Group of Governmental Experts 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

Geneva, 9–13 April 2018 (first week) and 27–31 August 2018 (second week)
Item 7 of the provisional agenda
Adoption of the report

Draft

Report of the 2018 Group of Governmental Experts on Lethal Autonomous Weapons Systems

I. Introduction

1. The 2017 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 Have Indiscriminate Effects (CCW), held in Geneva from 22 to 24 November 2017, decided, as contained in its final document (CCW/MSP/2017/8),

"The Group of Governmental Experts related to emerging technologies in the area of lethal autonomous weapons systems (LAWS) in the context of the objectives and purposes of the Convention on Prohibitions or Restrictions on the Use of Certain Conventional Weapons shall meet for a duration of ten days in 2018 in Geneva in accordance with Decision 1 of the Fifth Review Conference of the High Contracting Parties to the Convention (CCW/CONF.V/10), consistent with CCW/CONF.V/2.

The Rules of Procedure of the Review Conference shall apply mutatis mutandis to the Group. The Group shall conduct its work and adopt its report by consensus which shall be submitted to the 2018 Meeting of the High Contracting Parties to the Convention. The widest possible participation of all High Contracting Parties is to be promoted in accordance with the goals of the CCW Sponsorship Programme.

The Group will continue to be chaired by Ambassador Amandeep Singh Gill of India without prejudice to the principle of geographical rotation."

2. The Group of Governmental Experts met from 9 to 13 April and from 27 to 31 August 2018.

II. Organization and work of the Group of Governmental Experts (April session)

3. The following High Contracting Parties to the Convention participated in the work of the Group: Albania, Algeria, Argentina, Australia, Austria, Belarus, Belgium, Bosnia and Herzegovina, Brazil, Bulgaria, Canada, Chile, China, Colombia, Costa Rica, Croatia, Czech Republic, Denmark, Djibouti, Dominican Republic, El Salvador, Estonia, Finland, France, Germany, Greece, Guatemala, Holy See, Honduras, Hungary, India, Iraq, Ireland, Israel, Italy, Japan, Jordan, Kazakhstan, Kuwait, Lao People's Democratic Republic, Latvia, Lebanon, Lithuania, Luxembourg, Mexico, Montenegro, Morocco, Netherlands, New Zealand, Nicaragua, Norway, Pakistan, Panama, Peru, Philippines, Poland, Portugal, Qatar, Republic of Korea, Romania, Russian Federation, Saudi Arabia, Senegal, Serbia, Sierra Leone, Slovakia, South Africa, Spain, Sri Lanka, State of Palestine, Sweden, Switzerland,
Togo, Turkey, Uganda, United Kingdom of Great Britain and Northern Ireland, United States of America, Venezuela (Bolivarian Republic of).

4. The following Signatory State(s) to the Convention participated in the work of the Group: Egypt.

5. The following States not party to the Convention participated as observers: Ghana, Myanmar and Oman.


7. The representatives of the following non-governmental organizations participated in the work of the Group in accordance with the rules of procedure: Campaign to Stop Killer Robots, Amnesty International, Article 36, Association for Aid and Relief, Japan, Committee of 100 in Finland, Facing Finance, Human Rights Watch, International Committee for Robot Arms Control (ICRAC), Mines Action Canada, Norwegian Peace Foundation, PAX, Pax Christi Ireland, Project Ploughshares, Protection, Pugwash Conferences on Science and World Affairs, Seguridad Humana en Latino America y el Caribe (SEHIC), Women’s International League for Peace and Freedom (WILPF), and the Centre for a New American Security (CNAS).

8. The representatives of the following entities also participated in the work of the Group in accordance with the rules of procedure: Ada-AI, Birmingham City University, Centre for Emerging Technology Intelligence, Graduate Institute Geneva, Harvard Law School, ICT4Peace Foundation, International Panel on the Regulation of Autonomous Weapons (iPRAW), King’s College (London), National University of Ireland (Galway), Stockholm International Peace Research Institute (SIPRI), University of Barcelona, University of China, University of Oxford, University Pablo de Olavide (Seville), University of Tasmania, University of Zurich and the Vrije Universiteit Amsterdam.

9. On Monday, 9 April 2018, the first session was opened by the Chairperson, Ambassador Amandeep Singh Gill of India. Ms. Anja Kaspersen, Director of the Geneva Branch of the UN Office for Disarmament Affairs, addressed the session on behalf of Ms. Izumi Nakamitsu, the High Representative for Disarmament Affairs.

10. At its first plenary meeting, the Group adopted its Agenda (CCW/GGE.1/2018/1), confirmed the Rules of Procedure as adopted by the Fifth Review Conference (CCW/CONF.V/4), and adopted its Programme of Work (CCW/GGE.1/2018/2). Mr. Marco Kalbusch, Senior Political Affairs Officer, UN Office for Disarmament Affairs, served as the Secretary of the Group, and was assisted by Ms. Melanie Gerber, Associate Political Affairs Officer, UN Office for Disarmament Affairs. Ms. Isabelle Porou-Cartier, Staff Assistant and Ms. Nadiya Dzyubynska, Staff Assistant served in the Secretariat.

