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French thinking on AI integration and interaction with nuclear command and control, force structure, and decision-making

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1. Introduction

Automated systems and artificial intelligence (AI) represent a series of major technological, operational and societal disruptions in both the physical and cyber domains. In the military domain, they are likely to lead to a domino effect of disruptions across a wide range of factors. This includes the speed of decision-making and operations, the ratio of forces, command & control (C2) systems, nuclear command, control & communications (NC3) systems, human resources and, finally, the organisation of the armed forces and their doctrines and concepts of use.

In France, AI is therefore presented as a "priority for national defence"[1], both regarding the development of military tools and strategies which include AI, as well as the assessments of France's competitors' advance on AI military projects. However, this rise in the power of AI, and its implications for French defence strategy, is still relatively unexplored in official documents, think tank communities, or academia. According to the scarce literature, two areas deserve attention: the tools or systems considered strategic - including nuclear deterrence - and the strategic equilibrium between powers, whether global or regional, or those likely to influence our partnerships.[2] For example, nuclear deterrence, the keystone of French defence, must be able to adapt to the "complex and variable parameters"[3] that AI will inevitably disrupt at the dawn of the "third nuclear age"[4], specifically on decision-making. Moreover, while the French defence strategy is articulated between "strategic autonomy"[5], "European ambitions"[6] and "global responsibilities"[7], it also seems fundamental to understand and anticipate possible changes in the major strategic balances.

Given these considerations, this review paper aims to compile and analyse the French literature on France's perception of military AI, especially its consequences on strategic systems and competition, and nuclear deterrence. It draws from quite a limited pool of documents, that can be divided in three categories:

1. Official strategies, doctrines, and speeches on French defense strategy, the French understanding of AI or the use of AI and autonomous systems in the military. This includes the 'National strategy review 2022'[8] (Revue nationale stratégique), a French MoD speech on Artificial intelligence for defence from 2019[9], the report of the inter-ministerial task force on AI defense[10] and the 'Joint exploratory concept on the use of artificial intelligence and automated systems'[11] by the CICDE.

2. Reports and studies written by French scholars on these topics, especially from two think tanks: the bulletin of the Observatoire de la Dissuasion published by the Fondation pour la recherche stratégique (FRS) and Institut français des relations internationales (Ifri).

3. Articles written by former or active military officers during their higher military education, who might have a more informed point of view on these topics than think tanks.

Other resources, such as press articles, op-eds from disarmament activists, and from foreign think tanks will also be used to provide some context.

It is worth noting that none of the official documents, and only a few of the think tanks and academic papers, address the issue

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of AI in NC3 directly – or even the broader topic of links between AI and nuclear strategy. Contrary to English-speaking academia, where multiple books and articles have been published on these topics in recent years ('AI and the Bomb' by James Johnson, 'Deterrence under Uncertainty' by Edward Geist, etc.), there is no such scholarship in French. This can be explained by different factors that will be detailed in the review, but mostly centre around a reduced strategic community in these areas (even though some initiatives aim at creating a new generation of thinkers and researchers), the consideration that AI technologies are (for the moment) too premature to be seriously addressed in research or doctrines, and finally a conservative debate in France about nuclear deterrence. Talking about AI would, in that sense, decrease the 'purity' of nuclear deterrence and is considered a non-subject by most of the French officials working in that field.

Nevertheless, the existing documents still allow us to understand the French perception of military AI and its nuclear dimension. This review will: first, give a brief overview of the French approach of the debate, followed by the presentation of the official positions on the development of military AI. It will then focus on the impact of AI on C2 and the decision system, including the NC3 and its consequences on strategic stability. It will conclude with a short overview of how France understands the military AI programs from the P5 countries and provide recommendations.

None of the official documents, and only a few of the think tanks and academic papers, address the issue of AI in NC3 directly – or even the broader topic of links between AI and nuclear strategy.

2. A brief overview of the French approach to the debate on the military use of AI

Most of the AI-related debate in the French strategic community is focused on the capacities France's adversaries could acquire, and the investments that are consequently needed in order not to be left behind. The 'Joint exploratory concept on the use of artificial intelligence and automated systems', written by the Centre Interarmées de Concepts, de Doctrines et d'Expérimentations, is quite clear on this topic:

> "The adversaries of the French armed forces, whether in asymmetric conflicts linked to terrorism or in power confrontation scenarios, have, or will have, automated weapon systems that are likely to give them an operational advantage. France runs the risk of a major operational downgrade if it is unable to achieve the operational advantages that are likely to result from the integration of AI into its force systems. [*Les adversaires des forces armées françaises, que ce soit, dans des conflits asymétriques liés au terrorisme, ou dans des scénarios d'affrontement de puissances, disposent ou disposeront de vecteurs automatisés armés susceptibles de leur conférer un avantage opérationnel. La France court un risque de déclassement opérationnel majeur si elle n'est pas en mesure d'obtenir les avantages opérationnels susceptibles de lui procurer l'intégration de l'IA dans ses systèmes de forces*]"[12]

While the military applications of AI are already the subject of intense international debate, notably on the issue of lethal autonomous weapon systems (LAWS), General Pierre Réal, who wrote a paper on the strategic challenge that AI and its applications represent for France during his training at the College for Higher Military Studies, states that "the prospect of AI in nuclear and, more generally, strategic weapon systems could also fuel ethical debates. [*La perspective d'une présence de l'IA dans des systèmes d'armes nucléaires, et plus généralement stratégiques, pourrait également alimenter de vifs débats éthiques.*]"[13]

Indeed, the main issue driving the current debate in the field of nuclear AI is that of strategic stability. Benjamin Hautecouverture, a French researcher at the Fondation pour la Recherche Stratégique, and one of the most prolific writers on the impact of AI on nuclear deterrence in French, summarises the issue as such:

