EUROPEAN LEADERSHIP NETWORK

Building better security for wider Europe

Nuclear weapons decision-making under technological complexity

PILOT WORKSHOP REPORT

GLOBAL SECURITY

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The European Leadership Network (ELN) is an independent, non-partisan, pan-European network of nearly 300 past, present and future European leaders working to provide practical real-world solutions to political and security challenges.

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Introduction

In the near future, quantum technology applications, cyber weapons, artificial intelligence, deep fakes, autonomous, and adaptive networked armed drone swarms, to name but few, may interact with one another, nuclear commands and control infrastructures, and the human at the same time. These new and emerging technologies will impact a decision maker's ability to manage, assimilate, interpret, trust, verify the information, and, ultimately, make a nuclear decision.

This report by the European Leadership Network (ELN) draws on the insights of, and debate among, former high-level nuclear decision-makers and current officials at a virtual pilot-workshop. This was held in January 2021 and was organised by ELN in cooperation with the Oracle Partnership (see Annex 1). Based upon a "worst case scenario", the event explored the possible impact of predominantly aggregate technologies on nuclear weapon decision-making. It initiated one of four working strands which form a broader project on new technologies and nuclear decision-making undertaken by the ELN (see Annex 2).

The aim of this report is to summarise insights on some of the complexities posed by disruptive technologies and expand on related ideas of challenges, opportunities and pitfalls. At this stage, the focus is on identifying questions, research priorities and perspectives from which to approach nuclear decision-making under technological complexity in our future research. This is the first step towards addressing the problems, exploring strategic options and proposing solutions.

"Emerging technologies will impact a decision maker's ability to manage, assimilate, interpret, trust, verify the information, and, ultimately, make a nuclear decision."

The report does not reflect the view of individual workshop participants, the members of the ELN, or any other institution represented at the meeting.

1. Technological complexity: why silo-thinking misses the point

"Complexity from technologies acting in combination constitutes a distinct problem, amplifying challenges from individual technologies that the nuclear decision-maker faces."

Different angles of complexity are relevant to the nuclear decision-making process. Complexity stems from a multi-actor environment that includes official nuclear-weapon states, nuclear weapon possessing states, non-nuclear weapon states, international organisations, industry, and other non-state actors that could bring strategic stabilities out of balance. Weighting a rich set of offensive and defensive capabilities in a technologically evolving deterrence relationship is a complicated endeavour in itself. One example of disruptive technological change is the diversification in delivery systems (sub-tactical nuclear weapons, hypersonic glide vehicles etc.) and blurring of their nuclear-conventional division. But complexity also stems from an aggregation of technologies.

Complexity from technologies acting in combination constitutes a distinct problem, amplifying challenges from individual technologies that the nuclear decision-maker faces. It is hard to even predict how many or which combinations of technologies will impact a nuclear decision-maker in the future. Yet, as one of the workshop participants observed; as technology proliferates and advances, complexity may become "more and more dangerous." It could create "an additional challenge" for the following reasons:

- **Fog of war.** Every war in history has been foggy. But technology-driven complexity thickens the fog of war in an unprecedented way. The impact of this can be debated. Yet there is broad consensus that the increasing numbers of technologies will impact the nuclear decision-makers' ability to process a vast amount of information and make decisions under pressurised timelines. Therefore, the nuclear risk is plausibly higher in the 21st century than ever before. At the same time, the available technology may also lead to illusory assumptions of clarity within the fog.

- **Technological complexity could exacerbate the flaws within the rationality assumption governing today's nuclear decision-making processes.** Despite the best

support available, decision-makers do not have access to perfect information, possess limited processing abilities and have little time to make decisions. Specific for the nuclear decision-making process, the decision-maker needs to know the consequences of their decision with near absolute certainty. At the same time, as one participant implied, "the number of decisions that a decision-maker has to make at the national command level in a ridiculously short time is stunning." There "are too many things going on, and there is no time to sort things out with the kind of focus one needs at that time." The emergence of new, interplaying technologies may additionally exacerbate these elements of nuclear decision-making.

- **Uncertainty.** Every crisis in history has placed a heavy burden of uncertainty on the shoulders of the decision-maker. But technological complexity could quantitatively and qualitatively amplify uncertainties. Quantitatively, there are more technologies than ever touching the nuclear aspects of the crisis, interacting in ways we may not yet understand. Qualitatively, the extent to which these new technologies might integrate and interact with nuclear weapons in a crisis is still unclear. Even if a nuclear crisis has a history and context, and we would have managed it with persistent, continuous coverage, a baseline understanding of the adversary and what was deployed before the crisis might remain uncertain. This ambiguity may lead to misperceptions during a crisis. Complexity brings a level of uncertainty qualitatively and quantitatively much more significant than what Kennedy and Khrushchev faced in 1962 at the height of the Cuban missile crisis. Even if we know the biases and redundancies built into our algorithms and systems, those of the adversary may remain unknown.

