



# EDA Technology Foresight Exercise 2021

## Methodology

August 2021



*Text by Isdefe, Ingeniería de Sistemas para la Defensa de España  
(<https://www.isdefe.es/>)*



*Commissioned by the European Defence Agency, EDA*



*([www.eda.europa.eu](http://www.eda.europa.eu))*

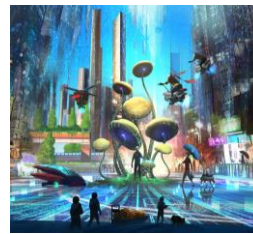
*Cover and back Illustrations: by Philippe Lozinski  
(<https://krolikbe.artstation.com/>)*

*© European Defence Agency, 2021. For reproduction or use of this material, explicit reference to the European Defence Agency, as copyright holder, and to the EDA Technology Foresight Exercise 2021 must be made. For more information please contact: EDA Research, Technology and Innovation Directorate at: [rti@eda.europa.eu](mailto:rti@eda.europa.eu).*

*This information has been generated based on the information provided in the EDA Technology Foresight Exercise execution and not to be openly published by no means. EDA does not guarantee the accuracy of the data included in this study. Neither EDA, nor any person acting on EDA's behalf may be held responsible for the use which may be made of the information contained therein.*

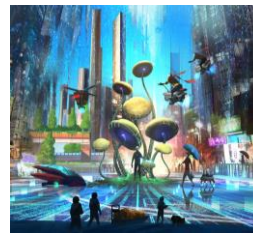
*This study was commissioned to Isdefe by the European Defence Agency in response to the invitation to tender No 17.ESI.OP.373, specific contract 20.RTI.SC.151. The study does not, however, express the Agency's official views. The views expressed and all recommendations made are those of the authors.*

*This study as well as any other results and rights obtained in performance of the ensuing contract, including copyright and other intellectual or industrial property rights, shall be owned solely by the Agency, which may use, publish, assign or transfer them as it sees fit, without geographical or other limitation, except where industrial or intellectual property rights exist prior to the contract being entered into force.*



## Contents

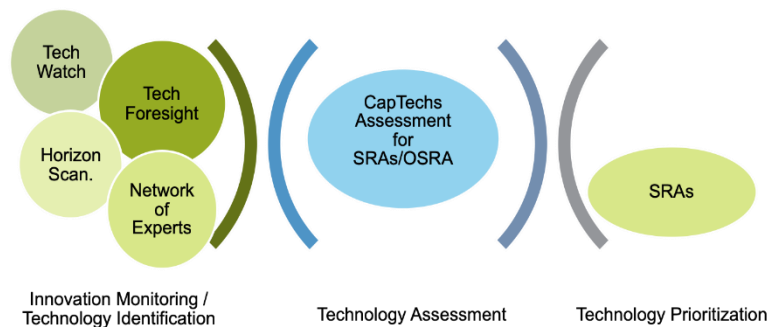
Introduction.....	3	Phase 3 - Tech Thinking .....	41
Context & objectives .....	3	Phase 3 - Tech Thinking Objective.....	41
About the exercise methodology.....	4	Phase 3 – Tech Thinking Theory .....	41
Theoretical Approach.....	4	Phase 3 – Tech Thinking Steps.....	47
Overall Implementation Structure.....	5	Phase 3 – Tech Thinking Means, Inputs & Outputs .....	51
Phase 0 - Design .....	6	Phase 4 - Final elaboration.....	51
Phase 0 – Introduction & Objectives.....	6	Phase 4 – Final Elaboration Objectives .....	51
Phase 0 – Theory.....	6	Phase 4 – Final Elaboration Steps .....	52
Phase 0 – Steps.....	7	Phase 4 – Final Elaboration Means, Inputs & Outputs .....	52
Phase 0 – Means, Inputs & Outputs.....	12	Lessons Learned on the Methodology as Applied to the Technology Foresight Exercise 2021.....	53
Phase 1 - Divergent Thinking .....	14	Glossary .....	55
Phase 1 – Divergent Thinking Introduction & Objectives .....	14	Annex – Surveys .....	57
Phase 1 - Divergent Thinking Theory .....	15	Film Back-casting survey .....	57
Phase 1 – Divergent Thinking Steps .....	19	Technology back-casting survey .....	60
Phase 2 - Convergent Thinking: Future Backwards .....	31	Satisfaction survey Phase 1 .....	64
Phase 2 - Convergent Thinking Objective .....	31	Satisfaction survey Phase 2 & 3 .....	65
Phase 2 - Convergent Thinking Theory .....	32		
Phase 2 – Convergent Thinking Steps .....	34		
Phase 2 – Convergent Thinking Means .....	40		



## Introduction

### Context & objectives

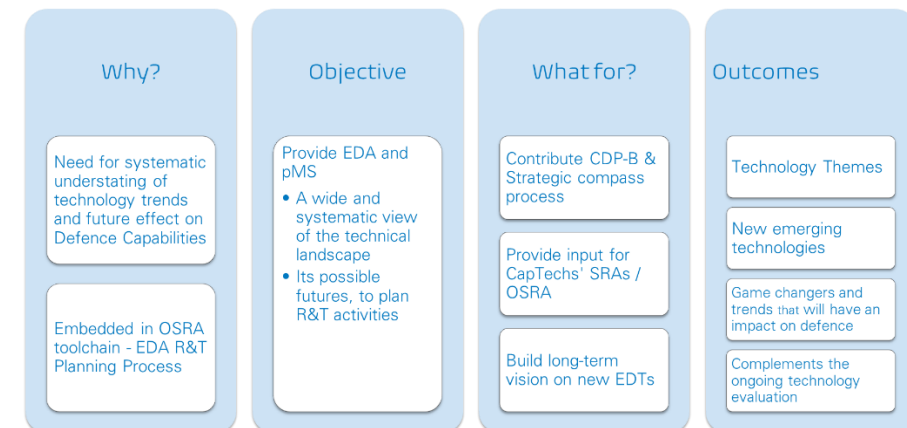
EDA has a large number of activities that rely on a systematic understating of evolving technical trends and their effect on future European Defence Capabilities, both at long and at short-term. Since 2014, EDA established a Technology Watch & Foresight activity, embedded in the Overarching Strategic Research Agenda (OSRA) toolchain, as the EDA R&T Planning Process. The objective of these activities is to provide EDA and its Member States with a wide and systematic view of the technical landscape, and its possible futures, when planning future activities.



The EDA Technology Watch & Horizon Scanning area addresses the first element needed for the evaluation of technologies: the identification and collection of technology trends. Therefore, this

exercise increases the technology awareness of the organization, in the areas covered by the CapTechs, and also highlight new emerging technologies that would be interesting for defence. It is thus also contributing in a broader way to the agency activities on emerging and disruptive technologies.

The EDA Technology Foresight Exercise is meant to provide a high-level long-term vision on multiple possible futures for defence, with a special focus of the impact of technologies. In this way, the Technology Foresight complements the technology evaluation process providing a long-term vision on emerging and disruptive technologies and their links to military applications that might be relevant for future defence capabilities. It also supports the identification of game changers and trends that will have an impact in defence. The long-term perspective can look at up to 20–30 years ahead, depending on the technological areas addressed.





The final goal of the exercise is to identify the most promising and potentially disruptive technologies for future defence.

The exercise is orientated towards producing valuable inputs for the long-term vision of the strategic pillars of the EDA: Capability Development Plan, OSRA / SRAs and KSA-related considerations with a view to identify capability requirements, also taking into account the strategic autonomy relevance. Therefore, the exercise has an open approach, considering a European perspective for the analysis, with Defence and world scope of interest.

### About the exercise methodology

EDA Technology Foresight Exercise has been designed as activity that starts by looking up to 20 years into the future, and 20 years back in the past, while being specifically designed to inform the foreseen updates of OSRA, CapTechs SRAs, Capability Development Plan (CDP) and Key Strategic Activities (KSAs) in their technological long-term vision.

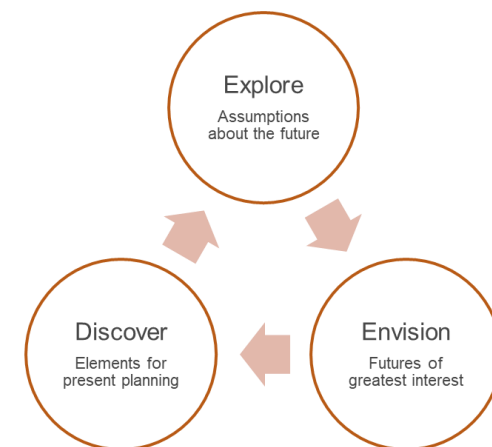
The methodology has been created as a step-by-step guide, to be able to reproduce the exercise in the future. It has also been updated with the lessons learned coming from its application in the first EDA Technology Foresight Exercise carried out in 2021.

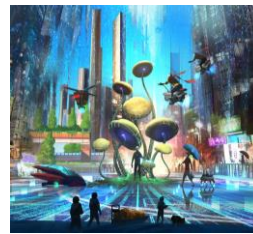
### Theoretical Approach

Top-down methodology approach provides an open white board in terms of technologies, to enable the identification of weak signals based on the definition of the "Futures". Specific scenarios, mainly proposed by CDP-B, are embedded in the defined futures. Capabilities and defence systems are derived from these Futures, allowing the identification of unknown known technologies.

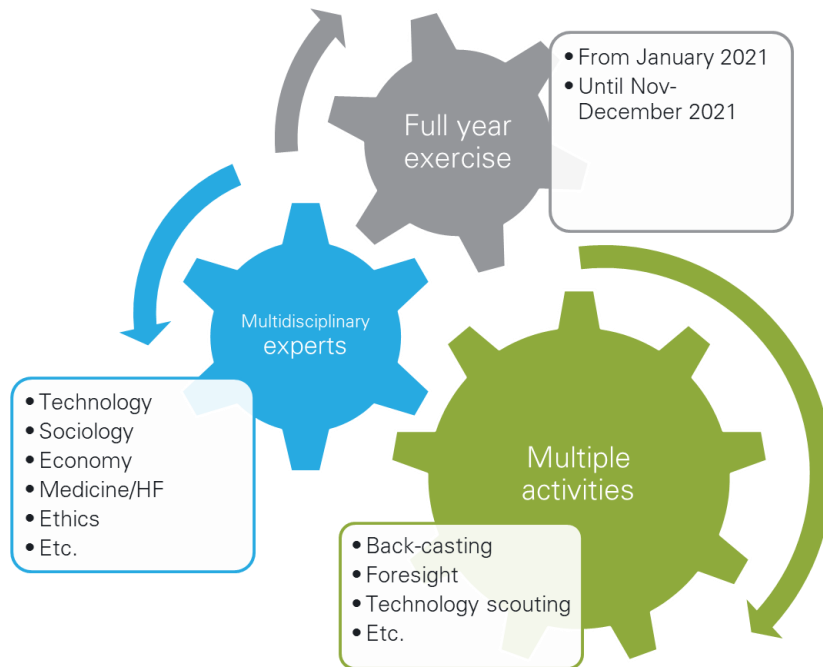
The methodology is based on a Future-back thinking that is refined through a process of iterative dialogues. These dialogues are based on two key elements: a structured workflow and the participation of experts. In this workflow, the participants work through their ideas cooperatively, diverging and ultimately converging on key questions and assumptions.

The general approach for the workflow is based on first exploring different assumptions about the possible futures, then envision which futures are of greatest interest, and built on these visions, back-casting to discover what elements of interest for our present planning are worth deriving from the future visions.





## Overall Implementation Structure



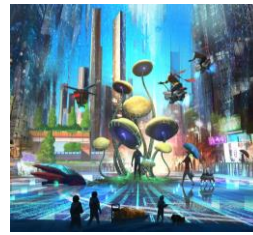
The implementation is carried out along five different phases:

- Phase 0 – Design
- Phase 1 - Divergent Thinking
- Phase 2 – Convergent Thinking
- Phase 2 – Tech Thinking
- Phase 4 – Final Elaboration.

These methodology proposed and used during the exercise in described following these phases in this document.

The main drivers for the implementation are:

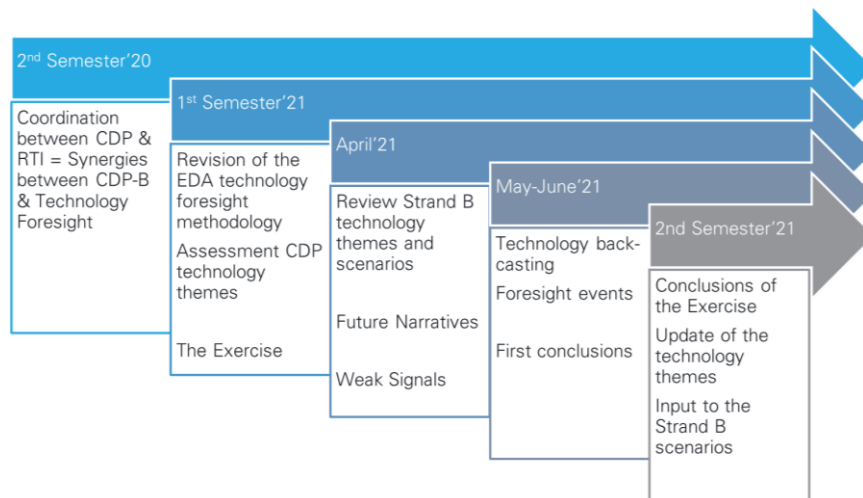
- An exercise developed and enriched throughout 2021.
- Encouraging and enforcing a multidisciplinary approach to futures thinking.
- Supported by different complementary foresight activities.



## Phase 0 - Design

### Phase 0 – Introduction & Objectives

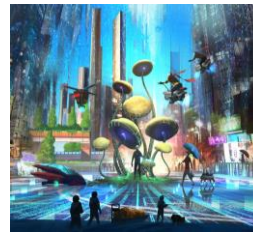
Therefore, the activities are carried out in coordination with the CDP Strand B, as it identifies key future strategic environment factors, future capability requirement areas, and technology themes that participant Member States (pMS) need to focus on to support the development of defence and security capabilities in 20-30 years-time.



## Phase 0 – Theory

As a basis, the technology watch & foresight processes, embedded in OSRA toolchain and supporting CapTechs SRAs, allows the technology identification considering defence specificities. In this way, the outputs of these activities also provide an input for the Capability Development Plan (CDP), and vice versa. Moreover, the Technology Foresight complements the technology evaluation process providing a long-term vision on emerging and disruptive technologies and their links to military applications that might be relevant for future defence capabilities. It also supports the identification of game changers and trends that will have an impact in defence. The long-term perspective can look at up to 20–30 years ahead, depending on the technological areas addressed.

Therefore, the EDA Technology Foresight Exercise has been prepared and is carried out in coordination with the CDP-Team, as its Strand B identifies key future strategic environment factors, future capability requirement areas and technology groups that pMS need to focus on to support the development of defence and security capabilities in 2040+. Furthermore, one of the first activities planned within the foresight exercise is a back-casting activity, looking into the identified and selected technologies to assess their evolution and build an understanding of how they will evolve in the future. This activity starts with the assessment of the technology themes identified in the previous or current CDP-B.



As a summary:

- Strand B identifies key future strategic environment factors, future capability requirement areas and technology groups that pMS need to focus on to support the development of defence and security capabilities in 2035+
- It reflects relevant R&T and KSA-related considerations to identify capability requirements, taking into account the strategic autonomy relevance.
- However, Strand B does not to predict the future - Provides a spectrum of possible factors to be considered, and it informs R&T work and long-term capability activities in the EDA framework.

Therefore, EDA Technology Foresight Exercise benefits from Strand B future scenarios, future capability requirements, Strategic autonomy considerations, and forward-looking analysis of the industrial and policy dimensions.

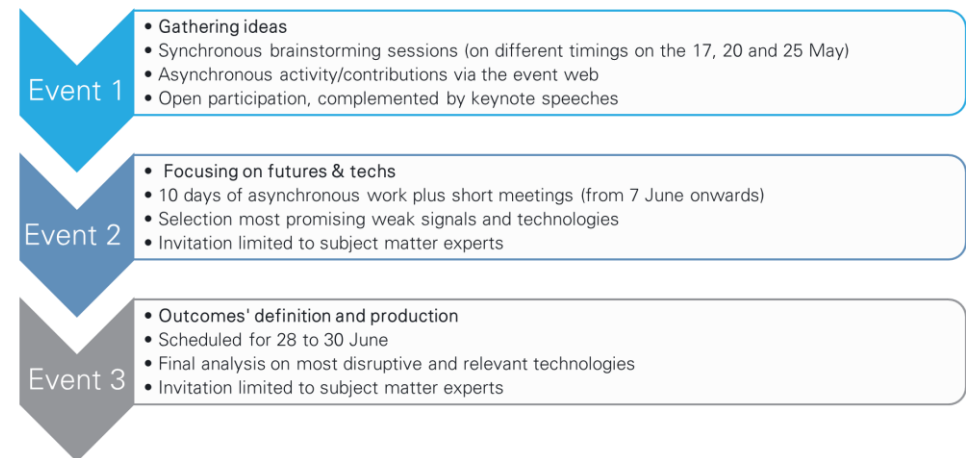
In this context the “Technology Themes” are:

- A Technology Theme is a clustering of technologies done in the CDP Strand B 2017
- It facilitated the analysis of Technology Trends and their Impact on Security and Military Capabilities

- This analysis provided the “technology push” to the CDP-B, giving an orientation of the capabilities enabled, in that time horizon in an EU context.

## Phase 0 – Steps

### Organization of the events



Encourage non-linear thinking by:

- An active participation and constructive comments, even if challenging and/or provocative!
- Replying the traditional What? Why? When? Where? How? Questions, but also the Why not? What If? What Else?





- Providing experts with different Roles: red team, shapers and icebreakers.



### Back-casting activity

The EDA Technology Foresight Exercise starts with a back-casting activity, looking into the past to be able to better foresee the future. The back-casting is performed by CapTechs and experts participating in the exercise, who assess the relevance of past technologies and predictions of interest for defence identified in the last decades.

The back-casting activity is three-fold:

- CDP-B Technology themes assessment: The assessment of the validity of the CDP-B technology themes is performed by EDA CapTechs. The objective of the assessment is to support the decision to revise the CDP, to confirm whether or not they will still be relevant in the time horizon of 2040+, both for the technology and the capability sides.

- Technology Back-casting Survey: The assessment of past R&T topics, such as the ones included in previous strategic research agendas or R&T strategies is performed by the experts participating in the Exercise via an on-line survey (see Annex for the details of the survey)
- Films' Back-casting Survey: To identify best practices and lessons learned from past predictions about the present times, the participants are invited to reply a survey asking questions around sci-fi movies, books, etc. (see Annex for the details of the survey)

### Technology Scouting

The back-casting is complemented by the EDA Technology Watch activity, thanks to which a set of weak signals is identified. This activity enables the bottom-up approach towards the identification of the technologies relevant towards 2040+, it is also needed to identify technologies under early stages of development. Therefore, individual weak signals in science and technology development, which could have an impact on defence, are identified. These weak signals are selected from the weak signals included in the JRC Technical Report on Weak Signals.

