autonomousweapons.org*, 30 April 2025, available at: https://autonomousweapons.org/autonomous-weapons-misconceptions/.

54 Workshop participants (see above note 5), 16 October 2025.

55 Antoinette Scherz and Laura García-Portela, "Climate Scientists as Trustees in Public Reason: The Legitimacy of Political Institutions amid Non-Epistemic Values", *Critical Review of International Social and Political Philosophy*, Vol. 28, No. 5, 2025, available at: www.tandfonline.com/doi/full/10.1080/13698230.2025.2499360#abstract.

56 Workshop participants (see above note 5), 16 October 2025.

57 Of note, participants in the workshop did not deem the UN Secretary-General's SAB briefs to be detailed or contextualized enough to be useful in this particular context.

58 The importance of tailored resources was highlighted by many States: anonymous interview with Latin American delegate, 16 June 2025; anonymous interview with African delegate, 18 June 2025; anonymous interview with African delegate, 16 July 2025.

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convergence and build a shared vocabulary that could inform or trigger more formal negotiations. The value of such an approach was noted in the case of the 1975 Asilomar Conference on Recombinant DNA, where discussions did not occur within formal regulatory fora and did not produce a binding legal instrument, but had far-reaching normative impacts. They established shared risk categories and normalized the idea that some research efforts in science should be constrained in order to protect public health.[59] Predictably, S&T experts will at times disagree with one another or fail to anticipate the exact trajectory of an S&T topic; even in these cases, though, such interfaces will sharpen the reflex to look ahead, to seek expert testimony and to establish the networks to do so. Engaging in these discussions on emerging S&T trends will help broaden disarmament actors' awareness of relevant developments and perspectives in the field.

Leveraging Article 36 reviews to address the technical complexity of emerging S&T

Legal mechanisms to contend with the weaponization of emerging S&T do exist in the form of Article 36 of Additional Protocol I to the Geneva Conventions (AP I).[60] Adopted in 1977, Article 36 obligates High Contracting Parties to determine, in the study, development, acquisition or adoption of a new weapon, means or method of warfare, whether its employment would be prohibited by AP I or by any other rule of international law applicable to the High Contracting Parties.[61] The logic of Article 36 is straightforward: if States assess the legality of new weapons as they come about, they can avoid introducing tools of war that violate international law. There are 175 States party to AP I, all of which are obligated to carry out these review processes.[62] For the ICRC, this review obligation also binds States outside this treaty framework as a matter of customary international law.[63]

59 Paul Berg, "Asilomar Revisited: Lessons for Today", *Nature*, Vol. 455, No. 7211, 2008, available at: https://doi.org/10.1038/455290a; workshop participants (see above note 5), 16 October 2025.

60 Protocol Additional (I) to the Geneva Conventions of 12 August 1949, and relating to the Protection of Victims of International Armed Conflicts, 1125 UNTS 3, 8 June 1977 (entered into force 7 December 1978) (AP I), Art. 36, available at: https://ihl-databases.icrc.org/en/ihl-treaties/api-1977/article-36.

61 A High Contracting Party is a State that has formally agreed to be bound by a treaty.

62 For an overview of States party to AP I, see the ICRC IHL Databases, available at: https://ihl-databases.icrc.org/en/ihl-treaties/api-1977/state-parties. On the review process, see Andreas Leupold, "Weapon Reviews: Legal Basis, Scope and State Practice", 24 February 2026, available at: https://leupoldlegal.com/weapon-review-article-36-ap-i/.