> "This question is usually divided into two types of issues: whether AI has, or will have, a destabilising effect on strategic stability; and whether AI represents a risk or, on the contrary, an opportunity for strategic stability. In the first case, the question is whether the perceived risks are premature or whether they should be anticipated. In the second case, the question is to what extent it is appropriate to take them into account. In both cases, the issue is controversial, although literature on AI suggests that it presents more risks than opportunities." [*Cette question se subdivise habituellement en deux types d'enjeux : celui qui consiste à savoir si l'IA exerce ou est en passe d'exercer des effets déstabilisants sur les équilibres stratégiques ; celui qui consiste à affirmer que l'IA pose un risque ou au contraire représente une opportunité en matière de stabilité stratégique. Dans le premier cas, l'on se demande si les risques envisagés sont prématurés, s'il faut les anticiper. Dans le second, l'on se demande dans quelle mesure il est pertinent de les envisager*

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en principe. Dans les deux cas, le sujet est controversé, même si l'IA présente dans la littérature a priori davantage de risques que d'opportunités.]"[14]

He then goes on: "To what extent could the already established strategic stability between the nuclear-weapons states be shaken by acquiring systems – conventional or nuclear – that are based on AI? In a stricter sense, because the concept of strategic stability refers to the situation in which the Nuclear Weapon States (NWS) are convinced that their adversaries are not capable of putting into cause their deterrence, then we need to identity first whether or not AI applications are likely to encourage first use, or the growth and diversification of arsenals. [*La question relative à la stabilité stratégique peut se poser dans les termes généraux suivants : dans quelle mesure l'équilibre établi entre États possesseurs de l'arme nucléaire pourrait-il être ébranlé par l'adoption de systèmes – conventionnels ou nucléaires – fondés sur l'IA ? Dans un sens plus restrictif, la stabilité stratégique faisant référence à la situation dans laquelle les États dotés sont convaincus que leurs adversaires ne sont pas en mesure de mettre à mal leurs capacités de dissuasion, il s'agit d'identifier en quoi les applications de l'IA sont susceptibles ou non d'inciter à un usage en premier ou à l'accroissement/diversification des arsenaux.*]"[15]

Indeed, a lack of trust in second strike capabilities could push some NWS to invest massively in AI in order to improve their detection systems and be ready to launch on warning, as soon as they have an AI-sanctioned assessment of an incoming massive conventional attack or a nuclear attack. Such a reliance could of course have dramatic consequences, depending on the reliability of AI (see below). Hautecouverture then notes that people who are afraid of AI being used in such contexts now push for globally adopting a no-first-use (NFU) policy, considered as a driving force of "strategic AI risk reduction"[16], even though the benefits of NFU for strategic stability can be discussed.

His analysis reflects the broader stance on military AI in France, and especially its impact on NC3. Put bluntly, it could be summarised as such: either it is something extremely dangerous that will change everything and then must not be talked about otherwise it will provoke a catastrophe, or NC3 is too sensitive and important to include AI in the process, thus there is no need – again – to address this problem because it will never happen. This lack of analysis is emphasised by disarmament activists such as the Initiatives pour le désarmement nucléaire (IDN), close to the International Campaign to Abolish Nuclear weapons (ICAN), who noted with regret in a written brief from 2018 that a report published by IFRI on military applications of AI did not address nuclear deterrence.[17] This lack of debate can be seen as an attempt to dissimulate the danger of nuclear weapons and thus discredits the analysis about military AI. Moreover, difficulties when it comes to understanding both nuclear deterrence and military AI can lead to dubious comparisons between the two, considering that "AI is the new atomic bomb"[18] and that the same ethical questions can be asked about the bomb and AI.

3. Official position on the development of military AI in France

a. Military modernisation and AI

France describes AI as "an indispensable strategic technology to ensure its operational superiority"[19] and identifies seven priority areas for its development: decision making for planning and operations; collaborative combat; cyber defence and influence; logistics, support and maintenance in operational conditions; intelligence; robotics and autonomy; and administration and health.

Military applications of AI: numerous possibilities, mainly outside the lethal field

The applications of AI concern three main areas, with more or less direct actions and effects on the battlefield, which are likely to provide a major advantage to the armed forces that master them. The report of the Task Force on Artificial Intelligence for Defence covers all these functions, excluding applications to lethal systems:[20]

- Combat and Operations: AI can augment the capabilities of a single human operator, either by replacing him altogether or by greatly enhancing his capabilities. The number of robots or drones can therefore compensate approximately for the number of personnel. On the other hand, the technological quality of the weapon system (ammunition, sensor quality, protection, agility and stealth, etc.), which is a source of increasing costs in modern combat vehicles, can also be compensated by the quality of the individual or collective intelligence of the AI. However, AI's contribution to the battlefield is not limited to weapon systems. As intelligent sensors produce ever more raw data, thanks in particular to advances in miniaturisation, AI will make it possible to sort through this mass of data, allowing human analysts to focus on the most relevant information[21]. Even if it is not specified in the National Strategy Review, there appears a first risk about using AI to sort data: indeed, algorithms must be properly trained, data correctly labelled, etc. Those arguments are mobilised by French officials in order to clearly differentiate 'strategic tasks' such as nuclear deterrence that must be conducted by humans, and others than can be helped by AI systems. Among staff at all levels, it is thus a consideration that AI will be able to assist in the selection of operational plans by testing different options against the most likely or dangerous enemy actions, notably through simulation and war-gaming.[22] The benefits of military applications of AI are therefore considerable, and massive investment in this field can be seen as a means of catching up for powers facing competitors with superior numbers or technology.[23]

- Force training: Modern weapon systems offer a wide range of virtual training capabilities through simulation. AI can generate training scenarios of varying complexities, possibly based on real-life situations, but also animate 'enemies' with reactions graded according to the required tactical level. In the case of AI-embedded weapon systems, for example at the human-machine interface level, simulation sessions will benefit not only the crew but also the embedded AI, enabling it to learn how to interact with humans and confront crisis scenarios and enemy weapon systems. Human-machine teaming will