The weak signals are selected as the most promising for defence applications. However, this does not prevent other weak signals to be also interesting and applicable for defence. The list of weak signals is by no means exhaustive and may contain technologies that will never lead to new innovations.



A report is built with this information and meant to provide new ideas about technologies to the experts participating in the EDA Technology Foresight Exercise. It is meant to inspire the experts, not precluding nor pre-empting the Exercise discussions or conclusions. This report is part of the “food-for-thought” package provided as a read-ahead package to the Exercise experts.

The list of weak signals presented in JRC report is the result of a detection process ran by the JRC on a corpus of peer-reviewed scientific publications using TIM Trends. This software combines text mining techniques with computational and data visualisation means and has been specifically designed by JRC to detect weak signals of emerging technologies or new scientific topics.

A dedicated dashboard is available for the readers that would like to go a step further in understanding the weak signals. It displays peer-reviewed scientific publications, patents and research projects (funded by the EU framework programmes) and offers many features to quickly grasp the main characteristics of each signal (what it is about, which organisations are active in the field, what countries are involved, what is the dynamics and the trajectory of the research, etc.). It is accessible here:

[https://www.timanalytics.eu/TimTechPublic/dashboard/index.jsp#/space/s\\_1597?ds=126842](https://www.timanalytics.eu/TimTechPublic/dashboard/index.jsp#/space/s_1597?ds=126842)

This dashboard is a projection of a dedicated space that has been set up in the TIM Technology system

## Futures Ideation

In addition, the “futures tellers”, a core team of multidisciplinary experts participating in the exercise, imagine a set of disruptive futures, providing the framework for the foresight activity. This food for thought information is gathered in a report on “Futures Narratives”.

The Futures Tellers propose a set of disruptive futures, looking up to 20–30 years ahead into the future, providing the framework for the Foresight Exercise. The objective of these futures narratives is to inspire and spark the imagination of the experts participating in the Exercise, not precluding nor pre-empting the discussions, but highlighting some possible future options (from very disruptive to more linear ones).

To create these futures, each of the Futures Tellers share their ideas in their areas of expertise, coming together as the pieces of a puzzle. Each of these puzzles conformed different alternative futures, and out of them 4 are selected and further developed as the main futures narratives presented the experts participating in the Exercise. The ideas conforming the other futures are just summarized for inspiration.

The futures are designed along the following dimensions: Defence; Economic; Environmental; Ethical; Geopolitical; Health / Human; Social; Technology. The dimensions of the four main futures are presented facilitating the narrative, not always following the same sequence. These dimensions, and the key ideas (focus topics)



around them, are the starting point for the discussions of the first event of the Exercise (Phase 1 – Divergent Thinking).

### Invitations to the network of experts

A wide variety of experts are invited to facilitate outside-the-box thinking. It is highlighted the need for an active participation relevant experts different technological and non-technological domain (sociology, history, economy, industry, law, etc.), CapTechs members and of military staff with experience in operations and interest on future technologies.

The interested experts are requested to register via the EDA Technology Foresight Exercise event web one week prior the first event. The number of participants is limited, and the registrations are to be done on a first come first served basis.

This event is open, upon registration, to a wider community, whereas the following events are upon invitation. At each event, the discussion topics for the next one are selected. Therefore, the participants interested in these topics are called for registration to these events right after the end of the previous one.

The background of the Exercise is also provided with the invitation, along with the information on the back-casting activity, including the links to the back-casting surveys.

Along the invitations, different groups of experts are created, to ensure the availability of expertise and to perform different roles

during the exercise. The main groups of experts are the Futures Tellers, the Inspirational Speakers, and EDA core team.

### Futures Tellers

The Futures Tellers are forward looking experts from different countries, with different backgrounds, defence/military and civilian, and from different generations. They cover domains as sociology, environment/climate change, biotechnology/medicine, economy, science fiction, design/arts, foresight/futurists, history, industry, philosophy, ethics, operations and technologies. This group is carefully constructed to foster cross-fertilization of ideas and increase creativity, also supporting the different phases of the EDA Technology Foresight Exercise.

They are also involved in the events, as participants, and as shapers of ideas and icebreakers, if required. Some of them are also part of the “red team”, challenging the discussions and offering different perspectives. And not only this, some of them are also providing additional inspiration talks, to be released during the events.

### Inspirational speakers

To encourage the exercise participants to think out of the box about the futures, escaping from the traditional linear-thinking process, a group of Inspirational Speakers is invited to share their vision of a future, what they think it will be the main challenges, turning points, etc. The inspirational speakers are high-level experts in different domains and with different back-grounds. The inspirational talks are



delivered during the meetings, and later it is also possible to enjoy the Inspirational Talks here.

The objective is to have a “Ted talks” style of speech, short (5-10 minutes) and focused. The talks are delivered (live or recorded) during one of the exercise events. Then, the recordings are available during the exercise, in case the participants need to look for inspiration, when contributing to the discussions.

The speeches reply one of these questions (or similar ones): What is the vision for 2040? What would the speaker think will be the main challenges in 2040+?; What would be the major technological breakthrough towards 2040?; What is a weak signal to play attention today towards 2040?, etc.

The interventions can be live during one of the meetings (and recorded, if possible), or released at one of the meetings (as if it was live) or during the other days of the activity. The recording is only available during the exercise, via a protected area only accessible to the participants (no possibility to download them), so the experts not attending that day could get inspired by the interventions any other day of the Exercise. In case of live intervention, a question and answers session follows the speech to allow the exchange of views between the inspirational speaker and the participants.

#### Core team – EDA staff + contractor

The Technology Foresight Exercise of 2021 is envisioned, managed and executed by a team of EDA staff across the entire Agency. This

cross-directorate initiative ensures the synergies among the Prioritization mechanisms (EDA Prioritisation Tool | (europa.eu), especially between OSRA and the CapTechs SRAs in their long-term and the Capability Development Plan – Strand B, and also with the KSAs.

The Research, Technology and Innovation (RTI) Directorate leads the exercise, with the support of an external contractor (ISDEFE) for the methodological aspects and the organization and execution of the events.

#### Communication means

To ensure the proper communication with the different groups of experts, a set of communication means is created. The main means are the e-mail, the daily newsletters and the Exercise web.

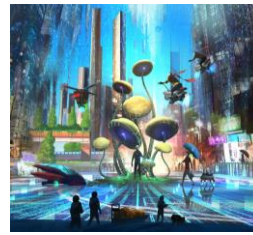
In addition, to exchange information, share ideas and host the virtual meetings, different IT tools are used as: WebEx, survey apps, VIIMA or KUMU.

#### The Exercise Web

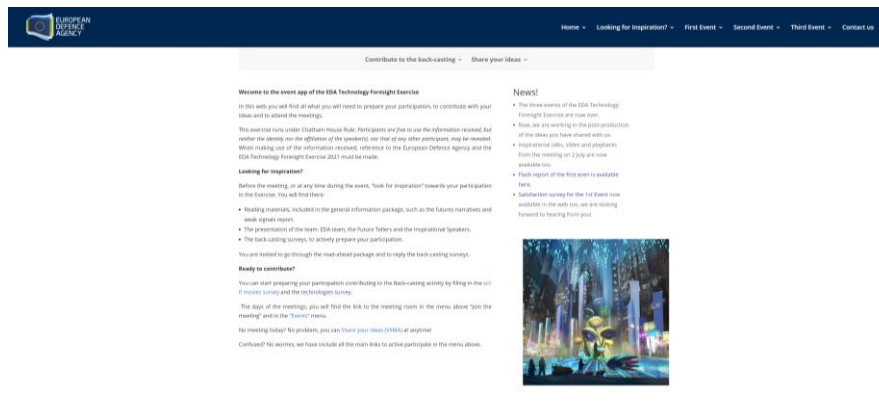
A specific website is created to host all the information of the Exercise. The web is continuously updated with the latest information, providing the links to the mail communication means.

The web main menus contain:

- Home, including the main information about the Exercise and the team.



- Looking for inspiration section, with the read ahead materials (Weak Signals report, Futures Narratives), the inspirational talks and links to the back-casting surveys.
- One section per event, including the agenda of the event, links to the virtual meetings, to the brainstorming app (VIIMA) or to the surveys, and also the materials from the meetings (presentations and videos) and minutes and reports.



### Daily newsletters

During the events, the participants receive a daily summary of the main discussions taking place in an asynchronous mode, and also on the main results and updates available in the Exercise web.

## Phase 0 – Means, Inputs & Outputs

### Means

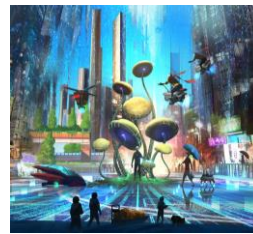
- Future Tellers
- Inspirational speakers
- Core team – EDA staff + contractor

### Inputs

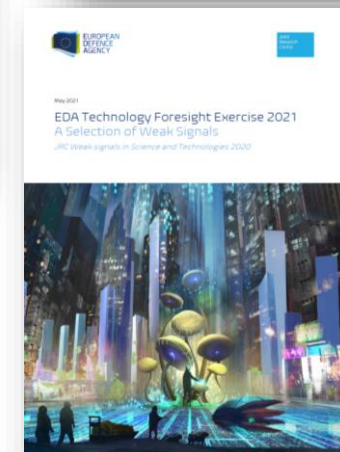
- CDP-B Information (Technology themes, scenarios)
- Previous technology topics from R&T strategies or strategic research agendas.
- Lists of experts
- Information about sci-fi movies, books, etc.

### Outputs

- Invitations to the future tellers, inspirational speakers and experts



- Read-Ahead package
  - About the Exercise documents
  - Futures Narratives
  - Weak Signals Report
- CDP-B technology themes assessment process/template
- Surveys on the past
  - Films back-casting
  - Technology back-casting
- Exercise web
- Newsletter template





## Phase 1 - Divergent Thinking

### Phase 1 – Divergent Thinking Introduction & Objectives

#### Identification of futures

**Opening ideas and visions** – This Foresight exercise is driven by several visions of the future and the identification of potential factors to reach, avoid, cope with those futures from the point of view of European defence. This contrasts present-forward thinking which is high in knowledge and driven by known rules, facts, and data.

Therefore the goal in this Divergent phase is to ideate functional views of alternative futures and possibilities with direct or indirect relevance for Europe and Defence in 2035+, embracing the complexity and uncertainty of a vision to describe multiple outcomes or futures that should be considered, rather than to predict one outcome

These future visions are conceived by future-back thinking which is low in initial knowledge and high in assumptions and aims is to elucidate on what could be true. Of course, it cannot predict the future, but aims to identify potential future patterns and trends and build on them, fleshing them out with informed imagination to create a plausible picture of how the future might be shaped.

**Approach to the future** – To future-back think participants need to approach the topics with a combination of what is known, what is unknown, and what is imagined or envisioned. To do so both

traditional logic and abductive reasoning (generation of hypotheses from incomplete observations). This phase of the exercise is focused on promoting a divergent and lateral thinking of the participants around different themes envisioned as highly relevant or probable in the future.

**Divergent and lateral thinking** are processes or methods used to generate creative ideas and innovative points of view by exploring many possible solutions not necessarily following a traditional step-by-step logic. These types of thinking typically occur in a spontaneous, free flowing, 'non-linear' manner, such that many ideas are generated in an emergent cognitive fashion. Many possible solutions are explored in a given amount of time, and unexpected connections are drawn.

#### Think of and use patterns



##### Trends and key drivers

They describe change that has been happening.

They are not the future, they aren't even statements about the future.



##### New sources of change (emerging issues)

Emerging issues in contrast to trends

Suggestions for what might be important factors or issues (new technologies, potential policy issues, new ideas or concepts,...)



##### Change

Inertia. Continuity-things stay the same

Disruptive change (Black Swans)

Incremental. Change-small slow changes.

Compounding progress: Each new innovation adds to the number of achievable possible (future) innovations. It opens up adjacent possibilities which didn't exist before, because better tools can be used to make even better tools.



After the process of divergent thinking has been completed, ideas and information should be organized and structured using convergent thinking. (Phase 2)

However, there is a needed structure in this divergent thinking, both at the process and at the elements. The following pages elaborate on this structure.

## Phase 1 - Divergent Thinking Theory

### Thinking Mindset

Adopting the right mindset is crucial to be productive in diverging and converging thinking for foresight, as well as acknowledging the importance of understanding of the strengths and weaknesses of one's cognitive processes.

In a divergent thinking approach, the key aspects to consider as a starting point are:

- **Forgetting about predictions** – Useful facts to bear in mind:
  - Nobody can predict the future and point predictions are isolated events, whether true or false, they are of little use overall because of their isolation
  - Embrace uncertainty. Complex transformations, interconnected events between emerging trends create uncertainty.
  - Divergent thinking is about seeing new possibilities involving imagination and creativity

- Foresight-Insight-Action. Foresight creates the vision and insight asks the question “what does this mean to us?” and Action encompasses the steps that we should take to shape the future into a more desirable outcome.

- **Focusing on signals** – Look for signals of the future to help us develop foresight. There is no data about the future, all the data we have is about the past. The future would be so easy to understand if everything stayed the same, but it does not; in fact, everything is changing more and more rapidly. A signal of the future can be just about anything.
- **Looking forward and back to see forward** – The past is not a reliable predictor of the future but there are larger patterns that repeat over and over. History allows us to put our signals into contextual understanding. Look for similarities. Use the similarities to back-cast from the future.
- **Uncovering patterns** – Trends, key drivers, new sources of change (emerging issues) and types of change (incremental, inertial, disruptive)
- **Making assumptions about the future** – Making assumptions about the future is not a problem but believing that they are facts can be. We are receiving a daily reminder of a core tenet of strategic foresight: there are no facts about the future. What has always been true might not continue to be true. Making assumptions about the future is natural and necessary.

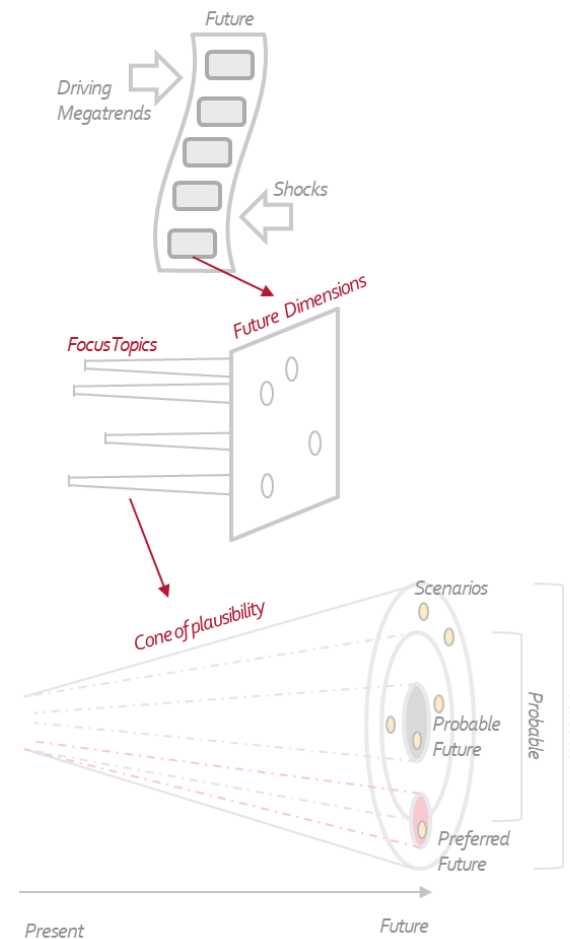




## Future Dimensional Space

The adopted structure is composed of the following elements:

- **Future Dimensions:** They represent a distinctive future perspective that can be depicted through a Cone of plausibility. They are the dimensions around which the divergent thinking is performed. These dimensions can be affected by trends, drivers and changes (inertial, incremental or disruptive). **Focus Topic:** represents a distinctive future concept under a "Future Dimension" can be depicted through a Cone of plausibility.
- **Cone of plausibility:** The Cone of Plausibility describes different types of futures. The Cone of Plausibility includes probable, plausible, possible, preferred, and provocative futures:
  - Probable futures: represent the future that will happen if everything remains the same based on trends (baseline)
  - Plausible futures include alternative futures that may occur given what you found during scanning.
  - Possible futures are even broader and include wild cards (those high impact/low probability events).
  - Preferable futures are plausible futures that your organization would like to occur.
- **Attributes:** The attributes are used to describe the different futures and their characteristics.



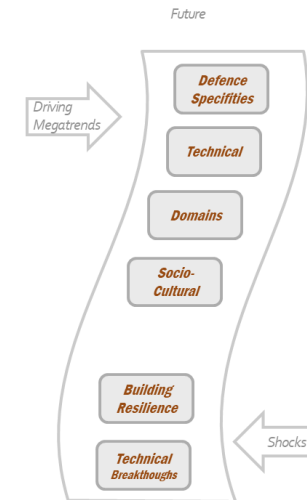


### Divergent Thinking Dimensions

The ideas about the future are structured around different **dimensions**. Examples of common dimensions of interest are:

- **Societal-Ethical:** Potential impact on society or address specific social, health and ethical needs.
- **Geopolitical-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-Technical:** Potential impact on future critical technologies or technological needs
- **Defence specificities:** Potential impact on future defence needs and capabilities.
- **Drivers Dimension:** Factors that may inflict significant changes in any of the dimensions. They are mostly trends of different nature.
- **Shocks Dimension:** Unexpected events and changes. Of interest for this exercise are those which pose potential strategic shock, such as disrupting technical breakthroughs, or natural or man-made catastrophes.

Under each dimension, relevant topics can be identified, these are the Focus Topics, which will be described in the following lines.



<i>Drivers (Megatrends)</i>	<i>Shocks Technical Breakthroughs</i>	<i>Shocks Building Resilience</i>	<i>Socio-Cultural</i>	<i>Domains</i>	<i>Technical</i>	<i>Defence Specificities</i>
Clima	Singularity	BIO-HAZARDS (virus/ new mosquitoes...)	Empire-Shift	Future # 1 Arctic	Bio-engineering	Cognitive Warfare
Megacities	Cold Fusion	Kessler Syndrom	Virtuality	Space	Robotic	New Conflicts
Technical trends	Clonation	Super solar flare		Cyber		Autonomous systems
Demographies		Magnetic Earth Spin		Economic-Industrial		Urban warfare
Energy						



In relation to these dimensions, it is important to bear in mind that:

- Dimensions represent thinking axes where it is expected to collect relevant ideas about the future. However, it is not expected to gather an equal number of ideas across all dimensions.
- These dimensions are not mutually exclusive. As a matter of fact, most of the proposed ideas could be associated with several of these dimensions by adopting a different perspective on the idea. In this sense, if any participant believes that an idea should be associated with another dimension is free to politely comment on that opinion on the idea or alternatively propose an additional idea on the other dimension elaborating on the other aspects of the idea.
- Therefore, around a similar topic, there can be several ideas-aspects distributed around different dimensions.