63 The customary duty follows from the prohibition on using unlawful weapons, since a State cannot faithfully honour that prohibition without assessing legality before a weapon enters its arsenal. ICRC, "A Guide to the Legal Review of New Weapons, Means and Methods of Warfare: Measures to Implement Article 36 of Additional Protocol I of 1977" *International Review of the Red Cross*, Vol. 88, No. 864, 2006, p. 933. This position remains contested, however – notably by the United States. See, for example, Natalia Jevglevskaja, "Weapons Review Obligation under Customary International Law", *International Law Studies*, Vol. 94, 2018, p. 205, available at: https://digital-commons.usnwc.edu/cgi/viewcontent.cgi?article=1724&context=ils. Despite rejecting the view that it is bound by Article 36 as a matter of customary international law, the United States conducts weapons reviews as a matter of policy. See US Department of Defense, *Law of War Manual*, Office of General Counsel, 2015 (updated July 2023), § 6.2.

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Article 36 reviews are crucial national processes through which States assess the legality of a new weapon, means or method of warfare. Almost fifty years after their codification, however, only about twenty States have reported conducting these reviews.[64] There is no internationally agreed standard prescribing how such reviews must be conducted, although an ICRC guide (published in 2006) and subsequent scholarship aim to provide guidance to States in carrying them out. The ICRC also encourages the sharing of practice as to how such reviews are conducted.[65]

Because States are not obligated to publish completed legal reviews, and no avenue exists for mutual verification of findings, the international community's ability to monitor compliance is limited. Damian Copeland, the founder of Article 36 Legal, a legal consultancy that specializes in legal reviews for new weapons, noted in an interview that in his time as an attorney in the Australian Defence Force, he would sometimes get a call to perform a legal review only a day or two before the decision to acquire a weapon.[66] Some States, such as the Netherlands, have chosen to release their reviews voluntarily,[67] but in practice, Article 36 has largely become a black box: quietly discretionary, poorly standardized and structurally unprepared for adaptive, software-driven systems. This is not, however, inevitable.

While Article 36 is the natural legal hook for what science anticipation could deliver, complying with it also requires a level of science anticipation: for adaptive and software-driven systems, an assessment of whether a new weapon will comply with IHL cannot be made without forward-looking scientific judgement about how the system will behave under conditions that have not yet arisen. Four steps could help to leverage Article 36 more effectively.

First, international standards, such as the current guidance offered by the ICRC for conducting Article 36 reviews, should be updated. These standards should establish the need for iterative review procedures of both hardware and software. Article 36 Legal recently published a 2026 review guide that includes a functional approach to the legal review of automated weapons systems and AI-DSS.[68] An

64 Damian Copeland, Rain Liivoja and Lauren Sanders, "The Utility of Weapons Reviews in Addressing Concerns Raised by Autonomous Weapon Systems", *Journal of Conflict and Security Law*, Vol. 28, No. 2, 2023, p. 298, available at: https://academic.oup.com/jcsl/article/28/2/285/6833182. For the list of States known to undertake these reviews, see also Asia Pacific Institute for Law and Society, "State Practice", *Legal Review of Weapons Information Portal*, available at: https://legalreviewportal.org/states.

65 Interview with Heidi Kandiel, Legal Adviser, ICRC, Geneva, 26 June 2025. Through conversations with the ICRC, the authors understand that a revision of the ICRC guide is in progress. For the guide, see Kathleen Lawand (ed.), *A Guide to the Legal Review of New Weapons, Means and Methods of Warfare: Measures to Implement Article 36 of Additional Protocol I of 1977*, Geneva, 2006, available at: https://library.icrc.org/library/docs/DOC/icrc_002_0902.pdf.

66 Interview with Damian Copeland, Founder, Article 36 Legal, 25 June 2025.

67 Government of the Netherlands. "Adviescommissie Internationaal Recht en Conventioneel Wapengebruik (AIRCW)", available at: www.rijksoverheid.nl/ministeries/ministerie-van-defensie/organisatie/commissies/adviescommissie-internationaal-recht-en-conventioneel-wapengebruik.

68 Damian Copeland, *Article 36 Legal Review Guide, Including a Functional Approach to the Legal Review of AWS and AI-DSS*, Article 36 Legal, 2025, available at: https://tinyurl.com/y8pd94se. See also Damian Copeland, *A Functional Approach to the Legal Review of Autonomous Weapon Systems*, Brill Nijhoff, Leiden, 2024, available at: https://doi.org/10.1163/9789004707047.