France describes AI as "an indispensable strategic technology to ensure its operational superiority".

thus be able to start before the real situation in a simulated environment.[24] As put by Pierre Réal:

"the contribution of AI in training will also be reflected in the ability to analyse the situation. In fact, only AI will be able to process the huge amount of data collected during training. This analysis could then lead to operational certification, the identification of areas of progress or even proposals for the composition of combat groups, depending on the character and skills of the soldiers required to operate together. [*L'apport de l'IA dans l'entraînement s'exprimera également dans les capacités d'analyses de mises en situation. En effet, le traitement de la quantité massive de données qui sera collectée lors de séances d'entraînement ne sera possible que par l'IA. Cette analyse pourra ensuite déboucher sur une certification opérationnelle, la détermination d'axes de progrès, voire des propositions concernant la composition des groupes de combat, en fonction du caractère et des aptitudes des militaires amenés à opérer ensemble*]"[25]

Again, even though it is not specified in these documents, it is worth noting that the French nuclear program runs entirely on mathematical modelling since France ratified the CTBT in 1998 and dismantled its testing installations. This program, called 'Simulation' and run by the Atomic Energy Commission, probably uses algorithms and AI-enabled tools in order to conduct the mathematical operations needed to certify the efficiency of the French nuclear weapons.

- Functions not directly related to combat: This concerns functions such as logistics, maintenance, health and human resources management.[26]

  "As in the civilian world, where the social and political consequences of these applications are being debated, major changes are expected in the composition of the armed forces, with a reduction in the number of personnel currently dedicated to these specialities and changes in the professional expertise of those concerned. *[Comme dans le milieu civil, où les conséquences sociales et politiques de ces applications feront débat, d'importantes mutations seront à prévoir dans la composition des forces armées, avec la diminution des effectifs aujourd'hui dédiés à ces spécialités et des changements dans les savoir-faire professionnels des intéressés.]*"[27]

  Consequently, we can notice that there is no precise document or section related to the links between AI and nuclear weapons, especially NC3.

b. French perception of trust in AI

France identifies several operational risks arising from limited trust in automated systems and AI:[28]

- Cyber-attacks that could lead to hacking, luring, or reprogramming;

- Interference that limits or prohibits use or control;

The contribution of AI in training will also be reflected in the ability to analyse the situation.

- Incorrect system programming;
- Misunderstandings of the operation of the system by the operator or commander;
- Disempowerment and extinction of the critical sense of the operator or command.

On this last point, with regard to C2 devices:

> "A risk often considered is not so much the removal of human responsibility in decision making, but rather an over-reliance on the repeated successes of algorithms by the human persons responsible in the chain of command. *[Un risque souvent envisagé n'est pas tant la mise à l'écart de la responsabilité humaine dans la prise de décision, qu'une confiance excessive accordée aux succès répétés des algorithmes par les personnes humaines en charge dans la chaîne de commandement.]*"[29]

These risks are not specific to AI or automated systems. Humans must also be trained and educated. This is especially important for nuclear weapons systems, since the consequences of use would be far more dramatic than the misuse of a conventional system.

4. The French perspective on the application of AI in C2 and the decision system

a. AI-based C2 and decision making is the key to gaining an advantage in future warfare

The French Armed Forces have started conceptual and doctrinal work on future C2. Reflections over the last few years have mainly focused on concepts and doctrines related to future C2 command structures. Technological solutions are already emerging that offer the possibility of better control and distribution of data.

> "On the specific topic of decision-making, the doctrine states that 'by 2040, the maturity of these tools will make it possible to guarantee the full interconnectivity of staffs with allies and partners, ensuring the highest level of security and access to information flows. They will offer new decision-making capabilities, leading to the targeted automation of decision-making processes (AI, big data), which will accelerate the phenomenon of the temporal contraction of the decision-making cycle.'" *[A l'horizon 2040, la maturité de ces outils permettra de garantir une pleine inter connectivité des états-majors, avec ceux de nos alliés et ceux de nos partenaires, de garantir le meilleur niveau de sécurité d'accès aux flux d'information et de proposer des capacités inédites d'aide à la décision, entraînant une automatisation ciblée des processus décisionnels (IA, big data), ce qui accélèrera le phénomène de contraction temporelle du cycle décisionnel.]*[30]

As stated in the report on Artificial Intelligence for Defence, decision support must be available in C2 centres at "strategic, operational, and tactical levels, before, during, and after the execution of the mission"[31].

By 2030-2040, the decision-making superiority of armed forces will depend on their ability to master data for operational purposes. In a strategic context redefined by the overlaps of competition-contestation-confrontation, the ability to retain the initiative through the processing, exploitation, and relevant sharing of data will be essential. Joint command and control will have to adapt to this new framework for force employment. Without calling into question the principles of war, it will continue to obey certain invariants: 1) the human being remains at the heart of the decision; 2) the principle of uniqueness and continuity of command; 3) the principle of verticality of the three levels (strategic, operational and tactical) supported by levels of authority.

The report of the AI Task Force further outline the plan and objectives for the C2 process enhanced by AI:

> "At the strategic level, the Joint C2 boosted by AI will refocus on its fundamental role: anticipation, definition of military objectives to achieve the military dimension of the desired end state (EFR), while contributing to non-military strategic objectives, planning and conducting operations at its level. The operational level will have to achieve optimal synchronisation of processes and timeframes from the planning phase onwards. Finally, the tactical level will ensure the implementation of the manoeuvre of military means, in which certain levers specific to the space and cyberspace environments, as well as to the information and electromagnetic fields, will be integrated, offering the field units a wide combination of actions. *[Au niveau*

stratégique, le C2IA se recentrera sur son rôle fondamental : anticipation, définition des objectifs militaires pour atteindre le volet militaire de l'état final recherché (EFR) tout en contribuant aux objectifs stratégiques non militaires, planification et conduite des opérations de son niveau. Le niveau opératif devra réaliser la synchronisation optimisée des processus et des temporalités dès la phase de planification. Enfin, le niveau tactique assurera quant à lui la mise en œuvre de la manœuvre des moyens militaires auxquels seront intégrés certains effecteurs propres aux milieux spatial et cyberespace ainsi qu'aux champs informationnel et électromagnétique, offrant une combinaison étendue d'actions aux unités de terrain.][32]

It is worth noticing that there are no particular remarks about nuclear deterrence in this Joint Exploratory Concept, partly because nuclear strategy is the particular realm of the President and his personal Chief of Staff - such sensitive subjects cannot be discussed in a Joint Exploratory Concept published by an organ not in direct relation with the Nuclear Staff.