#### Focus Topic- Description

As a preparation for the exercise, prepare for each focus topic an initial description of at least the following two attributes:

- **Description** – a brief description of the focus topic from the futuristic point of view (not the current situation), indicating the main aspects to consider later on.

- **Defence and strategic narrative** – a brief description of the potential relevance from the defence and/or strategic point of view.

During the meetings and collaborative work in the diverging phase, these other attributes are expected to be addressed / explored to fully picture the focus topic:

- **Future statements** – Elaborate some final statements associated with the Focus Topic with a futuristic view with helps to build a vision of the topic role or relevance in the future.
- **Key factors** – most significant factors in its emergence or relevance (both driving and hindering) indicating (if possible) the type of evolution of the factors (linear, exponential...)
- **Elements of uncertainty** – identification of known unknowns and elements associated with the focus topic complexity dimension.
- **Current weak signals**– identification of present or near future weak signals that may affect the focus topic in the future horizon of discussion.
- **Estimation of inflection points** – Estimation of the materialization point of the Focus Topic (or the factors) in relation to the future horizon of discussion (incipient, emerging, consolidating, mature, ...)
- **Opportunities and risks** – from the point of view Europe and defence and derived from the Focus Topic, its factors and



possible scenarios. Identify major implications and their relations to other Focus Topics.

- **Unintended consequences** - Consider adjacent influences and derives in relation to the focus topic. Link it with other attributes (opportunities and risks, implications, ...)
- **Relations with other Focus Topics** – Identification of which relations can be identified or propose to the other Focus Topics.

## Phase 1 – Divergent Thinking Steps

The Divergent Thinking Future Event approaches the future visions with a combination of what is known, what is unknown, and what is imagined or envisioned. The divergent phase results in the identification of the “Future Dimensions”, which are pillars of interest describing the futures.

### Divergent Thinking - Execution

The EDA Technology Foresight Exercise starts with a back-casting activity, looking into the past to be able to better foresee the future. The back-casting is performed by CapTechs and experts participating in the exercise, who assess the relevance of past technologies and predictions of interest for defence identified in the last decades. As part of the back-casting activity, looking into the past, two surveys, one themed on the 2007's R&T Technologies and one on Sci-Fi movies, have been launched:

1. The Sci-Fi survey aimed at identifying thinking patterns, when foreseeing the future and technologies' impact, turning points, drivers and showstoppers in the technology development process. To illustrate these ideas sci-fi movies from the 70's, 80's and 90's are assessed on what they predicted the 2020s may look like.
2. The technologies survey assessed 22 EDA R&T priorities from 2007 to gain a better understanding of their evolution and to derive lessons to be applied in the exercise for foreseeing future evolutions.

The back-casting is complemented by the EDA Technology Watch activity, thanks to which a set of weak signals is identified. The weak signals identified can be found in **Weak Signals Report**. In addition, the “futures tellers”, a core team of multidisciplinary experts participating in the exercise, have imagined a set of disruptive futures, providing the framework for the foresight activity. The narratives of these futures (brief description on the scope of the future dimensions initially considered relevant for Defence) can be found in the document called **Futures Narratives**.

The Exercise gathers high-level experts from different technological and non-technological domains (sociology, history, economy, industry, law, etc.), as well as from non-governmental bodies, academia, industry, and civil society. Military staff with experience in operations and interest in future technologies would also be



involved. There had participated two types of experts with different roles in the exercise:

- Future tellers. A core team of multidisciplinary experts. They were experts from a diverse set of technological and non-technological domains, with a civil and military background. They had collaborated drafted 4 future narratives meant to inspire all the exercise's participants. During the exercise's events, the future tellers had differing roles, as either member of the 'red team' to challenge and thereby enhance proposed ideas, as 'future shapers' to encourage participation and conform (some) ideas, or simply as subject matter experts with the addition of contribution to the final reporting and selection of ideas for further analysis.
- Experts. They were matters experts from a diverse set of technological and non-technological domains, with a civil and military background who contribute to the identification of ideas and disruptive technologies for future defence capabilities.

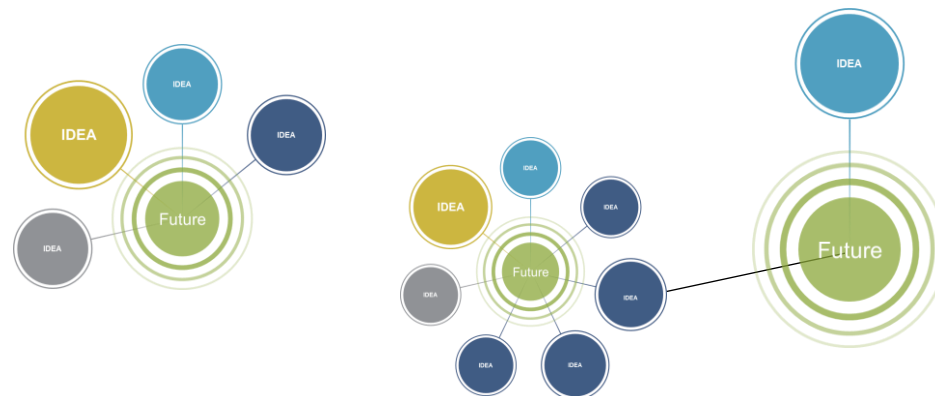
The first event fits in this context with the goal to explore different ideas of the future which may pose a direct or indirect relevance for the European defence in 2040+. In this sense, the results of this exploration serve as a baseline to aggregate, under key common topics, different future perspectives, within those perspectives, to identify a set of future scenarios to be used as a starting point in the second Event.

This exploration of ideas of the first Event is conceived around the following three pillars:

- An open mindset that encourages the exploration of the future from different points of view and without a conducted thinking. Therefore, participants with different backgrounds are encouraged to share ideas not necessarily driven by a common specific scenario or challenge. This includes ideas from many different dimensions (societal, technological, geopolitical, etc.). For this, approaching own ideas and other ideas with the right mindset is key. This mindset should combine what is known, what is unknown, what is expected, and what is imagined or envisioned. A clear understanding of the future impact of an idea is not required to post the idea, a vague understanding of its relation to defence is enough. Of course, the clearer understanding the better, but acknowledging and identifying the uncertainties as well as making assumptions around an idea is also valid and worth it.
- A "multiple futures" perspective. The exercise is oriented towards the identification of many possible and plausible future aspects and scenarios for 2040. These futures do not need to be focused exclusively on defence but they need to present a "feeling" of relevance for defence matters in 2040. In addition, participants should bear in mind that the exploration of the ideas does not aim to find or select a single future of interest but to identify and characterize a baseline of alternative futures of interest, which may constitute a reference for a long-term vision.



- A defined structure and terms to help the exchange of ideas. Despite the aforementioned encouraging openness in the mindset and ideas, a certain structure is needed to support the exchange, the common understanding among the participants, and the posterior analysis of the ideas.



The adopted structure is composed of two elements (dimensions and ideas) and a workflow.

- **Elements: Dimensions.** They represent thinking axes where it is expected to collect relevant ideas about the future.
- **Elements: Ideas.** The opinions proposed by the participants are the cornerstone of the exercise. These opinions may come in two different formats:

- As a standalone idea proposed to the rest of the participants.
- As a discussion based on comments around an existing idea.

- **Workflow:** The participation workflow is a combination of meetings (virtual or face-to-face) and asynchronous interaction done through an online collaboration tool.

Ideas are expected to be characterized during the exercise along with these different aspects:

- **Description.** As a minimum, a self-explanatory title and a short description of the idea and its relevance for the future are required. In addition, ideas also have different fields necessary for their future analysis and forecasting. As mentioned above, the fields are: Future statements, key factors in the development of the depicted future, elements of uncertainty, current weak signals, estimation of inflection points, opportunities and risks, and unintended consequences. These fields can be optional fields by the idea author/proposer. Regardless of the author's update of these fields, the moderators incrementally update these fields upon the exchanged information and gained insight from the discussions.
- **Enrichment.** The discussions based on the exchange of comments around a proposed idea are expected to enrich the understanding of the idea. Participants are encouraged to discuss

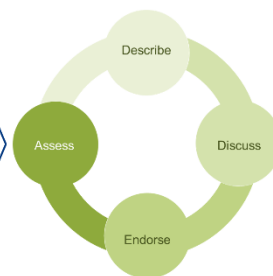


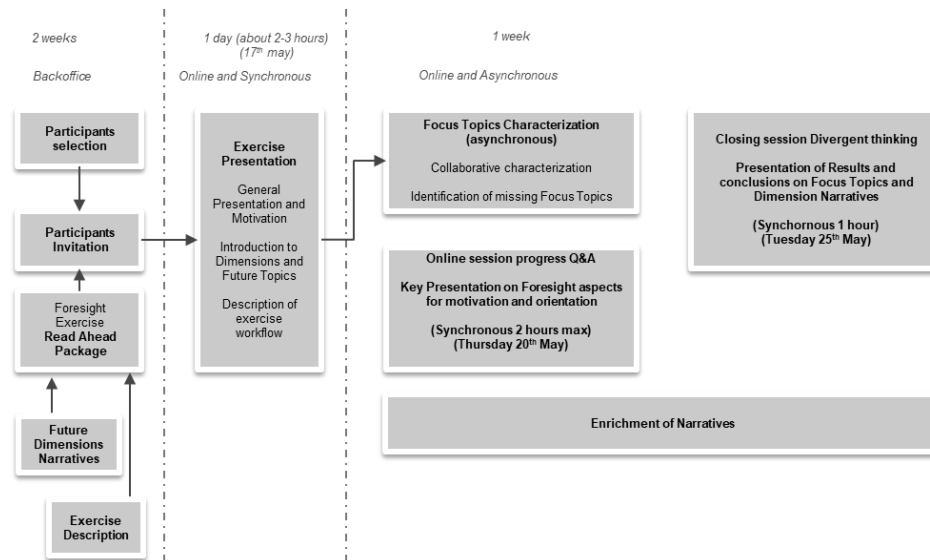
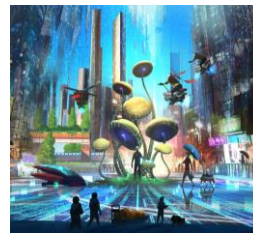
any aspect of the included description or introduce any new aspect or relation associated with the idea. The moderators routinely process these discussions and update the description upon the comments.

- Endorsing. Ideas can be endorsed either by explicit appreciation in the discussions or by “thumbing up” the idea in the enabled functionality in the supporting tool. The aggregated endorsements serve to gain an understanding of the importance and relevancy of the different ideas from the point of view of all participants.
- Assessment. In addition to the general endorsement described in the aforementioned bullet, participants are also requested to contribute to the characterization of the ideas by providing a final assessment of those ideas of their choice. This assessment is performed in a straightforward manner around the following criteria:

- Relevancy of the idea for Europe: Addressing how much an idea is expected to impact Europe in 2040+.
- Relevancy 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+).
- The singularity of the 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).

- **Relevancy of the idea for Europe.** Addressing how much an idea is expected to impact Europe in 2040+.
- **Relevancy 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).





### Divergent Thinking - Back-office step

Before the first event launching, an analysis of the IT tools available to carry out the asynchronous collaboration part of the event should be carried out. Previous experiences with VIIMA make it possible to determine that it would be the best candidate due to its ease of use to support the interaction of the participants and the possibility of having quick feedback on the proposed ideas.

Once the tools are selected, the divergent thinking board is configured based on the dimensions (called Categories in the tool) of interest and fields to be provided for each idea. And a set of ideas, corresponding to different dimensions, are created to serve as a

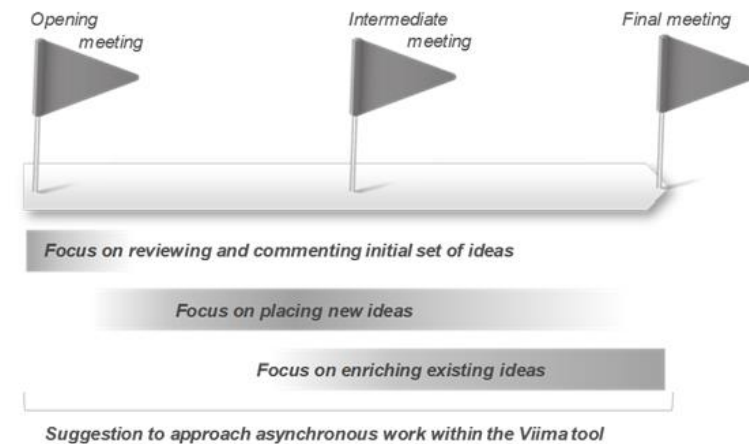
starting point for discussion and to encourage the creation of new ideas.

In addition, a read-ahead package is prepared, containing the necessary information on the background and objective of the first event, a description of the process, and a guide on how to handle VIIMA.

Participants in the first event are registered on VIIMA, receiving an email that allows them to log on to the IT tool and access directly to the working board.

### Divergent Thinking - The Event

The participation is a combination of virtual meetings and asynchronous interaction done through an online collaboration tool called Viima. The following diagram depicts such approach.







### *The meetings – synchronous participation*

As it is shown in the diagram of figure above, there are three meetings, all of them to be held on-line (via WebEx):

- **Opening meeting.** This meeting addresses:
  - Presentation of the exercise. Description of the objective and workflow of the first Event.
  - Presentation of the means to support the interaction of the participants. As already indicated, this interaction is done through the tool Viima.
  - Brief session on practicalities of the tool Viima.
  - Intermediate meeting. In this meeting, a review of the progress is performed jointly by moderators and participants. In addition, this meeting also addresses questions and problems related to the process and the interaction with the Viima tool.
  - Final meeting, with the presentation of results and the derived baseline of alternative futures of interest, derived from the analysis of ideas and different perspectives, which may constitute a reference for the long-term vision.

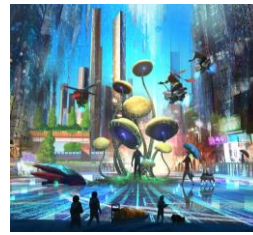
### *Asynchronous contributions*

A good part of this exercise is performed asynchronously throughout its week duration. In this sense, participants are expected and encouraged to contribute their ideas and interact with the existing

ones at any time. This asynchronous interaction is done through the online Viima application. An email is sent daily to the participants with an update on activity carried out so far on that day, in a form of a newsletter. Likewise, the tool notifies by email replies by other fellow participants to ideas or comments proposed by an expert as a participant.

The asynchronous work is expected to start after the finalization of the opening meeting. To guide the asynchronous work in an effective way, it needs to focus the interaction on the following phases:

- First, reviewing and commenting initial set of ideas. Starting by reviewing and commenting the initial set of existing ideas. This serves as an example and starting point for the interaction and discussions. Once acquainted with the tool, posting new ideas is possible and encouraged.
- Second, placing new ideas. Participants should focus on posting new ideas and engaging on discussions around those ideas they find of interest. Additionally, participants may start proposing interrelations, endorsing and assessing ideas, although it is preferably that these actions are performed towards the end of the exercise.
- Third, enriching existing ideas. Participants are encouraged to focus on adding comments, proposing interrelations, endorsing and assessing existing ideas. Proposing new ideas is still possible, overall if they complement existing

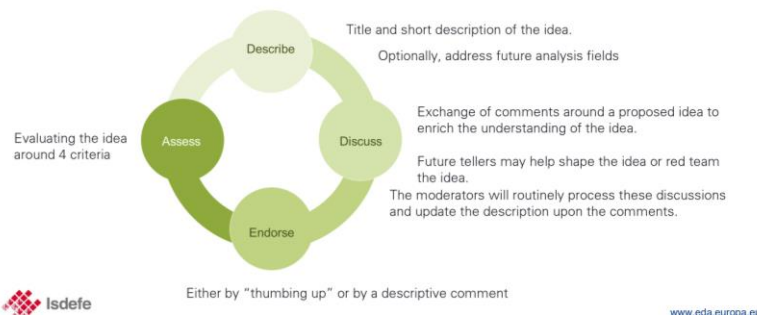


ones or present a significant value, but the focus should be placed on enriching the existing ideas.

These phases overlap themselves and differ in duration. It is possible that for some ideas the three phases compress in time, but as a whole, following these phases favour an incremental approach to getting acquainted with the interaction process and gaining insight collaboratively around those ideas.

## KEY ELEMENTS - IDEAS

- Ideas and opinions ⇔ Contributions from Participants and Future Tellers
- Ideas are expected to be characterized during the event along these different aspects



## Divergent Thinking - Inputs

The inputs for the first event come from the back-casting activities held in the run-up to the exercise:

- Futures narratives. A set of disruptive futures that provide the framework for the foresight activity
- The report on weak technological signals has been drafted thanks to the European Commission's Joint Research Centre.
- Two surveys, one themed on the 2007's R&T Technologies and one on Sci-Fi movies.

Other documents have also been used as inputs, such as:

- CDP-B Technology themes & Scenarios
- Topics and priorities from previous strategies, programmes (defence/EDA specific)
- Sci-fi cultural references: films, novels, etc.
- Foresight methodology
- Guide for the gurus
- Read Ahead Package 1<sup>st</sup> Event. Document with the information needed to prepare the participation in the event.

With this food-for-thought information, a set of three events have been organized allowing divergent and convergent thinking, to explore and define future technologies of interest for EU defence. The first of the events has been devoted to divergent thinking, to gather the widest range of ideas, whereas the second and third events have been focused on convergent thinking, towards the



identification of the weak signals, technology trends and potential disruptive technologies.

*Workflow: IT Tool and actions*

The interaction process is supported by the already mentioned Viima tool and a set of straightforward actions. These actions are:

1. Register in Viima. After the acceptance email from the EDA, each participant should have received an email with a link to provide a password to the login user (provided email to EDA).
2. Log in to Viima. Browsing by Viima Foresight Divergent Thinking platform link, participants are directed to the login screen of Viima where a welcome message, which sets the context and offers a briefing on the tool's functioning.
3. Navigate through the board. (in the tool they are called Categories). The tool allows the views of ideas by each dimension (societal-ethical, geopolitical-economical, technology-technological, defence specificities, drivers, shocks, and others). The default configuration (sort by Newest) shows the new ideas at the top of the board. But different views can be selected (trendy, liked, commented, etc.).

VIIMA also allows a keyword search on the texts of the ideas. When you click on an idea, the tool shows an idea record with the Title and Description of the idea. Additionally, there are tabs for:

- **More information:** Additional information that allows to characterise the idea for the creation of the scenarios. This

information can only be added by the author of the idea and the moderator.

- **Discussion:** This tab is where the discussions between the participants take place through comments.
  - **Evaluation:** In this tab, the Idea assessment based on four metrics takes place.
4. Enrich the board. Review existing ideas and react to them through the discussion tab on each idea form.
  5. Place an idea. Participants may place an idea by clicking on the plus symbol on the upper part of the screen. The description of the idea is done through a popping form. There are two parts, a compulsory one with the title and short description and an optional one with additional fields associated with foresight aspects. By default, the ideas are associated with the selected Dimension (Category in the tool). If no Dimension/category is selected, the form asks for this association.
  6. Update your ideas. Participants who have proposed ideas may update the idea description based on the comments exchanged in the discussion area of each idea. In any case, exercise moderators perform this task routinely.
  7. Endorse ideas. Participants can endorse ideas (theirs or others) by either explicitly stating so in the discussions or in a more straightforward (although less detailed) manner by “thumbing up” the idea, by clicking the icon in the description of the idea.