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updated ICRC guide for conducting Article 36 reviews is also in progress.[69] The ICRC, together with partners such as Article 36 Legal, should leverage this unique setting to encourage policy-makers to integrate such guidance into their formalized national procedures.

Second, technical expertise should be pooled among smaller States in order to lower the capacity barrier. Most States Parties lack the standing scientific and engineering capacity to assess complex, adaptive systems; this is one reason why reviews are conducted late, if at all.[70] A shared technical resource, whether an expert roster, a repository of assessment methodologies or a light-touch support unit, would allow under-resourced States to conduct meaningful reviews and reduce reliance on the few States and private consultancies that currently hold this expertise. The assistance and cooperation database established under Article X of the BWC offers a low-cost institutional precedent.[71]

Third, States should make a broader commitment to publishing review findings. While mandatory publication of review findings would likely face resistance from several States, those with the greatest commitment to disarmament could follow the Netherlands' lead and commit to voluntarily sharing their findings.[72] In the process, they would contribute to creating pressure for other States to align with an increasingly widespread practice. Precedent for such incremental transparency exists in the biological weapons regime, where States have, since 2013, organized a series of voluntary peer review exercises that invite others to assess selected aspects of treaty implementation and exchange good practice, building confidence even in the absence of a formal compliance mechanism.[73]

Finally, States should commit to voluntary verification of findings, as publication alone does not establish that a review was rigorous – but a requirement for mandatory verification of findings would likely face the greatest resistance today. States could start by developing cooperative arrangements to build confidence in one another's review methodologies without disclosing the sensitive or classified details of the weapon under assessment. These arrangements could take

69 Interview with Heidi Kandiel, Legal Adviser, ICRC, 26 June 2025.

70 Vincent Boulanin and Maaike Verbruggen, *Article 36 Reviews: Dealing with the Challenges Posed by Emerging Technologies*, SIPRI, December 2017, available at: www.sipri.org/publications/2017/other-publications/article-36-reviews-dealing-challenges-posed-emerging-technologies.

71 The Seventh Review Conference of the BWC established, in 2011, an Article X database matching voluntary requests and offers for assistance and cooperation among States Parties and international organizations. *Seventh Review Conference of the States Parties to the Convention on the Prohibition of the Development, Production and Stockpiling of Bacteriological (Biological) and Toxin Weapons and on Their Destruction: Final Document*, UN Doc. BWC/CONF.VII/7, 13 January 2012; see also UNODA, "International Cooperation and Assistance", available at: https://disarmament.unoda.org/biological-weapons/assistance-and-cooperation/.

72 An upcoming report by Lex International tracks States with a perfect score of adherence to treaties that protect people from the harms of war, twelve in total. These twelve States could form an initial group to publish reviews voluntarily.

73 On the biological weapons peer review exercises, see María José Espona, *Voluntary Transparency Initiatives: The Case of Peer Review Exercises in the Context of the BWC*, UNIDIR, Geneva, 2024, available at: https://doi.org/10.37559/WMD/24/CBW/02. France launched the first pilot exercise in Paris in December 2013, and six such exercises have since been organized.

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place within political groups or military alliances, such as the European Union. Here again, there is precedent: in 2015, the UK–Norway Initiative and the International Partnership for Nuclear Disarmament Verification convened nuclear and non-nuclear weapon States, together with technical NGOs, to develop and test procedures calibrated to confirm compliance while shielding proliferation-sensitive information.[74] Transposed to Article 36, such a partnership could pilot verification methods for adaptive, software-driven systems that States could subsequently adopt on a voluntary basis.

Taken together, these steps would move Article 36 from a discretionary, siloed national exercise towards a networked practice. They could also, over time, help to build confidence in effective verification mechanisms.