11. At the same plenary meeting, the following States participated in a general exchange of views: Argentina, Australia, Austria, Belgium, Brazil, Bulgaria, Canada, Chile, Costa Rica, Cuba, Egypt, Estonia, Finland, France and Germany (joint statement), Greece, Holy See; India, Ireland, Israel, Italy, Japan, Latvia, Luxembourg, Mexico, Netherlands, Pakistan, State of Palestine, Panama, Republic of Korea, Russian Federation, South Africa on behalf of the African Group, Spain, Sri Lanka, Sweden, Switzerland, Turkey, United Kingdom of Great Britain and Northern Ireland, United States of America, European Union, Venezuela (Bolivarian Republic of) on behalf of the Non-Aligned Movement and other States Parties to the CCW, UNIDIR, ICRC, Campaign to Stop Killer Robots, International Committee for Robot Arms Control, Human Rights Watch, Mines Action Canada and PAX.

12. In accordance with its programme of work (CCW/GGE.1/2018/2), the Group commenced with a general exchange. The Group then considered the following agenda items:

a) Characterization of the systems under consideration in order to promote a common understanding on concepts and characteristics relevant to the objectives and purposes of the Convention.
b) Further consideration of the human element in the use of lethal force; aspects of human-machine interaction in the development, deployment and use of emerging technologies in the area of lethal autonomous weapons systems

c) Review of potential military applications of related technologies in the context of the Group's work

d) Possible options for addressing the humanitarian and international security challenges posed by emerging technologies in the area of lethal autonomous weapons systems in the context of the objectives and purposes of the Convention without prejudging policy outcomes and taking into account past, present and future proposals

13. The Group heard presentations from the following experts: Expert Panel on the review of potential military applications of related technologies in the context of the Group's work: Professor Pascale Fung, Hong Kong University of Science and Technology; Professor Anthony Gillespie, University College London; Professor Mary Cummings, Duke University; Professor Dominique Lambert, University of Namur; Professor Viacheslav Pshikhopov, Southern Federal University.

14. The Group considered the documents listed in Annex I. The Group noted with appreciation the contributions of those High Contracting Parties submitting Working Papers, presenting their national policies and positions, and the input of civil society, including industry.

III. Organization and work of the Group of Governmental Experts (August session)

15. The following High Contracting Parties to the Convention participated in the work of the Group: Algeria, Australia, Austria, Belarus, Belgium, Brazil, Bulgaria, Canada, China, Chile, Colombia, Costa Rica, Croatia, Cuba, Cyprus, Czechia, Denmark, El Salvador, Ecuador, Estonia, Finland, France, Germany, Greece, Guatemala, Holy See, Hungary, India, Iraq, Ireland, Israel, Italy, Japan, Jordan, Kazakhstan, Latvia, Lithuania, Luxembourg, Mexico, Montenegro, Morocco, Netherlands, New Zealand, Nicaragua, Norway, Pakistan, Panama, Philippines, Poland, Qatar, Republic of Korea, Romania, Russian Federation, Senegal, Serbia, Slovenia, South Africa, Spain, Sri Lanka, Sweden, Switzerland, Turkey, United Kingdom of Great Britain and Northern Ireland, United States of America, Venezuela (Bolivarian Republic of).

16. The following Signatory State to the Convention participated in the work of the Group: Egypt

17. The following States not party to the Convention participated as observers: Islamic Republic of Iran, Myanmar and Oman.

18. The representatives of the United Nations Institute for Disarmament Research (UNIDIR), the United Nations Mine Action Service (UNMAS), the European Union and the International Committee of the Red Cross (ICRC) participated in the work of the Group in accordance with the rules of procedure.

19. The representatives of the following non-governmental organizations participated in the work of the Group in accordance with the rules of procedure: Campaign to Stop Killer Robots, Amnesty International, Article 36, Association for Aid and Relief Japan, Committee of 100 in Finland, Facing Finance, Human Rights Watch, International Committee for Robot Arms Control, Mines Action Canada, Nobel Women's Initiative, Norwegian Peace Foundation, PAX, Pax Christi Vlaanderen, Project Ploughshares, Protection, Rete Italiana per il Disarmo, SEHLCAC, WILPF, Conscious Coders, International Action Network on Small Arms, Pax Christi International and Zonta International.

20. The representatives of the following entities also participated in the work of the Group in accordance with the rules of procedure: Birmingham City University, Centre for Emerging Technology Intelligence, CAN Center for Autonomy and AI, Geneva Center for Security Policy, Harvard Law School, ICT4 PeaceFoundation, IPRAW, National University of Ireland (Galway), New York University, NewSpace2060, University of Leicester,
University of North Carolina, University of Oxford, University Pablo de Olavide (Seville),
University of Tampere, University of Tasmania and Vrije Universiteit Amsterdam.

21. On Monday, 27 August 2018, the first session was opened by the Chairperson,
Ambassador Amandeep Singh Gill of India. Ms. Melanie Gerber, Political Affairs Officer,
UN Office for Disarmament Affairs, served as the Secretary of the Group, and was assisted
by Ms. Amy Dowler, Political Affairs Officer, UN Office for Disarmament Affairs. Ms.
Maria José Orellana Alfaro, Ms. María-Luisa Zeballos and Ms. Nadiya Dzyubynska, Staff
Assistants served in the Secretariat.

22. In accordance with its programme of work (CCW/GGE.1/2018/2), the Group
commenced with a panel discussion on agenda item 6 c. The Group then considered the
following agenda items:

a) Characterization of the systems under consideration in order to promote a
common understanding on concepts and characteristics relevant to the objectives
and purposes of the Convention

b) Further consideration of the human element in the use of lethal force; aspects of
human-machine interaction in the development, deployment and use of emerging
technologies in the area of lethal autonomous weapons systems

c) Review of potential military applications of related technologies in the context of
the Group’s work

d) Possible options for addressing the humanitarian and international security
challenges posed by emerging technologies in the area of lethal autonomous
weapons systems in the context of the objectives and purposes of the Convention
without prejudging policy outcomes and taking into account past, present and
future proposals

(The Group then considered and adopted the final report.)

