Global Military Perspectives on Quantum Technologies

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Abstract — In recent decades, a technological impactful movement on society is being visualized: the second quantum revolution; a consequence of decades of advances in nanotechnology and atom by atom assembly of materials, thus, enabling to take the advantages of phenomena intrinsic to quantum mechanics, such as superposition and entanglement, to design quantum devices possessing novel or better capabilities. Alongside, a new dimension of war, a quantum domain, concerns governments worldwide, as well as private parties, especially connected to the industry sector. Managing resources to the most promising military applications in quantum technology is a subject in an ongoing discussion in terms of political and strategic planning. With that, an auspicious schedule and a favorable political-financial global plot has its origin in the present days. This article gives a global overview of the main political perspectives, American and European, on contemporary quantum technologies and their potential general and military applications.

I. INTRODUCTION

A technological revolution is currently happening in every branch of the social development panorama, giving birth to the field of Quantum Information Science and Technology (QIST).Inevitably, the military usage of quantum technology became crucial for political and strategical planning of many governments. This subject points out to the establishment of different initiatives around the world with multiple parties and to direct management of this subject by the government. Either way, the rising involvement of various parties with this affair in recent years is notable [1].

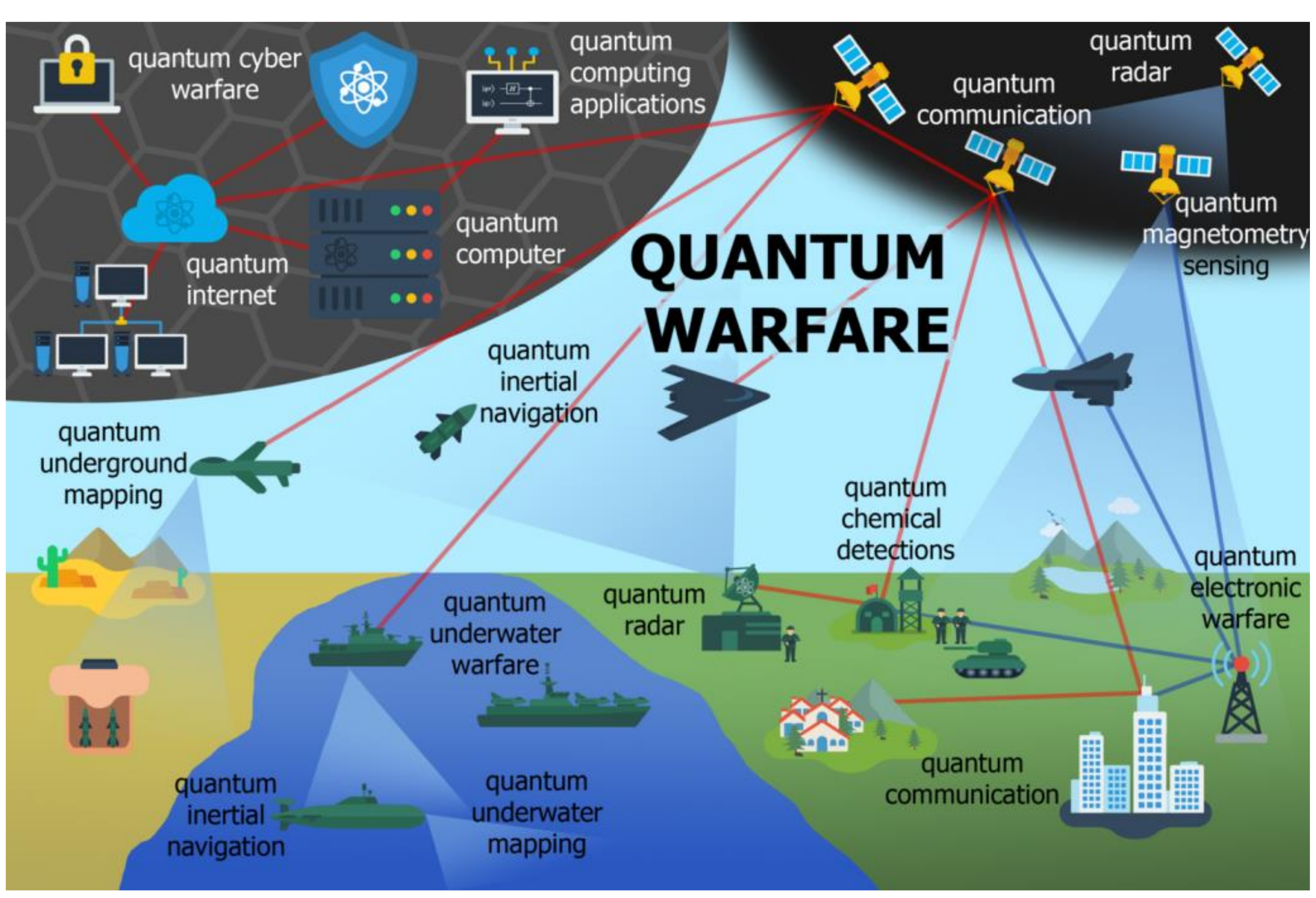
II. QUANTUM TECHNOLOGIES

One of the definitions of quantum technology concerns its core potentials, which translates the theory in practical application. Under this perspective, quantum technology has not yet reached maturity. However, several applications can be visualized:

- **Quantum Computing and Simulations**: It can be defined as an alternative way to process information. We use a basic set of quantum systems to simulate more general types of quantum systems. The two-level quantum system (qubit) is used to encode information via the superposition of many quantum states. By measuring the qubit, the quantum system collapses, and we obtain the answer of the problem – which may provide a "quantum advantage" in some cases [2].
- **Quantum Communication and Cryptography**: It consists of transmitting data encrypted through a classical channel while using quantum bits as keys to decrypt the information. For instance, we can use photonic qubits to transmit data in optical cables via quantum states in superposition. Thus, when a bad actor tries to intercept the communication, the superposition state collapses immediately, and we detect the hacking activity. That is the core principle behind the Quantum Key Distribution (QKD) [3].
- **Quantum Sensing and Metrology**: It consists of using a quantum object to measure a physical quantity. We can use quantized energy levels or quantum coherence to achieve this goal. Due to its high precision and sensitivity, quantum sensing might have several applications in Engineering and Applied Physics, for instance [4].

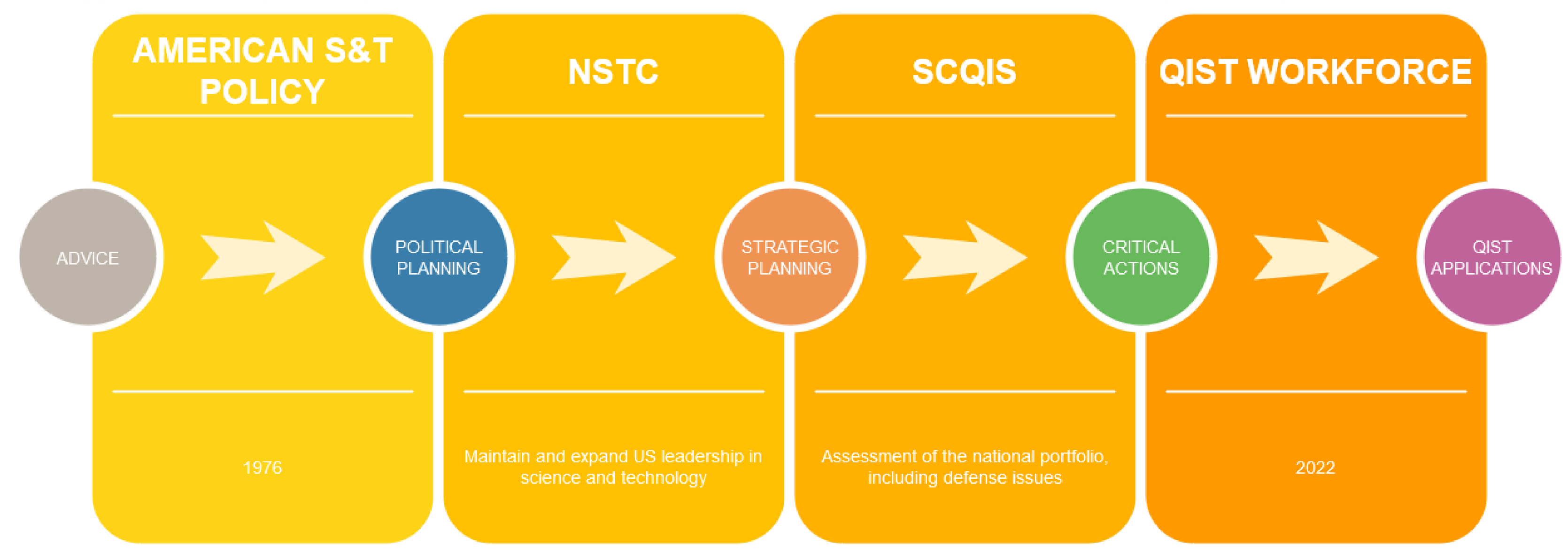
III. MILITARY APPLICATION OF QUANTUM TECHNOLOGIES