Leveraging science anticipation to better protect civilians

Given the speed of technological developments and the time lag between technological development and disarmament or arms control processes, it is becoming increasingly evident that technological change cannot be approached solely through a reactive lens.[75] By the time emerging S&T are weaponized at scale, the risks for civilians – and, indeed, to all humanity – are harder to contain. Anticipation is therefore essential – but what might this look like in practice?

Every year, GESDA draws on contributions from more than 2,300 leading scientists from eighty-seven countries to map the next quarter-century of frontier research in its Science Breakthrough Radar®.[76] Building on initiatives such as the Radar, we recommend the creation of a frequently updated "issue tracker" to support States involved in multiple complex disarmament issues. This tracker could be a joint venture between organizations engaged in science anticipation and others working on peace, security and disarmament, aiming to allow States to easily follow the development of emerging technologies and efforts to weaponize them. These issues would span fields at different levels of development, from AI-DSS systems already deployed on the battlefield to the near-future weaponization of quantum technologies or risks associated with developments in synthetic biology, for example.

To take the topic of neurotechnology as an illustration, an effective issue tracker would monitor the development of neuroscience and brain–computer interfaces more broadly, while simultaneously tracking the military development and use

74 On the nuclear precedents, see International Partnership for Nuclear Disarmament Verification, "About the IPNDV", available at: www.ipndv.org/about/; UK Ministry of Defence, "UK/Norway Initiative on Nuclear Warhead Dismantlement Verification", available at: www.gov.uk/government/publications/uk-norway-initiative-on-nuclear-warhead-dismantlement-verification–2. Both initiatives brought nuclear and non-nuclear weapon States – and in the UK–Norway case, an independent NGO – together to develop verification methods that confirm compliance without disclosing proliferation-sensitive information.

75 See, for example, Security Council Report, *Maintaining International Peace and Security in the Age of Rapid Technological Change: Is the Security Council Wired for Purpose?*, Research Report No. 2, 27 March 2026, available at: www.securitycouncilreport.org/atf/cf/%7B65BFCF9B-6D27-4E9C-8CD3-CF6E4FF96FF9%7D/Cyber_report_2026_v10.pdf.

76 See the GESDA Science Breakthrough Radar®, available at: www.gesda.global/gesda-science-breakthrough-radar/.

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of weapons leveraging these developments as they are made public through press releases and public contracts, or through evidence from the battlefield. A third facet of the tracker would monitor and list State positions in the treaty negotiations as they change, leveraging the thorough databases of other NGOs on similar matters.[77] Critically, the issue tracker would also include expert scientists' anticipations of use cases for each weaponized emerging technology and science. This would help establish a credible voice on harm in the absence of victim advocacy, although it would lack the emotional resonance provided by the latter.

By integrating the collected perspectives and testimony of S&T experts, the above-mentioned tracker would capture the likely evolution of technical capabilities and allow disarmament experts to situate focused progress on specific issues within a broader overview of trends whilst also covering a range of issues to avoid losing track of the bigger picture. By leveraging and packaging the work of science anticipation in this way, the disarmament community would be equipped with an overview of each issue as it evolves. Each individual facet of this recommendation comes from a direct issue that we have identified: packaging science anticipation and technology lifespan in an accessible and consumable format; keeping tabs on the real state of weaponized technologies, their capabilities and shortcomings, and the States using them; expert-informed use cases that fill the gap left in the absence of victim advocacy; and maintaining a list of State positions to allow diplomats and civil society to find areas of convergence and lay the groundwork for partnerships. It is the embodiment of science anticipation as a tool for education, capacity-building and effective pre-emptive disarmament.