23. The Group heard presentations from the following experts under agenda item 6 c: Dr.
Lydia Kostopoulos, Digital Society Institute at the European School of Management and
Technology; Lieutenant Colonel Christopher Korpela, Research Center at the United States
Military Academy at West Point; Professor Anthony Gillespie, University College London;
Dr. Gautam Shroff, Tata Consultancy Services and Dr. Knut Dörmann, International
Committee of the Red Cross (ICRC).

24. The Group considered the documents listed in Annex II. The Group noted with
appreciation the contributions of those High Contracting Parties submitting Working Papers,
presenting their national policies and positions, and the input of civil society, including
industry.

25. A summary of the discussions held during the April and August meetings of the
Group, prepared under the Chairperson’s responsibility, is attached to this report as Annex
III.
IV. Conclusions and Recommendations
Annex I

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# Annex II

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Annex III

Chair's summary of the discussion of the 2018 Group of Governmental Experts on emerging technologies in the area of lethal autonomous weapons systems

Agenda item 6 (a)

Characterisation of the systems under consideration in order to promote a common understanding on concepts and characteristics relevant to the objectives and purposes of the Convention

1. Delegations exchanged views on different approaches to the characterisation of lethal autonomous weapons systems (LAWS) based on emerging technologies related to intelligent autonomous systems in order to promote a common understanding on concepts and characteristics relevant to the objectives and purposes of the CCW. Four broad approaches to characterisation were highlighted and served as a reference point during the discussions.

Separative approach

An approach whereby characteristics and concepts not relevant to the objectives and purposes of the CCW are set aside ("via négativa"), while gathering the characteristics and concepts that are definitely relevant to the objectives and purposes of the CCW ("via positiva").

Cumulative approach

An approach whereby categories of characteristics are added to a master list and then concepts and characteristics therein are evaluated against certain technical, legal-humanitarian or political-security criteria to assess their relevance to the objectives and purposes of the CCW. Such categories could include physical performance, targeting performance and other technical characteristics. They could also include characteristics that are related to the human-machine interface, the human-machine relationship or secondary characteristics such as reliability, predictability and, subordination to command and control.

Accountability approach

An approach, which considers a set of characteristics related to the functions and type of decisions handed over to machines, and which avoids using levels of autonomy and other technical characteristics or categories related to the loss of human control. This approach would depend rather on the context and scenario in which the systems under consideration would be used and would involve a combination of technical and human-interface evaluations centred on accountability of States and humans.

Purpose oriented and effect-based approach

This approach focuses on desirable and undesirable consequences of possible lethal weapons systems based on emerging autonomous intelligent systems and technologies.

2. Delegations listed comprehensive sets of characteristics that were of interest to the deliberations while reaffirming the applicability of International Humanitarian Law (IHL) to all new weapons developed for use in armed conflict, including those with autonomous functions, and the responsibility of States to ensure such compliance. Some delegations noted
that the key obstacle to further work was the absence of working samples as well as a common understanding on a working definition. It was felt, however, that while a definition would be eventually essential the absence of an agreed definition should not prevent the Group from moving forward with the discussions. Others pointed to the lack of common understanding on various issues related to emerging technologies in the area of LAWS and encouraged more effort to be invested in education and deepening the collective understanding. There was a desire to ensure that understandings on characterization stood the test of time and were not overtaken by technological developments. Physical or technical attributes alone would not be sufficient to characterize LAWS and the Group sought to focus on considerations related to the human element in the use of force and build understandings on the human-machine interface throughout the lifecycle of weapons systems. In examining approaches to characterization, the Group sought to treat technology characteristics as capabilities and not as human features or stand-alone physical objects. Some delegations suggested that existing weapons systems were not the subject of the discussions, whereas others expressed the view that systems under consideration were already in existence. Likewise, some delegations felt that lethality was an essential characteristic spelled out in the mandate while others felt that the term "lethal" as a characteristic needed to be further examined in the light of the fundamental notion of use of force, which triggers legal obligations under international law irrespective of lethality. Several delegations expressed the view that a focus on lethality would fail to address injuries to persons or damage to objects that are protected by IHL. The interface of lethal systems with non-lethal decision support or other systems was highlighted as well.

3. Delegations also discussed important questions related to the ability of the machine for self-learning and self-evolution, which could potentially enable the machine to redefine targets. Some delegations considered distinguishing autonomy from semi-autonomy or automation to be helpful, while others promoted the consideration of autonomy as a broad spectrum, noting that autonomy was not an on/off phenomenon and there is lack of a clear line beyond which human control is lost or autonomy becomes problematic. The possibility to interrupt or abort the operation of a system was also discussed as a characteristic. In discussing technical characteristics, delegations underlined the need to apply a human-centric focus in the discussions to focus on the human element in the design and (ultimate) decision-making chain when choosing targets, authorising or using (lethal) force.

4. Delegations generally viewed human control as core concept for advancing discussion on LAWS and narrowing the focus of the Group’s future work. Many delegations were of the view that agreement on each and every characteristic was not essential and the Group could proceed in a step-by-step manner when characterising the systems under consideration. This was also true for one approach that suggested a distinction between anti-personnel and anti-material systems.