"Complexity brings a level of uncertainty qualitatively and quantitatively much more significant than what Kennedy and Khrushchev faced in 1962 at the height of the Cuban missile crisis."

- **Trust.** Verifying and trusting information may become even more complicated and prone to mistakes. On the one hand, it may simply become impossible to have a thorough understanding of how machines are interacting with other machines and to know whether or which device to trust. The challenge and difficulties of attribution will raise questions like:

was the drone attack intentional or a product of AI and a faulty algorithm? Questions like these will put unbridled pressure on decision-makers. On the other hand, the deliberate use of technological advancements such as deep fakes and generative adversarial networks (GANS) could compound difficulties in identifying key facts. For example, which of the 10 Khrushchevs that appear to be providing contradictory statements is the real one? Under time constraints, which of the Khrushchevs should decision-makers listen and respond to?

- **Multiplayer environment.** In 1962, few nuclear weapons states could take or directly impact strategic nuclear decisions. Today, low entry barriers among some new and emerging technologies mean that almost all the nuclear weapon possessing states or non-nuclear weapon states could potentially disrupt strategic stability or play a role in a third-party conflict. Additionally, large corporations and private sector companies that invest and develop these technologies are new independent players in the field. Organised crime or other non-state actors interested in seeding chaos could become another participant to be considered. As the security environment is fraught with challenges, multiple players in the ecosystem of disruptive technologies create an additional layer of complexity.

“Low entry barriers among some new and emerging technologies mean that a variety of new players could potentially disrupt strategic stability or play a role in a third-party conflict.”

- **New technologies and multipolarity could undermine the Cold-War understanding of strategic stability.** The arms race and crisis stabilities are likely to suffer if technologies and a plurality of actors significantly impact escalation and de-escalation, war initiation and termination, deterrence, crisis management and peacetime rivalry. Technologies already contest the status quo in the doctrinal application of nuclear deterrence in response to technologically driven non-nuclear threats. Actors from outside dyadic deterrence relationships could seek to destroy strategic stability for their own reasons and would now potentially have non-nuclear means to do so. At its most extreme, the technological disparity could ultimately

render nuclear arsenals ineffective. Scientific and expert literature produced plenty of warning signals on how multi-domain complexity could affect strategic stability in peacetime, crisis, and war.[1] Such a new environment is a marked change from the 20th-century nuclear policy decision making.

- **No uniform impact.** The effect of novel technologies is not uniform across the nuclear weapons domain. Non-strategic nuclear weapons have different decision criteria from strategic nuclear weapons. In the judgement of some workshop participants, it may prove more difficult to ensure that these are not affected by or effectively shielded from the impact of new technologies.

- **The illusion of control.** While the aggregate impact of new technologies and actors in the nuclear policy realm increases complexity and exacerbates risk, some look for ways to harness the technologies whilst retaining control of perhaps the most demanding human decisions. But is this at all possible? Don't we risk creating an illusion of control?

"Non-strategic nuclear weapons have different decision criteria from strategic nuclear weapons and may prove more difficult to shield from the impact of new technologies."

[1] Jacek Durkalec, Zachary Davis, Lauren Borja, Krystyna Marcinek, Anna Peczeli, Brian Radzinsky, Brandon Williams (2021) Annotated Bibliography, Multi-domain Complexity and Strategic Stability in Peacetime, Crisis; and War Center for Global Security Research, Lawrence Livermore National Laboratory, https://cgsr.llnl.gov/content/assets/docs/CGSR_Annotated_Bibliography_Emerging_Tech.pdf; and Brad Roberts (2021) Emerging and Disruptive Technologies, Multi-domain Complexity, and Strategic Stability: A Review and Assessment of the Literature, Lawrence Livermore National Laboratory, https://cgsr.llnl.gov/content/assets/docs/EDT_ST2_BHR_2021.3.16.pdf.

2. Amending the nuclear-new tech conversation

While there is merit in developing a comprehensive understanding of individual technologies' impact on nuclear decision-making, there is an increasing need to explore their cumulative effect as well. There is also a pressing need to outline pathways to harness technological advancements to strengthen the stability of strategic relations.