Of all the challenges facing C2, three are of paramount importance to the French Armed Forces:

- The ability to collect, process, and analyse an exponentially growing volume of data and information from a wide variety of sources;
- The ability to manage both the uncertainty and the transparency of the battlefield;
- Speed of decision and connectivity for its implementation (integration of effects) as factors of operational superiority, if not survival.

b. AI as an enhancement of decision support processes

Anticipate more and influence more effectively

The AI Task Force on Defence recognises that:

> "The most important contributions related to AI will be in the technological data-processing improvements. These will help improving foresight and decision-making by analysing and cross-referencing sources of different origins, especially in military intelligence. The monitoring and detection components will therefore have to be enhanced by digital tools that allow correlations to be made in the various fields and environments. In particular, these tools will allow early detection of the adversary's initiatives and a faithful and precise understanding of his manoeuvres in the multi-domain environment. *[Ce sont désormais dans les capacités de traitement des données collectées que les apports technologiques seront les plus importants pour améliorer l'anticipation et la pertinence des options possibles, par l'analyse et le croisement de sources d'origines diverses dans le cycle du renseignement, afin d'accélérer le cycle décisionnel. Ainsi le volet surveillance et détection devra être complété par des outils numériques permettant d'opérer des corrélations dans les différents champs et milieux. Ces outils apporteront notamment une perception*

The most important contributions related to AI will be in technological data-processing improvements.

au plus tôt des initiatives de l'adversaire et une appréhension fidèle et précise de sa manœuvre dans l'environnement multi-domaines.]"[33]

To be fully effective, C2 structures will need to have access to all collected data and will therefore need to be part of a network architecture with controlled compartmentalisation, which will help to save resources but will also pose security challenges, including data protection.

Deciding around information for autonomous action

For the French Armed Forces, the actors capable of mastering these digital decision support levers will gain a decisive advantage over their competitors and adversaries by gaining and maintaining superiority in decision-making. At this point, the commander, not the AI, will remain at the heart of the decision and will be positioned at the decision points of process automation (human in the loop). Decision support tools will suggest prioritised options for action to the commander. All autonomous analysis and decision-support tools will have to cope with the growing volume of information in order to extract the most relevant information and to speed up the decision-making cycle in order to take and maintain the initiative against the adversary. The quality of data is therefore a major issue for France in terms of its use for operational purposes. Mass data processing capabilities based on artificial intelligence will speed up analysis and reveal correlations that are beyond the reach of human analysis.[34]

Again, even though the term 'nuclear' does not appear clearly in these documents, nuclear strategy will encounter the same challenges than the conventional domain, with even more restrictions and carefulness about data use. It is worth noting that none of the LAWS currently in development within the French military will carry nuclear weapons or have a primary role in nuclear deterrence: some could serve as 'loyal wingmen' of the strategic bombers or help in supporting the deterrence mission (for example, UUV cleaning the Brest maritime corridor that the SSBNs go through) but no more.[35]

c. Risks associated with the application of AI in C2 and the decision-making system

A very high dependency on data

According to the Joint Explanatory Concept:

> "The performance of AI in practice depends directly on the quantity and quality of the training and qualification data. The time spent preparing this data (collecting, filtering, cleaning, annotating) represents nearly 70-80% of the time required to design a neural network. To design a high-performance AI, it is therefore essential to have data that is accessible, sufficient in number, of high quality and reliable [*La performance en exploitation des IA dépend directement de la quantité et de la qualité des données d'apprentissage et de qualification. Le temps amont consacré à la préparation de ces données (collecte, filtrage, nettoyage, annotation) représente près de 70 à 80 % du temps nécessaire à la conception d'un réseau*

The actors capable of mastering these digital decision support levers will gain a decisive advantage over their competitors and adversaries by gaining and maintaining superiority in decision-making.

de neurones. Pour concevoir une IA performante, il est donc indispensable de disposer de données à la fois : accessibles, en nombre suffisant, de qualité et fiables].”[36]

Error acceptance processes to be put in place

Given the imperfections and uncertainties of learning, AI-enabled systems produce potentially erroneous information. However, detecting and diagnosing errors made by AI-enabled systems may prove difficult for operators or decision-makers, especially if the information thus produced is simply used to feed one or more other AI-enabled systems without prior control or verification. By choosing military systems equipped with AI, the French Armed Forces will have to learn to manage this risk of error in the design and verification phase, but especially in the operational phase. The legal accountability of the consequences of a malfunction of a military platform equipped with AI, made possible by one or more pieces of information that are not necessarily controlled from end-to-end, will be an essential aspect to be taken into account.[37]

Managing a growing dependence on AI

By progressively equipping armies, AI-enabled systems will facilitate military action, but could also contribute to the insidious development of harmful dependencies. The fluidity of the chain of command and feedback from the field could lead to a challenge to the principle of subsidiarity. Moreover, the acceleration of the decision-making loop could lead to a runaway command process. To guard against overconfidence and loss of insight, the critical examination of options proposed by AI-enabled systems will need to be maintained as long as the pace of operations allows. Finally, AI-enabled systems may create an over-reliance on the support they provide to operators. To maintain the resilience of the French Armed Forces, it will be essential to provide systems and networks that are resilient and reconfigurable in the face of failures and potential threats in the field. This resilience is likely to be achieved by:

- Systematic protection of AI-critical assets from physical and cyber threats;
- The systematic use of resilient transmission means with adapted speeds;
- Failing that, the ability of AI to operate with low data rate, high latency and low information in a disturbed electromagnetic spectrum;
- Failing that, the ability of AIs to operate without any connectivity and from local, partial, desynchronised databases;
- As a last resort, a minimum capability for armies to operate without recourse to AI-enabled systems.[38]

Impacts of ethical and regulatory issues related to the integration of AI in force systems

For France, the operation of AI leads to the consideration of two important issues at the legal and ethical levels: the emergence, in terms of responsibility, of actions carried out through the

automation of tasks and the risks of abuse brought about by the collection and processing of significant amounts of data necessary for the development of AI.[39] These two issues will make it necessary to constantly ensure the legal compliance of AI-enabled systems and to understand the ethical consequences of their use throughout the life cycle of the systems on which they are deployed. For the military use of AI-enabled systems, France maintains the following principles:

- Respect international law, in particular the principles of proportionality, necessity, humanity and discrimination between combatants and non-combatants;
- The maintenance of sufficient human control;
- Permanence of command responsibility.

France will not develop lethal autonomous weapons systems (LAWS). It refuses to entrust the decision of life or death to a machine that would act in a fully autonomous manner, beyond any human control. The use of AI in the French Armed Forces, and in particular the automation of platforms, will be carried out in such a way as to guarantee the continuity of command responsibility. To this end, it will be necessary to preserve the deliberate nature of any action carried out by AI. As stated by the Joint Exploratory Concept on AI and Autonomous Systems, this is based on the need to maintain command confidence in the weapon system to produce the desired end effect when used within the defined scope and domain of employment, and the ability of the system and the chain of command to comply with the operational rules of engagement. In order to ensure permanent control of the framework of engagement, automated systems must be programmed according to four criteria: 1) rules of operation; 2) rules of use; 3) rules of engagement; and 4) rules of optimisation and adaptation to the environment.[40]

Finally, for France, the human-system relationship must preserve the user's ability to be critical of the solution proposed by the AI. This capacity must be verified during the design of the systems, but also during the implementation training.

d. Views on the implications of military AI on nuclear deterrence and strategic stability

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Strategic functions were defined for France in the 2013 White Paper on Natonal Defence and Security (LBSDN) : deterrence, protection, knowledge and anticipation, intervention, and prevention. They were confirmed in the 2017 strategic review and then in the 2021 strategic update. In 2022, a new strategic function was added: influence.[41] They have been broken down into operational capabilities, among which the implementation of the nuclear deterrent posture can benefit from additional insights from the perspective of AI.

Due to evolutions in the strategic context, nuclear deterrence is still the cornerstone of French defence and security. A "robust and credible nuclear deterrent"[42] is the first strategic objective of the National Strategy Review 2022. It has to be safe and secure in order to be credible and functional, and supported by a strong industrial base.

The 2013 LBSDN recalls that the French nuclear forces are split into an airborne component and a sea-based component, whose performance, adaptability, and complementary characteristics make it possible to maintain a tool that remains credible in the long term in a changing strategic context, while maintaining a level of strict sufficiency.[43] Moreover, nuclear comms, without constituting a third component in the true sense of the word, are essential for the functioning of the deterrent. Diversified, hardened, and redundant, their mission is to enable the components of the deterrent and the transmission of government orders to be implemented in all circumstances.

French nuclear forces, which are not based on an area missile defence capability or an advanced detection architecture, are configured with the flexibility and responsiveness to inflict absolutely unacceptable damage on the power centres of states that would attack France's vital interests. Moreover, they are not directed against any country, and France has always refused to consider nuclear weapons as a weapon of war. As the President of the French Republic states: "France will never take part in a nuclear battle or in any kind of graduated response."[44]

Thus, strictly defensive and limited to a second strike and a single, non-renewable nuclear warning that can be delivered to an aggressor state to restore deterrence, the implications of AI are officially not a concern for the credibility of the French deterrent posture. This does not mean, however, that the integration of AI into the C2 architecture and nuclear forces of states whose posture differs from that of France are not subjects of attention in terms of its potential impact on the major strategic equilibrium.

As previously noted in the analysis provided by Benjamin Hautecouverture, it is the need to ensure the credibility and reliability of second-strike capabilities that explains the evolution of weapon systems towards greater sophistication in detection, early warning and force command and control systems. As arsenals have been built and strategic triads have been established, the need for careful planning, the implementation of launch-on-warning postures, and the requirement for rapid decision making have emphasised the need to rely on automated or semi-automated systems.

The potential contribution of AI to the success of nuclear missions

Despite the fact that using a nuclear weapon would irremediably change the course of a war (and the existence of specific procedures, as well as rules of engagement and C2 chains) the success of nuclear missions also depends on tactical systems and know-how that are largely identical to those of conventional missions. The need for 'robust conventional forces' is also emphasised in strategic documents in order for deterrence missions to succeed.[45] For example, the success of an airborne nuclear strike requires surviving enemy defences, fighter aircraft or surface-to-air missile batteries, just like a conventional strike. Strategic weapons systems also rely on conventional means, either to open corridors of passage or to create diversionary attacks.[46] Therefore, the combination of AI contributions to conventional military systems described above is also likely to increase the effectiveness of nuclear missions.[47]

The implications of AI are officially not a concern for the credibility of the French deterrent posture.