5. Delegations stressed that autonomy can exist throughout or during different parts of the targeting cycle. Accordingly, some semi-autonomous machines can have highly autonomous critical functions while highly autonomous machines can have no autonomy in critical functions. Moreover, different functions of a weapon system may have different levels of autonomy and there may be no single general level of autonomy across the system. Thus, purely technical criteria may not be sufficient in framing a characterization of existing weapons or future weapons and could only serve as a reference point given the fast evolution of emerging technologies. Delegations underlined that a focus on the level, nature and primacy of human control rather than purely technical criteria was also logical given the purpose and scope of the CCW.

6. Delegations suggested a variety of attributes and interpretations that could be used in characterizing emerging technologies in the area of LAWS. These included:

(a) A system operating with neither human control after activation nor subordination to the chain of command

(b) A system capable of understanding higher level intent and direction with the ability to take appropriate action by choosing its course of action without depending on human oversight and control, although these may still be present.

(c) A system capable of carrying out tasks governed by IHL in partial or full replacement of a human in the use of force, notably in the targeting cycle.
(d) A system that once launched or deployed assumes a complex adaptive self-learning mode

(e) An adaptive system capable of navigating through a complex environment by redefining scenarios and approaches

(f) A rules-based system able to switch to autonomous mode

(g) A system that can select and attack targets without human intervention, in other words a system that self-initiates an attack

(h) Fully-autonomous systems, that is, unmanned technical means, other than ammunition, that are designed to carry out combat and support tasks without any participation of an operator

(i) A weapon system which can act autonomously in delivering (lethal) effects to a target and may also act autonomously in detection and target selection prior to engagement of the target. The level of autonomy can vary from basic levels of automation through a spectrum of an increasing number of autonomous functions and decreasing human control up to and including fully autonomous systems which operate across a range of functions without direct human control.

7. Delegations also discussed if the following systems should fall under the mandate of the GGE:

(a) A system with manual override, self-destruct, or self-deactivate function

(b) Systems that are technologically advanced but have no autonomy

(c) Systems with some degree of autonomy like close-in weapons systems, which autonomously engage incoming targets based on clearly defined parameters

(d) A rules-based system that is subject to a clear chain of command and control

(e) A learning system that offers options

8. Some delegations emphasised that autonomy in non-critical functions could be adequately addressed within existing legal frameworks. Others considered it important to cover not only critical functions but also other situations for use of force such as close combat when discussing the characteristics of LAWS. Delegations discussed if the method and nature of human control over critical functions were the key consideration in judging the weapons systems' compliance with IHL. Some delegations emphasized that consideration of the intended or expected circumstances of the use of the weapon was an important factor for compliance with IHL.

9. Delegations emphasised the importance of reaffirming relevant States' obligations to a legal review of current and new weapon systems. The importance of examining and sharing best practices was also underlined, which included but was not limited to sharing national policies and approaches for assessing and dealing with autonomous technologies; considerations related to the human element in the use of force; intelligibility and explainability; and adoption of new standards, methods and protocols for testing and validation. In the context of the discussion on a purpose-oriented approach, some delegations stated that policy should drive definitions and related characteristics, not the other way around.

Agenda item 6(b)

Further considered the human element in the use of lethal force and aspects of human-machine interaction in the development, deployment and use of emerging technologies in the area of lethal autonomous weapons systems

10. The Chair presented as a reference for delegations a set of three slides: first, on four broad areas of touch points in the human-machine interface (the 'sunrise' slide); second, a
list of terms used by different delegations; and third, some qualitative, purpose and practice related considerations with regard to the human-machine interface. The solid line indicates that while national frameworks could cover all areas of the human-machine interface, the extent of international or industry level regulation could be limited.

Image 1 - Human-machine touchpoints in the context of emerging technologies in the area of lethal autonomous weapons systems, as updated at the August meeting.

11. Delegations underlined the need to apply a human-centric focus in discussing technical characteristics of LAWS. The nature and quality of the human-machine interface was viewed as critical for addressing concerns related to the development, deployment and use of technologies in the area of LAWS. Most delegations supported the notion that maintaining human control over weapons systems, particularly their critical functions, was necessary for compliance with IHL. Different terminologies and conceptualisations were brought forward by delegations with regard to human control. One was the importance of maintaining human control over the critical functions of autonomous weapons systems. Another was the human element in the different phases of the lifecycle of a weapon system and the level and quality of human control that can be applied at each stage.

12. Regardless of the approach, delegations reaffirmed the essential importance of human control, supervision, oversight or judgement in the use of force. It was pointed out that while terms such as human control were not expressly foreseen by IHL; their use could be derived from the requirement for compliance with IHL in the application of force.

13. Using the 'sunrise' slide of the various touchpoints in the human-machine interface, delegations stated that human control, supervision, oversight or judgement could be exerted in varied forms and at different times in the following phases: first, in the research and development phase; second, at the stage of testing and evaluation, verification and validation; third, the deployment, command and control stage; and fourth, the use and abort stage. Some delegations mentioned additional stages, such as a stage preceding the first one, consisting of national policies and regulations with regard to weapons development or the actual decision to procure weapons, or a stage after the fourth related to evaluation and assessment of use. The addition of training to the third stage was also discussed. The distribution of human control across the various different touchpoints does not mean a dilution of responsibility because each touchpoint is threaded with the notion of accountability. Many delegations thought it would be fruitful for the Group to focus on the qualitative and
quantitative dimension of human control required to ensure compliance with international law and in particular IHL for each of these touchpoints. Delegations also called for elaboration of the human-machine interface in order to balance the weaknesses of one with the relative strengths of the other as well as to maintain the human as the essential element in the man-machine team, with overall responsibility for coordination and decision-making.

