
LEARNING UNIT 15
Emerging Technologies:
Challenges For Arms Control
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Start Learning Unit
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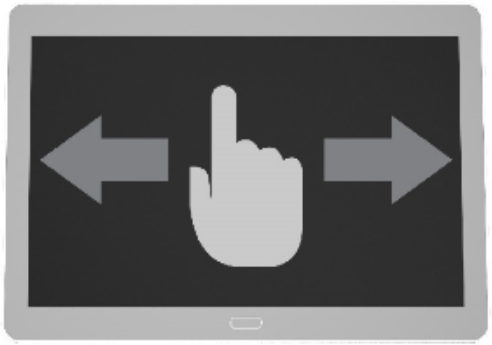

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with the arrow keys of your keyboard

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Introduction

Learning Objectives

After completing this learning unit, the student will

- have an overview over several emerging technologies and their various states of use by the military,
- know the state of proliferation with regard to unmanned weapon systems and the trend toward more autonomy in them,
- know the current state of affairs with regard to the development of hypersonic glide vehicles and the military use of nanotechnology,
- be able to assess the challenges involved with cyber security as well as the growing demand for non-lethal weapons.
- understand the challenges of the 21st century due to the dual-use problem and the need for qualitative rather than quantitative arms control

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Introduction

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US Marines testing the 'Legged Squad Support System (LS3)'. Photo Credit: US DoD/Sgt. Sarah Dietz

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Chapter I: Visible Threats: Military Robots and Hypersonic Vehicles

A Brief History of Unmanned Weapon Systems

In this video lecture, you will learn:

- that unmanned weapon system technology dates back as early as World War I.
- which technological advances and political context factors gave rise to what we today know as 'drone warfare'.
- which technical problems and challenges the use of drones evokes from a military perspective.
- why, in light of these challenges, 'weapon autonomy' is the next step in conventional weapons development.

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Chapter I: Visible Threats: Military Robots and Hypersonic Vehicles

The Current State of Drone Proliferation

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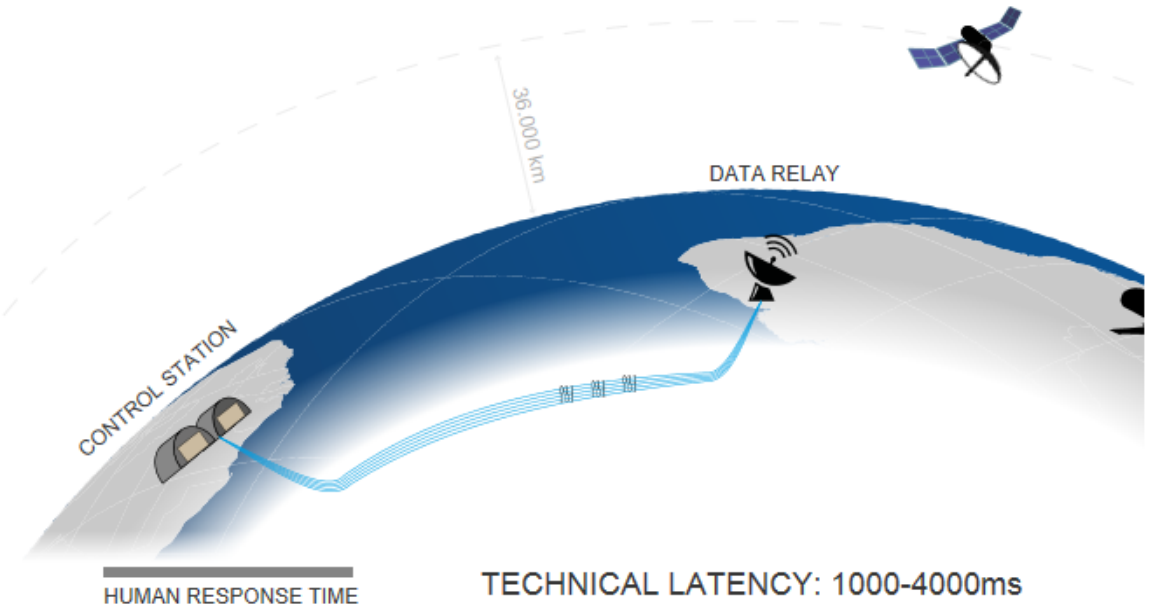
Chapter I: Visible Threats: Military Robots and Hypersonic Vehicles

Animation: The Latency Problem

When a remotely piloted unmanned military system is controlled via satellite, the problem of **signal latency** – that is, the time the signal needs to travel into space and back and get processed – becomes an issue.

Check out this short animation to understand the **military implications** of signal latency.



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Chapter I: Visible Threats: Military Robots and Hypersonic Vehicles

From Drones to Robots: Increasing Autonomy in Weapon Systems Today

'The Guardium'. Photo: IDF/Cpl. Zev Marmorstein, IDF Spokesperson's Unit.

The Guardium is an unmanned ground vehicle (UGV) developed by G-NIUS, a joint venture by Israel Aerospace Industries and Elbit Systems. It entered operational service in the Israel Defense Forces in 2008. The vehicle is remotely controlled but can be used in 'autonomous mode'. This primarily means the ability to drive along pre-programmed routes without direct human control. Guardium – currently – remains unarmed.

'X-47B' Photo: U.S. Department of Defense

The U.S. Navy's **X-47B** was a technology demonstrator run within the Unmanned Carrier-Launched Airborne Surveillance and Strike (UCLASS) system development program. The stealthy, sub-sonic, carrier-based drone demonstrated autonomous take-off and landing as well as mid-air refueling. This testbed was unarmed. Future systems might have strike capabilities.

'CARACaS' Photo: US Navy Photo by Mass Communication Specialist 2nd Class John Paul Kotar

CARACaS – which is short for Control Architecture for Robotic Agent Command Sensing – is a module that provides command, control and sensing capabilities to turn a regular (armed) boat into a remotely piloted sea vehicle. When deployed as a swarm, armed CARACaS-controlled boats can autonomously coordinate their behavior to patrol an area or even defend a convoy against attackers.