The ELN workshop discussion underscored the demand among experts and practitioners to design strategies that reduce and mitigate risks specific to technological complexity challenges.

"It is necessary to understand technology-related risks to miscalculation and misperception and work back to develop mitigating strategies."

2.1. Risk reduction and mitigation

While the workshop focus was on understanding possible worst-case risks inherent to technological complexity, participants devoted a significant amount of time to exploring how to use technologies themselves to mitigate or minimise risks that they could possibly create or amplify.

- **Prioritise.** In the judgement of some workshop participants, the greatest risk of nuclear weapon employment today, and in the future, is not a strategic nuclear attack but nuclear use through misinterpretation or miscalculation. While there is a chance that this could occur out of the blue, it is probably more likely to occur as a result of conventional escalation. Therefore, the best lens to examine the effect of any individual and combination of technology, on the situational awareness and decision making of the nuclear command authorities under stress, is to **understand the specific miscalculation or misinterpretation risks and work back to develop mitigating strategies.**

- Because most warfighting capabilities exploit new technologies, and preventing the employment of such technologies may not be a viable option, we **need to ensure a human remains in the decision making process.** Giving all decision to machines may lead us to an "uncertain and dangerous world." Decision-makers must, therefore, be prepared and practiced, and have a good grasp of the technologies and a clear sense of how to integrate a human in the chain. Unaided humans will never

"We need to explore how different levels of the nuclear decision-making process are affected by technologies and devise strategies to mitigate risks at each level."

be able to operate at the speed of machines during, for instance, a cyber-attack.

- Traditional strategies to mitigate nuclear catastrophe were built on the human-in-the-loop principle, including robust **communication channels between decision-makers. It remains the ultimate safety standard** for any crisis at any level in the future. The human-to-human interface gives decision-makers more time and improves their understanding, while evening the playing field with respect to deterrence. According to a participant, however, relations between nuclear weapon states leaders are "at the lowest level in nuclear history." (Re-)establishing and strengthening them is required. One solution to mitigate the "lack of ability to talk" risk is building a resilient global communications system between global leaders and officials, such as CATALINK.[2]

- Technologies will affect individual levels of authority and control differently. At the tactical level, the likely focus is on adversary capabilities and actions, as well as following orders and plans. At the strategic level, the psychology and history of the adversary's leadership become a major focal point. Still, it would be an error to assume that either level is somehow "shielded" away from new technologies and complexity challenges. There is a need to explore **how different levels of the nuclear decision-making process are affected by technologies** and devise strategies to mitigate risks at each level.

- **Special attention should be paid to technology-driven risks to the non-strategic decision tree.** Technology-driven risk of misinterpretation or miscalculation could especially affect non-strategic or sub-strategic nuclear weapons, as well as low yield and dual-capable weapons. Multiplication of these threats could risk accelerating the decision to use such weapons. We thus need a particularly thorough understanding of how technologies will affect this particular decision-making level and implement mitigation activities subsequently. However, should proper mitigation of technological effects in this area be impossible, considering alternative ways to removing the risk altogether may be required.

[2] Institute for Security and Technology (2020) Catalink. Preventing the onset or escalation of conflict by building a resilient global communications system, https://securityandtechnology.org/catalink/.

- **Risk mitigation starts in peacetime** when nuclear weapons possessing states and nuclear alliances design and communicate their nuclear weapons policy, define red lines, explore signalling strategies and work on de-escalation management. All these policies, measures, practices, and processes need to account for the implications generated by technological complexity.

- Given the current stalemate in nuclear arms control and disarmament talks, imminent disproportions in nuclear weapon arsenals, and a wide-spread research and development (R&D) into new technologies across states possessing nuclear weapons, **new technologies could open the door to discuss nuclear policies and re-frame strategic stability.**

- **Thinking outside the box.** Can individual arms control instruments solve problems inherent to complexity? What is it that they cannot cover?

- **Technologies mitigating technology-driven risks** (e.g., personal identification codes for nuclear decision-makers, exploring machine vs machine relations).

- Understanding how technologies play into an escalation framework and **designing de-escalation paths** and mechanisms (off-frames/ramps). How to design and measure "acceptable escalation limits" for effects generated by the complex interplay of new technologies?

- **Explore the development of a regulatory framework concerning emerging technologies**, possibly by expanding the body of international law.

- **Involve industry in the conversation.** The commercial aspect of R&D in new technologies might present challenges in terms of proliferation and offer new partnerships to understand, control, and limit associated risks.