14. Delegations noted that human control is already exerted in the research and development phase, which includes weapons reviews. In the research and development phase, teams of software developers will jointly create algorithms, technical experts will design and/or "train" the software and engineers will be responsible for the hardware and the integration of the software. Hardware and software design must allow an operator to actually exercise control during the operation of the system, through specific instruments in the human-machine interface and relevant procedures programmed into the system’s processes to enable human input and intervention.

15. Delegations highlighted the necessity to demonstrate that weapons systems have the capacity to be used in accordance with IHL, in particular the rules on the conduct of hostilities, distinction, proportionality and precautions in attack. Training of armed forces to ensure the ability to use a given system in compliance with international law, specifically international humanitarian law, was also important. The importance of legal weapons reviews under Article 36 of Protocol I to the Geneva Conventions was reiterated by delegations.

16. In the context of deployment and command and control, delegations underlined the need for a system to maintain the double principle of command and subordination. Subordination means that the framing, re-definition and adjustment of a weapons system’s mission needs to be done by humans. Concrete decisions related to the ‘when and where’ of the use of force need to be taken by humans. It was added that, communication links, even if intermittent, must be maintained – through a variety of means – between the chain of command and the weapons system, in order to maintain sufficient control and allow humans to take ultimate decisions regarding the use of force.

17. In context of the deployment and use of a weapons system in an armed conflict, delegations noted that military personnel activate the weapons systems and monitor their functioning. This would require that the operator know the characteristics of the weapons system, is assured that they are appropriate to the environment in which it would be deployed and has sufficient and reliable information on them in order to make conscious decisions and ensure legal compliance. It was also noted that control over use encompasses the procedural requirements to maintain control over the systems during planning, tasking and operation in a two-step approach: the ability to understand the situation and its context, for example when battle space situations change or during malfunctions, and the option to appropriately intervene if necessary by overriding the system or manipulating the machine, either at all steps of the targeting cycle, or at least during the target selection and engagement phases. It was also expressed that machines cannot simply be programmed to comply with IHL, and that therefore positive measures are necessary to prevent indiscriminate action and maiming by LAWS caused by breakaway from human control. To develop such measures, the concepts of meaningful human control and human judgment need to be further elaborated and clarified.

18. Delegations mentioned that an autonomous system must not acquire the capacity to repurpose itself automatically and repeatedly, and the human operator must maintain the capacity to intervene as is the case in current civilian applications. Further, human control over a machine must be adapted to the specific sets of tasks and the environment in which a system is operating and must allow the human to make meaningful decisions that comply with IHL and other requirements or to disengage the system if required. Several clarifications on how to describe the extent of human interaction with LAWS were suggested, such as substantive, meaningful, appropriate or sufficient human control. Delegations also suggested a minimum level of or minimum indispensable extent of human control.

19. Delegations stressed that post-use, it is necessary to have the possibility to establish accountability. Delegations stressed the importance of ensuring that humans remained at all times accountable for the use of force and related decisions and actions. Ensuring accountability would require actions of a weapons system to be recordable, auditable or
explainable. Reliability, predictability and trust were mentioned as other qualitative aspects of control.

20. The discussions benefited from presentations by delegations of four real-world examples:

- Delegations discussed an existing defensive weapon system with the capability of countering rocket, artillery and mortar threats. The case study served as an example of a weapon system whose operations involve a mix of human decision-making and automation. High levels of automation and some autonomous functions allow the system to operate at the necessary speed, while human operator oversight and inputs assures the safety of the operation and allows for intervention if necessary. The presentation provided information on why and how the weapon system was developed, how it functioned, and whether it has worked as intended. The presentation was made with the intention to increase the understanding in the GGE of how autonomy in various functions can enhance the ability of weapons to serve their purposes while also respecting IHL.

- Delegations also discussed an example of a weapon system under development whose operations could lead to greater compliance with IHL. This system, an underwater autonomous vessel equipped with a sonar, ship registry data, and torpedoes would be able to recognise and differentiate between civilian and military vessels based on the input from the sonar system and comparison of the input with the onboard ship registry. In case a civilian vessel is detected, the torpedoes would not be launched or would be diverted.

- Delegations received an overview of an anti-tank artillery weapon system for which human control is limited to the selection of the target area. Rather than using high explosives, the system’s warhead contains two metallic slug munitions that must hit their target very precisely to be effective. Each munition is equipped with heat and radar sensors which can scan a 200m diameter area. If a target is detected, the warhead is activated; otherwise it self-destructs. This system, which provides no opportunity for a human to control or abort following the release of the submunitions, has been operational for fifteen years and passed legal weapon reviews in two States. The presenter argued that the autonomy-enabled precision of this system allowed it to have a smaller footprint than a traditional explosive warhead.

- Delegations also heard about a system that employs autonomy in naval mine countermeasures. The system utilizes autonomy to reduce or eliminate the most time-consuming steps in traditional mine counter-measures processes. Its primary component is an unmanned surface vessel (USV) that carries mine-hunting unmanned underwater vehicles (UUVs) and neutralizing systems. The system uses automated algorithms enabling the in-situ planning, scheduling, and deconfliction of UUV missions. The UUVs are able to detect and identify targets autonomously and send data back to the USV, which launches neutralizers on that basis. The neutralizer proceeds autonomously to the mine location, validates the target and autonomously renders the mine inert. The system communicates with an operator on a mothership who is able to abort the mission.
21. During discussions on agenda time 6 (b) the following terms were listed non-exhaustively by the Chair for further discussion.