For C2, the increased automation of early warning will speed up detection. The time saved theoretically provides an indirect benefit by giving decision-makers more time in complex environments. This is a potential gain in stability. In addition, automated systems add redundancy features to ensure launch orders if necessary; although in reality, French researchers on these issues do not see the replacement of human responsibility by a fully automated device in these processes. However, they recognise that the increasing combination of human operators with machines will in many cases significantly improve the safety and reliability of C2 architectures in the future. Similarly, continued improvements in AI technology are likely to minimise risks in the longer term.[48]

The role of AI in cyber and exo-atmospheric spaces

Even if not directly related to nuclear deterrence, missions in space and cyber domains often integrate a strategic dimension. Consequently, the missions of the armed forces depend on the shared domains of space and cyberspace. Even if the strategic components are designed to be as resilient as possible, massive cyber-attacks would likely degrade their effectiveness.[49]

Similarly, military anti-satellite (ASAT) actions would have a potential impact on at least five strategic segments: navigation and its corollary, which is fundamental to modern systems; high-precision time synchronisation; earth observation (strategic reconnaissance); long-range communications; and, finally, early warning systems, which France does not have. However, the applications of AI in these two fields are promising, particularly for offensive applications.

The role of AI in nuclear and missile defence C2: AI and strategic defensive functions

The ability of a C2 structure to react faster than the enemy is considered a critical success factor: this is the contribution of Boyd's theories on the Observation-Orientation-Decision-Action (OODA) loop, which has been emphasised since the first Iraq war. This time factor is particularly critical in strategic systems, whether in the command posts of nuclear forces or in missile defence, when it comes to reacting to an enemy attack. In the case of an intercontinental ballistic missile launch, for example, the military level has, at best, a few minutes to assess the situation, communicate it to the political level with options for a defensive response (deployment of missile defence, warning of the population, etc.) or even an offensive response (nuclear strike as a second option), and to launch these options.[50]

In these conditions, Pierre Réal, then a military officer in the College for Higher Military Education, states that:

> "Any help from AI to analyse the situation and facilitate its presentation to the authorities is welcome. It can save dialogue, analysis time, and even requests for clarification from the other side. AI can also play a fundamental preliminary role thanks to its contribution to intelligence analysis, in particular the identification and tracking of enemy strategic systems and their vectors and platforms (launchers, aircraft, including stealth aircraft, submarines, etc.), with a level of efficiency far superior to current capabilities. *[Toute aide de la part d'une*

IA pour analyser la situation et en faciliter la présentation aux autorités serait la bienvenue. Elle permettrait de gagner sur le dialogue, le temps d'analyse, voire les demandes d'explication avec le camp adverse. L'IA peut également tenir un rôle préliminaire fondamental grâce à son apport dans les analyses de renseignement, en particulier le repérage et le suivi des systèmes stratégiques ennemis et de leurs vecteurs et plateformes (lanceurs, aéronefs y compris furtifs, sous-marins…) avec une efficacité très supérieure aux capacités actuelles.] "[51]

Regarding non-proliferation (both vertical and horizontal), AI could also be of help by processing large quantities of satellite images in order to improve the detection of suspect sites and new arsenals. This could be also done by external organisations (such as think tanks) through the democratisation of commercial satellite images, thus posing another problem of how to best use these experts in Open Source Intelligence. It is one of the risks (or advantages) identified by Corentin Brustlein, then head of the Security Studies Center at Ifri, in an interview after the publication of a RAND report on the links between AI and nuclear deterrence. He thinks that:

"AI is going to enhance military intelligence, and it could increase their efficiency for some very complex missions, such as strikes against mobile ballistic missile. AI-enhanced intelligence systems coud also weaken nuclear deterrence by making robust systems like SSBN more vulnerable, thus reinforcing fears of NWS about their own arsenals, hence that could lower the threshold for the use of nuclear weapons. *[On pense que l'IA va renforcer les capacités de renseignement et de discrimination des armées, ce qui pourrait décupler leur efficacité pour certaines missions jusqu'à présent très complexes telles que les frappes contre les lanceurs mobiles de missiles balistiques. En rendant plus vulnérables des systèmes jusqu'alors considérés comme relativement protégés, qu'ils soient terrestres ou sous-marins, les moyens de renseignement appuyés par l'intelligence artificielle affaibliraient la dissuasion nucléaire en exacerbant les craintes des puissances nucléaires quant à la protection de leur arsenal, et pourraient pousser ces puissances à recourir de manière plus rapide à l'arme nucléaire.]"*[52]

Another interesting consequence of AI on nuclear deterrence is the specific topic of modernisation and technologies enhanced by AI. A report published by the Senate in 2017 about the necessary modernisation of the French nuclear deterrent points out that:

"Through the combined effects of digitalisation, robotisation and growing use of AI, technology progresses even faster and the cost of access to innovation is getting lower. It necessitates a broader surveillance of these evolutions, because strategic breakouts can be issued from civilian programs of which it is now easier to reproduce the results in the military domain. *[Sous l'effet de la numérisation, de la robotisation et de l'utilisation croissante de l'intelligence artificielle, on assiste à une accélération des progrès techniques et de la baisse des coûts d'accès aux technologies innovantes. Cela impose une surveillance plus large de ces évolutions, car les ruptures peuvent être issues de programmes civils dont il devient facile de reproduire les résultats dans le domaine militaire.]"*[53]

It is especially true for AI as it is a very mixed technology, with innovations first occurring in the civilian domain and then being adopted by the military.

