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The 7 Technologies that will Revolutionise the Battlefield by 2040

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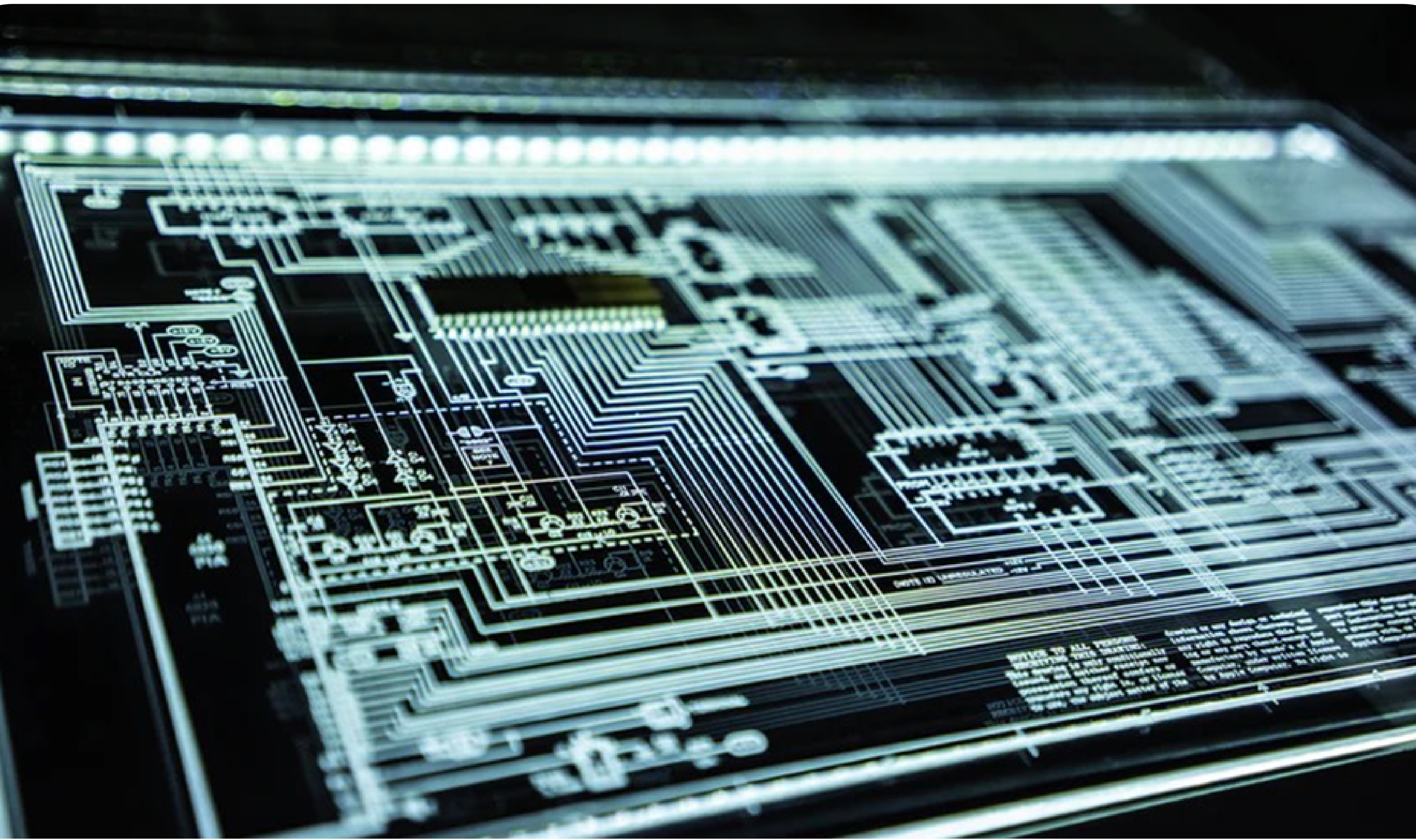

Introduction

In this article, we will present the seven technologies under development, which are at different stages of technological maturation, but which all have the potential to profoundly transform the battlefield by 2040, to the point of creating new forms of war or confrontation hitherto unknown, or even to render obsolete certain technologies which today represent a strategic pivot of the organisation of La Défense: directed energy weapons, quantum computers, hypersonic weapons, intelligence artificial intelligence, rail guns, robotics and the controversial neutrino detectors.