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22. It was also stated that the GGE could usefully focus at its future meetings on practice-related considerations, including the feasibility of some measures of human control, supervision or judgment, keeping in mind qualitative requirements such as reliability, predictability and explainability or auditability.

**Agenda Item 6 (c)**

**Review of Potential military applications of related technologies in the context of Group's work**

23. Delegation consideration of this agenda item proceeded through two interactive expert panel discussions, held on 12 April and 27 August 2018.

24. Professor Mary Cummings (Professor, Duke University, Fellow of AIAA and Co-Chair of WEF’s Council on Artificial Intelligence and Robotics) spoke of the three core functions in weapons release in the military – the decider, the executor and the validator. In the case of drones, there was a human decider, a robotic executor and a human validator. In the case of LAWS, the validator would be a computer. In the next five to fifteen years, technology in the battlefield would move to co-operative control with multiple vehicles coordinating together, sharing information and using computer vision for target identification and validation. She expressed concern about the lack of knowledge among engineers on the subject as well as the challenges concerning certification of LAWS for both civilian and military uses. It is the civilian world that currently has dominance over AI, which is the reason why the military establishments are seeking help from multinational companies to develop algorithms. Due to the innate neuro-muscular lag of humans to perceive and act upon a situation, she said that LAWS would be far more discriminatory provided existing computer perception issues were sorted out. On human-machine teaming, she said that the ideal system in the battlefield would be the one that could strongly leverage the human-machine team.

25. Professor Dominique Lambert (University of Namur in Belgium, member of Royal Belgian Academy and International Academy for Philosophy of Science) noted that from the viewpoint of ethics, the question of responsibility is crucial. Ultimately, it is the human being who would have to take responsibility for his or her actions. A machine or artificial system cannot be held accountable or penalized for its actions. He also spoke about the limits to the algorithmic approach in problem solving. He said that even if we were able to introduce an ethical component into algorithms, it may be able to generate legal databases and provide information that could assist in legal and ethical decisions, but it would not be able to replace the role of a judge who actually makes a ruling. There is a need to draw a distinction between assistance in decision making and taking a decision itself. One cannot ignore the interpretation aspect which comes into play in different scenarios. Ethical decisions cannot be replaced by formal processes.

26. Professor Vlacheslav Pshikhopov (Director of R&D Institute of Robotics and Control Systems of Southern Federal University and Head of Robotics and Intelligent Systems Laboratory of Russia) discussed the anti-ship P-700 Granit from the 1980s to underline that
decision making through intelligent technology where you have group control is an effective approach. At the same time, he acknowledged the difficulty in having an equivalent number of operators when given a group of weapons systems. He pointed out that in terms of motion control, there are limits for human intervention. He also spoke of the disadvantages of the existing control methods with a human operator, pointing out that human error causes 10 per cent of total losses in unmanned systems. He highlighted the benefits of using LAWS by introducing an example from the US showing that Intelligence technology allows identification of mobile objects with lower error level than when humans carry out the same task. He posed a question - what would be a better choice from the point of IHL - to let the human operator take the wrong decision and let people die or to use smart LAWS with much less casualties? In response to a question about apportioning blame, he said that war was always inhumane and if it were to happen then diplomats should also take the blame, and not just engineers, researchers or the military service.

27. Professor Pascale Fung (Director of the Centre for AI Research, Hong Kong University of Science and Technology, IEEE fellow, ISCA fellow and expert of the WEF Global Future Council on AI and Robotics) said that existing and emerging AI-based technologies continue to be funded by militaries for several operations and some have been adapted to civilian uses including for speech recognition, autonomous flight, and facial and object recognition. She pointed out that rules-based systems are more susceptible to hacking and that machine learning allows the systems to become fully autonomous by optimizing functions such as minimal harm and risk. She highlighted the current trend away from the rules-based systems to machine learning based systems in the civilian sector. For the military, a hybrid approach could be a valid option. She expressed concern over the black box nature of such decision-making algorithms as well as their scalability. Machine learning could be used to reinforce proportionality, necessity and discrimination. She pointed to the need of cross-cutting education and STEM training for ethicists, doctors, lawyers, philosophers and humanists, as well as experience sharing across different cultures.

28. Professor Anthony Gillespie (Visiting Professor at University College London, Fellow of the Royal Academy of Engineering) referred to technologies, capabilities, competence and authority. He spoke of targeting functions taking the example of Observe, Orient, Decide and Act (OODA) as a sequence of multiple post-task decisions. He pointed out that there must be success-based criteria for each task, probably based on Rules of Engagement (RoE), to ensure operation within bounds set by humans. In his view, it should be possible to define the technical competence or authority level for machine decisions. He spoke about the qualitative aspects of the human machine interface, trust issues between man and machine, separation of decision making and reliability. He pointed to the importance of training operators so that they are aware of the limits of behaviour of the automated decision-making system which is under their command. It is imperative for the human to trust the operational capability and reliability of the machine. He added that IHL sets a much higher threshold than HRL and other commercial considerations. The difference between military and civilian systems is that the former will always be a part of a command and control chain.

29. Delegations held a lively moderated exchange with the panel on a variety of aspects of the issue. They considered which related technologies were most likely to be applied in the military domain, and whether some domains were more likely to see the early deployment of such technologies. The question of whether there would be situations in which the complete loss of human control, supervision or judgement would be acceptable or even desirable was raised. The concept of human-machine teaming was interrogated, specifically whether it brought something different to the table with respect to the exercise of human control, supervision or judgement.