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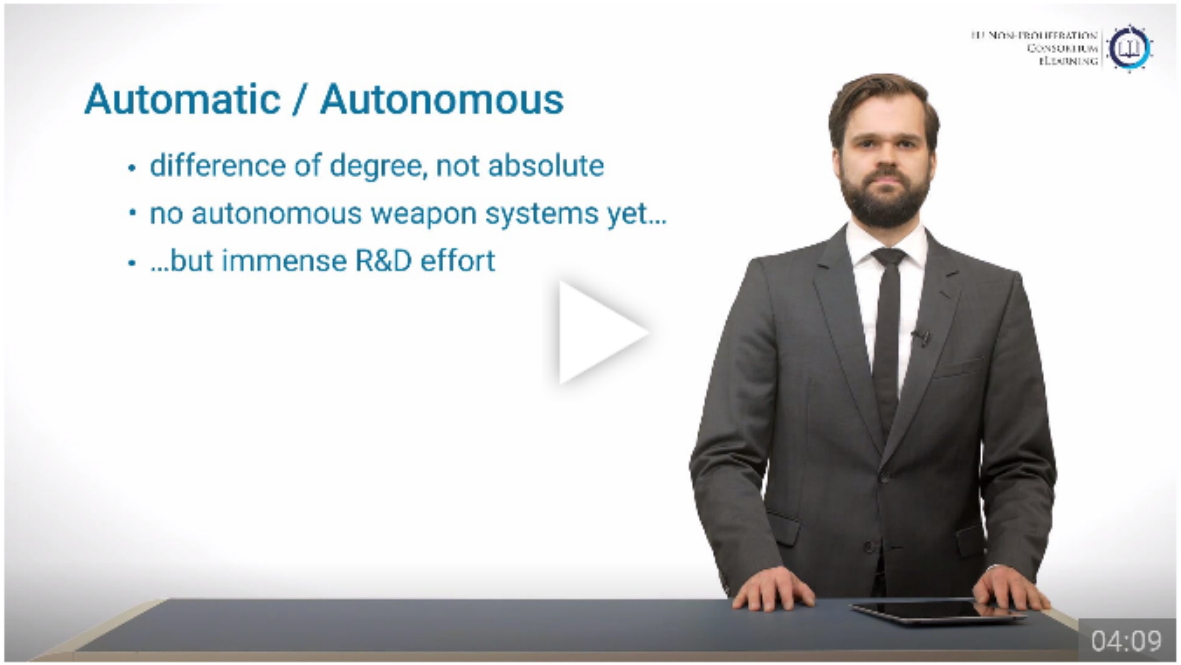
The Future: Lethal Autonomous Weapon Systems (LAWS)?

In this video lecture, you will learn:

- how 'autonomy' in weapon systems is a continuum but can most easily be grasped by artificially juxtaposing already existing defensive weapon systems that are 'automatic' with the 'autonomous' systems currently anticipated for the immediate future.
- how an autonomous weapon system is currently defined in the key U.S. policy document on autonomy in weapon systems.



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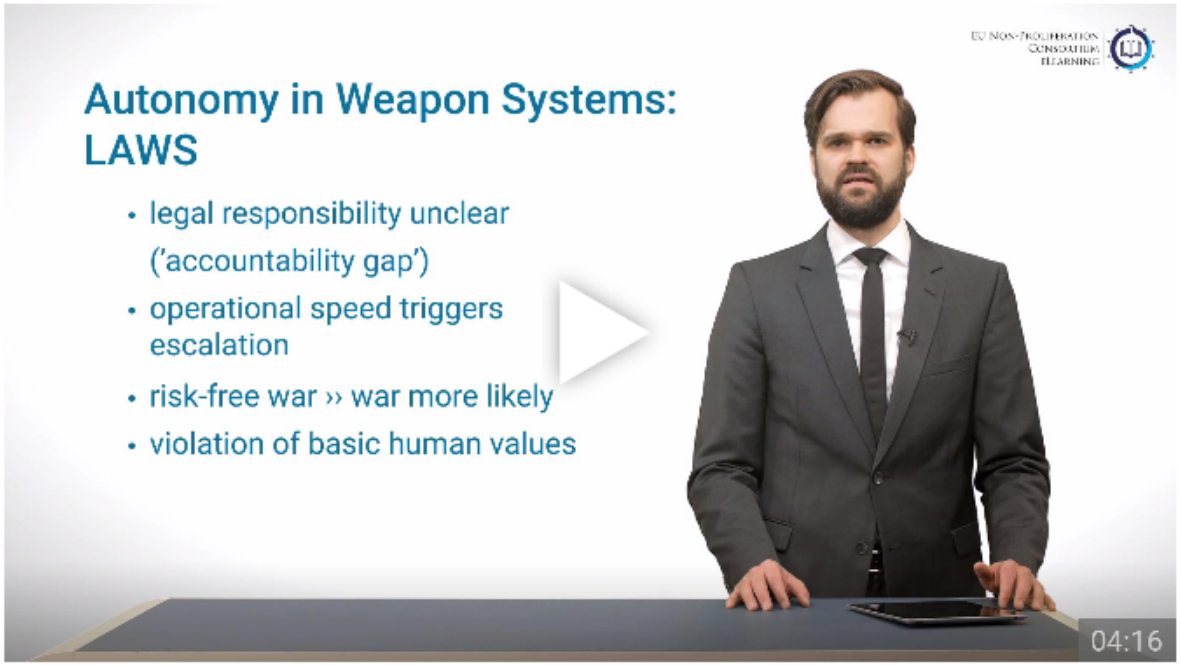
Chapter I: Visible Threats: Military Robots and Hypersonic Vehicles

Arms Control for Robots?

In this video lecture, you will learn:

- which technical, geopolitical, ethical and legal implications of LAWS the United Nations Convention on Certain Conventional Weapons is currently discussing.
- what the challenges regarding 'arms control for robots' are.



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LAWS, the Martens Clause and Public Opinion

The question of **public opinion** regarding either the development and use or the ban of LAWS is not just relevant from a perspective of legitimate policy-making.

Above and beyond that, it stands to reason that the issue of LAWS is connected to the **'Martens Clause'**. This clause was introduced with the 1899 Hague Convention II and has since then repeatedly appeared in international legal documents, rendering it relevant to the laws of armed conflict. Its interpretation and scope are a subject of debate, however.

The Martens clause states that **'the laws of humanity and the requirements of the public conscience'** are to be taken into consideration in cases not yet regulated via existing law.