8. Identify relations. Viima allows for the inclusion of hashtags for cross-relation of topics across different ideas and dimensions. Moderators routinely identify and place such hashtags (#topic) across different ideas, and participants may search through those hashtags as a way to check interrelated ideas. Optionally, they can also propose hashtags on key topics or adhere to existing hashtags, by placing the #topic themselves on the related idea.

9. Review progress on ideas descriptions. This action is more of a reminder to encourage all participants to routinely check the progress and updated descriptions on overall the ideas of those of greater interest to each participant.

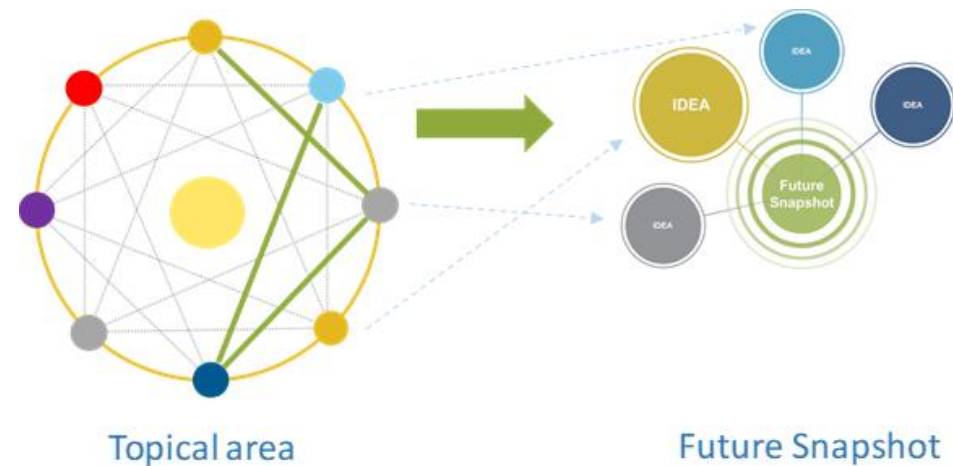
10. Assess ideas. By the end of the exercise, or alternatively, when a good insight is reached on an existing idea, it is possible to assess the criteria concerning four different criteria. If no assessment is provided by the participant, the participant does not see any results on the assessments from the rest of the participants. Once an assessment is provided, Viima indicates the participant's assessment and the average of the rest of the participants on those criteria. A participant may change several times the assessments on each criterion and each idea.

#### Divergent Thinking - After the 1st event

The first phase's postprocessing is based on the assessment of the ideas gathered with regards their value for Europe, for defence, their plausibility, and their un-commonality. The ideas is analysed around a common thread to identify topical areas, potential futures, and

relations among them. The topical areas could contain ideas (and contents from the discussions) from the different dimensions, being this way, multifaceted topical areas.

Derived from each of these topical areas different alternative futures visions are identified by the composition of subsets of ideas/comments within a topical area. These subsets of the topical area depict an alternative future snapshot of 2040. As depicted in the following figure.





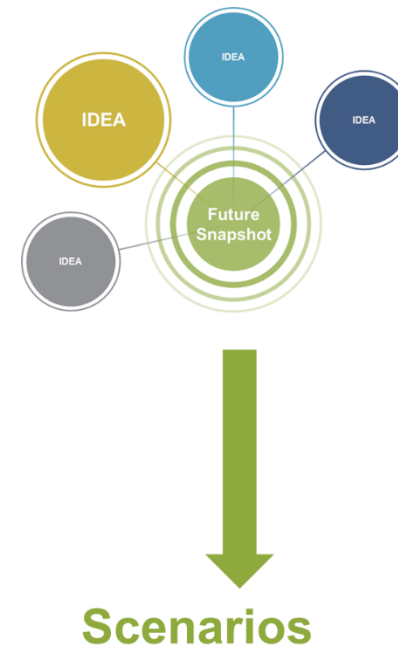
For each of the identified future snapshots, a form is created with the following fields:

Title of the Future Snapshot	
DESCRIPTION	
KEY FACTORS	
UNCERTAINTIES	
CONSIDERATIONS AND POSSIBLE SCENARIOS	
COMPOUND ASSESSMENT	
CDP STRAND B. FACTOR	
RELATED CAPTECHS	
ASSOCIATED IDEAS	

The scenarios are derived from the specific possible views of a "Future snapshot" by focusing on possible their values of uncertainties and key factors.

Each scenario contains ideas from the different dimensions of the alternative futures (societal - ethical, environmental – health – human, geopolitical–economical, technology - technical, defence specificities, others), plus the related drivers and shocks, and they need to be characterised by the dominance of a given factor or influence of specific relations.

Only the most relevant scenarios for the exercise are further analysed, resulting in a set of selected scenarios as starting point of the second event. The selection of scenarios is done with the support of the Future Tellers and is proposed to the experts



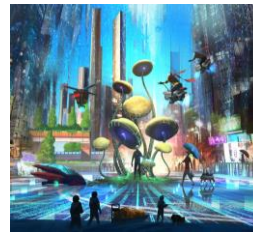
participating in the second event. The selection is based on the usefulness of the scenario with regards to the Exercise.

Scenarios are specific possible views of the Future Snapshot. They are derived by focusing on possible values of the Future Snapshot uncertainties and key factors.

Key Factors and uncertainties are the baseline to build scenarios. These scenarios are models of alternative futures. Depending on the value and meaning of the factors and assumptions, these alternative futures may be probable, plausible, possible and preferable (as described previously).

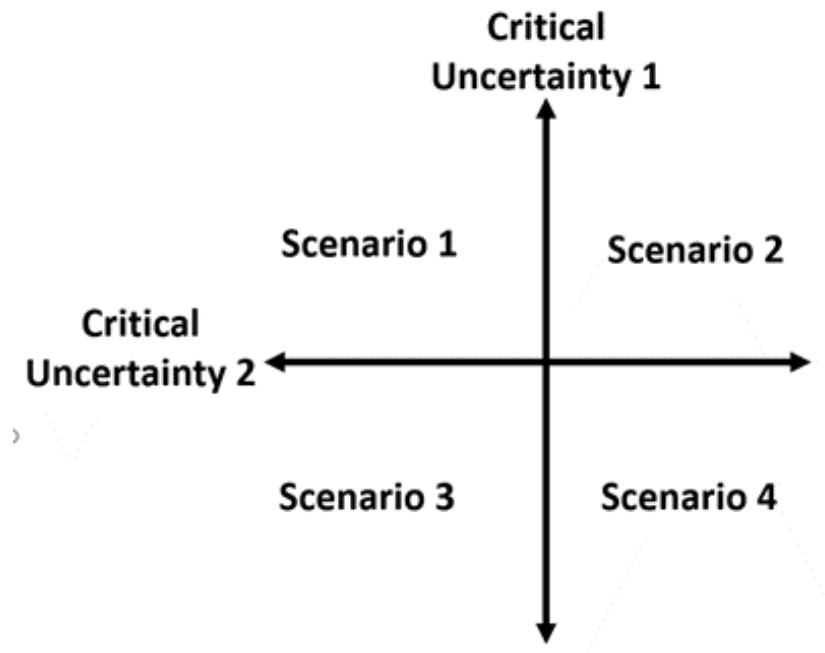
Effective scenarios should be:

- Be narrative-based, coherent, plausible, internally consistent, specific, plausible, relevant, unambiguous and balanced.
- Help change the attitudes of those who read them.
- Reflect trends as well as weak signals and wild cards.



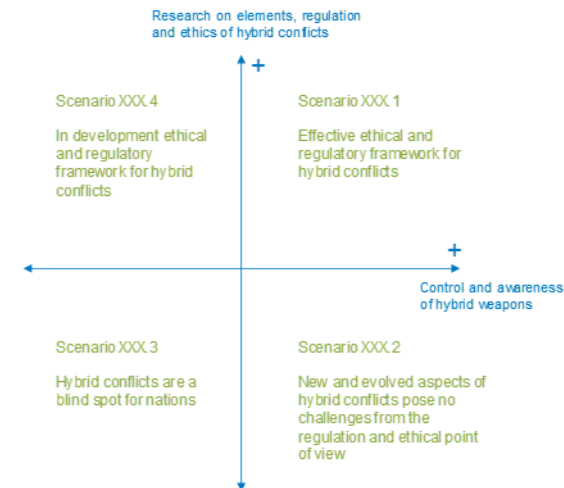
- Reflect that scenario's unique characteristics.

There are many approaches to build scenarios, the most common one is the 2x2 scenario matrix.

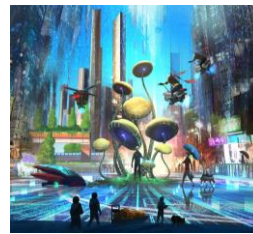


Exploring different possibilities of scenarios composing alternative characteristics of key factors and identified uncertainties or confronting success vs. failure approaches to or heaven vs. hell scenarios.

1. Identify two impactful factors and associated uncertainties to them
2. Translate them to critical uncertainties by identifying the extremes.
3. Place critical uncertainties on axes
4. Describe the likely characteristics in each of the four quadrants
5. Use these four characteristics to develop narratives for each of the four quadrants



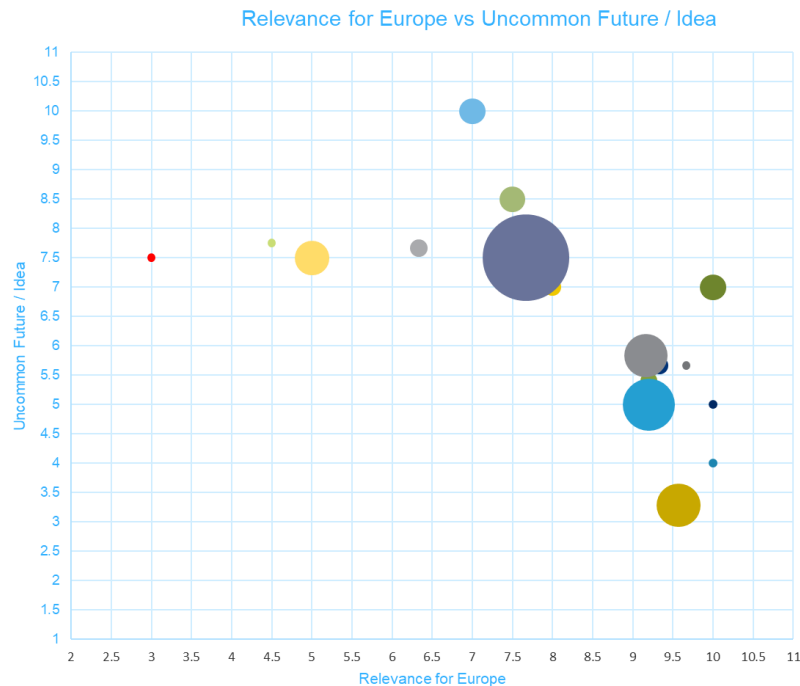
- 07.FS1.1 Effective ethical and regulatory framework for hybrid conflicts
- 07.FS1.2 New and evolved aspects of hybrid conflicts pose no challenges from the regulation and ethical point of view
- 07.FS1.3 Hybrid conflicts are a blind spot for nations
- 07.FS1.4 In development ethical and regulatory framework for hybrid conflicts



### Divergent Thinking - Outputs

The outputs of 1<sup>st</sup> event are summarised as follows:

- List of discussed ideas and their average assessment by the participants across the selected criteria.



- Set of alternative future visions (future snapshots). Identified by the composition of subsets of ideas/comments within a topical area.
- Set of common topical areas were identified containing ideas which share concepts and relations (both in the description and on the discussions).
- Set of key scenarios on selected focus topics. – Transferring the characteristics of the selected scenarios and focus topics to a platform (VIIMA) for collaborative visual and design thinking.
- 1st Event Conclusions Report. This report compiles the results of the Divergent Thinking event.



## Phase 2 - Convergent Thinking: Future Backwards

### Phase 2 - Convergent Thinking Objective

In general terms, convergent thinking is essentially about traditional problem solving. Convergent thinking typically involves bringing material from a variety of sources to bear on a problem, in such a way as to produce the "correct" answer. This kind of thinking is particularly appropriate in science, maths, and technology, since it involves description, observation, deduction, and/or prioritisation in relation to a given problem.

However, in the frame of this exercise, two distinctions need to be enforced.

First, the set of sources where to feed to bear on a problem, are the set of the thematic futures and their interrelations, identified in phase 1.

Second, in this case the convergence is not about a "correct answer" about a problem. It is about adding structure to how you think about the future. Within the frame of this exercise, the convergence is towards the identification of technology trends and their impact from the point of view of the EDA's key strategic pillars (KSA, CDP, OSRA).

The Convergent thinking follows these three steps:

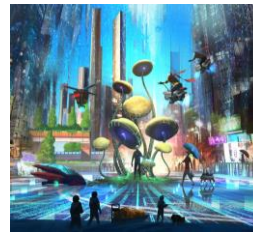
- **Consolidation** – Reduction of the level of complexity and identification of elements of consensus and open issues.

- **Prioritisation** – Gaining perspective on the elements and issues in relation to the Topic focus and the EDA strategic pillars.
- **Recommendations and actions.** Identifying and elaborating recommendations and actions for the present planning.

The identification of impact from the point of view of the EDA's following perspectives:

- OSRA TBBs and SRAs
  - Technology trends with an outlook to 2040+ with an assessment of their impact on security and military capabilities.
  - Factors which will shape technology development with an outlook to 2040+ and a European perspective.
- CDP Strand B
  - Key future strategic environment factors,
  - Future capability requirement areas
  - Technological areas of relevance from the capability requirements
  - Technology trend support to the design of future conflict scenario
- Key Strategic Activities
  - Technology trend support to the identification of critical activities in Europe and the proactive mitigation of current and future dependencies.

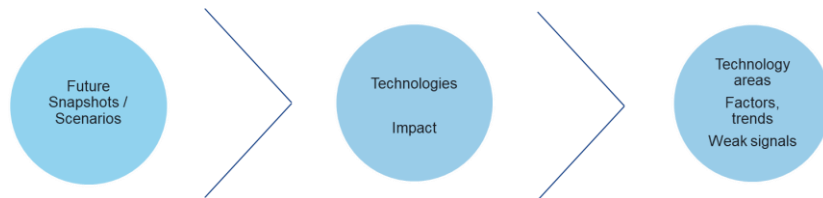




## Phase 2 - Convergent Thinking Theory

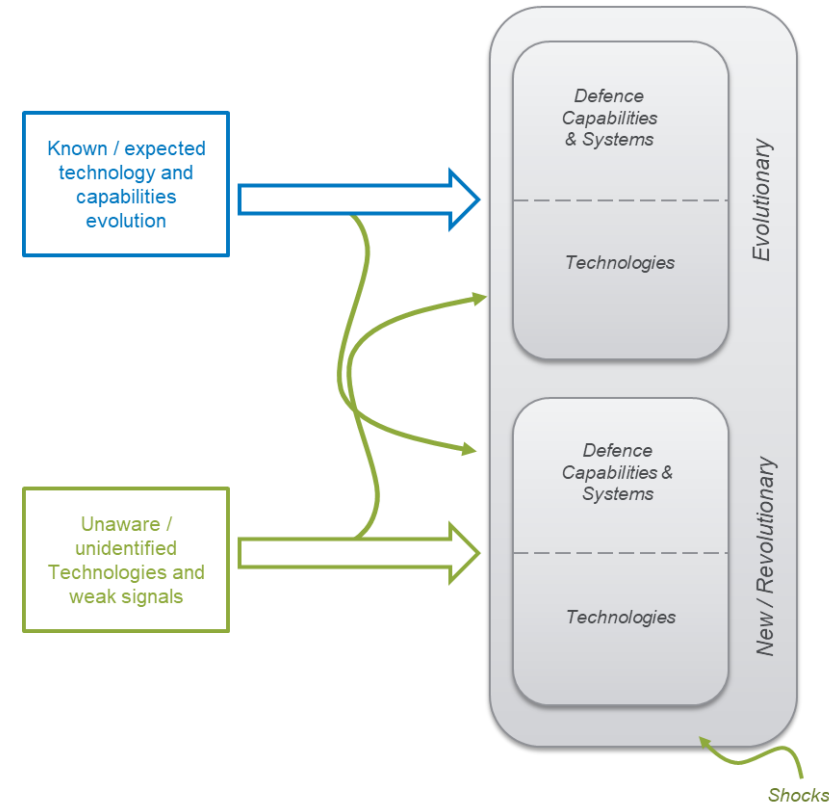
### Convergent Thinking - Future Backwards - Approach

From exploration (alternative futures) to building future(s) (of interest), by identifying potential technological aspects of interest in the possible pathways to those alternative futures identified from 1<sup>st</sup> Event.

