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EDA Technology Foresight Exercise 2021

1st Event Results – Publishable Summary

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About The Exercise

The EDA Technology Foresight Exercise Technology aims at planning and informing future defence policies and programmes of the European Union and its Member States. The Foresight Exercise looks up to 20 years into the future, to provide this strategic vision of the possible impact of technologies in defence in 2040+.

To facilitate outside-the-box thinking, different activities are planned within the exercise, and it is open to high-level experts from different technological and non-technological domains, as well as from non-governmental bodies, academia, industry and civil society.

Expected results

- Provide a high-level, long-term vision on multiple possible futures with defence relevance, with a special focus of the impact of emerging and emerged disruptive technologies.
- Take advantage of the synergies between technology foresight and the Capability Development Plan (CDP) Strand B in order to identify weak signals and new emerging disruptive technologies.
- Contribute to future updates of the EDA Prioritization tools such as Overarching Strategic Research Agenda, CDP or Key Strategic Activities.

On the Divergent Thinking Event

From the 17th to 25th of May, the EDA held a Divergent Thinking event within the EDA Technology Foresight Exercise 2021. The goal of this event was to ideate functional views of alternative futures and possibilities with direct or indirect relevance for Europe and Defence in 2040+. This was performed by a divergent thinking approach to the future visions with a combination of what is known, what is unknown, and what is imagined or envisioned. The most promising of these alternative futures views will serve as the basis for the discussions of the posterior events of the Foresight initiative.

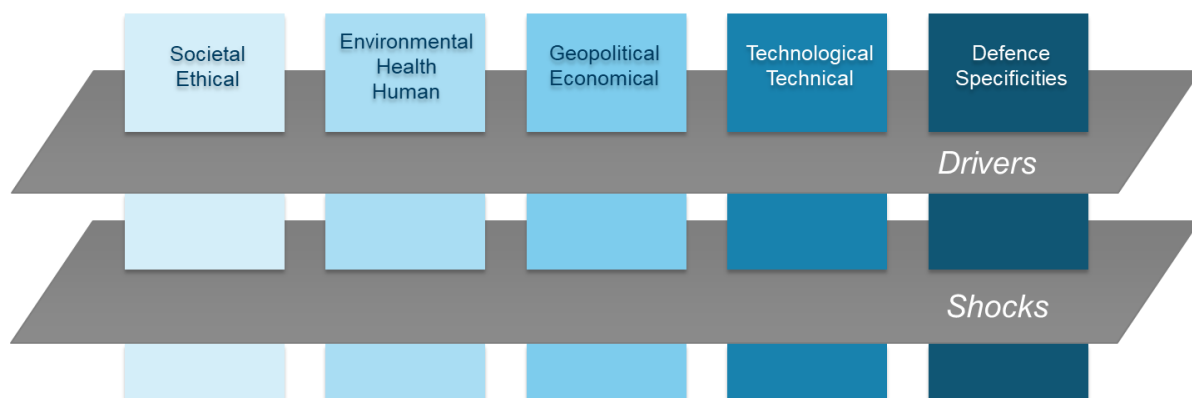
The event was organized around the concept of a virtual word-café, fostering discussions around different topics, starting with the proposed four futures¹ arranged around the following dimensions:

- Societal and Ethical. Potential impact on society or address specific social and ethical needs.
- Environmental, Health and Human. Potential impact related to environmental, health and human aspects.

¹ The four futures proposed were: TechUtopia, Business as usual, Darwinian Games and Humanity versus the Hungry Beast.



- Geopolitical and Economical. Potential impact to affect future dependencies in critical value chains, to affect peace and stability, and to leverage financial resources in support of geopolitical and economical objectives.
- Technology and Technical. Potential impact on future critical technologies or technological needs.
- Defence specificities. Potential impact on future defence needs and capabilities.



Conceptual structure of the dimensions

Also, the possible drivers, shocks and other aspects were looked upon, taking into account the interwoven impacts of the different dimensions. The drivers aggregated those factors that may inflict significant changes in any of the dimensions. They are mostly trends of different nature. While the shocks aggregated unexpected events and changes, in special those ones which pose potential strategic shock, such as disrupting technical breakthroughs, or natural or man-made catastrophes. The following figure depicts the conceptual structure of the dimensions.