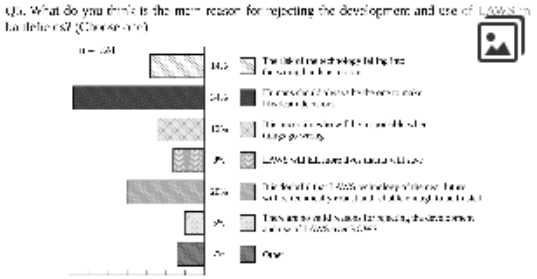
Equating public opinion polls with a measurement of 'the public conscience' short-circuits this matter to a considerable extent, but the Martens clause and public opinion are nevertheless oftentimes

In a 2013 survey conducted by Charli Carpenter in the US (www), '55% of Americans opposed autonomous weapons (nearly 40% were 'strongly opposed'), and a majority (53%) expressed support for the new ban campaign.'

A 2015 international survey conducted by the Open Roboethics Initiative (www) (ORI) across 14 different languages produced similar results.

According to this study, '67% of people indicated that all types of LAWs should be internationally banned, 56% of people said that LAWs should not be developed or used.'

In her data, Carpenter found 'intuitive concern over autonomous weapons. There is certainly an 'ugh' factor among many respondents.' This ugh-factor seems closely connected to the delegation of life and death decision to a machine, as the ORI data shown on the right suggests as well.



Source: Open Roboethics Initiative 2015: The Ethics and Governance of Lethal Autonomous Weapons Systems, p. 7.

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Chapter I: Visible Threats: Military Robots and Hypersonic Vehicles

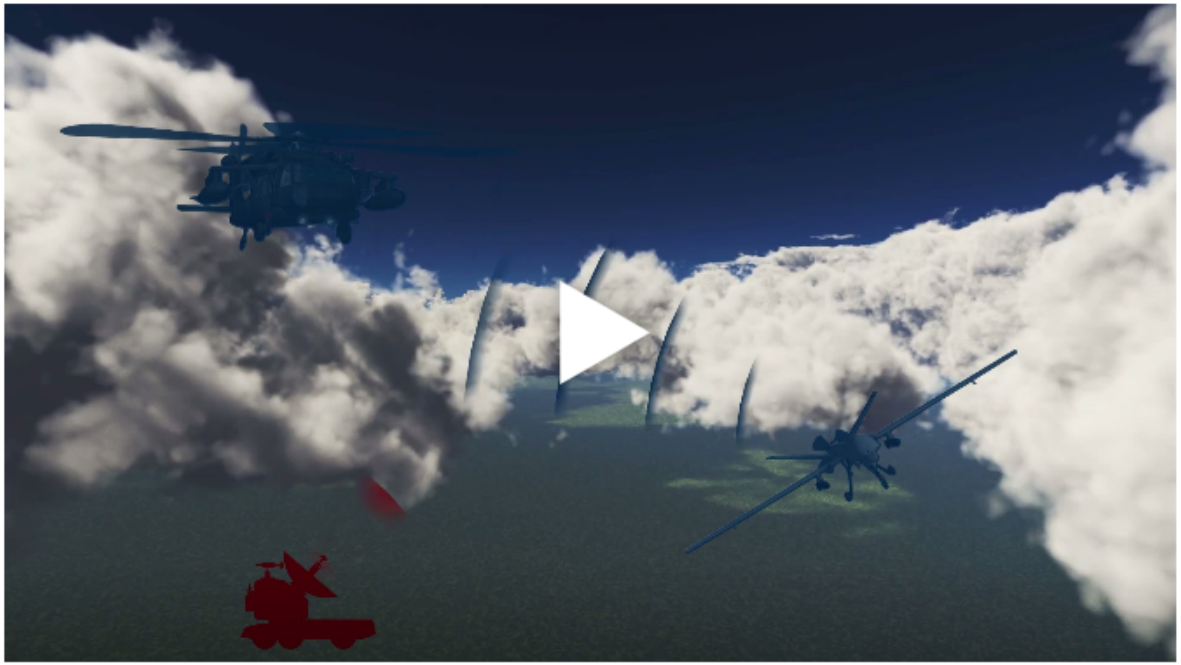
Avoiding 'full autonomy' with Manned-Unmanned Teaming?

Manned-Unmanned Teaming (MUM-T) is understood to be a solution to the latency problem which keeps human control over unmanned systems intact.

The basic idea is that a human will control an unmanned system in his closer proximity via direct communication, thereby avoiding problems like the time lag emerging from a satellite link and keeping full control.

To avoid overstraining the operator, the system needs a high level of semi-autonomy to understand and perform the tasks given.

However, as this short video shows, MUMT is not without problems as well.



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The Arms Control Debate on LAWS at the CCW

The Debate about LAWS in the CCW

The United Nations Convention on Certain Conventional Weapons in Geneva bans or restricts inhumane weapons that are excessively injurious or have indiscriminate effects. The CCW is currently discussing the issue of lethal autonomous weapon systems.

Since 2014, the CCW addresses the numerous legal, political and ethical questions raised by LAWS in expert meetings and during its annual States Parties meetings.

Informal expert meeting on LAWS at

So far, **three informal expert meetings and two meetings of the formal Group of Governmental Experts (GGE**) have been held (as of 2018). It is possible (albeit unlikely at this point in time) that the CCW adopts a Protocol to regulate or even preventively ban LAWS, as was done with blinding laser weapons.

Until today **no state has explicitly endorsed the use of autonomous weapons systems** – a notable difference to other debates in the realm of conventional arms control, for instance regarding antipersonnel mines or cluster munitions.
However, some states, while aware of the risks that LAWS pose, argue that regulation is premature because potential benefits have not been fully explored yet.

Nevertheless, as of 2018, **25 CCW States Parties have explicitly called for a ban**: Algeria, Argentina, Austria, Bolivia, Brazil, Chile, Colombia, Costa Rica, Cuba, Djibouti, Ecuador, Egypt, Ghana, Guatemala, Holy

The Role of the Critical Public

The debates in the CCW probably would not have happened without pressure from NGOs and the critical public.

Since 2012, a civil society coalition comprised of (as of 2018) 85 international, regional, and national non-governmental organizations (NGOs) in 40 countries, the **'Campaign to Stop Killer Robots'** calls for a legally binding international treaty to ban what they refer to as 'killer robots'.