Directed Energy Weapons

2022 will be a crucial year in the emergence of directed energy weapon technologies, namely laser weapons and microwave guns. Indeed, this year, the Guardian of the US Army, also called DE-SHORAD for Direct Energy – Short Range Air Defense will enter the service. The Guardian will indeed be the first high-power mobile anti-aircraft and anti-drone defence system to join combat units, with a power of 50 Kw sufficient to take on category 1 to 3 drones, that is less than 25 kg, but also to intercept and destroy artillery and mortar shells, and the lightest air-to-surface missiles. This same year, the destroyer USS Preble of the Arleigh Burke Flight IIA class will also be equipped with a self-defence laser system, the Helios system, with a power of 60 Kw. In Israel, Prime Minister Naftali Bennet confirmed, on February 1, that the armies will have, "in less than a year", a laser weapon system called "Laser Wall" using a 100 Kw laser to reinforce and partly replace the Iron Dome system to defend the country from Hamas-led rocket and mortar attacks.

This craze for directed energy weapons responds to an urgent need, to counter potential attacks from light drones, vagrant ammunition, rockets and artillery. Indeed, most of these threats have a meagre unit cost, allowing the adversary to implement saturation campaigns at a lower cost. At the same time, the missiles used to counter them have a unit cost of 10 to 50 times greater. In addition, a 100 Kw laser can destroy a target up to 20 km away, where an artillery CIWS system can only be effective at less than 4 km, often less, requiring the deployment of 25 times more CIWS systems to cover the same area. However, the development of directed energy weapons is still in its infancy today, and many technological obstacles remain to be overcome to use these new systems' full potential.

The first of them is the sheer power of these armaments because if a 50 or 100 Kw laser can effectively eliminate light drones or homemade rockets, it is necessary to provide much higher power, beyond 300 Kw, to be effective against heavier cruise missiles, aircraft or drones. However, increasing the power of combat lasers is a trivial subject since it is not only necessary to have the technology to create a laser of this power, but it is also necessary to be able to supply these systems with electrical energy. Moreover, whether it is the production of power or the laser itself, they all produce a huge quantity of heat which it is necessary to dissipate to sustain a sustained and repeated engagement, posing significant challenges in terms of materials but also infrared radiation. At the same time, multispectral stealth has become a priority for all fighting forces.

Quantum computers

If there is one area of physics that has seen significant progress over the past 30 years, it is quantum physics and its many applications. Suppose the effectiveness of this technology has yet to be demonstrated. In that case, there is one area in which the quantum revolution is well and truly underway, with considerable consequences in terms of defence, the famous quantum computers.

This technology is not new since the first quantum processor was designed in 2009 by researchers at Yale University. However, the arrival of accurate operational and non-experimental quantum computers has not yet taken place, mainly because to manipulate Qubits, it is still necessary to use "cold atoms", i.e. at -273° c. However, colossal investments are being made in the United States, and in China, Russia, and Europe to make this technology operational and embeddable, particularly in weapon systems. Indeed, a quantum computer can perform much more complex operations than current computers in a single operation, making this technology say that it constitutes a wall whose crossing would open up great operational prospects. One of the most radical applications of this technology, once mastered, will be to decode almost in real-time all the encryption codes used by the adversary, whatever their level of complexity.

Hypersonic Weapons

In recent years, and more specifically since Vladimir Putin's announcement in 2019 of the entry into service of the Kh47M2 Kinzhal hypersonic airborne missile, the field of hypersonic weapons has gone from a subject of interest to a significant priority for many countries, in particular for the United States, which until then felt that it had a substantial technological lead in this area. Since 2019, the US Army, the US Air Force and the US Navy have undertaken no less than five hypersonic weapons programs, depending on whether they are airborne, land-launched or from a ship, and depending on whether they use classic ballistic kinetics with a rocket engine, or a super ramjet-type aerobic engine also called a Scramjet.