These dimensions represent thinking axes which aggregate relevant ideas about the future and are not mutually exclusive. Therefore, around a similar topic there could be several ideas-aspects distributed around different dimensions.

Due to the pandemic related restrictions, the event was fully held on-line. Therefore, to allow the word-café type of exchange, a virtual whiteboard, using the commercial IT tool called VIIMA, was provided to the participants for their discussions. This tool was embedded in the Exercise web, accessible to the registered participants via the following link: <https://technologyforesight.eda.europa.eu/>. The web of the Exercise was also used as a central hub where to find all the relevant information (read-ahead materials, the presentations made during the meetings, agendas, links to the meetings, the inspirational talks, etc.).

The experts were requested to have an active participation, providing constructive ideas and comments, even if challenging and/or provocative. They were requested to think about the regular What?, Why?, When?, Where?, and How?, and also beyond trying to reply to Why not?, What If?, or What Else?



The ideas and opinions were mainly the contributions from experts participating in the event and from the Future Tellers. The ideas were characterized during the event along these different aspects, thanks to the comments of other experts. The ideas included a title, a short description, and then room for additional details as links to documents, relations with other ideas, discussion board, etc. The full list of ideas discussed can be found at annex I.

During the event, these ideas were assessed by the participants, regarding the:

- Relevance of the idea for Europe. Addressing how much an idea is expected to impact Europe in 2040+.
- Relevance of the idea for defence matters. Addressing how much an idea is expected to impact defence matters in 2040+.
- Idea plausibility in the future. Addressing how likely is an idea to happen in the future (2040+).
- Singularity of the idea or how uncommon the idea is. Addressing how singular or unique is an idea in relation to other ideas about the future (mainly in the context of the exercise).

In total, 97 ideas were identified across the 8 days of asynchronous participation of more than 160 experts representing various organisations and nationalities from 20 EDA participant Member States (pMS) and associated countries (CH & NO), as well international organizations (EEAS, EC-JRC, NATO-STO), as industry, SMEs, academia, and research centres.

The set of ideas and discussions represent a wide range of perspectives. The resulting 92 ideas are distributed across the 7 perspectives providing an interesting coverage of possible futures, and a successful indicator of the divergent character of the event.

Despite the divergent character of the results, the ideas and discussions, present many inter-relations, ensuring that expected key aspects are addressed from different points of view.

A good and varied set of divergent ideas on the future stands a good foundation for performing posterior foresight analysis, even if this only performed on a small subset of those ideas, as it helps to have an understanding of side and contextual issues of the selected ideas for posterior analysis.

This analysis is done in the next phases of the exercise, in a convergent thinking approach, starting from a general depiction of the future, in which both technologies and defence capabilities, and systems are the aspects of interest. To do so the approach adopted is to focus the thinking process on the futures selected, out of the key aspects presented below from the first event. Then, iteratively converging from those futures towards the present, by identifying which changes would have need to happen in order to those futures take place. This process, known as future backwards, is the methodological backbone of the second event. The results of the convergent thinking will be available along the final results of the exercise.



Results of the Divergent Thinking

Summary of the key aspects

On a general and high-level view, the shared ideas provide a vision of the future in 2040 with the following key aspects:

Key Aspects
Biotechnology as a threat and challenge
Information and misinformation as pivotal
The emergence of an extended reality
Demography and an aging society conform a new playground
Shifting values and beliefs
The new frontier of human enhancement
Environment as a driver
New contexts require new regulatory and ethical frameworks
The pervasiveness of cyber and AI
The evolution of the battlefield
The many challenges of autonomy
New space. The space domain is redefined as an operational domain
New warfare aspects in conflicts
A new order beyond the conventional geo-strategies



Details on the key aspects

The details of around these key aspects are expanded in the following table:

Key Aspect	Description
Biotechnology as a threat and challenge	<p>Advances in biotechnology (gene edition, synthetic biology...) will originate new biohazards that may be used as bioweapons. At the same time, these technologies will allow a rapid and reliable identification of those new biological threats, and to be prepared for them through appropriate medical care, containment, and control.</p> <p>Climate change is becoming a threat multiplier of disease transmission by progressively weakening ecosystem resilience, reducing biodiversity, and removing natural buffers between disease hosts and humans.</p>
Information and misinformation as pivotal	<p>By 2040, the new information age will be based on new dimensions of information (breakthroughs in information technologies, quantum computing and brain-machine interfaces) which will open new capabilities never thought before.</p> <p>At the same time, the power of misinformation has become a weapon of choice. The misuse of information becomes a weapon targeting other information systems and enabling influence operations on a scale that challenges the capability of nation-states to counter or control.</p>
The emergence of an extended reality	<p>In 2040 the evolution of information technologies, integrated with new concepts of communication and making use of new advances in fusing Brain-Computer Interfaces (BCI) with Augmented / Virtual Reality (AR/VR) have led to the creation of an extended reality where many aspects of our existence (learning, relation, properties...) are deployed exclusively or in combination with the actual reality.</p>
Demography and an aging society conform a new playground	<p>The impact of aging western societies and an accelerated demographic decline greatly affect Europe in 2040 both from the military and general society point of view. This will impact society across many aspects. This exercise identified of particular interest:</p> <ul style="list-style-type: none"> • The importance of robotization and its extension to military. • Declining manpower for traditionally military matters. • Growing support for human-life enhancements, overall with those dealing with life-extension.
Shifting values and beliefs	<p>By 2040, the perception of the world and society will have changed, among the most significant characteristics that will have shaped the perception and understanding of the world and society are:</p>



Key Aspect	Description
	<ul style="list-style-type: none"> Climate change, population growth, and depletion of some key resources (raw materials, especially unique ones), or the increase of polluting resources can destabilize financial transactions on major exchanges and bourses. The development of technologies as biomanufacturing, robotics, and mixed-material additive manufacturing push the development of new food and food industry habits and lead to a local market. The scramble to defend informational sovereignty in an era of intrusive internet surveillance, and the rapidly emerging power of data leads to a digital world controlled by a handful of corporations.
The new frontier of human enhancement	<p>Advances in biotechnology (synthetic biology and gene editing technologies) and brain-machine interfaces (advancement of intracortical brain-computer interfaces, etc.) combined with advances in information technologies (AI, information transmission technologies, etc.) and robotics, provide a potential enhancement (intelligence, cognitive and physical) of the soldier.</p> <p>This potential will pose a great challenge on defining and enforcing the regulatory and ethical framework for the new possibilities, both at European and global scale.</p>
Environment as a driver	<p>By 2040, environmental changes have ignited new threats (global climate disasters, greenhouse effects, food, and water shortage) where the military will have to play additional roles (emergency and disaster management, increased protection against non-controllable movement of the population).</p> <p>Additionally, defence organizations will have to adapt to this driver as well, from the point of view adapted infrastructures, energy sources, and compliance with validation and verification and certification specifications of constrained environments (such as the military one).</p>
New contexts require new regulatory and ethical frameworks	<p>In 2040, advances in technologies and the evolution of stakeholders' power and role will require sound and practical ethical and regulatory frameworks. Key contexts requiring these new frameworks are:</p> <ul style="list-style-type: none"> Hybrid conflicts and the understanding of tactical, ethical, and practical consequences of hybrid warfare. Biological weapons and new genetic engineering techniques. The use in 2040 of technology for soldier enhancement (intelligence, performance, cognitive, physical).