Conclusion

Among the geopolitical events that shaped our interviews for this piece were the withdrawals of five European States – Estonia, Latvia, Lithuania, Finland and Poland – from the APMBC, with Lithuania also departing the CCM.[78] This is the first sustained reversal of universalization that humanitarian disarmament has faced since these instruments were established.[79] In the course of many conversations, representatives from these States cited palpable national fear of war on the doorstep and a disarmament ecosystem that was failing to efficiently regulate new technologies.[80] Underpinning all these sentiments was a fundamental distrust of the most powerful

77 See, for example, Reaching Critical Will, available at: www.reachingcriticalwill.org; Humanitarian Disarmament, available at: https://humanitariandisarmament.org/; Future of Life Institute, available at: https://futureoflife.org/project/autonomous-weapons-systems/.

78 This was the first time any State had withdrawn from the CCM since its entry into force, a precedent that arguably opened the door to the 2025 APMBC withdrawals.

79 These withdrawals have since moved from announcement to legal effect: the three Baltic States' departure from the APMBC took effect in December 2025, followed by Finland in January 2026 and Poland in February 2026.

80 Anonymous interview with Baltic State delegate, 18 June 2025; anonymous interview with Central European State delegate, 16 June 2025.

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actors and a demand to leave no options off the table in the event of large-scale armed conflict. A countervailing trend is also visible, however, as other States have continued to join disarmament treaties. Most recently, Tonga acceded to the TPNW and the Comprehensive Nuclear-Test-Ban Treaty (CTBT) in July 2026, and Lebanon to the APMBC in May 2026.[81] Taken together, these withdrawals and accessions describe an arms control system whose credibility stands in the balance. What steps States, civil society, scientists and private companies take in the coming months and years will determine whether or not the next generation of weapons enters the battlefield with rules in place to constrain them.

There is reason for cautious optimism. The arms control field's anticipatory capacity has been on an upward trajectory: with LAWS, the international community began debating governance before significant harm had occurred, something it largely failed to do with nuclear weapons. As we have argued, the disarmament ecosystem has neither failed nor been rendered obsolete by emerging technology; it requires intentional investment and a more proactive posture, and many of the tools that this demands already exist. The three we propose are deliberately modest in their novelty: embedding standing scientific advice where bodies like the CCW still lack it, as similar fora have already done; better leveraging the Article 36 review obligation that 175 States Parties are required to carry out but very few operationalize; and building shared anticipatory tools, chief among them a regularly updated issue tracker, that can put an expert-validated picture of harm into the conversation before any victim can be asked to. Anticipation will not always be right – experts disagree among themselves, and projections can both overstate and understate risk – but its value lies less in any single forecast than in building the reflex and networks to look ahead. What is now needed is the will to learn from the challenges of the past in order to do better in the future.

A common misconception is that in a world of armed conflicts, humanitarian emergencies and diminishing resources, investing in anticipation is a luxury. Scientific and technological advances unfold regardless of diplomatic bandwidth, however, and if States, civil society and scientists do not invest even modestly in understanding what could be coming, they will be forced to respond later, under pressure and with fewer options and less room for deliberation, all while the list of victims grows. Civilians in conflict zones are often the first to bear consequences they had no part in creating, and protecting them – now and in the years ahead – depends on a capacity to anticipate, integrate and act on scientific and technological change before it becomes a source of disruption.

It is true that pre-emptive measures in disarmament are rare, but if those involved in science anticipation can effectively anticipate emerging threats and disseminate this information to diplomats and civil society, building a case for pre-emptive measures will become feasible. Equally importantly, even if pre-emptive measures fail, this process will have equipped actors to respond to harm if or when it occurs. The preliminary work – bringing States together, educating stakeholders

81 Other recent accessions include Tonga and the Marshall Islands, which joined the APMBC in 2025. Ghana ratified the TPNW in 2025, and Kyrgyzstan formally signed the treaty in that same year.

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on technical details and finding convergence of interests – will already have been done. This enables actors to move quickly on instances of harm and call for specific and effective regulation with like-minded States in these new fora. This pre-emptive education, coordination and capacity-building will also serve to close the dangerous gap we currently see between rapid innovation and regulatory stagnation in emerging weapons technologies. Anticipation is not a luxury but a form of protection – the most basic purpose disarmament exists to serve.