Members of various scientific communities have been concerned about LAWS since at least 2009, e.g. the International Committee for Robot Arms Control (ICRAC). (www)

In 2015 and 2017, members of the AI community chimed in, releasing an open letter which called for a ban on LAWS and urged the CCW to take action(www). These letters received widespread media attention.

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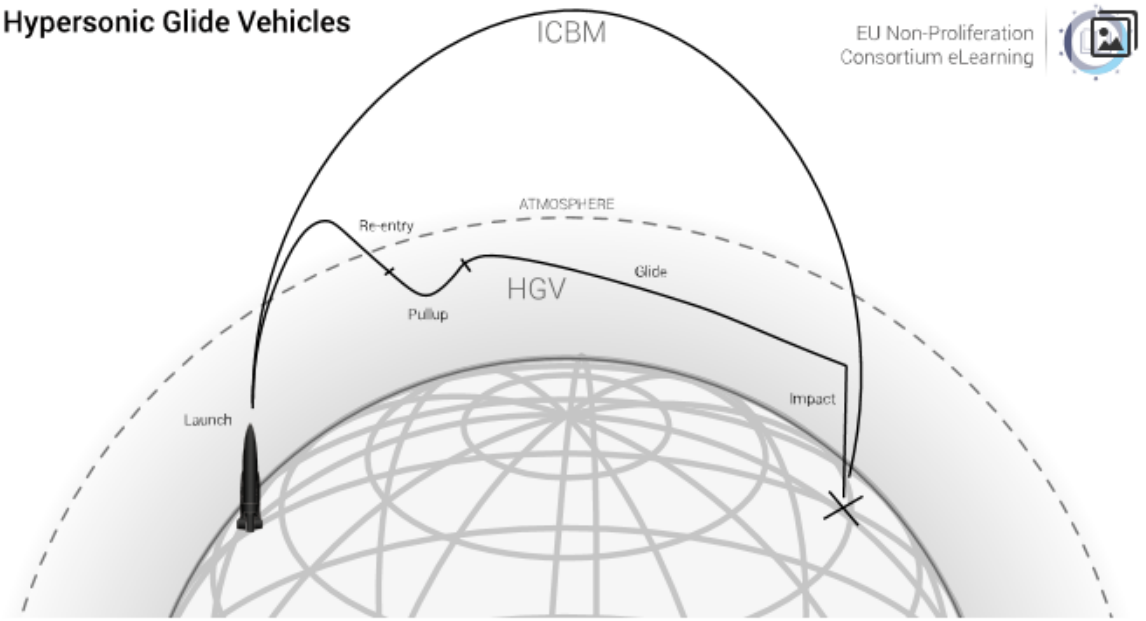
Hypersonic Glide Vehicles

In recent years, the US, China, and Russia (albeit with less success) have intensified their efforts to develop **Hypersonic Glide Vehicles (HGVs).**

A **new arms race** may well be under way. In recent years, the US, China, and Russia (albeit with less success) have intensified their efforts to develop **Hypersonic Glide Vehicles (HGVs).**

HGVs are weapons that travel within the atmosphere faster than five times the speed of sound, or Mach 5. Some tested systems already reached speeds of 21,000 kph (almost Mach 17). A booster, either a jet plane or a rocket, brings the HGV into the upper atmosphere to the edges of space where the hypersonic vehicle separates and transitions to an aerodynamic flight, descending towards its target at extreme speeds. In contrast to Intercontinental Ballistic Missiles (ICBMs) HGVs are highly maneuverable because they travel within the atmosphere.

Hypersonic Glide Vehicles



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HGVs: Scenarios and Stability Risks

How will the military utilize HGVs in the future? Two scenarios are possible.

US plans foresee that a strike would either be delivered via the sheer kinetic impact of the HGV crushing into its target or via a conventional payload. Either way, the system would be of a conventional nature.

Less is known about the Chinese plans. It could very well be that China sees HGVs as an alternative nuclear weapon delivery system.

It stands to reason that such weapons, even in a purely conventional configuration, have a profound impact on strategic stability.

In a seminal paper on the issue, Carnegie's James Acton identifies three ambiguities that add up to stability risks (www): Warhead ambiguity, destination ambiguity, and target ambiguity.

Warhead ambiguity: As HGVs use missiles as boosters, their launch could be mistakenly interpreted as an ICBM launch. The targeted country would not be able to distinguish a conventional from a nuclear attack.

Destination ambiguity: As hypersonic systems are highly maneuverable, their ultimate destination is not predictable. Countries observing the launch of an HGV could wrongly determine that they are under attack, even when they are not the target.

Target ambiguity: Again, due to the high maneuverability, the targeted country might not be able to determine whether its conventional (e.g. anti-satellite or anti-access/area denial systems) or its nuclear forces are the target of the hypersonic

All three ambiguities might lead the target state (or an observing state) to wrongly assume that it is under nuclear attack – resulting in the launch of a nuclear armed second strike and thus 'accidental nuclear war'.

Are there options for arms control?

As all HGV programs are still in the R&D phase and no country deployed such systems yet, one proposal from the nongovernmental field is to address the issue through a **test ban**. Without tests, developing reliable and deployable HGV systems is impossible. Such a ban, physicist Mark Gubrud argues (www), would be reliably verifiable as flight tests can be easily observed by national technical means (e.g. satellites, radars, signal intelligence).

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Quiz

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If you want to skip the quiz click here.

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Chapter I: Visible Threats: Military Robots and Hypersonic Vehicles

Quiz

According to data gathered by the New America Foundation, how many countries possess armed drones?

1. 7 ○
2. 9 ○
3. 11 ○
4. 13 ○

Check answer | Show solution | Reset

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Chapter I: Visible Threats: Military Robots and Hypersonic Vehicles

Quiz

Fill in the missing words.

According to the Pentagon's Directive 3000.09, issued in November 2012, an autonomous weapon system can be described as a ...

1. 'weapon system that, once activated, can _____
2. and _____ targets without further
3. _____ by a
4. _____ '

Check answer | Show solution | Reset

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Chapter I: Visible Threats: Military Robots and Hypersonic Vehicles

Quiz

The United Nations arms control body that has most intensively discussed the issues surrounding lethal autonomous weapons systems is the...