Especially from World War II until now, the purpose of the utilization of technology on war is studied by military leaderships and the investment in military technology by the states is increasing significantly, as well as the amount of academic research on this topic. A new dimension of war, a quantum domain, is visualized, in which the comprehension of time, space, and matter are different from the classical and, therefore, the classical warfare is disrupted from whatever existed before. In order to visualize the main implications of quantum technologies on a hypothetical warfare, the figure below suggests the military applications and mentions the probable capabilities and performances [5][6]:

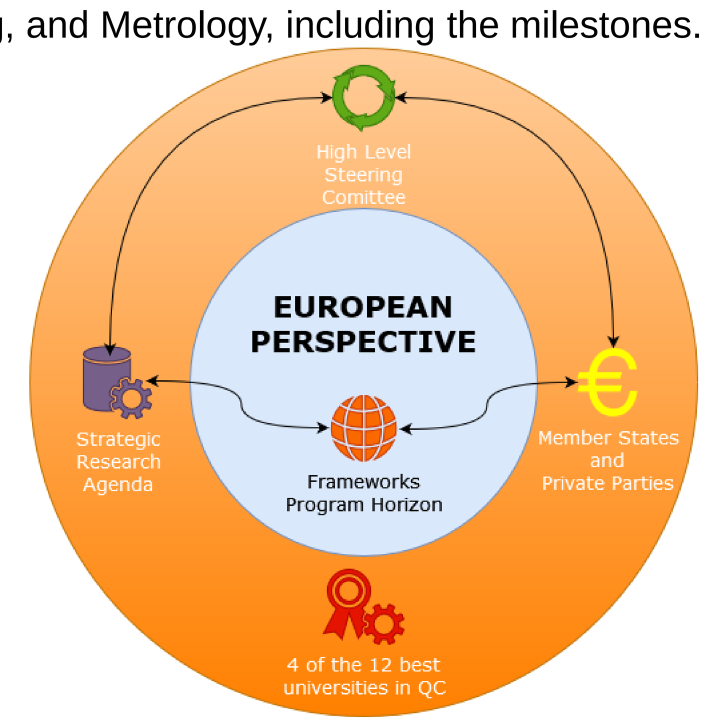


IV. GLOBAL OVERVIEW ON QUANTUM TECHNOLOGIES

The **American Perspective** is linear, which includes government institutions to provide advice, planning and execution of a Science and Technology (S\&T) development agenda: The National Science and Technology Council (NSTC) Subcommittee on Quantum Information Science (SCQIS):



The **European Perspective** follows the Framework Program Horizon since 1980s. With the ninth Framework Program Horizon Europe, which covers the years 2021-2027, the High-Level Steering Committee has released a Strategic Research Agenda in 2020, which includes the achievements and expected goals for near, mid and long term future around major areas: Quantum Communication, Computing, Simulation, Sensing, and Metrology, including the milestones.



V. REMARKS

- **Remarks on China:**

China's quantum technology funded subjects include quantum information research, quantum control and sensing, quantum materials, quantum dots, quantum cryptography and quantum chips.
Open source documents prospects, at least, an investment of 25 billion US dollars by Chinese government in quantum technology, without including private investment, from mid-1980s to 2022.

- **Remarks on Brazil:**

At the national level, the main coordinated effort is the *Conselho Nacional de Desenvolvimento Científico e Tecnológico / Fundação de Amparo à Pesquisa do Estado do Rio de Janeiro* (CNPq/FAPERJ) funded *Instituto Nacional de Ciencia e Tecnologia de Informação Quântica (INCT-IQ)*, that aims the development of basic research which leads to the development of quantum computing and communication technologies. This Institute has 120 researchers of 29 universities and institutes across the country. The possibility of Brazil being a player in quantum technologies will depend on reenacting the same environment that created the Brazilian Aerospace industry.

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