This dimension of AI integrated in NC3 systems is emphasised in a SIPRI report coordinated by Vincent Boulanain, a French researcher working for the Swedish think tank.[54] In an interview with French-speaking media after the publication of the SIPRI report, he notes that "the rapidity of reaction is key in a nuclear crisis". Thus, AI-enhanced algorithms, able to analyse mass data very quickly, "can give political decision-makers more time to take a decision. *[C'est une variable fondamentale en cas de crise nucléaire. Elle peut donner aux responsables politiques plus de temps pour prendre une décision.]"*[55]

It is also addressed more officially by Emmanuel Chiva, Delegate for Armament at the French MoD, in an official hearing at the Parliamentary Assembly about nuclear deterrence. Answering the question of a MP about AI and deterrence, he states that:

> "About the capability of better information processing in order to enhance early warning, we know that both partners and adversaries use that, but it does not challenge the bases of our deterrence. However, we keep an eye on it and future innovations by 2050-2060. *[En ce qui concerne la capacité à mieux traiter l'information pour obtenir une meilleure précision en matière d'alerte avancée, nos compétiteurs comme nos adversaires utilisent déjà ce type de techniques, sans que cela ne remette en cause les fondements de notre dissuasion. Nous devons néanmoins poursuivre cette veille active en matière d'innovation, en gardant à l'esprit l'horizon 2050 ou 2060.]"*[56]

The temptations of complete AI autonomy

An extremely theoretical use of AI would be to completely replace the human decision to retaliate after an initial 'decapitation' attack. Such an application is unthinkable in France, whether it be for conventional or nuclear systems. These are the conclusions of the Defence Ethics Committee's report on autonomous lethal weapons systems, quoted by Pierre Réal.

> "An 'on-board' AI responsible for an entire nuclear mission without human supervision, which would carry out the nuclear mission from beginning to end, cannot be accepted in French doctrine, whatever the directions taken in this field by other powers. Coupled with a C2 system that is also autonomous, such an architecture would create great uncertainty about the overall reliability of the system. *[Une IA « embarquée », responsable sans supervision humaine de toute une mission nucléaire qui effectuerait la mission nucléaire de bout en bout, ne peut être acceptée dans la doctrine française, quelles que soient les orientations seront prises en la matière par d'autres puissances.]"*[57]

At the last NPT Review Conference, France, together with the United States and the United Kingdom, proposed that the NWS should ensure that human control is maintained and involved in all critical actions to inform and execute sovereign decisions on the use of nuclear weapons. Additional declarations on the same page are needed in order to clarify – at least between allies – what the use of AI in the nuclear domain means.

AI: a factor of ambiguity in deterrence

Pierre Réal also notes that:

> "A great power that does not invest in AI, or that refuses to integrate it even in functions not related to nuclear weapons systems, risks losing the credibility of certain tactical means at the service of its deterrence. It runs the risk of weakening deterrence itself, especially in the face of an adversary with additional offensive capabilities in cyber and exo-atmospheric space. *[Une puissance dotée qui n'investirait pas dans l'IA ou qui refuserait de l'intégrer même dans des fonctions sans aucun rapport avec les systèmes d'armes nucléaires prendrait le risque de voir certains moyens tactiques au service de sa dissuasion perdre leur crédibilité, au risque de fragiliser la dissuasion elle-même, en particulier face à un adversaire disposant en plus de capacités offensives dans les espaces cyber et exo-atmosphérique.]"*[58]

Furthermore;

> "France could be confronted with powers that would communicate aggressively on the place of AI in their deterrence systems. A misunderstanding of the enemy's rules of engagement, of the effective level of delegation to AI compared to human supervision, could lead to a phenomenon of self-dissuasion on its part, for fear of provoking an uncontrolled escalation in the face of a supposedly unstable system. *[La France pourrait être confrontée à des puissances qui communiqueraient agressivement sur la place de l'IA dans leurs systèmes de dissuasion. Une erreur d'appréciation sur les règles d'engagement ennemies, du niveau effectif de délégation à l'IA par rapport à la supervision humaine, pourrait entraîner de sa part un phénomène d'auto-dissuasion, par crainte de provoquer une escalade incontrôlée face à un système supposé instable.]"*[59]

Ambiguity about the real role of AI on the other side would then act as an additional dissuasive factor.[60]

5. French observations on the military developments and applications of AI of the major powers

The benefits of AI as a potential for operational dominance are well understood by states. It is likely that concrete applications will be effectively developed and that AI will be used as a tool for strategic dialogue, for example, in the field of arms control.[61]

In any case, France will have to be able to adopt an attitude and a doctrine in line with its interests. Below are some understandings by French researchers and official documents about the AI doctrines and programs from the other nuclear weapons states.

a. The United States

Driven by the financial and institutional strength of the Defense Advanced Research Program Agency (DARPA), as well as the recent establishment of an endowed Joint AI Center within the Department of Defense (DoD) in 2018, published applications are primarily focused on decision-making or maintenance processes rather than combat tasks. Nevertheless, breakthroughs in these areas could have important implications for U.S. strategic systems, such as C2 components of missile defence, with both defensive and offensive applications, for example in pre-emptive and even preventive strike systems implementing the Prompt Global Strike concept.[62] Such progress, legitimately defended by the United States in the name of its extended deterrence responsibilities, could revive discussions within NATO on the relative weight of the various components of the Alliance's deterrent, based on a balance between nuclear forces, missile defence, and conventional forces. This is currently the subject of an evolving consensus among the 30 member states, which involves significant industrial stakes in the field of armaments.[63]

b. China

China is committed to a proactive AI policy, with massive investment, concrete results in terms of patents, and active pursuit of mergers and acquisitions abroad. As for military applications, the Chinese discourse is reassuring, focusing on the promotion of peace and arms control, including AI. This is classic Beijing rhetoric, tried and tested in other areas, including nuclear deterrence. Its reassuring nature, used for communication purposes, must be set against more worrying elements about how a regime can use technology without restraint. Moreover, informed observers of Chinese strategy point to the 'irrational' nature of the People's Liberation Army (PLA) military's infatuation with the potential of AI.[64] More specifically, the assertion of Chinese power in the China Sea, for example, involves advanced research into underwater robots for reconnaissance and countermeasures in the face of threats from American aircraft groups.[65] The long-term disruptions that this type of development could cause, with consequences for French interests in the area, require particular vigilance in the context of heightened competition with Beijing.[66]

France will have to be able to adopt an attitude and a doctrine in line with its interests.