30. Delegations raised questions concerning the unique difficulties posed by LAWS for legal weapons reviews, including testing and whether a self-learning system would need to be reviewed every time it changed itself. The concept of machine decision making was further explored, including whether this represented true machine agency or just algorithmic response to inputs, and whether complexity was relevant in this regard. There was discussion of ethics in the context of programming and design, as well as how meaningful human control could be applied over autonomous swarms. Delegations raised concerns about the black box nature of current AI algorithms and questioned whether advances in explainability would
address this. Delegations sought examples of other sectors that provided good examples of
optimising human-machine collaboration in decision making.

31. The August panel was comprised of five experts, who each tackled the issue of
potential military applications of related technologies from different angles, and in light of
the discussions of the Group in April.

32. Dr. Lydia Kostopoulou (Researcher, Digital Society Institute for European School of
Management and Technology in Berlin) presented a matrix covering characteristics of
autonomous weapons systems, and human involvement at different stages of the weapon’s
life cycle, based on the previous discussions of the Group. She also presented a related matrix
covering issues of trust and confidence in autonomous weapons systems related to different
stages of its life cycle and different forms of human involvement. She noted that a common
vocabulary was important to progress discussions on human accountability and
responsibility.

33. Dr. Gautam Shroff (Vice President and Chief Scientist, Tata Consultancy Services)
discussed the importance of considering the level and degree of the human element in the use
of force to ensure that the unintended or unpredictable application of force is prevented. The
glaring errors made by otherwise highly accurate deep learning systems, and their high degree
of confidence in patent errors, underline the importance of human judgement in the
application of force. He also discussed the possibility of AI systems helping to prevent war
crimes. He noted the apparent desire within the Group to prevent the unintended or
unpredictable application of force and argued this would require considering the level and
granularity of human involvement.

34. Lieutenant Colonel Christopher Korpela (Associate Professor and Director, Robotics
Research Center, United States Military Academy) discussed human roles in the targeting
cycle, noting that the human commander is held accountable for the use of force regardless
of the weapon system used. Lt. Col. Korpela said that weapons must effectuate human
intention in the use of force and that decisions on the use of force are not delegated to
machines. He noted that if autonomy could provide humanitarian benefits and compliance
with IHL, it would be more ethical to use it than not to.

35. Professor Anthony Gillespie (Fellow, Royal Academy of Engineering) presented his
work looking at ensuring that the human who has delegated authority to a machine is held
accountable. He suggested there was need for further consideration of where in the decision
chain leading to the use of force it was acceptable for there to be no further human
involvement. He underlined the importance of a clear distinction between human and
machine actions for accountability and questioned whether rules of engagement could be put
into a form intelligible to machines.

36. Mr. Knut Bjurman (Deputy Head, Legal Division, ICRC) welcomed the renewed
interest in weapons reviews, noted the importance of States sharing national processes
leading to the approval of weapons with autonomous functions, and provided an overview of
four areas of challenges for weapons review of autonomous weapons systems: (i) deciding
when a system warranted a review (not just new systems, but changes to existing systems);
(ii) determining criteria for assessment (IHL, treaty law, operating environment, Martens
clause, ethical Considerations); (iii) assessment process (much is left to the discretion of
States; need to ensure sufficient expertise); (iv) and how to deal with uncertainty (which
raised novel compliance issues and renders testing difficult).

37. In the interactive discussion that followed, delegations made several comments and
posed a number of questions. The relationship between requiring human intervention and
prohibiting LAWS was raised. The concept of human-machine pairing was raised, as well as
the question of whether human involvement was more of a concern from an operational or
an ethical perspective. The ability of machines to react to sudden changes of circumstances
was raised, as was the question of holding developers accountable. More information on the
use of autonomy in extreme environments such as outer space and the deep oceans was
sought. It was also asked whether an autonomous system would be capable of determining
whether it was operating in the context of a war or not.
38. With regards to legal weapons reviews, delegations were interested to know whether existing processes met the standards discussed and whether they were sufficient to ensure compliance with IHL. A related query was how and by whom international standards for weapons review could be developed and how to monitor their implementation. Concern regarding verification of weapons reviews, which could be tantamount to interference in the national affairs of a State, was also expressed. One delegation sought views on whether a distinction between weapons systems focused on individuals and those focused on other weapon systems, or between weapons operating in different environments, would be useful in the context of weapons reviews. It was noted that it was difficult to assess the quality of weapon reviews given only a limited number are publicly available. It is important that they are not only conducted by lawyers but incorporate adequate inter-disciplinary expertise. Given the lack of guidance in Article 36 about how to conduct reviews, information sharing by States in this respect would be of value.

**Agenda item 6 (d)**

**Possible options for addressing the humanitarian and international security challenges posed by emerging technologies in the area of lethal autonomous weapons systems in the context of the objectives and purposes of the Convention without prejudging policy outcomes and taking into account past, present and future proposals**

39. Delegations reiterated the need to address various international security-related and humanitarian challenges arising from emerging technologies in the area of LAWS in the context of the objectives and purposes of the CCW. Among the security related challenges, the possibility of a new arms race, the danger of proliferation to non-state actors including terrorists, lowering of the threshold for the use of force, and the risk of cyber-attacks, hacking and spoofing of network-centric weapon systems were mentioned. In addition, the potential detrimental effects on global and regional security and stability were highlighted.