2.2. Opportunities

In addition to posing risks, technologies (including in aggregate) could support decision-makers in preventing miscalculation, misperception, and miscommunication. This could contribute to the stabilisation of relations, maintenance of credible deterrence and the reduction of nuclear risks.

- **Technologies strengthening deterrence.** How could technologies make deterrence more robust, improve data quality, and make communication channels more resilient to prevent a negative scenario?

- **Technologies to aid nuclear decision-makers.** How could technologies improve the quality and quantity of information? How could technologies affect the ability to trust the information provided, increase their relevance and timeliness?

3. Sparking a sense of urgency

The nuclear community is increasingly acknowledging technology-related changes to reality and the many implications, both understood and – as of now – incomprehensible. But we still act as if this reality is a person on a bike slowly ambling towards us. It might be, however, that with multiple emerging technologies creating complexity, we have a large truck thundering towards us at high speed (probably without a driver!). Strategic surprise thus may emerge in the gap between complexity, uncertainty and rate of change in the operating environment.

With time passing, there will be a better understanding of how different technologies integrate, interact, and interplay. Yet until we can discern with clarity the unidentified object rapidly approaching us, this creates a vast space for uncertainties. There was a sense among participants that, although many of the issues discussed at the workshop have been identified in the past, the reality of politics and competing priorities meant that they were not addressed. Experienced members in the workshop also felt that challenges and opportunities stemming from technological complexity could be dealt with once the political will, need, or pressure arises. But can the global nuclear community afford to leave the risks emanating from disruptive technologies to chance?

“We still act as if this reality is a person on a bike slowly ambling towards us. It might be, however, that with multiple emerging technologies creating complexity, we have a large truck thundering towards us at high speed (probably without a driver!).”

Annex 1: List of participants

Decision-makers included:

1. **Eric Brewer**, Deputy Director and Senior Fellow, Project on Nuclear Issues, International Security Program, Center for Strategic and International Studies (CSIS) (US)
2. **Vincenzo Camporini**, Former Chief of the Joint Defence Staff, Former Chief of Staff of the Air Force (Italy)
3. **Giampaolo Di Paola**, Former Minister of Defence of Italy; Former Chairman of NATO Military Committee (Italy)
4. **John Gower**, Former Assistant Chief of Defence Staff (Nuclear, Chemical, Biological) in the United Kingdom Ministry of Defence (UK)
5. **Andrey Kortunov**, Director-General, Russian International Affairs Council (RIAC) (Russia)
6. **Franklin C. Miller**, Former Special Assistant to President George W. Bush, Former Senior Director for Defence Policy and Arms Control on the National Security Council, Former Chair of NATO's nuclear policy committee and of NATO's counterproliferation policy committee (US)
7. **Rolf Nikel**, Vice President, German Council on Foreign Relations (DGAP) (Germany)
8. **Curtis Scaparrotti**, 18th NATO's Supreme Allied Commander Europe (US)
9. **Ahmet Üzümcü**, Former Director-General of the Organization for the Prohibition of Chemical Weapons, Former Permanent Representative of Turkey to NATO (Turkey)

Organisers:

1. **Peter Kingsley**, Chairman and Co-founder, Oracle Partnership (UK)
2. **Jane Kinninmont**, Impact Director, European Leadership Network (ELN) (UK)
3. **Katarzyna Kubiak**, Senior Policy Fellow, European Leadership Network (ELN) (Poland/Germany)
4. **Thierry Malleret**, Co-Founder, Oracle Partnership (France)
5. **Sylvia Mishra**, New Tech & Nuclear Officer, European Leadership Network (ELN) (India)
6. **Andreas Persbo**, Research Director, European Leadership Network (ELN) (Sweden)
7. **Graham Stacey**, Senior Consulting Fellow, European Leadership Network (ELN); Former Chief of Staff of NATO Transformation (UK)
8. **Adam Thomson**, Director, European Leadership Network (ELN) (UK)
9. **Simon Tilford**, Director, The Oracle Partnership (UK)

Annex 2: The report's approach

The project

In 2020, the European Leadership Network initiated a multi-year, open-ended project aimed at unpacking technological complexity and proposing practical and policy approaches to deal with related nuclear risks. The project is divided into four strands:

1. A **baselining exercise** to establish what literature there is on the technological complexity question and to harvest practical recommendations.

2. An **open-ended scenario-based iterative analysis** designed to generate practical policy recommendations on handling technological complexity.

3. A **study of methodologies and technologies** for complex decision making, specifically nuclear.

4. Work to generate **recommendations for arms control and risk mitigations** on the interface between new technologies and nuclear systems.