1. Security Council
2. General Assembly
3. Human Rights Council
4. Convention on Certain Conventional Weapons

Check answer | Show solution | Reset

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Chapter II: Invisible Threats: Nano Technology and Cyber Security

Photo Credit: U.S. Department of Defense

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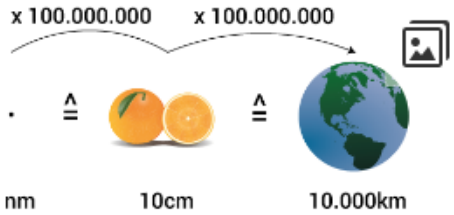
Chapter II: Invisible Threats: Nano Technology and Cyber Security

Nanotechnology: Facts and Figures

A nanometer (nm) is defined as the millionth of a millimeter – which is approximately the size of a glucose molecule. Nanotechnology (or nanotech) deals with creating or manipulating such very small objects on the atomic or molecular scale. When experts use the term nanotech, they usually refer **to systems between 0,1nm and 100nm.**

Nanostructures offer the possibility of creating **new materials** with enhanced, novel or **unique characteristics** and capabilities, including even electromechanical objects on a nanoscale.

The ultimate goal is to design nanomaterial by placing **individual atoms** or molecules at a predesignated space in a structure



'How small is a nanometer?'

Significant government interest in nanotech started at the advent of the new millennium. From the very beginning, the USA has been at the forefront of the nanotech revolution. In 2000, President Clinton created **the National Nanotechnology Initiative (NNI)**, a federal research and development program. Between 2001 and 2016 the NNI received more than **$22 billion** from participating agencies, including – amongst others – the Department of Defense, Department of Energy or NASA. Between 2001 and 2012, the DOD's annual contribution was between 23% and 32%.

Other countries with a strong interest in nanotech includes member states of the European Union (especially Germany and the UK), Japan, China, Russia and Korea.

While many nanotech applications are civilian, there are many military usages as well.

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Chapter II: Invisible Threats: Nano Technology and Cyber Security

Military Nanotechnology and Challenges for Arms Control

Military Nanotech: Applications

Nanotechnology might impact on many military related issues. **Reducing weight** for soldiers is one likely application, for example by creating lighter but still robust body armor, weapons and equipment. Lighter and at the same time more powerful **batteries** and computers can offer new forms of tactical communication.

Nanostructures can also enhance the effectiveness of **drugs, explosives or propellants**.

Some projects based on nanotechnology work on active optical **camouflage** for individuals, tanks or even warships.

Scholars even envision **'smart dust'** of communicating sensors smaller than one cubic millimeter.

Military Nanotech and Arms Control

Experts took nanotech from very early on to be a perfect candidate for **preventive forms of arms control**, that is restrictions based on the forecast threat an emerging technology is likely to pose. However, there has not been any serious attempt to regulate military nanotechnology yet.

First, nanotechnology is a **classical dual-use technology**. New materials with extraordinary characteristics will find application in the military as well as the civilian sector. The civilian market is forecast to grow with double digit numbers for years to come. So finding a balance between legitimate civilian interests and military restrictions will be hard.

Second, as the range of diverse examples for potential applications of nanotech demonstrates, it would be counterproductive to try to restrict nanotech per se.

Third, many military applications of nanotech still look like **science fiction** to the uninformed observer. While arms control advocates point to the precautionary principle, 'invisibility cloaks' (aka 'active camouflage') or smart dust seem still far too far out for many political decision-makers to focus on.

In sum, how to prevent or even stop an already ongoing 'nanotech arms race' is still an **open question** – a question not receiving much attention at the moment.

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Chapter II: Invisible Threats: Nano Technology and Cyber Security

Cyber Security I: Definitions

This video

- explains why it is hard to find a defintion for cyber attacks
- introduces different forms of cyber incidents
- describes how international law deals with cyber incidents
- discusses the 2013 Tallinn Manual

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Cyber Security II: Problems and Arms Control

In this video you will

- be introduced to the 'attribution problem'
- see why deterrence is problematic in the cyber realm
- learn about the problems of conventional arms control measures in cyber space

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Cyber Incidents in the Physical World

Estonia 2007

In late April 2007, many Estonian websites, including those of banks and governmental institutions, were flooded with denial-of-service attacks from millions of computers captured in 75 countries for several days. Estonia suspected that Russia was behind the attack or had at least assisted Russian 'patriotic hackers' as retaliation for the relocation of a Soviet-era grave marker. However, these allegations could never be proven.
The new NATO member Estonia turned to its Alliance partners for help, citing Article 5 of the Washington Treaty. However, after some deliberation the other NATO members concluded that collective defense as stated by Article 5 was not applicable, based on the same arguments fleshed out in the Tallinn Manual a few years later.

'Operation Orchard' 2007

Shortly after midnight of September 6, 2007, fighter jets believed to belong to the Israeli Air Force (IAF) attacked a suspected nuclear reactor facility in Syria, destroying the site completely.
According to news sources, Israeli intelligence had learned about the complex from a spying software planted on a computer of a senior Syrian government official. In addition, experts suggested that the Syrian air defence had been spoofed with the help of a U.S.-developed software called 'Suter'. This software made the Syrian systems believe that there was nothing out there to defend against.

However, neither the bombing nor the use of cyber means has been confirmed.

'Stuxnet' 2010

In 2010 security experts discovered a very sophisticated piece of malware, utilizing four previously unknown vulnerabilities as well as stolen security certificates. Instead of causing indiscriminate harm, this software, 'Stuxnet', was after something very special: a specific program controlling Siemens industrial hardware. Coincidently, it was the exact software used for the enrichment centrifuges in Iran's highly controversial nuclear enrichment plant in Natanz. When the software reached Natanz it subtly altered the rotation speed of the centrifuges, not enough to be noticed, but enough to damage and break them eventually. It is believed that 'Stuxnet' was jointly programmed by Israeli and American experts to delay the Iranian nuclear program.

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Quiz

Now it's your turn! Take the following quiz to check what you have learned so far.

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Chapter II: Invisible Threats: Nano Technology and Cyber Security

Quiz

How small do things have to be in order to be considered 'nano'-technology?