Annex 1: Methodology note

The primary evidence base for this research is a series of twenty-nine semi-structured interviews conducted between June and July 2025. Of these, twenty were with delegates from ministries of foreign affairs or defence to the UN in Geneva speaking under the condition of anonymity. Nine took place with representatives of civil society organizations, who agreed to being cited by name. Interviewees were selected with the intention of capturing a breadth of perspectives across regional groups, positions on the regulation of autonomous weapons systems, and mission sizes. They also had varying professional backgrounds in diplomacy, law and technology.

Interviews were mainly conducted in person in Geneva, lasted approximately thirty to ninety minutes, and began with the topic guide reproduced below, which was shared with participants ahead of time. Contemporaneous notes were taken. Responses were analyzed inductively to identify recurring themes.

To protect anonymity requested by State representatives, no statement in this article is attributed to a named delegate or to a specific State; interviews are cited by date and by the participant's general category only. Participating States and organizations are listed below with the consent of participants; individual names are withheld, except for civil society members who gave their consent.

Limitations

The sample does not include States that are currently developing or fielding autonomous weapons systems at scale, nor the major military powers whose positions have shaped the trajectory of the CCW GGE. The findings should be read as reflecting the perspectives of a majority of States and organizations broadly supportive of a legally binding instrument, although not exclusively.

Author positionality

At the time of writing, the authors were affiliated with Yale University and GESDA. One author holds an additional concurrent affiliation with Lex International. GESDA convened the workshop discussed below, which was treated as corroborative rather than primary evidence.

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Workshop

A workshop entitled "Revitalizing Disarmament through Science Anticipation: How Multilateralism Can Contend with the Rapid Weaponization of Emerging Technology" was convened at the October 2025 GESDA Summit in collaboration with the Geneva Centre for Security Policy, under the Chatham House Rule. The workshop served to test findings from the interviews rather than as a primary source of data; discussions are reported here only in aggregate. Participants were broadly supportive of the article's central recommendation that S&T expertise and a science anticipation lens be integrated into disarmament processes, identifying this as a means of addressing a recognized gap in the current disarmament architecture and of avoiding a repetition of the delayed and reactive responses to earlier weapons technologies.

Interviewees (listed in alphabetical order)

- *States:* Austria, Bosnia and Herzegovina, Brazil, Bulgaria, Cameroon, Colombia, Costa Rica, Ireland, Italy, Malawi, Netherlands, Nigeria, Norway, Pakistan, Peru, Philippines, Poland, South Africa, Switzerland, United Kingdom.
- *Civil society organizations:* Article 36, Article 36 Legal, Harvard Law School International Human Rights Clinic, Human Rights Watch, International Campaign to Abolish Nuclear Weapons, International Committee of the Red Cross, Lex International, Stop Killer Robots, University of Queensland.

Workshop participants (listed in alphabetical order)

- *States:* Austria, Brazil, Bulgaria, Cameroon, Costa Rica, Holy See, Ireland, Italy, Peru, Philippines.
- *Civil society organizations:* Geneva Centre for Security Policy, International Campaign to Abolish Nuclear Weapons, International Committee of the Red Cross, Lex International, Stop Killer Robots, UN Institute for Disarmament Research.
- *Academia and the private sector:* Graduate Institute of International and Development Studies, Quantum Economic Development Consortium, UK National Quantum Computing Centre, University of California Los Angeles Department of Neurosurgery, Yale University.

Interview topic guide

1. How would you describe the current disarmament ecosystem?
2. What are the biggest issues facing disarmament work today?
3. Are you confident in your ability to anticipate major developments in science and technology and their implications for the future of conflict, peacebuilding and

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protection of civilians? If so, what tools do you use? If not, what would you find helpful?
4. What emerging science and technologies are you most concerned with?
5. Do you believe that current interpretations and applications of international humanitarian law provisions are protective enough when it comes to the use of new weapons? What could make them more protective?
6(a). (Civil society) Do you have a dialogue with States about their Article 36 review process – what does this look like?
6(b). (State) What does your weapons review process look like? What challenges do you encounter in this process? What could improve it?