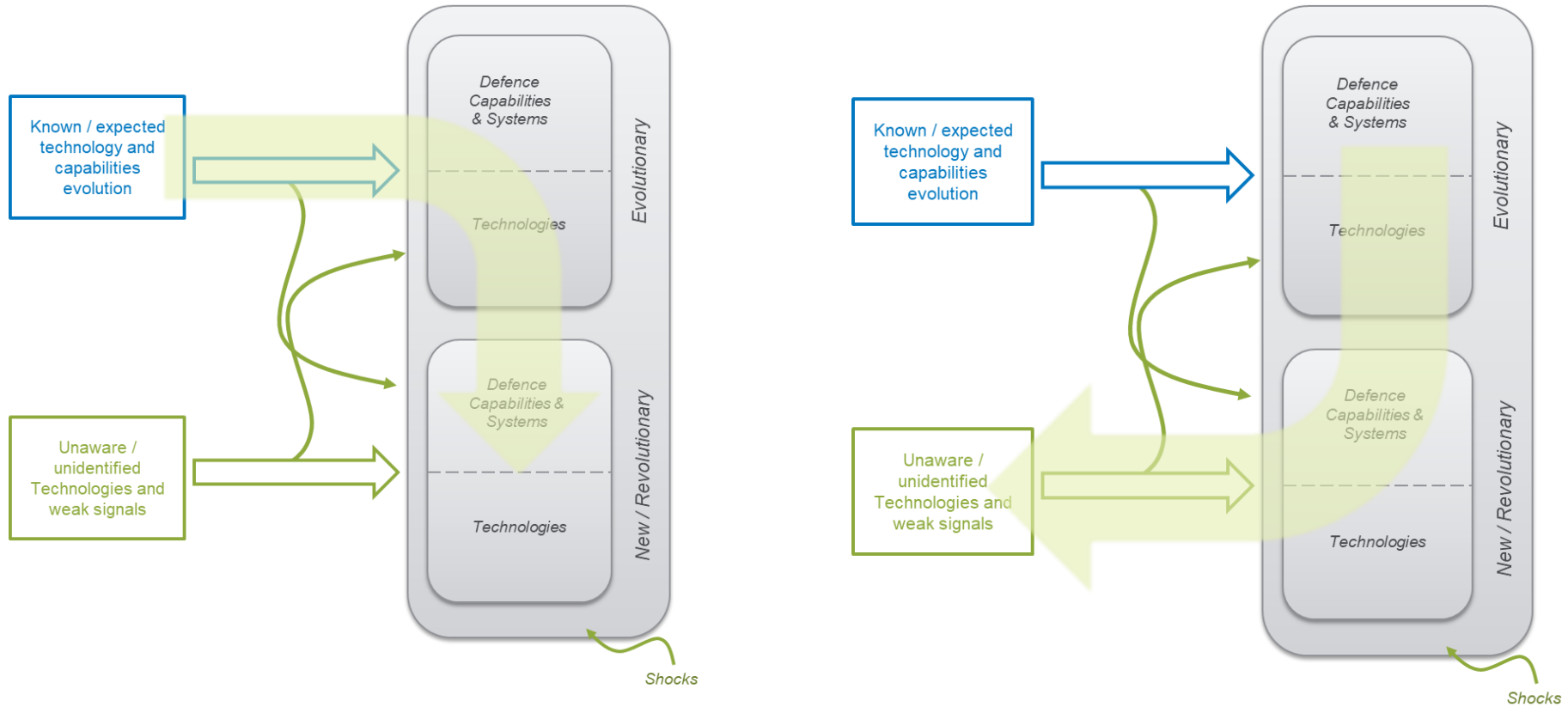
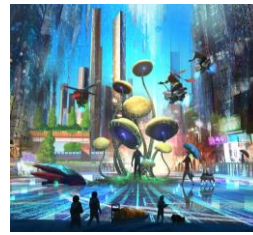


To do so the approach adopted is focusing the thinking process on the futures selected on the first event and iteratively converge from those futures towards the present, by identifying which changes would have need to happen in order to those futures take place. This process, known as future backwards, will be the methodological backbone of the second event.

Starting from a general depiction of the future, in which both technologies and defence capabilities and systems are the aspects of our interest, it is possible to divide these aspects between those which have evolve from present technologies and capabilities and those which are new or revolutionary.



With forward looking approach to foresight, as one goes from the known and expected technologies and capabilities evolution it is more likely and feasible to address those evolutionary aspects in the future, rather than those new and revolutionary.



On the contrary, with the future backwards approach, by starting on the future (from those multiple futures conceived in the divergent phase) the goal is to identify those technologies and weak signals from the present time, which are unidentified or not under the radar.

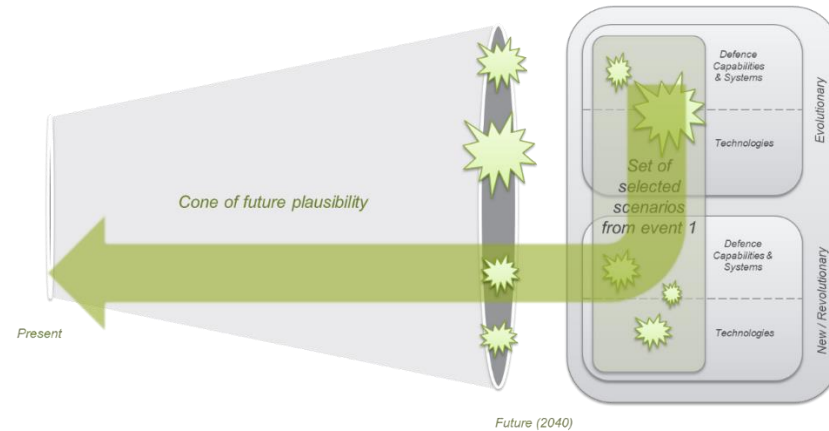


## Phase 2 – Convergent Thinking Steps

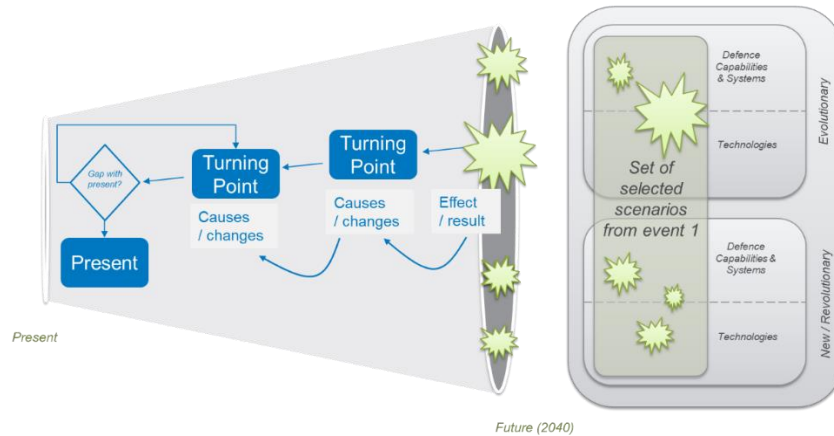
The objective is to build upon the previous results, starting from the future snapshots/scenarios, to identify the most relevant technologies and their impact. In this way, at the end of the process, it is expected to identify technology areas, factors, trends, and weak signals that could be relevant towards 2040.

### Future Backwards - Execution

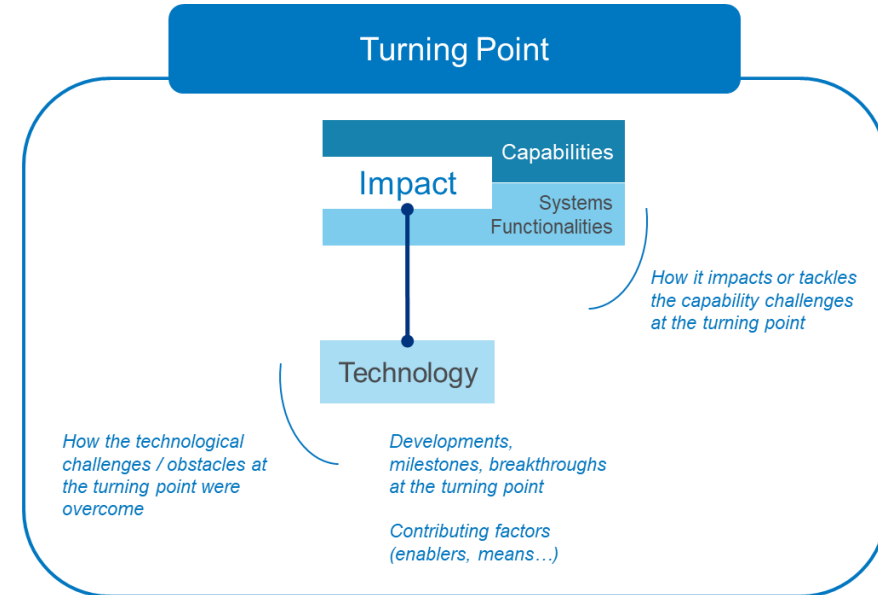
The methodology applied is futures-backward, starting from a possible given future, traveling back to the present. With this trip through the cone of future plausibility, from the set of selected 2040 scenarios to the present, it was expected to identify an evolutionary path towards a possible future in 2040, with known and expected technologies and capabilities evolution, but also new and revolutionary ones, with unaware or unidentified technologies and weak signals.



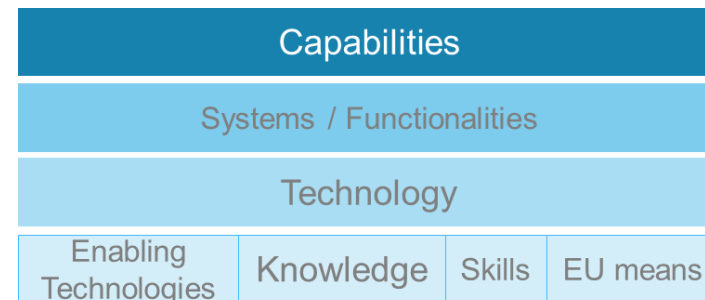
To guide the thinking process, several turning points have to be established, in addition to the “now”, 2021, and the time horizon at 2040. These turning points are used to map the effect-results of a given scenario, and also the causes and changes at each turning point.

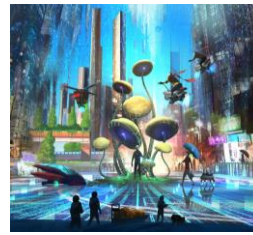


For each turning point, the impact of technology on future capabilities and systems functionalities, how it impacts or tackles the capability challenges at the turning point, how the technological challenges/obstacles at the turning point will be overcome or development, milestones, breakthroughs at the turning point and contributing factors (enablers, means...) are looked upon.



The structure of the different areas is the regular one: capabilities, systems/functionality, technology, and then enabling technologies, knowledge, skills, and EU means.





Two final aspects to complete the execution structure are: timescales and red teaming.

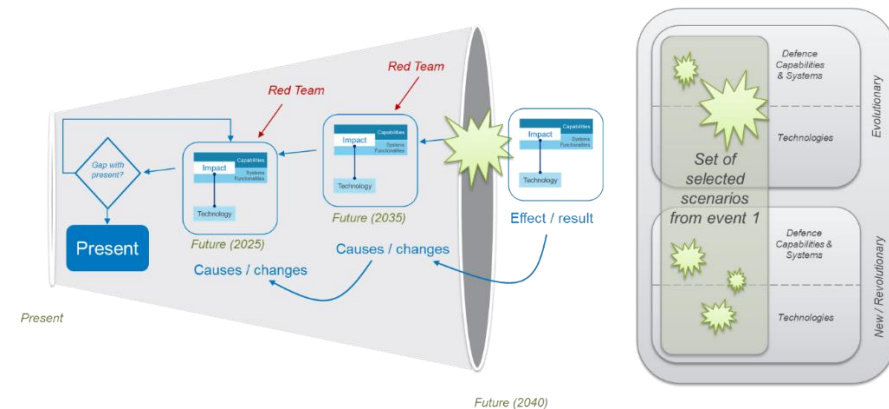
Three different timescales are defined: the extremes (2040 and present time) and the intermediate turning points (2035, and 2025). The idea behind the different timescales set for the turning points is to have shorter time-leaps at the extremes, to make the thinking process easier from the Exercise references (2040 and present, 2021). However, these time-points are to be taken as approximations to better come with ideas about the evolution of the aspects under discussion. In this way, in some areas, there can be needed for only one turning point, for example in 2030. It is also highlighted the "clash" of timelines with long-term planning of key platforms. At the same time, these already "fixed" aspects and systems provide a contrast to the estimates and the guessing on technologies and impacts on the scenarios under analysis.

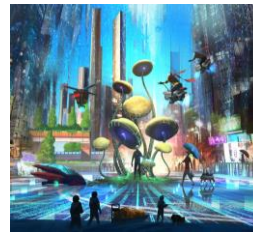
Red teaming can be used to enhance and complement the understanding and insight of ideas. In this regard, the focus should be put on either:

- Not so much the traditional enemy/adversarial P.O.V.
  - Applying the red perspective to a widen Defence and Sovereignty perspective
  - From the point of view of vulnerabilities and dependencies EU, and geostrategic shifts
  - Adversary perspective in new defence domains

- Challenging to cooperatively find out / think of new perspectives of those ideas
- Proposing changes / perspectives in the used hypothesis (approaches, paradigms...)
- Identifying indirect impacts (e.g., System of systems) and unexpected shocks

With these final aspects, the final structure is:

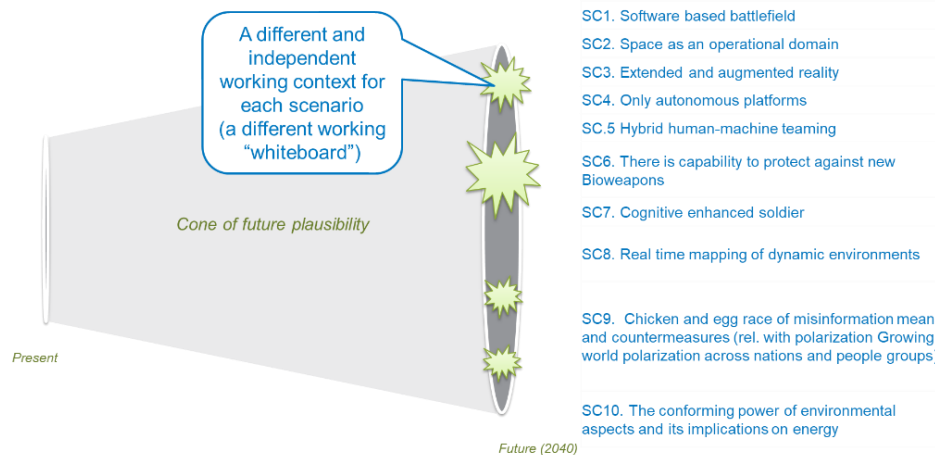




### Convergent Thinking - Pre-event step

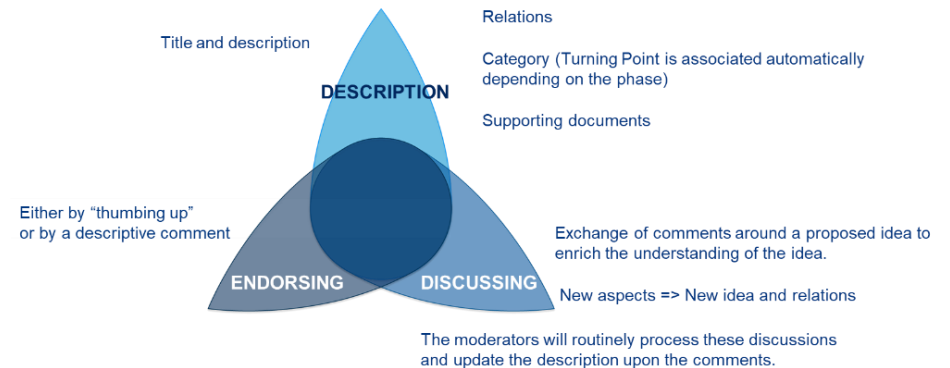
The second phase has a convergent thinking approach, going from the exploration of alternative futures proposed for the first phase to building futures of interest. These futures of interest are derived from the ideas gathered and post-processed after the first phase.

The discussions around the selected scenarios, as for the first event, take place asynchronously in the online whiteboard (VIIMA), the same platform which was used in the first event, thereby providing a familiar IT infrastructure for the event. However, for this event, a different and independent whiteboard has to be created in VIIMA, one per scenario.



To promote the discussions around different aspects, four categories of information are created in each of the whiteboards: Scenario context, Technological aspects, Impact on defence functionalities and capabilities and Red Team. Convergent Thinking.

The ideas will be the contributions from Participants and Future Tellers, either as a standalone idea or as a comment to an existing idea. Ideas are expected to be characterized during the event along these different aspects depicted in the following figure:





### Convergent Thinking – The event

As with first event, the participation is a combination of virtual meetings and asynchronous interaction done through an online collaboration tool called Viima.

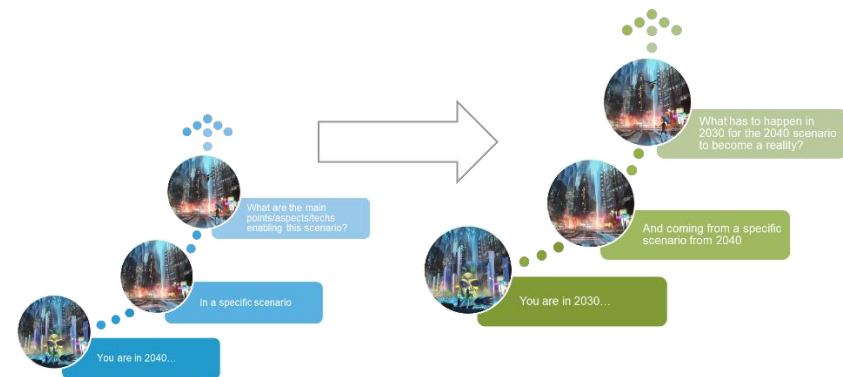
The approach for synchronous and asynchronous meetings follows the same fashion as with Event 1 and as described afore in this document.

As a starting point for the first event, the experts are requested to enrich the selected scenarios with the 2040 perspective. The contributions are expected on what is needed for a given scenario to be a reality (what is needed for the scenario to be achieved by 2040, as defined). The experts are also requested to identify aspects that could lead to considering this scenario as not reachable. In this case, it was requested to save the ideas and include them in the next phases (2030 and 2021).

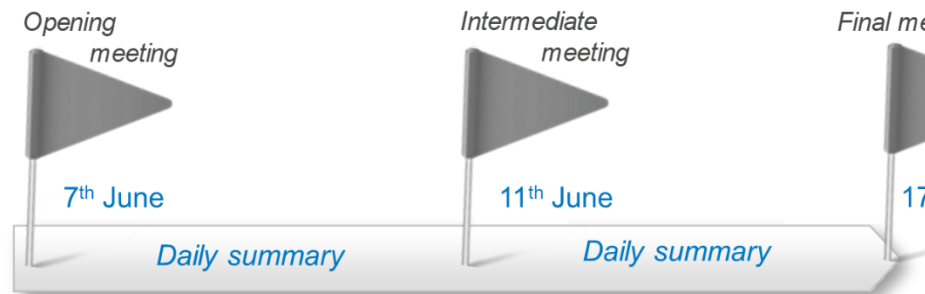
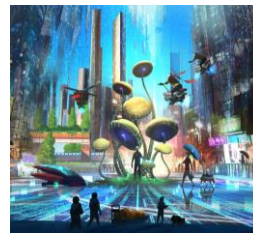
To give an initial example, one scenario is further developed, adding some related technologies and initial impacts. It needs to highlight that the information there is just an example to guide the participants and needs to be further elaborated (inputs from the experts). In addition, the experts are given the possibility to provide any additional or different suggestions regarding the proposed scenarios or to add a new one.

For the discussions around 2040, it has also to propose thinking about different questions for each scenario: Which key technologies

are enabling the scenario? What is their impact on defence? What do you think about the ideas already shared? Additionally, for each new idea, it has to request to create the idea in the specific category and turning point, including a title and description, relating it with # to other ideas or key topics, adding supporting documents. For existing ideas, the objective is to discuss them by exchanging comments to enrich the understanding of the idea, to add new aspects, or relate it to another one. Moreover, it is also possible to endorse an idea by “thumping up” or by adding a comment.



After 6 days focused on 2040, the next turning point in 2030 has to be open for discussions. The same questions are asked but with a different time perspective, and also on what has to happen by 2030, to get to the 2040 scenario. Nevertheless, it is always possible to “get back” to 2040 to append and check ideas “back then”.



### Focus on enriching 2040

### Move on to 2035

### Move on to 2025

### Focus on completing information

The focus on 2030 is maintained for five-six days. Then, the experts participating are requested to provide comments and ideas about the actions to be taken from Now (2021) to reach the proposed scenario in 2040. They are also requested to link the ideas to the information already contained in roadmaps or research agendas, as the SRAs from the CapTechs or relevant TBBs. The discussion about the different time frames could be left open beyond the last meeting, if needed or required.