1. approx. 1cm ○
2. less than 1nm ○
3. 0,1-100 nanometer ○
4. 100nm – 1cm ○

Check answer | Show solution | Reset

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Chapter II: Invisible Threats: Nano Technology and Cyber Security

Quiz

What is the main challenge regarding arms control in particular and the application of interntional law in general in cyberspace?

1. outdated international law
2. not enough lawyers in the military
3. lack of agreed definitions
4. only national law applicable

Check answer | Show solution | Reset

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Chapter II: Invisible Threats: Nano Technology and Cyber Security

Quiz

What is understood by the term 'attribution problem'?

1. States have to respect the property rights of hacking software when defending against intrusion. ○
2. It describes a conflict of competences when too many state agencies are controlling the cyber domain. ○
3. The creator of Bitcoin is only known under the pseudonym 'Satoshi Nakamoto' but no real person can be attributed with the fame of designing bitcoin. ○
4. States can never be 100% sure when tracking who was behind a cyber incident. ○

Check answer | Show solution | Reset

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Chapter III: Elusive Threats: Non-Lethal Weapons, 3D-Printing, Synthetic Biology & Cybernetic Organisms

Photo Credit: U.S. Navy photo by Mass Communication Specialist Seaman Tyler R. Fraser.

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Chapter III: Elusive Threats: Non-Lethal Weapons, 3D-Printing, Synthetic Biology & Cybernetic Organisms

Non-Lethal Weapons

This video

- describes what is understood by the concept of 'non-lethal weapons'
- shows that the concept is far from being clear
- explains why non-lethal weapons, albeit not being new as such, have become more important recently

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Chapter III: Elusive Threats: Non-Lethal Weapons, 3D-Printing, Synthetic Biology & Cybernetic Organisms

Examples of Less Lethal Weapons

Non Lethal or Less Lethal come in a great variety. The table on the right side gives you an overview over the most important systems. Please click to enlarge.

NLW Technology	Examples
Kinetic energy	Impact munitions (wooden dowels, bean bags, plastic bullets, water cannons, ring airfoil projectile, foam rubber projectiles)
Barriers and entanglements	Devices to slow the progress and stop vehicles or boats (e.g. nets, chains, spikes, rigid foams)
Electrical	Electro-muscular disruption technology (e.g. Taser stun guns, retractable 'stun sword', exoskeleton stun weapon, wireless electrical weapon (e.g. Close Quarters Shock Rifle), laser-induced plasma weapon
Acoustic	Acoustic generators, acoustic cannon, long-range acoustic devices
Directed energy	High power microwave, millimeter wave, lasers, pulsed energy projectile weapon
Chemical	RCAs, malodrants, anti-traction materials, obscurants, sticky foam, anti-material chemicals, defoliants/herbicides
Chemical/biochemical	Calmatives, convulsants, incapacitants
Biological	Anti-material microorganisms, anti-crop agents
Combined technologies	Flash-bang grenades, kinetic + chemical dispersal devices, optical + chemical dispersal devices
Delivery systems	'Non-lethal' munitions (e.g. mortar shells), landmines, unmanned vehicles and vessels, encapsulation/microencapsulation

Chapter III: Elusive Threats: Non-Lethal Weapons, 3D-Printing, Synthetic Biology & Cybernetic Organisms

3D Printing

Additive manufacturing, more commonly known as 3-D printing, is about to transform the way we make things in the future. In contrast to traditional manufacturing, 3-D printers build objects from digital build files by depositing and joining **successive layers of material**. 3D printers can process a wide variety of materials, including plastics, metals (like steel or aluminium), ceramics, and even organic tissues.

Many industries, with the automotive, aerospace and health care industries at the forefront, already draw upon 3-D printing – not only for rapid prototyping but more and more also for the production of end-use parts.

Additive manufacturing offers **many advantages** over traditional manufacturing. It allows, for example, for producing parts with complex geometries, such as lattices or hollow structures. The resulting parts can be lighter and yet stronger.

Additive manufacturing is a **potentially disrupting technology** that comes not only with benefits but also risks, in particular for (international) security.

Military planners and defence contractors already realized the potential of additive manufacturing – but so have **non-state actors**.

3-D printed drones and hand guns, albeit crude ones, have already been proven to be functional. This poses potentially huge challenges for domestic security. Terrorists could use 3-D printing, for example, to produce ceramic or plastic firearms that could pass unnoticed through metal detectors. Or a swarm of cheap drones, equipped with C-4 plastic explosives, that are used as improvised explosive devices.

3-D printing may also impact on the **proliferation of WMD weapons**. Whereas we are far away from having to fear that someone may be able to '3-D print the bomb', additive manufacturing may facilitate clandestine state and non-state WMD programs. Proliferators could, for example, use the technology to illicitly manufacture components of a gas centrifuge at less risk of being exposed.

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Chapter III: Elusive Threats: Non-Lethal Weapons, 3D-Printing, Synthetic Biology & Cybernetic Organisms

New Methods of Human Enhancement

The idea to **enhance a warfighter's quality** by either using tools – weapons or armor – or drugs is almost **as old as warfare itself**. And injured or maimed soldiers have gotten prostheses and artificial limbs for a long time to regain some quality in life. For a **very long time**, however, those 'enhancers' were **inferior, not very practical or even dangerous**. Almost all drugs do have negative side effects, including addiction. Body armor was heavy and restricted movement. And replacements for limbs were ungainly and crude.

What is recently new, however, is the expectation that high-tech solutions can actually **enhance human performances without drawbacks**. Three ways to enhance the human body are currently heavily researched.

1) The most 'conventional' approach focusses on active, that is, battery powered **equipment attached to the human body**. While active night vision goggles have been in use with the military for decades now, motor driven exoskeletons are being tested to enhance a soldier's endurance, strength and resilience. The development of **miniaturized motors, tough but lightweight materials and high-capacity power supplies** has boosted this development.

2) **'Bodyhacking'**: The same developments have increased the performance of **artificial limbs and implants**. Some observers speculate that in the not so distant future soldiers will or might even be ordered to undergo surgery to have certain parts of their body permanently replaced by enhanced artificial products to enhance performance or sensation – the idea of the **cyborg** coming true.