Each of the four strands - like four legs of a stool - support the main goal. We begin by asking what the science (strand 1), practitioners (strand 2) and current policies (strand 3) tell us about the impact of and ways of dealing with technological complexity in nuclear decision making. We then craft policy approaches (strand 2, 3 and 4) that governments might pursue to begin to responsibly regulate and steer the weaponisation of potentially disruptive technologies and their use in warfare. These are aimed at reducing risk in the decision-making window, identifying de-escalation solutions as well as managing potential escalation. Findings within each strand nourishes the analysis and recommendations in the other strands.

The pilot workshop

The European Leadership Network, in cooperation with the Oracle Partnership, organised the *Nuclear Weapons Decision-Making under Technological Complexity* pilot workshop via Zoom on 15 January 2021. It aimed to develop and initiate a process in which scenario-design and big data interacts with high level practitioners to generate insight into the unprecedented complexity now increasingly presented by disruptive technologies operating in aggregate on the interface with nuclear decision making.

An outline generic situation provided context, a reference point, and a framework for discussion. Scene setting included a political and technological aspect. Politically, participants were asked to imagine being part of a nuclear decision group of a

western style mature democracy that possesses nuclear weapons. Attacked by an autocratic nuclear armed state with escalation looming in the air, decision makers were to consider nuclear options. This decision-making process was then put into a technological context prepared by the Oracle Partnership.

Due to the pilot nature of this workshop, six technologies were considered: drones, space threats, cyber threats, deep fakes, AI, and quantum technology. We accounted for trends in individual technologies as well as likely or possible interactions between them. Data was sourced from world's patent databases and the web for new market introductions and promotional material about new technologies or products in development over the last five years. Translated into the context of nuclear weapons and nuclear weapons decision-making, these outcomes provided the technological backbone of a "worst case" scenario.

The scenario explored a wide range of possible turns and twists. While they cannot be presented in full here, an exemplary development that could have emerged from the technological context follows below.

An unknown non-state actor triggers a satellite collision. The domino effect causes significant global loss of space capability. There is lack of clarity about who caused the initial event as well as the scope of other major powers suffering similar loss of capability. Forces are being put on alert.

At the same time, unproven autonomous and semi-autonomous persistent drones are launched across all domains. Initially they shall replace sensors and communications, but attack drones are also brought to higher readiness. The time lag between satellite loss and drone deployment creates a period of high risk, as either side perceives a strategic advantage or disadvantage. Decision-makers now face a deluge of information from sources that have not been routinely operated or practiced at this scale. Information flow and speed means that decision making must now be aided by AI for sorting, prioritizing, and displaying information. Questions about algorithms and fail safes emerge.

Then, malware manipulates AI in hardware and communications systems. AI-aided decisions may, as a result, be corrupted. The loss of links to drones puts them on fully autonomous mode and they act at machine speed. There is a possibility that a drone-versus-drone battle has already commenced.

Decision-makers experience loss of information (or false information) and loss of control of key weapons systems. Near total confusion and loss of trust in information spread. The human may be relegated to watching events on a screen – without understanding them or knowing if they are true. This could lead to an assumption

that an attack is in progress or about to happen. There is a high risk of one side feeling they are already losing and retaliate.

At this point in the conflict, assessing intent seems more important than capability. But at the point where human-to-human de-escalation among the leaderships becomes essential, there appear to be multiple versions of adversaries' leadership as a result of deep fakes. All are convincing and capable of undertaking rational and logical discussions. This fuels information overload and steers total confusion. Finally, the pace of events, volume of information and speed of change becomes unmanageable for human decisions. Complexity has defeated us.

After introduction and scene setting, the discussion aimed to better understand whether this technology driven context will significantly impact on nuclear decision making and identify the combinations of disruptive technologies that, in the view of the panel members, could increase the risk of wrong or untimely decisions. The positive aspects of the technologies were also explored.

The workshop was possible due to generous funding by the German Federal Foreign Office, the MacArthur Foundation, the Carnegie Corporation, and the Nuclear Threat Initiative.

About ELN

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About the Oracle Partnership

The Oracle Partnership brings together some of the world's leading domain experts, well-proven foresight, scenario and strategy methodologies and a range of state-of-the-art AI tools, focusing on strategic risk and innovation. It develops intelligence beyond conventional futures research, looking for tell-tale early signs of political and economic disruption, policy changes, sudden shifts in public sentiment and breakthrough technologies, long before they go mainstream. The goal is to model complexity and uncertainty, creating strategic frameworks for organisations to navigate emerging reality.

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