c. The Russian case: AI as a compensation technology

Russia is developing a rich declaratory strategy on AI, reflected in modest investments compared to the American and Chinese powers, but also in concrete experiments on the ground. The Kremlin is seeking to demonstrate its capabilities in this field without getting bogged down in ethical debates, including with regard to nuclear deterrence systems. Faced with a complex equation, including a vast territory to defend, more technologically advanced competitors, modernisation slowed down by the economic crisis, manpower eroded by demographic change, and a decline in the number of professions, the Russian armies could see AI as a way of alleviating some of their difficulties thanks to the autonomy of their systems.[67] As with other Russian niches of excellence, the development of these systems, their use against NATO, or their proliferation through arms exports must be monitored.

d. Non-NPT NWS

As described by Benjamin Hautecouverture;

> "The force architectures of the nuclear-armed states have so far been very conservative regarding new technological inputs, given the safety and security criteria adopted in the developed economies. As the primary objective is not to create vulnerabilities or reduce the reliability of weapons, nuclear history points to the maintenance of a culture of robustness of proven systems. In this respect, one of the questions raised today by the impact of AI developments on deterrence is that of the security culture of the new states that have acquired nuclear weapons since the end of the Cold War (India, Pakistan and North Korea). *[Les architectures de forces des États dotés ont jusqu'à présent été très conservatrices s'agissant des nouveaux apports technologiques au regard des critères retenus de sûreté et de sécurité dans les économies développées. L'objectif prioritaire étant de ne pas générer de vulnérabilités ou de ne pas réduire la fiabilité des armes, l'Histoire nucléaire indique plutôt l'entretien d'une culture de la robustesse de systèmes éprouvés. A ce titre, l'une des questions que pose aujourd'hui l'impact des développements de l'IA sur la dissuasion est d'une part celle de la culture de sécurité des nouveaux États possesseurs de l'arme nucléaire depuis la fin de la Guerre froide (Inde, Pakistan, Corée du Nord).]"*[68]

Developments in AI could appeal to states facing difficulties of strategic depth or numerical inferiority, such as Israel or North Korea. Israel, already a very active player in cyber and AI, has in the past demonstrated its ability to research and deploy disruptive capabilities based on the latest technologies, such as the Iron Dome anti-projectile and anti-missile system, which also benefits from very broad US support. As analysed by Pierre Réal:

> "The destabilisation that could result from the disruption of the military balance in the region, in the context of the current reshaping of the Middle East and in the absence of a solution to the Israeli-Palestinian conflict, would have major strategic consequences for our country and for the entire European

continent. *[Les déstabilisations qui pourraient se produire par rupture des équilibres militaires dans la région, dans le contexte de recomposition actuel du Proche et Moyen-Orient, et en l'absence de règlement du conflit israélo-palestinien, auraient des conséquences stratégiques majeures pour notre pays et l'ensemble du continent européen.]"*[69]

6. Conclusion and recommendations

Deterrence is first and foremost a dialectic and a balance of power between two political wills. With a solid doctrine in this field, France is therefore in a position, within Europe, to respond to the questions raised by AI by demonstrating its quality as a responsible power committed to international law, multilateralism, and strategic stability. In particular, the robustness of its chain of command and its choices in terms of governmental control, which necessarily imply human supervision, are regularly recalled. This doctrinal work is intended to prevent any challenge to French defence strategy by delegitimising the choices of powers that do not respect its moral concerns.

More than AI, it is the increase in the speed of operations that is perceived as a source of strategic instability. The various risks identified in the analysis are exacerbated by the uncertainty in which the actors in the chains of command find themselves and will find themselves when faced with the functioning of the adversary's autonomous systems:

> "The lack of mutual knowledge of technological developments in the armed states is a risk factor in itself. If AI applications can improve strategic stability, it will be thanks to forms of coordination between states that make it possible to avoid or minimise the emergence of new phenomena of asymmetry in a dynamic of technological reaction. *[La méconnaissance mutuelle des développements technologiques dans les États dotés est bien un facteur de risque en tant que tel. Si les applications de l'IA peuvent améliorer la stabilité stratégique, ce sera grâce à des formes de coordination entre États permettant d'éviter ou minimiser l'émergence de nouveaux phénomènes d'asymétrie dans une dynamique d'action réaction technologique.]"*[70]

Consequently, concrete recommendations can be developed from this analysis, both on a domestic and international level for France:

1. **Building a stronger community of researchers, officials and private sector on AI and its impact on nuclear deterrence.** Even though some initiatives such as the Réseau Nucléaire & Stratégie aim at creating a new generation of strategists and researchers on nuclear policy and industry, it could be interesting to fund additional scholarships, to create a chair on these topics in academia, or to support a seminar on this subject.

2. **Strengthening the links between the public and the private sectors.** As it was demonstrated in the review, misunderstandings about AI can fuel wrong analyses about its impact on military and nuclear strategy. Getting together data scientists and computer scientists, with IR specialists and nuclear experts could be helpful.

3. **Supporting a P5 initiative on AI and risks related to the NC3.** The P5 process on Strategic Risks Reduction, including the Youth Group, could be a good arena to push for these topics. In this P5 process, a statement about the necessity to keep humans in the loop, and to introduce strong means of crisis communication in order to avoid inadvertent escalation, could be a good initiative.

More than AI, it is the increase in the speed of operations that is perceived as a source of strategic instability

In a broader sense, France should seek to play a leading role in the debate on AI arms control, not only to address the two issues of maintaining the initiative and anticipating strategic dilemmas, but also to prevent any strategic rupture. AI is a new field of investment and competition between the two great powers but it is also a tool for others to catch up in all areas of conflict, could provoke future arms races harmful to its security interests. International forums such as the REAIM Conference could also be used by France to spread its ideas and to be visible on the scene.

In conclusion, in the specific realm of the AI-nuclear nexus, additional research produced and written in French is needed in order for France to immerse itself within these debates and to better understand the points of view of its allies and adversaries on these matters. Even though carefulness is necessary while dealing with nuclear deterrence, such a prudish approach can only be undermining in the long term.

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