3) The third field encompasses the design of **new artificial biological or chemical systems** with up-to-now unknown qualities., called 'synthetic biology'. This might include new designer drugs, powerful steroids, fast-healing first-aid or new vaccines . At the current stage, however, military actors are still funding basic research rather than concrete applications.

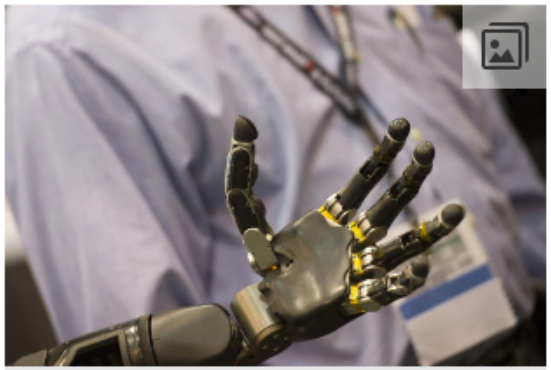

Photo Credit: US DoD/Senior Master Sgt. Adrian Cadiz (www)

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Chapter III: Elusive Threats: Non-Lethal Weapons, 3D-Printing, Synthetic Biology & Cybernetic Organisms

Legal and Ethical Implications of Human Enhancement

As described before: the idea to enhance ordinary humans to some sort of super soldier is not new. And some enhancers, being either technological or bio-chemical, are already in use.

However, aside from a slowly intensifying scientific discourse, there has been **almost no international debate** about the implications of current technological developments. These developments beg new legal, ethical and political questions . But as in other cases, the debate lags behind what is – or is about to become –technically feasible.

The first and most obvious question regards the **risks one is willing to take** or asking others to take. Every medical procedure entails certain risks for those who undergo it. There has been a debate whether a state can order a soldier to get a risky vaccination. Ordering a soldier to accept an implant or even to replace a healthy limb or organ is even more intrusive and fundamental. Negative side effects can never be ruled out. Do soldiers have to accept these risks to become, for example, a member of an elite unit?

In addition, what are the **risks to others** – especially when it comes to stimulants or drugs. Can soldiers be held accountably for war crimes if they were 'high'? What if there are unforeseen adverse reactions with other enhancers or medicines?

Depending on the grade of enhancement a human has gone through: will they still count as humans with a POW right or are they considered a weapon of their own? Would it be legal to 'deactivate' certain functions of captured soldiers, i.e. switch of artificial legs?

Another important issue is of **ethical nature**: is it ethical to ask soldiers to enhance their body with potentially irreversibly methods? Would they have to give back implants or certain abilities once they leave the military? Would that prohibit any permanent enhancements?

We do not claim that there are no answers to these questions. Probably most can be answered in a satisfactory way. However, up to now there is simply **no international forum** where these questions can be raised and addressed, let alone be answered in an internationally satisfying way.

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Chapter IV: Outlook

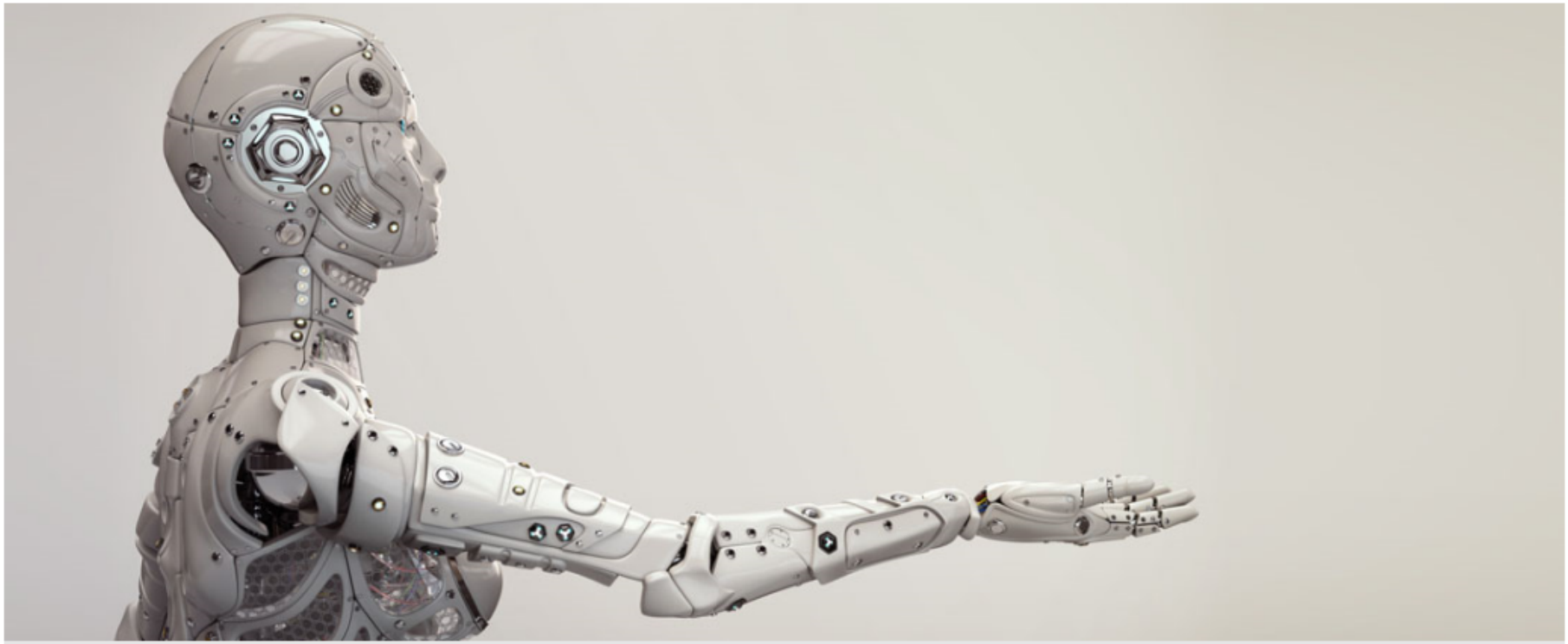

Photo Credit: Denned / fotolia

EU NON-PROLIFERATION CONSORTIUM eLEARNING

Chapter IV: Outlook

Outlook: From Quantitative to Qualitative Arms Control?

How can arms control react to the challenges deriving from this plethora of new technologies?