There is a second meeting with the objective to resynchronize the participants, updating them with the main discussion items and

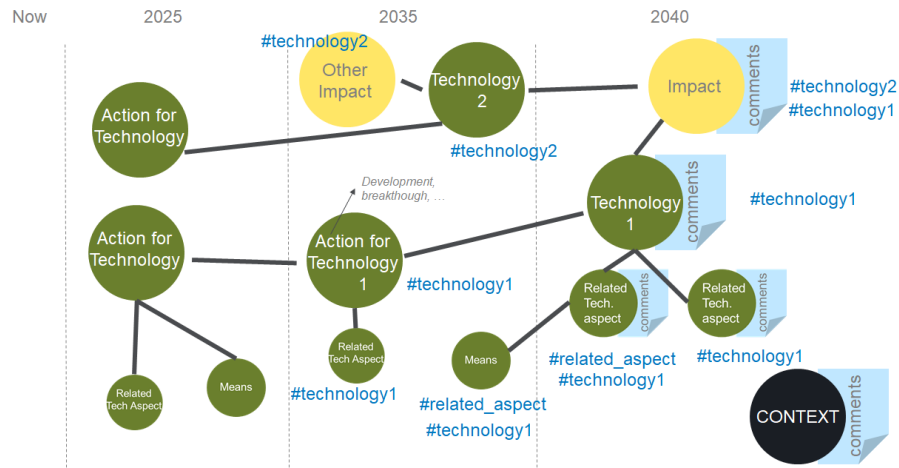
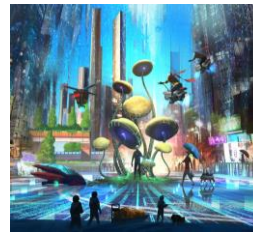
explaining the next steps. Attendees are asked about the issues faced towards their participation on the VIIMA platform.

The third meeting has as objective to wrap up the discussions and present the preliminary results of the first analysis. It could be possible to allow parallel discussions around each of the scenarios, with the objective to enrich the existing set of ideas, pathways to technologies, and impacts from the scenario in 2040 to the present. In addition, the discussions could be focused on the identification of technological developments/advances, or defence impacts associated to a specific time-point (Now, 2030, 2040) that enable the ideas depicted in a posterior time-point. For that, the parallel discussions could be organized in different sessions addressing a set of scenarios in each one. Each breakout room has a dedicated moderator. The goals of the dedicated breakout session are to further flash out the pathways of the technologies from the future to the present, in the context of the selected scenarios provided at the beginning of the second event. The participants are provided with the links to the sessions, and they are free to select the scenario closer to their area of expertise

### Convergent Thinking - After the 2nd event

The results from the second event will be a collection of scenarios containing related technologies and impacts across the defined timeline.





## Phase 2 – Convergent Thinking (Futures backwards) Means

In relation to the means for the Phase 2. The afore mention tool (VIIMA) can be used for this convergent thinking phase. For this, it is important to make use of the status property to reflect the time-mark of each of the turning points. Additionally, the categories do no longer reflect multi-perspective approach (economical, geopolitical, societal...) but the key aspects under assessment in the convergent thinking: Technological and impact aspects.

For the back-office analysis of the identified relations, it is convenient to make use of network analysis tools such as KUMU. This tool also allows the arrangement and display of the different clusters and relations identified for each existing aspect and scenario.

However, in preparation for the 3<sup>rd</sup> event, it is important to enrich as much as possible those relations within each scenario and assess if the descriptions of the different elements (technologies and identified impacts) are self-contained, as in the next event, the goal will be to cross-check scenarios against scenarios, and for this a overall understanding of each scenario and its composing elements is needed.



## Phase 3 - Tech Thinking

### Phase 3 - Tech Thinking Objective

The objective of this phase is to identify and elaborating recommendations and actions for the EDA strategic lines of action:

#### OSRA TBBs and SRAs

- Technology trends with an outlook to 2040+ with an assessment of their impact on security and military capabilities.
- Factors which will shape technology development with an outlook to 2040+ and a European perspective.

#### CDP Strand B

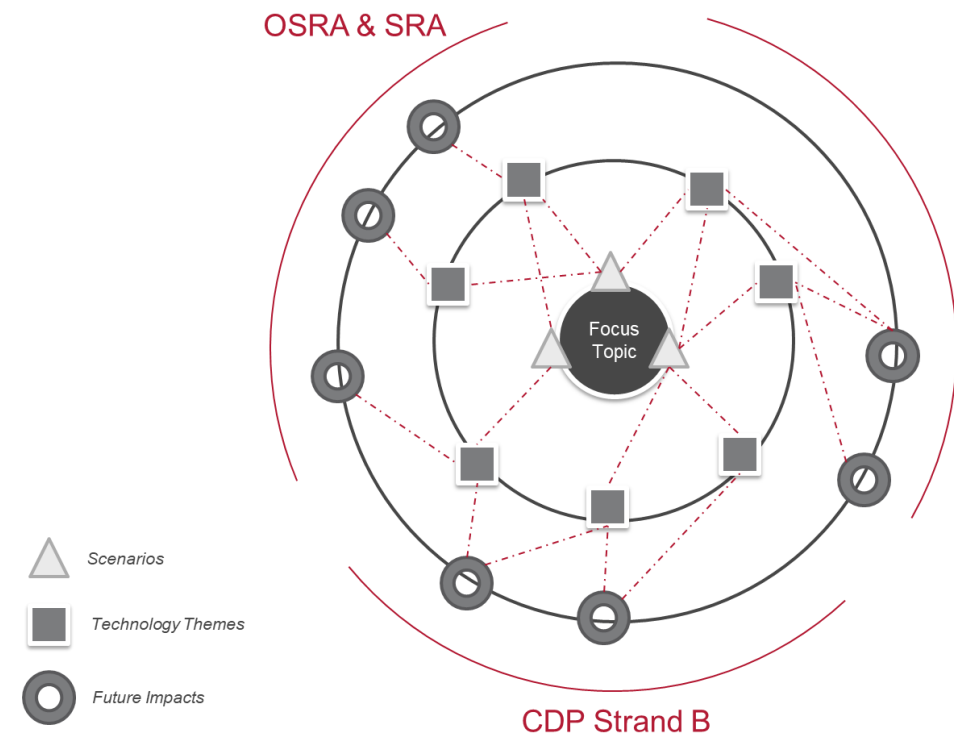
- Key future strategic environment factors,
- Future capability requirement areas
- Technological areas of relevance from the capability requirements
- Technology trend support to the design of future conflict scenario

#### Key Strategic Activities

- Technology trend support to the identification of critical activities in Europe and the proactive mitigation of current and future dependencies.

## Phase 3 – Tech Thinking Theory

### Convergent Thinking - Impacts





An analysis of potential impacts is performed. These impacts are assessed from to different perspectives:

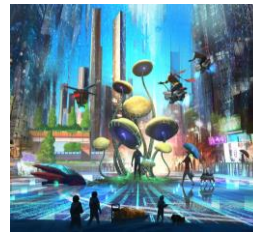
- Cross-Impacts between scenarios. With the:
  - Identification of cross-cutting issues.
  - Identification of interrelation among drivers and factors.
  - Mapping of the structure of relations (IT support).
- Impacts and relations to CDP Technology Themes and CapTechs SRAs.

#### Convergent Thinking - Cross Impacts

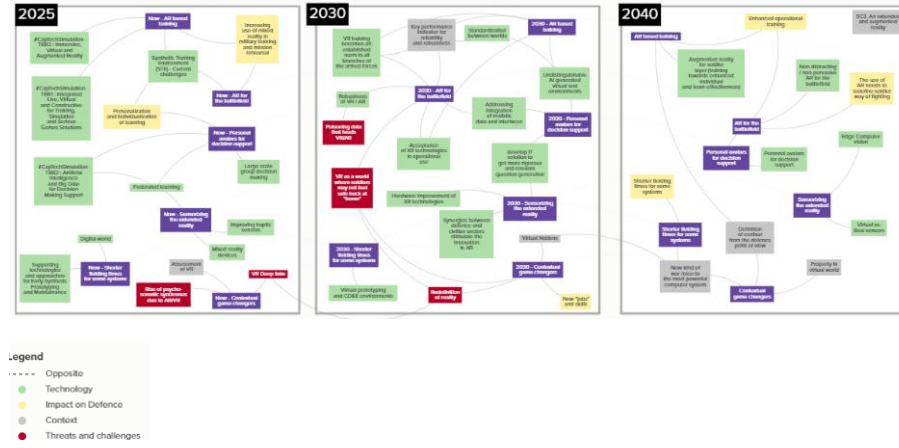
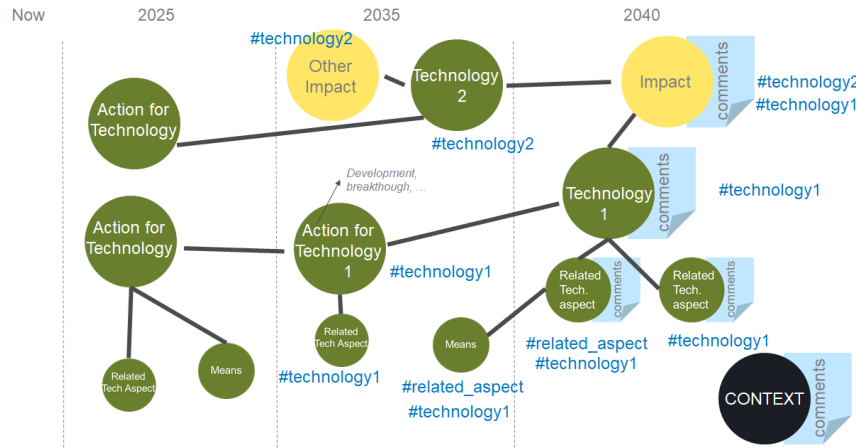
The goal is to find relations among the ideas worked on the scenarios.

	<i>Topic Focus 1</i>	....	<i>Topic Focus n</i>
<i>Topic Focus 1</i>	<i>Factor</i>		
...			
<i>Topic Focus n</i>			

The identification of cross-cutting issues and interrelation among drivers and factors, starts from the scenario-maps produced at event 2.

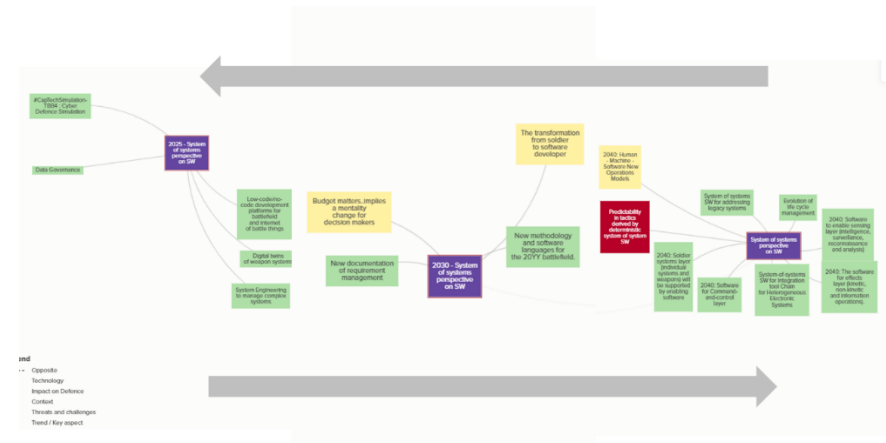


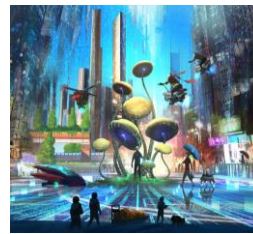
Methodology  
EDA Technology Foresight Exercise'21



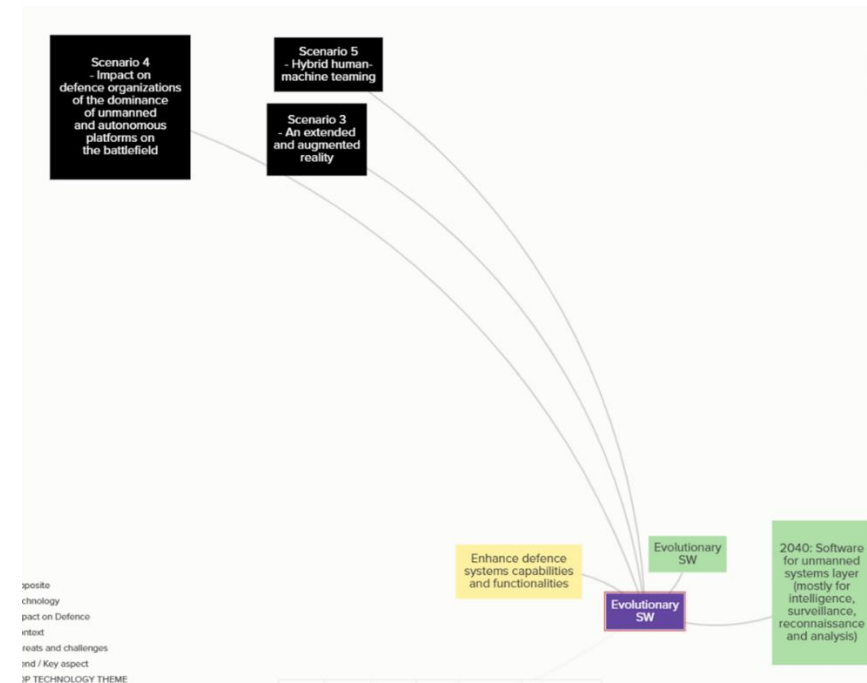
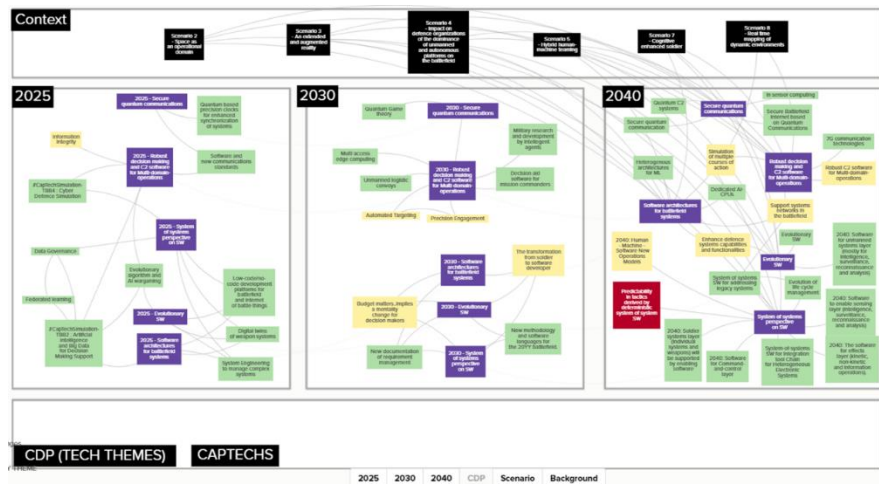
Depicting all the ideas (technologies and impacts) on a scenario across a specified timeline. These ideas should be interlinked already, although it may be necessary to characterize further these relations within the scenario. As in the example below:

These maps allow the identification of chains of technological and capability changes across the timeline.





Following is the identification of relations between technological and impact aspects of each scenario, mapping each element on a specific scenario to the rest of related scenarios, as depicted in the next two examples.



When gathering all the relations identified it is possible to identify which are the most common / related aspects across the different scenarios, as in the following example.



### POTENTIAL CROSS CUTTING ISSUES ACROSS THE 10 SCENARIOS

SCENARIO	TREND	RELATION TO OTHER SCENARIOS
SC1	Robust decision making and C2 software for Multi-domain-operations	6
	Software architectures for battlefield systems	6
	System of systems perspective on SW	5
SC3	AR for the battlefield	5
	Sensorizing the extended reality	6
SC4	Autonomy and decision making	6
	Trust and "human" conception of IA	5
SC5	AI support AI support to human-machin teaming	6
	Hybrid decisión-making	5
SC8	Quantum computing	5
SC9	Authentication	5
	AI-Driven Tech for misinformation	5
	Battle networks	5

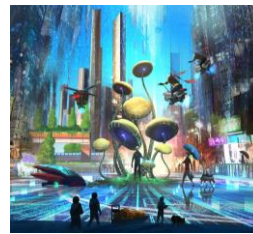
Impacts and relations to CDP Technology Themes and CapTechs SRAs

The goal is to find relations and potential impacts in relation to the current lines of strategic work of the EDA.

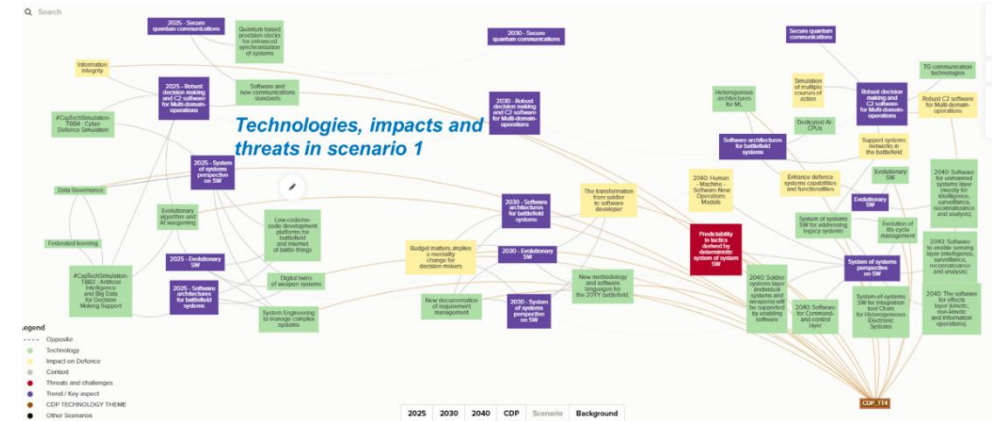
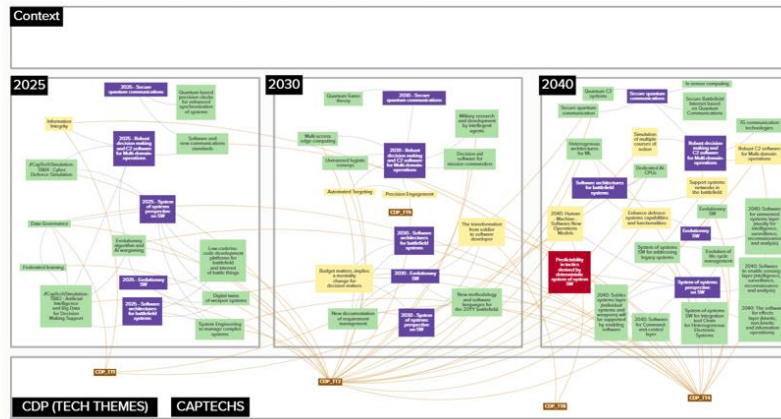
	<i>Topic Focus 1</i>	....	<i>Topic Focus n</i>
<i>OSRA</i>	<i>Impact and recommendation</i>		
<i>CDP</i>			
<i>KSA</i>			

Relating the scenario-maps produced at event 2 to TBBs, CapTechs and Technology Themes from the CDP.