40. With regard to humanitarian challenges, delegations noted that emerging technologies in the area of LAWS raised following concerns: compliance with IHL, possible gaps in legal and political responsibility and accountability frameworks, and ethical and moral questions raised by increased machine autonomy in the use of force. Several delegations also stressed the need to further assess possible humanitarian and military values or benefits of LAWS. Many delegations stressed that any possible regulation should not impede the development or application of related technologies in the civilian sector for beneficial uses.

41. Some delegations advocated the establishment of transparency and confidence building measures (CBMs) through clearly outlined and harmonized legal review weapons processes as a means to prevent the acceleration of a new arms race and proliferation to non-state actors and terrorist groups. It was further suggested that relevant scientific and commercial communities should be included in any transparency and CBM efforts, including to prevent the potential leak of newly developed technologies from the civilian sector to illegitimate actors.

42. Support was expressed for the harmonization of legal weapons review processes and the elaboration of internationally agreed norms and standards. It was suggested that a technical comparative analysis of comprehensive weapons review mechanisms on development and procurement of new weapons could be undertaken, which would help to identify shortcomings and potential solutions. This could also result in a compendium of good national practice on weapons reviews and reviews of new means and methods of warfare and contribute towards establishing transparency and information exchange measures and cooperative technical analysis arrangements among States. The idea raised under agenda item 6 (c), that success and failure criteria could be programmed into autonomous weapons systems, and that these should be rigorously verified in the testing phase, was mentioned in this regard. The human control element was suggested as a necessary design requirement for all upcoming and future weapons developments. The
43. There was a call for greater technical expertise, which could be achieved by establishing technical bodies or expert groups to follow the development of emerging technologies. The possibility of establishing a standing group of technical experts under the CCW to monitor developments in science and technology and serve as an early warning function was introduced in this connection.

44. Some delegations expressed the view that the better application of existing international law, in particular IHL, was sufficient for maintaining the necessary human involvement in the use of weapons and force. Delegations also reaffirmed that the regime of international responsibility and accountability for the use of force in armed conflict fully applies when LAWS are employed and that individuals could be held accountable under applicable provisions at all stages of weapons development and deployment.

45. Other delegations viewed that new legally-binding provisions were necessary for addressing the humanitarian and international security challenges posed by emerging technologies in the area of LAWS. Such provisions could encompass measures mentioned above, including a comprehensive ban, prohibitions and restrictions of the type already seen within the CCW framework, or a positive requirement for maintaining human control over the critical functions of a weapons system.

46. Some delegations supported the 2017 proposal to establish a political declaration, which would affirm, inter alia and without prejudice to policy outcomes, that humans should be responsible for a) making final decisions with regard to the use of force and b) maintaining control over autonomous weapons systems. This could be followed by the development of codes of conduct and further confidence-building measures. A technology review functionality was proposed as part of such an approach. This could serve a lighthouse function on relevant developments in emerging technologies in the area of LAWS. Some delegations, citing the possible inadequacy of non-binding approaches in the context of LAWS, viewed a political declaration as an interim step prior to the conclusion of a legally binding instrument, perhaps in the form of a new protocol to the CCW. Several delegations called for a moratorium on the development of LAWS.

47. Some delegations underlined the need to further develop understanding of the subject within the context of the GGE’s mandate before considering which option(s) to pursue.

48. There was broad support for continuation of the GGE in 2019. In addition to the agenda items, delegations therefore discussed various options for the mandate of the Group in 2019, including:

- a continuation of the existing discussion mandate;
- an amended discussion mandate, reflecting the progress made by the Group to date, which could focus the work of the Group on compiling elements for an outcome document;
- a negotiating mandate.

49. The following amendment was proposed by Germany to the existing mandate:

“The Group of Governmental Experts related to emerging technologies in the area of lethal autonomous weapons systems (LAWS) in the context of the objectives and purposes of the Convention on Prohibitions or Restrictions on the Use of Certain Conventional Weapons shall meet for a duration of ten days in 2019 in Geneva in accordance with Decision 1 of the Fifth Review Conference of the High Contracting Parties to the Convention (CCW/CONF.V/10), consistent with CCW/CONF.V/2, with a focus on exploring and agreeing options for an Outcome Document.”

50. With regards to the proposal for a negotiating mandate, Austria, Brazil and Chile proposed the following language:

to be Excessively Injurious or to Have Indiscriminate Effects decides to establish an open-ended Group of Governmental Experts to negotiate a legally-binding instrument to ensure meaningful human control over critical functions in lethal autonomous weapon systems."

51. A view was expressed that IHL is fully applicable to lethal autonomous weapons system and its modernization, or adaptation, to such weapons systems is not needed. It was also stated that the meeting of the Group in 2019 should be rationalised to 5 days. There was some discussion on the relative merits of holding two one-week meetings or one two-week meeting; the former allowing for intersessional work and increasing the chance that experts with many competing demands could attends and the latter being more cost effective.

52. Delegations commended the discussions which had taken place during the two weeks and the progress made in terms of reaching a greater understanding of the subject matter in general and the notions of the human element and of accountability in the use of force in particular. The interactive discussion on characterization, human-machine interface and military applications of relevant technologies had helped underscore areas of convergence, such as the applicability of IHL, while clarifying areas that required further work. Delegations underscored the value add of the Guiding Principles that had emerged out of the discussions in 2018 as an "early harvest". They could be updated as work progressed and could also help policy communities working on issues related to intelligent autonomous systems outside of the CCW framework. Delegations welcomed the contributions and involvement of the civil society, industry and youth in the process and expressed appreciation for the contribution to the discussion made by the ICRC.