The key is a **qualitative rather than a quantitative approach.** Take lethal autonomous weapon systems as an example. From an arms control perspective, the key insight regarding the military use of robots is that the good old days of treaties and regimes relying mainly on quantification for verification and compliance are over.

Dual-use hard- and software is what makes these conventional weapons systems tick. And numbers are of less importance than capabilities.

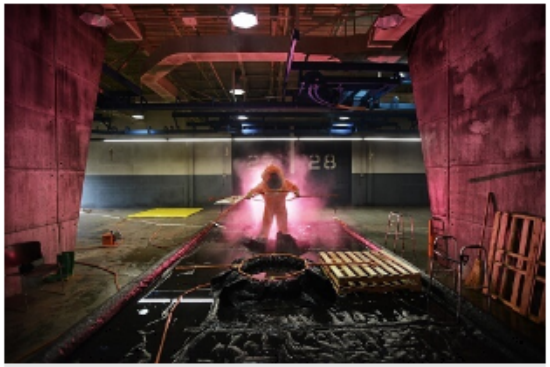

Photo Credit: Pixabay, Public Domain

In other words, you do not need fissile material and enrichment facilities or chemical precursors and laboratories to build an autonomous weapon system that can wreak havoc on an enemy or even a civilian population in a terrorist attack; there are no warheads that an inspection team might count, maybe not even facilities or weapons systems to scrutinize.

In the not-too-distant future, the hardware of an autonomous weapon might be 3D-printed just-in-time and the software running it downloaded from the internet.

Consequently, if lethal autonomous weapon systems are not desirable as an outcome of the current trend in weapons development, than specific uses, rather than numbers, of weapons systems need regulation.

Not the autonomous system as such but its 'kill function' needs to be subject of regulation to assure that humans remain in the loop of decision-making as well as legally accountable and morally responsible when military force is applied in a deadly fashion on the battlefield.

EU NON-PROLIFERATION CONSORTIUM eLEARNING

Chapter IV: Outlook

Interview: From Quantitative to Qualitative Arms Control?

In this video Giorgio Franceschini, Niklas Schoernig and Frank Sauer debate:

- why so many new technologies are emerging in the military sector at the moment
- why the debate about certain technologies seems to lag behind technological feasibilities
- in how far arms control has to undergo fundamental changes to stay on the agenda

Chapter V: The EU & Emerging Technologies

The EU & Emerging Technologies

Given the diverse nature of the issues covered in this learning unit as well as the different stages of technological development, it is hard to summarize the EU's activities with regard to emerging technologies.

Some of the issues covered in this learning unit have not yet led to a systematic and comprehensive review by EU institutions.

Others, however, like drones, have received more attention or, like cyber security, are ranking high on the Union's security agenda.

Regarding **armed drones and LAWS**, on 27 February 2014, the European Parliament (EP) adopted resolution 2014/2567(RSP) (www) on the use of armed drones, drawing attention to the increase of extraterritorial lethal operations by drones and the resulting civilian death toll, calling 'drone strikes outside a declared war by a state on the territory of another state without the consent of the latter or of the UN Security

Notably, in that resolution, the EP also calls for a 'ban [on] the development, production and use of fully autonomous weapons which enable strikes to be carried out without human intervention'. This call for a prudent use of drones and a ban on AWS is yet to be implemented by EU member states.

Regarding **cyber security**, the EU has put forward a cyber security strategy (www, pdf) for 'preventing and responding to disruptions and attacks affecting Europe's telecommunications systems' (www). The proposal was first published in 2013 and was the EU's first comprehensive document covering the issue. It can also be read as a reaction to the diverse individual cyber security strategies of EU member states.

It states five priority areas (www):

- achieving cyber resilience
- drastically reducing cybercrime
- developing cyber defence policy and capabilities related to the EU's common security and defence policy (CSDP)
- developing the industrial and technological resources for cyber security
- establishing a coherent international cyberspace policy for the EU.

As one concrete action, the European Council as well as the European Parliament issued Directive (EU) 20136/1148 (www) 'concerning measures for a high common level of security of network and information systems across the Union' which was adopted by the European Parliament on 6 July 2016 (www). It is now up to EU Member States to put it into national law.

EU NON-PROLIFERATION CONSORTIUM ELEARNING

Summary and Further Reading

Summary

Given the rapid pace of technology, even experts have a hard time keeping track and anticipating all the implications of emerging technologies for international security and stability.

A crucial aspect of this dynamism is the dual-use character of many of the technologies discussed in this learning unit. More often than not, the technological edge is nowadays pushed by the civilian sector rather than the defence industry.

Technological progress should not generally be met with suspicion, of course. However, this learning unit demonstrated that some emerging technologies pose difficult challenges not only from a security but also an international law and ethics point of view.

If the risks do in fact outweigh the benefits in certain fields, then (preventive) arms control is a prudent choice.

The selection of technologies presented in this learning unit is as diverse as the reactions of nation states and the international community at large are with regard to regulation, limits or bans.

In the cyber domain, we have seen some progress over the last couple of years, with many states by now acknowledging the relevance of cyber security. While arms control in this field is still in its infancy, significant efforts have been put into resilience, transparency, and the interpretation and development of international law. However, the hurdles for more substantial arms control agreements regarding the cyber domain are high, especially since verification is hard and the attribution of responsibility remains extremely tricky.

Regarding drones, it seems that the horse has left the barn. The proliferation of armed and unarmed drones continues. States have yet to come up with at least a code of conduct regulating or limiting the use of drones to balance their military advantages with the risks they pose to state sovereignty and territorial integrity as well as international stability as a whole.

In the field of Lethal Autonomous Weapon Systems, there is reason for cautious optimism. With the establishment of a Group of Governmental Experts, talks at the CCW in Geneva are not only continuing but intensifying in 2017. It is unclear, however, what the outcome of this process will be.

What many of the technologies debated in this learning unit have in common is that the relevance of quantity is declining vis-à-vis the relevance of quality. Finding suitable arms control strategies for dealing with qualitative characteristics of weapon systems will thus be one of the most

EU NON-PROLIFERATION CONSORTIUM eLEARNING

Summary and Further Reading

Additional Links and Further Literature

General information on latest developments in military technology

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http://www.nato.int/cps/en/natohq/topics_7

https://ccdcoe.org/

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Summary and Further Reading

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