Once again this is done at the level of each of the idea (technology / impact) on each of the scenarios. As depicted in the following examples with the CDP Themes (depicted in brown boxes in the lower part of the image)



### RELATIONS TO CDP TECH THEMES



For a particular Technology Theme, it is possible to depict the relations to technologies and impacts across the considered timeline. As in the example depicted in the two following figures.

### EXAMPLE OF RELATIONS TO CDP TECH THEMES

#### CDP Technology Theme Globalisation of Technology and Modularisation of Systems

...and on the fact that (military) systems are increasingly designed in a modular way in order to make it easier to scale, upgrade or add new functionality / technology throughout the lifecycle of the particular system.

...To make maximum use of technology that can be obtained on the market, military systems must possess a certain amount of 'openness'. In the world of 'software' (and there are now more software than hardware engineers in the developed world), open modularity (e.g. service-oriented architecture) has led to remarkable efficiency gains...

A similar trend is now also taking over the world of 'hardware' with new architecture schemes based on the 'modular, open and flexible' paradigm. Modularity, in this sense, goes beyond simply having modular components, and refers to a 'general set of principles for managing complexity. By breaking up a complex system into discrete pieces – which can then communicate with one another only through standardised interfaces

System of systems SW for addressing legacy systems	Technology	2040
Heterogenous architectures for ML	Technology	2040
Evolutionary SW	Technology	2040
Robust C2 software for Multi-domain-operations	Impact on Defence	2040
Evolution of life cycle management	Technology	2040
Predictability in tactics derived by deterministic system of system SW	Red Team	2040
New methodology and software languages for the 20Y battlefield.	Technology	2030
New documentation of requirement management	Technology	2030
Budget matters implies a mentality change for decision makers	Impact on Defence	2030
The transformation from soldier to software developer	Impact on Defence	2030
System Engineering to manage complex systems	Technology	2025
Evolutionary algorithm and AI wargaming	Technology	2025
Data Governance	Technology	2025
Software and new communications standards	Technology	2025
Digital twins of weapon systems	Technology	2025
Information Integrity	Impact on Defence	2025



### Phase 3 – Tech Thinking Steps

The third phase follows up the previous one with a convergent thinking approach. This time, after building the futures of interest, the objective of this event is to create links between the ideas, concepts, comments gathered, plus the TBBs from several CapTechs. During this event, the enriching of the future scenarios is still possible.

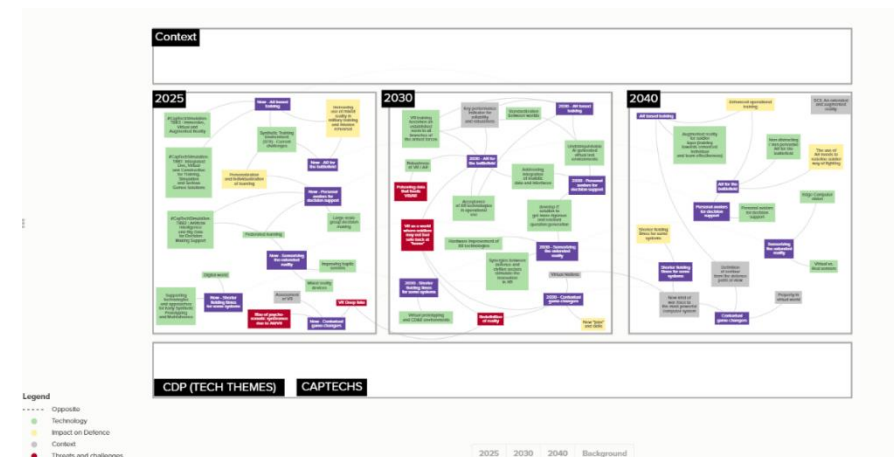
#### Tech Thinking - Execution

To support the linking process, an online questionnaire is launched. The experts participating are asked to relate the technologies and trends from each scenario against other scenarios. It consists of a matrix per scenario including its main trends, which is to be crossed checked against all the other related scenarios. It is also possible to include the rationale behind the proposed relations per scenario.

In addition, a mind-map per scenario with the ideas and trends gathered along the timeline is distributed, to help the linking process and to provide a broader perspective to give final comments. Also, the links within the given scenario are included. Furthermore, the relations to the CDP Technology Themes are also included.

The mind-maps are interactive, allowing the possibility to browse freely and click on any element. For the development of the mind-map a visualisation platform such as kumu.io is used. Each of the rectangles included in the map depicts an idea, and if clicked it displayed the information and discussion from VIIMA. It will be also

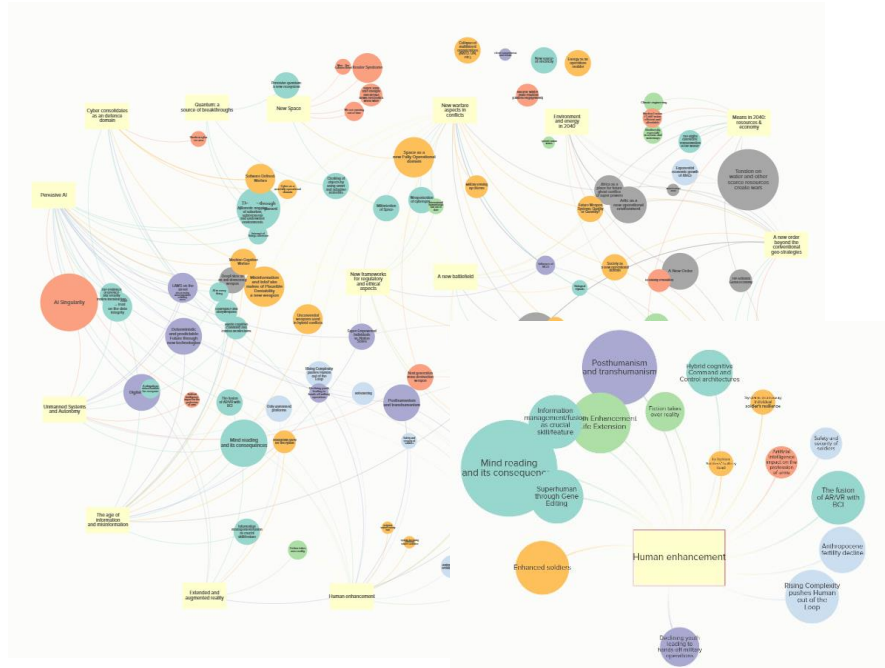
possible to explore the relations of an idea, either globally (by zooming in / out with the mouse wheel), or specifically of a selected idea (rectangle) by increasing/decreasing the focus (on a selected idea by pressing from 1 to 4, depicting first to fourth-degree relations).



#### Tech Thinking - Back-office step

The back-office in this phase will be focused on the elaboration of the supporting network maps (KUMU) for the identification of linkages within and between scenarios and the elaboration of the questionnaire to enrich further these relationships.





the timelines, one per scenario. In addition, they are requested to contribute to the identification of links via an online questionnaire.

The questionnaire is set up in a matrix format, requesting from the experts just to tick the cell matching two related ideas. The survey was shared via e-mail and also via the Exercise web. The time estimated to reply the survey is 30 minutes, and it was set up to be able to save the replies for later on.

Enriching still needed!

Add your vision to 2040, 2030 or to Now



Create links between ideas, comments, concepts...



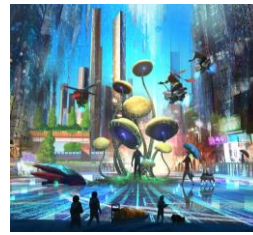
TBBs from CapTechs will be added through the week  
Please feel free to comment them or link them!





### Tech Thinking - The Event

Two meetings are held in this phase. The first meeting of the last event starts with an overview of the activities foreseen, summarizing the ideas gathered so far. The workflow foreseen is based on the identification of trends over the timelines and links between the scenarios fleshed out in the second event.

To facilitate the linking process, the participants are informed about the release of the set of mind maps including the ideas along with




Opciones



## Trends vs Scenarios

---

### WS Foresight - exercise 3

Identification of relations between trends/technologies and the other scenarios

---

**Description of the survey:**

In this survey you are asked to relate the technologies/trends obtained from each scenario against the other scenarios used in the event 2.

The survey consists of a total of 10 pages (one per scenario). Each page presents a matrix of the main trends of a specific scenario to be cross-checked against all the related scenarios.

Optionally, you can include a rationale on the relations for each scenario.


For further detail on the technologies and ideas you can make use of the attached document in the email sent with the link to this survey.

The survey does not need to be filled at once, as progress can be saved and recovered later on for further continuation.

The survey takes around 30 minutes.

Thank you very much for your time and contributions!

Next



### SCENARIO 1 - SOFTWARE BASED BATTLEFIELD

---

The scenarios titles are:

- SC1 - Software based battlefield
- SC2 - Space as an operational domain
- SC3 - An extended and augmented reality
- SC4 - Impact on defence organizations of the dominance of unmanned and autonomous platforms on the battlefield
- SC5 - Hybrid human-machine learning
- SC6 - Protection against Bioweapons
- SC7 - Cognitive enhanced soldier
- SC8 - Real-time mapping of dynamic environments
- SC9 - Chicken and egg race of misinformation and related polarization
- SC10 - The conforming power of environmental aspects and its implications on technologies

---

Relate the technologies from Scenario 1 to the other scenarios:

	SC1	SC2	SC3	SC4	SC5	SC6	SC7
Secure quantum communications	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Robust C2	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Software architectures	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Evolutionary SW	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
System of systems SW	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

---

(Optional) Comment on the relations identified:

Previous
Next

×

Your progress has been saved

You can use this unique link to come back and fill in your survey anytime.

**Survey link**

[https://survey.zohopublic.eu/zs/65BzG5?zs\\_save\\_uniqueid=rt...](https://survey.zohopublic.eu/zs/65BzG5?zs_save_uniqueid=rt...)
📄

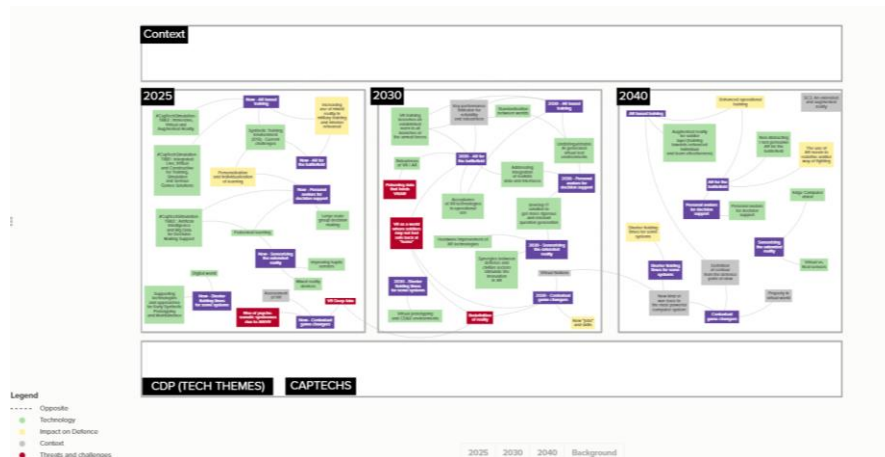
**Get notified**

Enter your email address to receive the unique survey link via email

SEND



In addition, during the event the maps with the trends and ideas along the timeline are distributed to the experts, using a mind map IT tool, such as Kumu.



The meeting proceeds with the continuation of the Q&A session on the asynchronous format used in the exercise.

The last meeting of the exercise starts with a presentation on the preliminary results of the entire exercise, including the links to the more CDP Strand B and the results' relation to the TBB (Technology Building Blocks).

Some of the most remarkable aspects and different ideas for follow-up actions of the EDA Technology Foresight Exercise are presented and the attendee's inputs welcome.

Finally, a feedback session has to be organized, to gather immediate reactions from the participants about different aspects of the exercise. The main questions are on the asynchronous format, on the process and tools, and on possible follow-on activities.

The questions on the asynchronous format are:

- Does it improve / ease participation?
- Does it improve the quantity / quality of contributions?
- How other ways could be experts / specific insights got involved?
- Over a longer / shorter period of time?

The questions on the process and tools are:

- Has it been difficult to walk back from 2040?
- Would you use different tools?
- Should we go to more quantitative / deterministic approaches (e.g., prediction markets)?
- More scenarios (and more specific) vs. less scenarios (less specific / wider scope)

Final questions are about the way ahead:

- Does it make any sense to have a permanent exploratory future thinking group?
- Interest in having a common repository + blog



- And a dossier of future of interests for defence / Europe? Interesting background for other initiatives?

At the end of the event the participants are provided with a global Exercise overview, with the initially identified remarkable aspects from some of the scenarios and informed about the next steps, regarding the release of information and documents:

- Final integration of all information in two reports, one with the results from the first event and one with the results coming up from the second and third events, including the future snapshots collection, the trends and potential impacts from the scenarios
- Articulation of results beyond a report => online & interactive in EDA web site.
- Update and consolidate methodology with lessons learned.

### Tech Thinking - After the 3rd event

Thanks to the inputs of the experts participating in the events, it is possible to establish main links between scenarios and the identification of the most cross-cutting trends, and more remarkable aspects from the scenarios.

All the information is analysed in order to identify the main technologies, trends and weak signals towards 2040.

### Phase 3 – Tech Thinking Means, Inputs & Outputs

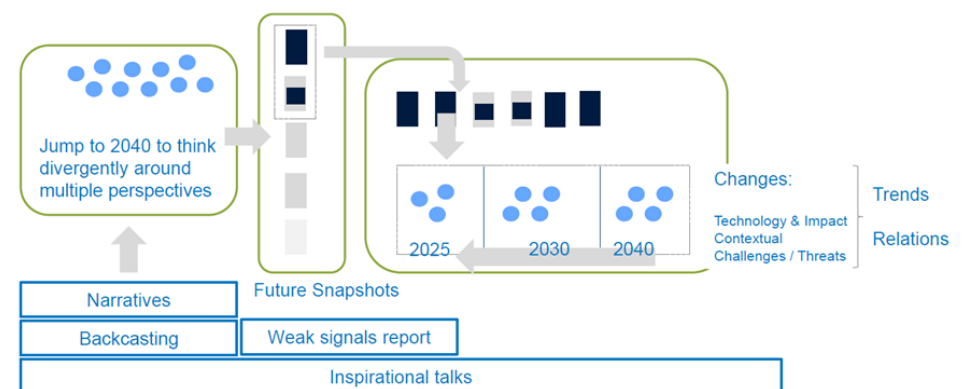
Viima and Kumu tools used in the same way that in Event 2.

## Phase 4 - Final elaboration

### Phase 4 – Final Elaboration Objectives

A final post-processing and integration of all the information is performed to produce a report on the future snapshots' collections, and a report on the trends and potential impacts from the scenarios.

### GLOBAL OVERVIEW EXERCISE



### Objectives:

- Identify Technology Themes & Weak signals
- Describe them
- Produce exercise products (report, executive report, web content)



- Share results
- Feedback

#### Phase 4 – Final Elaboration Steps

- Wrap up info
- Selection of topics
- Finalize descriptions
- Draft products
- Share them with the core team of experts (“Futures tellers”)
- Finalize products
- Share results
- Satisfaction survey

#### Phase 4 – Final Elaboration Means

- Elaboration of a web communication tool (via KUMU, or Kontextlab) for the dissemination of results on an easy manner while showing the associated information and linkages among the ideas across the scenarios.
- On-line satisfaction surveys on the different events



## Lessons Learned on the Methodology as Applied to the Technology Foresight Exercise 2021

From the feedback received and the assessment performed during the execution of the three first phases, it is possible to identify the following lessons learned:

- On the methodological approach
  - Asynchronous approach has proven an effective and efficient approach for this kind of exercises. More specifically:
    - It has worked better for divergent thinking than convergent thinking. Although this also related to other reasons (participation of experts in the convergent thinking / specific scenarios) it is advisable to explore ways of improving the application of asynchronous means with convergent thinking.
    - In relation with afore point, some feedback emphasized the convenience of mixing asynchronous and physical meetings.
    - In general, tools for asynchronous participation have been effective.
  - To keep the number of scenarios limited. When several scenarios are run at the same time, it becomes difficult to manage the ideas and replies across those scenarios.
  - Improve the time framing, and its communication, of the exercise. Timescales have been a source of distraction for some participants. There is the need to emphasize the relativeness of timescales and explore other approaches for future backwards foresight.
  - Enhance clarity between the Exercise, its Events, the synchronous work and asynchronous work, putting the focus on the participation on the asynchronous work and less on the events.
  - Support for a multidisciplinary scope of the exercise. General positive acceptance of multidisciplinary approach to futures by participants.
  - Improve the use of assessment of ideas. The participation on the assessment has been lower than on the ideas posting and reviewing.
- On the participation
  - Decreased engagement at the end of the exercise. Combined with the summer period and the greater expertise or more effort for contributions, the engagement of participation decreased at phase 3. Possibility of merging with phase 2 or explore other



means on interaction, as physical meetings, so they would be possible.

- Gamification, recognition and take-aways from participation. In line with previous point, some feedbacks recommended the introduction of some gamification to encourage participation and recognition. Additionally, participants have emphasized the importance of take-aways (documentation, information, diagrams...)
- The multidisciplinary and openness of the divergent exercise implies the potential of identifying many different fields of expertise. Creating a potential gap between the experts taking part in the divergent part and those needed for the convergent thinking scenarios. The methodology should be updated addressing this issue. Including aspects such as finding experts for some specific scenarios, timing and scheduling of events and adapted procedures for these matters.
- On the results (so far)
  - Multidisciplinary approach to futures has turned out effective, producing rich and comprehensive future visions non only focus on technology / defence.
  - The results allow the identification of good linkages to current TBBs and to CDP Technology Themes, therefore

it seems reasonably to derive good contributions in these aspects in following parts of the exercise.



## Glossary

**Alternative Futures:** The basic idea behind the phrase “Alternative Futures” is two-fold. First, the future is not pre-determined and multiple potential futures are possible. Second, the future that does unfold is a function of patterns that are already unfolding in the environment, emergent events for which it is impossible to plan and decisions that are made today. In other words, our decisions give us a measure of control over how the future might unfold.

**Back-casting:** Working backwards from a possible future state to determine how it might unfold

**Black swan:** The Impact of the Highly Improbable. This term indicating a particular kind of event was popularized by Nassim Nicholas Taleb in his 2007 book on forecasting and uncertainty.

**Cone of Plausibility:** A way to indicate graphically the potential for alternative futures to unfold, depending on the course of future events, the trajectory of existing trends, and current decisions.

**Critical Thinking:** The capacity to reflect from a distance on our own thought processes. In the same way that one might walk around a sculpture in order to see it from many angles and understand what it does and means, thinking ‘critically’ is the ability to objectify your thoughts, so that you can ‘walk around them’ and therefore better understand the workings of your own mind.