It must be said that hypersonic weapons, particularly tactical ones, will be a major game-changer on the battlefield. First, there is currently no missile defence system capable of effectively opposing this weapon. Even the much-vaunted American THAAD, SM3 and Patriot PAC-3 are not able, today, to intercept a missile with the flight profile of a Kinzhal. In addition, hypersonic missiles considerably reduce the reaction time of defenders due to their high speed and a low trajectory taking advantage of the masking of the earth's roundness to get closer to the target as close as possible, before knocking.

However, the implementation of hypersonic weapons is still far from operational. Thus, the shielding necessary to withstand the very high heat resulting from the friction of the air on the projecting parts of the missile constitutes a severe obstacle to installing a seeker system there. In addition, the world's armies have begun designing systems specifically intended to counter these hypersonic threats, as is the case in Europe with the TWISTER program. However, the implementation of hypersonic weapons will undoubtedly represent a significant step in the evolution of offensive and defensive military capabilities for many armies in the coming years. It could drive a wedge between armies with this capability, as well as capacities to guard against it and others.

Artificial Intelligence

Receptacle of many fantasies, the arrival of Artificial Intelligence (AI) within the armies has been underway for almost a decade. Essentially, it is, above all, a question of taking advantage of the increased computing capacities of the systems, the increase in the sources of information, and the capabilities of traditional AI to process a lot of data very quickly to have of the most exhaustive analysis possible without being impossible to assimilate by its amplitude for a human brain, and thus allowing efficient decision-making. However, in many aspects, the use of AI in the armies is, today, only at an initial stage, and many advances are to be expected in the years to come.

One of the most advanced and ambitious programs in this area is the US Air Force's Skyborg program. The latter is indeed developing an AI that would be able to pilot several types of drones autonomously, but also to interact with its environment, particularly with the piloted devices of which it would be the extension. The complexity of this program is obvious since where the majority of current uses of AI are single-tasking, it is a question here not only of responding to the priority piloting mission but also of integrating effectively into a dynamic environment, the aerial battlefield, and to adapt to the instructions and needs of other devices, in particular piloted machines, with all the complexity that a man-machine interface can represent in this context. The same goes for the US Navy's autonomous ship programs or the land drone programs developed by the US Army.

Therefore, the future challenge of combat AI goes far beyond optimised analytical processing to become an extension of the human fighting force, a sort of over-multiplier of the performance of a fighter, whoever he is. However, the development of such systems represents an important step and a significant step to cross regarding the existing in this field. Thus, to date, there is still no AI capable of moving effectively in all terrain, constituting a major obstacle in developing combat drones.

Electric guns or Rail Gun

Some may be sceptical about the presence of rail gun technology in this list of disruptive technologies for 2040. After all, the US Navy has thrown in the towel regarding its Rail Gun program, after more than ten years of substantial investments. But it is important to remember that the judgment of the American military is not infallible. And the fact is, several countries continue, for their part, to invest and develop the technology of the electric gun, or Rail Gun, including France, within a European program called Pilum.

It must be said that the theoretical promise of the Rail Gun has something to seduce since it is no more and no less than putting artillery back at the heart of the offensive and defensive system of armies instead of expensive and vulnerable missiles currently in service. Schematically, a rail gun is a cannon that uses a powerful electromagnetic field to propel a shell at very high speed, beyond Mach 4 out of the muzzle, to reach ranges and altitudes currently inaccessible to conventional artillery. In addition, ignoring the thermochemical reaction that traditionally propels artillery shells, the Rail gun would simplify logistics and limit the risk of secondary explosions in the event of an attack. As such, the Rail Gun would represent an economical and highly effective alternative to anti-aircraft, anti-missile, and long-range artillery missiles and rockets.

However, the Rail Gun technology is still far from operational, if indeed it is in the more or less near future. Indeed, the Rail Gun requires a substantial power supply to operate. In fact, the existing prototypes of electric guns all come up against these problems today, with very rapid fatigue of the parts of the weapon requiring them to be replaced after only a few shots, the impossibility of embarking guidance systems in the projectiles likely to strike at more than 200 km, and the need to have a small electrical plant near the gun to supply it.