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Annex 2: Overview of existing disarmament instruments

Category	Instrument/ forum name	Shorthand	Location	Decision-making	Forum type	SAB	Ratification/ participation*
Advisory/research	**Comprehensive Nuclear-Test-Ban Treaty Organization**	CTBTO	Vienna	Soft consensus**	Support body (treaty not in force)	Yes	179***
	UN Secretary-General's Advisory Board on Disarmament Matters	SGABDM	Geneva	N/A	Advisory	Yes	N/A
	UN Institute for Disarmament Research	UNIDIR	Geneva	N/A	Advisory (research)	No (research institute)	N/A
	International Atomic Energy Agency	IAEA	Vienna	N/A	Advisory	Yes	181
General fora (including enforcement bodies)	**Conference on Disarmament**	CD	Geneva	Consensus	Negotiations	No	65
	UN Disarmament Commission	UNDC	New York	Consensus	Deliberative	No	193

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Category	Instrument/ forum name	Shorthand	Location	Decision-making	Forum type	SAB	Ratification/ participation*
	UN General Assembly (First Committee)	UNGA	New York	Majority vote	Deliberative	No	193
	UN Security Council**	UNSC	New York	Procedural: any nine affirmatives substantive: nine affirmatives including P5	Binding resolutions	No	15
Treaty-based bodies (global)	**Anti-Personnel Mine Ban Convention**	APMBC	Geneva	Majority vote	Treaty framework	No	162

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Category	Instrument/ forum name	Shorthand	Location	Decision-making	Forum type	SAB	Ratification/ participation*
	Biological Weapons Convention	BWC	Geneva	Consensus	Treaty framework	No (proposals under discussion)	189
	Chemical Weapons Convention (implemented by the OPCW)	CWC	The Hague	Soft consensus	Treaty framework	Yes (via the OPCW SAB)	193
	Convention on Certain Conventional Weapons	CCW	Geneva	Consensus	Treaty framework	No	128
	Convention on Cluster Munitions	CCM	Geneva	Majority vote	Treaty framework	No	112

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Category	Instrument/ forum name	Shorthand	Location	Decision-making	Forum type	SAB	Ratification/ participation*
	Outer Space Treaty	OST	New York	Consensus	Treaty framework	No	114
	Seabed Arms Control Treaty	Seabed Treaty	New York	Consensus	Treaty framework	No*****	94
	Treaty on the Non-Proliferation of Nuclear Weapons	NPT	New York	Consensus	Treaty framework	No	190
	Treaty on the Prohibition of Nuclear Weapons	TPNW	New York/ Vienna	Majority Vote	Treaty framework	Not yet (expert consultations held)	75

Source: compiled by the authors from the constitutive instruments, rules of procedure and depositary records of each body.

* This column reflects the number of States that have ratified or signed treaties, or that actively participate in multilateral disarmament forums, as of July 2026. "N/A" indicates bodies that do not have formal State membership structures.

** Consensus is often defined as the absence of a no. Soft consensus is a decision-making approach that is taken if consensus is not attainable. The chairman shall defer any vote for twenty-four hours and during this period of deferment shall make every effort to facilitate achievement of consensus, and shall report to the Conference of States Parties to the CTBT before the end of this period. If consensus is not possible at the end of 24 hours, the Conference shall take the decision by a two-thirds majority of members present and voting unless specified otherwise in the CTBT.

*** Refers to 179 ratifications of the CTBT, which is not yet in force. The CTBTO operates as a support body for the treaty pending ratification by key States.

**** The UN Security Council can adopt binding resolutions under Chapter VII of the UN Charter, which authorizes enforcement measures, including sanctions or military force, when international peace and security are deemed threatened.

***** The Seabed Treaty is in force but is largely inactive in current disarmament negotiations.