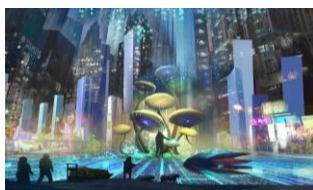
Key Aspect	Description
	<ul style="list-style-type: none"> • The weaponization of cyberspace and misinformation. • LAWS (Lethal Autonomous Weapon System) • By 2040, Space has been transformed into a contested domain.
The pervasiveness of cyber and AI	By 2040, an accessible and contested cyberspace domain exacerbates hybrid conflicts and consolidates cyberspace, with Electronic Warfare (EW), and the control of electromagnetic spectrum, as a powerful operational environment.
The evolution of the battlefield	<p>The battlefield in 2040 will be a software-based battlefield. The development of technologies related to artificial intelligence, machine learning, 5G/XG communication networks, will make the conflicts to be conducted in a faster way. Increased development of system-systems based defence solutions on the above-mentioned technologies will require appropriate software and algorithms to ensure systems stable operation on the different platforms and processing and storing data necessary to perform the mission. Well-functioning software will be mission critical.</p> <p>Linked to the software-based battlefield vision, the system of systems as an offensive capability is present in 2040 as a real threat to many platforms and systems. The most common approach to this system of systems advantage is the swarming of numerous autonomous or automatic systems. Furthermore, the risk of cascade failures makes the system of systems advantage a very effective capability, in some cases, even from the cost-effective point of view.</p> <p>In parallel, the application of new science and technological dimensions will introduce new/enhance capabilities. In this sense, quantum technologies will be source of technical breakthroughs which may revolutionize battlefield aspects as real-time mapping of dynamic environments based on advance sensing and navigation capabilities.</p>
The many challenges of autonomy	<p>2040 security and defence operations require extraordinary capabilities to operate in contested operating environments and to master the command-and-control challenges of complex systems and interdependencies. Mission success is strongly linked to effective interaction and collaboration with non-human autonomous and intelligent systems.</p> <p>However, by 2040 the adoption of autonomy will be still challenging the defence organizations from many different perspectives:</p>



Key Aspect	Description
	<ul style="list-style-type: none"> Decision loop and ethical implications. Weapon systems are becoming increasingly autonomous and intelligent, operational complexity is increasing dramatically, making soldiers more and more dependent on solutions proposed by AI systems, and their decisions are not based on human moral judgment, losing their ability to think critically. International Humanitarian Law compliant /robust / certified LAWS. Technical and technology developments <ul style="list-style-type: none"> The software developer role. Designing ethically sensitive machine learning systems. Reaching developments in the field of modelling human thinking and behaviour. Number, characteristics and diversity of the entities required to interact and collaborate in Joint Systems Operations. Operational sub-domains in which these entities operate. Interdependencies among operations in these domains and the effects they create. Organizational challenges. The availability and proliferation of unmanned platforms in the battlefield induce major changes to the defence MODs as organizations. In special from the point of view of military operational doctrine, materiel and acquisition policy and logistics implications.
New space. The space domain is redefined as an operational domain	In 2040 Space has been transformed into a fully operational domain. New threats to commercial and military uses of space have emerged. In addition to increasing digital connectivity of all aspects of life, business, government, and military it has also facilitated significant vulnerabilities and threats
New warfare aspects in conflicts	<p>The growing role and involvement of private military and security companies, ghost conflicts, and particular interests of international corporations or institutions will drive and shape some of future conflicts up to 2040.</p> <p>The increasing hybridization of conflicts (misinformation as a weapon of choice, the military use of the passive or active role of citizens as intelligence providers, grey zones of humanitarian and conflict laws, etc.) set the focus on the society as a new operational domain.</p>



Key Aspect	Description
	In this new domain, traditional states and multilateral organizations (NATO, UN, etc.) face new challenges as they clash with emerging aspects of conflicts and new stakeholders (empowered individuals, misinformation creators, etc.).
A new order beyond the conventional geo-strategies	<p>In addition to the current drivers for geostrategic order, there are new drivers shaping the world order, such as:</p> <ul style="list-style-type: none"> • New domains of potential confrontation and types of conflict (Arctic, overseas, ghost conflicts, Africa, the commercialization of conflicts, or targeting the society as new operational domains...). • New actors and perception of order across the world. • New energy sources, resources and, economic drivers (water scarcity, potential economic boosts of new geographical areas such as Africa...).



Quick links
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