The robotics

Of all the disruptive technologies presented here, robotics is indisputably the one that will go most resounding into all battlefields in the years and decades to come. Whether developing aerial combat drones, autonomous ships and submarines or ground combat robots, whether used for reconnaissance, logistics or combat, whether piloted by a human, autonomous or directly implanted on humans in the case of exo-suits, robotics is becoming more and more part of the daily lives of all soldiers, at all levels, for all missions and all battlefields, including in space.

While in the area of disruptive defence innovations, the traditional pattern is Top-Down, with a handful of large technology nations developing key technologies and then distributing them to their allies and customers, the trajectory followed by part of the current battlefield robotisation is of the Bottom-Up type, with applications, and even critical technological developments, coming from isolated small groups, or countries not renowned for their technological advances. This is particularly the case today in the Persian Gulf with Iran, which has developed a large number of aerial and naval drones of different sizes and functions, and uses them against the Gulf monarchies through the intermediary of the rebels.

If the robotics revolution has had difficulty taking root in many staff's minds, particularly in Europe. In that case, it is now perfectly integrated, and it is to be expected, in the next few years, that the robotic reality will become as common at all levels of an army as digital systems today or traditional weapon systems.

Neutrino detectors

Brought to the fore in France by a candidate for the presidential election, neutrino detectors have the reputation of being a technological sea serpent. Not without reason, it is true, since the first references to this system would theoretically be capable of detecting the radiation emitted by a nuclear reactor in operation, including underwater, and therefore of locating submarines and aircraft carriers with nuclear propulsion, were published in the early 90s. On several occasions, however, limited advances in this field gave rise to speculation on the end of the submarine component of nuclear deterrence, yet the unwavering pillar of the second strike strategy at the heart of the deterrence doctrines of the five permanent members of the Security Council.

The problem is all the more significant in that the design of these ships is both very expensive, between 6 and 12 billion euros for SSBNs and nuclear aircraft carriers. Between 1.5 and 3 billion euros for the SNAs, and very long, France having rightly announced the start of the SNLE 3G project aimed at modernising its submarine deterrent component. France is not the only one in this case. The British have also started the construction of their new Dreadnought-class SSBNs, the United States of the Columbia-class SSBNs and Ford-class nuclear aircraft carriers, Russia's SSBN Boreï M and China's future SSBN Type 096 as it simultaneously develops a new class of nuclear-powered Type 004 aircraft carriers, all aiming for entry into service within the next 20 years.

However, there are still many unknowns in this file, whether it concerns the reliability of the detection itself about the level of use of the nuclear reactor, the practical accuracy of this detection, and obviously the context of operational use of this technology to be effective. The fact remains that even if it were to be ineffective, imprecise, and very restrictive to use, it could pose a significant threat to the effectiveness of the submarine component of deterrence, potentially obliging nuclear nations to multiply the number of submarines at sea to increase operational resilience. Moreover, it is more than likely that in the near future, this technology will upset the concept of nuclear deterrence inherited from the 1960s and still rules today.

Conclusion

Obviously, the recent increase in international tensions, and the renewed military competition between great powers, have largely stimulated technological research in recent years. And as it was almost impossible for a soldier in 1955 to imagine the arrival of the F-15, F-16 and other M1A1 in 1975, it is presumptuous today to think of being able to anticipate with certainty the technological panel which will be the basis of the military balance of power in 2040. This observation invites us to reconsider the timetable for certain major programs, such as in the case of SCAF and MGCS, which are certainly very ambitious, but projected with an immediate vision into a much more uncertain, and with operational constraints that are hard to imagine today. Like the technological tempo that served as a benchmark in the 1950s and 1960s, another period of rapid innovation and transformation of the defence technological environment, it could be effective and useful to aim for less ambitious technological objectives but less hypothetical and to accelerate the succession and the linking of programs, as do, by the way, the Russians and Chinese do today.

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