**Drivers of Change:** Drivers are categorical factors whose condition may create changes elsewhere in a system. Frequently used in strategic planning and foresight projects.

**Foresight:** This term refers to a range of methods used to anticipate, explore and plan for the long-term future. These methods are considered distinct from conventional methods of strategic planning and forecasting, which are also tools for evaluating potential futures.

**Future:** In the context of foresight work, the future is often conceived as a conceptual space that can be proactively influenced by decisions that are made in the present.

**Futures:** foresight practitioners often prefer to use the term, “futures” rather than “future” to underscore the recognition that multiple potential futures are possible.

**Forecasting:** In everyday usage, to forecast simply means to estimate the probability of a future event. In the more specialized context of Foresight, to forecast is to make a statement about the probability of a future event based on the quantitative or qualitative extrapolation of past data, using statistical methods.

**Scenarios:** Scenarios are narratives or stories about the future. They are typically the result of research and analysis of how different drivers of change are likely to affect the future. Scenarios are not meant to be predictions but rather to showcase a range of possible futures in a compelling style. Scenarios serve as tools for decision makers and stakeholders to discuss the risks and opportunities that





different futures may hold, and to explore strategies to adapt or leverage opportunities.

**Strategic foresight:** Refer to the same broad systematic approach to planning for the future and identifying alternative futures.

**Trend:** A trend is a historical pattern of change (either up or down) in events over time. If the same event happens in the same way over time, then there is no trend or change. Contextual factors should be taken into account to determine how reliable forecasting based on trend may be. Such factors may include the rate of change in that trend, the drivers or factors of change, and other contextual information.

**Uncertainty:** In its basic meaning, uncertainty denotes unpredictability and unreliability. uncertainty cannot be calculated because there is no data, or insufficient data, from the past to support a calculation of probability. For analysts seeking to understand the potential future/s of the military operating environment, the concept of uncertainty is a useful reminder that the range of possible futures is, from the perspective of the present, so large as to be effectively beyond calculation.

**Weak Signals:** The premise that the present-day environment contains “signals” that indicate potential events or changes in the future is important in the field of Foresight. It is grounded in the assumption that those who identify such signals in an incipient stage stand a better chance than others of ameliorating risks or taking advantage of opportunities that the signal portends.



## Annex – Surveys

### Film Back-casting survey

#### EDA Technology Foresight Exercise 2021

#### EDA Films Back-casting Survey 2021

Welcome to the films' back-casting survey of the EDA Technology Foresight Exercise 2021.

Thanks for taking your time to assess different aspects defining “The Futures”. This activity helps the identification of thinking patterns, when foreseen the future and technologies impact, turning points, drivers and showstoppers in the technology development process.

To illustrate the ideas, you are invited to travel back in time and go to the sci-fi movies from the 70's, 80's and 90's. Most of these movies set the scene in the 2020's, but the future foreseen when made is somehow different from our times.

Specific characteristics of these moves have been selected to guide you through the thinking process used when describing the possible futures. Your answers will be essential to fine tune the foresight process, contributing at the end to increase the impact of this exercise.

This survey has an optional answering structure, so you can skip any question you feel like you have not much to respond to. However,

on the questions which touch on your expertise (or interest) please be as elaborate as you can. And feel free to provide examples!

Lastly, please be informed that a compilation of the anonymized replies will be shared with the participants of the EDA Technology Foresight Exercise. They will be available for further discussion and inputs in the protected area of the Exercise. Therefore, please do not include sensitive information among your answers. By answering this survey, you agree on the above-mentioned processing and sharing of information. In case of questions, please contact us to [rti@eda.europa.eu](mailto:rti@eda.europa.eu).

#### About the EDA Technology Foresight Exercise

Technology foresight is a vital activity to plan and inform future defence policies and programmes of the European Union. Furthermore, in the light of increasingly noticeable impacts of emerging and disruptive technologies, a global pandemic and the growing importance of initially civilian technologies for military applications call for a comprehensive and updated foresight exercise.

As such, the EDA Technology Foresight Exercise is a wider exercise of technology foresight, looking up to 20 years into the future, while being specifically designed to provide tangible results to support EDA R&T Planning process, and to inform updates to the Capability Development Plan (CDP) and the creation of the EU's Strategic Compass. The main outcomes will be the identification of weak signals and possible technology themes, which will provide strategic and long-term guidance when updating the EDA Overarching



Strategic Research Agenda (OSRA), the CapTechs Strategic Research Agendas (SRAs) and the technology side of the Capability Development Plan (CDP) Strand B and Key Strategic Activities.

### The Films Back-casting Survey

About the past, to the present

Q1 – Several Sci-Fi films like Start Trek or 2001: Space Odyssey and Blade Runner, in which the action takes place in the early 2000s and late 2010s respectively, accurately predicted now ubiquitous devices like smartphones and wearables many decades ago. Nowadays video telecommunication and touchscreens are, now more than ever, everywhere.

Could you think on other technologies correctly forecasted (their impact, development speed, uses...)? Why do you think they were accurately predicted?

A2 – Free text

Q2 - In "The Terminator" the titular machine is sent to the past from 2029, implying that "the singularity" already took place years before today, and therefore artificial intelligence surpassed human intelligence with the result being ... time traveling killer robots. However, now in the 2020's, the singularity did not occur yet and is foreseen to take place around 2045 (also as reflected in more recent movies, such as Blade Runner 2049 (2017)). Other film miscalculating the evolution of a technology is "Minority Report" (2012), where shopping habits are tracked to propose the customer

best buying offers (customer-tailored advertising). The movie takes place in the 2050s, hence having vastly underestimated the speed of the development of predictive technology.

Could you think on other technologies NOT correctly forecasted (their impact, development speed, uses...)? Why do you think the predictions were not accurate?

A2 – Free text

Q3 - In "Demon Seed" (1977) there is a smart house with all the appliances connected and integrated into a single computer system (predicting AI and Internet of Things). This film correctly identified a weak signal at the time, proposing a spot-on evolution and use of it. In "Back to the Future II" (1989) the vision of an "SMS" was a fax embedded in walls, printing paper messages, whereas some other incipient technologies (weak signals) were well reflected, such as mobile communications or wearables.

Could you think in other weak signals that were identified on time and predicted correctly? And weak signals that were disregarded at the time and then become a major trend? Why do you think they were considered or disregarded?

About the present, towards the future

Q4 –Mad-Max takes place in 2021, and the use of resources (oil) imagined in 1979 is extremely impacted by the oil crisis of 1973. In this way, the film extrapolates a problem of that time into the future,



disregarding other possible alternative resources under development at that time (solar power).

From your perspective, what kind of contemporary problems do we tend to project into the future?

A4 – Free text

Q5 – In one of the most successful Eastern Sci-Fi books (and film) of Liu Cixin, “The Three-Body Problem”, a vast number of the human population's minds are modified by a new technology in which a device is physically installed into the brain to instil a belief system, to avoid the psychological pitfalls of defeatism/pessimism. In another example in the Western TV series “Black Mirror”, people can interact with an AI programme which has been made to resemble (and physically replace) a deceased family member. In “The Truman Show” (1998) the life of a person is broadcasted in a TV show 24/7 (set sometime in the 2020s) and the movie shows some parallels to today's use of social media and associated broadcasting and (over)sharing of one's life 24/7. These stories may trigger different reactions in the public depending on the cultural and ethical background or generation of the audience, demonstrating that the use of certain technologies, and its acceptance, is heavily depending not only on the technological options.

What other cultural contexts influenced the evolution and use of a technology? And, could you imagine how a possible change in the dominant culture, or differing moral/ethical/cultural context or legal

framework which will impact the use of an existing or envisioned technology?

A5 – Free text

Q6 – In some of the most popular Sci-Fi movies of the 2010s, a run-away event/domino or butterfly effect leads to a devastating scenario. In Gravity (2013), a shot-down satellite creates a cloud of run-away space debris which circles the earth and orbit by orbit grows by crashing into ever more space vehicles (the “Kessler Syndrome”), eventually destroying all of humanity's space infrastructure. Similarly, in “Interstellar”, climate change has entered such a vicious cycle as well and thereby made agriculture on earth almost impossible.

What other effects were predicted in the past, and occurred with a high impact? And, based on your expertise, could you imagine any scenario in which there is a similar domino effect? (not limited to physics) Could you identify other possible “syndromes” that may trigger a high-impact effect over the future?

A6 – Free text

Q7 – Any other idea?

Would you like to share any other example of a concept, key factor or event that was recorded in a sci-fi movie or book and did not materialized? Any other element that from your perspective should be considered when thinking into the future that can be illustrated by a movie example?



## A7 – Free text

Disclaimer: As informed, your answers will be anonymised and compiled with the other replies and this compilation will be shared with the participants of the EDA Technology Foresight Exercise. The information will be available for further discussion and inputs in the protected area of the Exercise.

By answering this survey, you agree on the above-mentioned processing and sharing of information, and you confirm that sensitive information has not been included in your replies.

Thanks again for your time and your ideas!

Looking forward to meeting you and further discuss about technologies at the first event of the EDA Technology Foresight Exercise.

## Technology back-casting survey

### EDA Technology Foresight Exercise 2021

### EDA Technology Back-casting Survey 2021

Welcome to the technology back-casting survey of the EDA Technology Foresight Exercise 2021.

Thanks for taking your time to assess the following technologies (or technological areas), which were selected as the 22 R&T Priorities of the European Defence Research & Technology Strategy, published by EDA in 2007.

This survey will help to understand the evolution of technologies, by assessing the impact of technologies identified as priorities more than 15 years ago.

Therefore, your answers will be crucial to better understand the evolution of technologies in the past, to better foresee what could be the evolution of new technologies in the future.

Your assessment should be a combination of strategic and technology assessment, taking into account that the technologies listed were identified as priorities in 2007 and that the projection of this exercise is 20 years ahead (2040+).

The survey will give you the opportunity to select the technologies/technological areas you would be interested in assessing, among the 22 R&T Priorities. Then, the same set of 9 questions will be presented for each of the selected technologies.



Please be informed that a compilation of the anonymized replies will be shared with the participants of the EDA Technology Foresight Exercise. They will be available for further discussion and inputs in the protected area of the Exercise. Therefore, please do not include sensitive information among your answers. By answering this survey, you agree on the above-mentioned processing and sharing of information. In case of questions, please contact us to [rti@eda.europa.eu](mailto:rti@eda.europa.eu).

#### About the EDA Technology Foresight Exercise

Technology foresight is a vital activity to plan and inform future defence policies and programmes of the European Union. Furthermore, in the light of increasingly noticeable impacts of emerging and disruptive technologies, a global pandemic and the growing importance of initially civilian technologies for military applications call for a comprehensive and updated foresight exercise.

As such, the EDA Technology Foresight Exercise is a wider exercise of technology foresight, looking up to 20 years into the future, while being specifically designed to provide tangible results to support EDA R&T Planning process, and to inform updates to the Capability Development Plan (CDP) and the creation of the EU's Strategic Compass. The main outcomes will be the identification of weak signals and possible technology themes, which will provide strategic and long-term guidance when updating the EDA Overarching Strategic Research Agenda (OSRA), the CapTechs Strategic

Research Agendas (SRAs) and the technology side of the Capability Development Plan (CDP) Strand B and Key Strategic Activities.

#### The Technology Back-casting Survey

Q1 – Which of the following technologies would you like to assess?

Please take into account that 8 specific questions will be asked per technology item selected, therefore, even there is no limit for the selection, it is recommended not to select more than 2-3 technologies.

A1 – Type multiple choice, possible to select multiple options. Conditional question/answer

1. RF generic technologies (components, processing, systems, integration) and multifunction RF technologies.
2. EO Systems & Integration
3. Electronics hardware
4. Structural modelling design & through life support
5. Networked sensor control, management and cueing
6. Command and control techs (campaign/ops/mission planning/mgmt, battlespace mgmt, shared situational understanding, data fusion/mining/reduction, image exploitation, Urban Warfare innovative sensors, also acoustic/seismic ones)
7. HF, VHF & UHF communication technologies



8. Waveform design, spectrum and bandwidth management
9. Network management in NEC operations (Fault, Configuration, Administration, Performance & Security management)
10. Technologies for secure and robust information management, information exchange and communications
11. Human integration and interoperability
12. Energetics & energetic materials
13. Soldiers systems (incl. integration into Systems of Systems and NEC)
14. Counter-mine (land), gap-crossing and counter-mobility systems
15. Power source and supply technologies
16. Ground platform technologies (structure, mobility...) and mounted platform systems
17. Uninhabited land systems
18. Aerial platform technologies (airframes, propulsion, aerodynamics, structures, control... - incl. Helicopters, UAVs (incl. High altitude platforms)
19. Environment definition (Oceanographic & hydrographic techniques and analysis)

20. Uninhabited naval systems, especially underwater systems
21. Physical protection
22. Concepts, design, integration, simulation & modelling

Q2 - Is this technology still valid in terms of defence R&D? (Please answer this question considering if the technology still needs to be further developed)

Please provide justification to your answer, focusing on the technology maturity (indication of the TRL in 2007 and in 2021 would be welcome)

A2 – Type multiple choice, only one answer allowed, plus box of free text.

- Yes.
- No.
- Needs to be updated.

Q3 – Since 2007, has the technology evolved as planned?

Please provide justification to your answer, explaining the foreseen evolution at the time and how it may differ from the real one. Focusing on these key factors: main drivers in case of a faster development, or showstoppers in case of a slower development.

A3 – Type multiple choice, only one answer allowed, plus box of free text.



- Yes.
- No, the development has been slower.
- No, the development has been faster.

Q4 – According to your understanding, was this the “right” topic to invest in R&T at the time?

Please provide justification to your answer, taking into account the technology was selected as a priority in 2007. The context at the time and the capability needs were different, from the ones at the time the technology was ready (Urgency of the capability needs vs. speed of R&D activities (time taken from the lab to the field)).

A4 – Type multiple choice, only one answer allowed, plus box of free text.

- Yes.
- No.
- Maybe

Q5 – Has the technology been used as initially planned?

Please provide justification to your answer, explaining the applications in terms of defence capabilities, and if the use has been impacted by the evolving and different context.

A5 – Type multiple choice, only one answer allowed, plus box of free text.

- Yes, it has been used as foreseen, fulfilling a capability need.
- Yes, it has been used as foreseen, enhancing an existing capability.
- Yes, it has been used as foreseen, and in addition new applications have been developed.
- No, the use has been different as the one foreseen.
- No, it has not been possible to use this technology.

Q6 - How the interaction with technology has been? (Please explain how the appreciation towards this technology has been and whether its integration and use were easy or if it implied changes in, for example, doctrine, training, maintenance, etc.)

A6 – Type: free text box.

Q7 – Highlights & developments since 2007 (Please explain the main developments of the related technologies in this area and highlights, key projects, key applications, if any).

A7 – Type: free text box.

Q8 - Guidance for future work (Please explain what are the main activities that should be taking place to reach the required maturity level of the area in the given timeframe (20 years), if any)

A8 – Type: free text box





Q9 – If you were able to travel to the past (2007), with the experiences gained through these years, would you have proposed different R&T priorities? Which ones would you have selected and why?

A9 – Type: free text box

Q10 – Anything else would you like to add?

A10 – Type: free text box

Disclaimer: As informed, your answers will be anonymised and compiled with the other replies and this compilation will be shared with the participants of the EDA Technology Foresight Exercise. The information will be available for further discussion and inputs in the protected area of the Exercise.

By answering this survey, you agree on the above-mentioned processing and sharing of information and you confirm that sensitive information has not been included in your replies.

Thanks again for your time and your ideas!

Looking forward to meeting you and further discuss about technologies at the first event of the EDA Technology Foresight Exercise, taking place from 17 to 25 May 2021.

## Satisfaction survey Phase 1

### Satisfaction survey on EDA Technology Foresight Exercise

#### First Event

Dear Colleague,

Thank you for your participation in the first event of the EDA Technology Foresight Exercise.

In the aftermath of the closing meeting and the end of the first asynchronous work cycle, we would like to ask for your feedback on this first event.

Thank you very much in advance for taking the time to fill out this (short) feedback survey.

(Please, when required, rate from 1 to 5, being 1 the lowest rate and 5 the highest one in terms of agreement/satisfaction)

#### Question 0:

Did you actively participate in the first event?

A0:

Yes (if Yes, continue with the next question)

No (if answer is No, survey should just go to the last question Q5)

#### Question 1:



Did the read-ahead package (Exercise briefing, Futures Narratives & Weak Signals report) and the inspirational talks succeed with their intention on providing inspiration and helped you to have different perspectives on possible futures?

A1: Rating 1-5

**Question 2:**

Did the meetings helped you to follow the event and its discussions?

A2: Rating 1-5

**Question 3:**

Did the IT tools (Event app and Viima) allow you to catch up on what happened so far and to share your ideas easily?

A3: Rating 1-5

**Question 4:**

Were the provided communication channels adequate? (e-mails, meetings, Exercise web)

A4: Rating 1-5

**Question 5:**

We would be glad to hear more from you, so please provide any constructive criticism, feedback, or suggestions for things to improve below. If you would like to elaborate on one of the 4 ratings above, please also use this opportunity here:

A5: free text box

## Satisfaction survey Phase 2 & 3

### Satisfaction survey on EDA Technology Foresight Exercise 2021

#### Second & Third Events

Dear Colleague,

Thank you for your participation in the second and third events of the EDA Technology Foresight Exercise.

In the aftermath of the closing meeting and the end of the asynchronous work cycle, we would like to ask for your feedback on this series of events and on the Exercise as a whole.

To provide feedback about the use of the IT tools, read-ahead material, communication channels or the first event meetings, please feel free to fill in the first event survey.

Thank you very much in advance for taking the time to fill out these (short) feedback surveys.

(Please, when required, rate from 1 to 5, being 1 the lowest rate and 5 the highest one in terms of agreement/satisfaction)

**Question 0:**

Did you actively participate in the 2<sup>nd</sup> and 3<sup>rd</sup> events?

A0:

Yes (if Yes, continue with the next question)



Only partially / in one of them (if so, continue with the next question)

No (if answer is No, survey should just go to the last question Q5)

### Question 1:

Did you contribute by sharing your ideas in VIIMA and/or via the linking survey?

A1:

- Yes
- No

### Question 2:

If not, could you please explain us why? (Please, select a maximum of two of the answers) (If you did contribute, please go to the next question)

A2:

- Lack of time
- Expertise not related to any of the discussions
- Problems to access the tool
- Tools difficult to use
- Process too difficult to follow

### Question 3:

Was the process to discuss the scenarios in different time-frames clear and useful to provide your inputs?

A3: Rating 1-5

### Question 4:

Were the scenarios selected adequate to identify weak signals, technology themes and trends relevant for EU Defence towards 2040?

A4: Rating 1-5

### Question 5:

We would be glad to hear more from you, so please provide any constructive criticism, feedback, or suggestions for things to improve below. If you would like to elaborate on one of the questions above, please also use this opportunity here:

A5: free text box