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Original Paper

The Prospect of Electronic Warfare in the 21st Century: An Analysis of Electronic Warfare Equipment Innovation and Its Strategic Impact Based on the Fusion of Quantum Communication and Artificial Intelligence

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Abstract

The rapid development of science and technology is driving the shape of electronic warfare to change dramatically, especially under the influence of quantum communication and artificial intelligence (AI) technology. This article comprehensively explores innovative approaches to the development of electronic warfare readiness in the 21st century, with a focus on the composite application of quantum communication technology and artificial intelligence technology in modern electronic warfare equipment. The non-reproducibility and anti-interference characteristics of quantum communication, as well as the rapid decision making and learning ability of artificial intelligence, are studied in this

paper, and the impact of this technology fusion on the strategy and tactical execution of electronic warfare is further discussed. Using quantum communication, the communication security of electronic warfare system is greatly enhanced. The introduction of artificial intelligence can optimize tactical decisions and improve response speed. In addition, the paper also discusses the far-reaching impact of these technological integration on the global strategic security pattern, pointing out that it will promote the change of electronic tactics and bring new strategic competition focus. Finally, the paper puts forward some suggestions for the future research and development of electronic warfare equipment, emphasizing the need to find a balance between technical advantages and ethical regulations.

Keywords

Quantum communication, Artificial intelligence, Electronic warfare strategy, Secure communication, Tactical decision

1. Introduction

In the context of the 21st century, the importance of electronic warfare has become increasingly prominent, followed by the intervention of new technologies, such as quantum communication and artificial intelligence, to make a completely new rewrite. The participation of quantum communication ensures the security of communication, and its special protection is difficult to eavesdrop and destroy, which undoubtedly brings higher communication security. On the other hand, the application of artificial intelligence has accelerated the speed of military decision-making and optimized the strategy of enemy and us. Therefore, this study will explore how the two can be combined to change the basic face of electronic warfare with a new look, and theoretically explore the new challenges it may open up. The pace of the development of science and technology should go hand in hand with the requirements of safety and ethics, escort the development of technology, maintain its behavior and set its trend.

2. Overview of Electronic Warfare

2.1 Definition and Development of Electronic Warfare

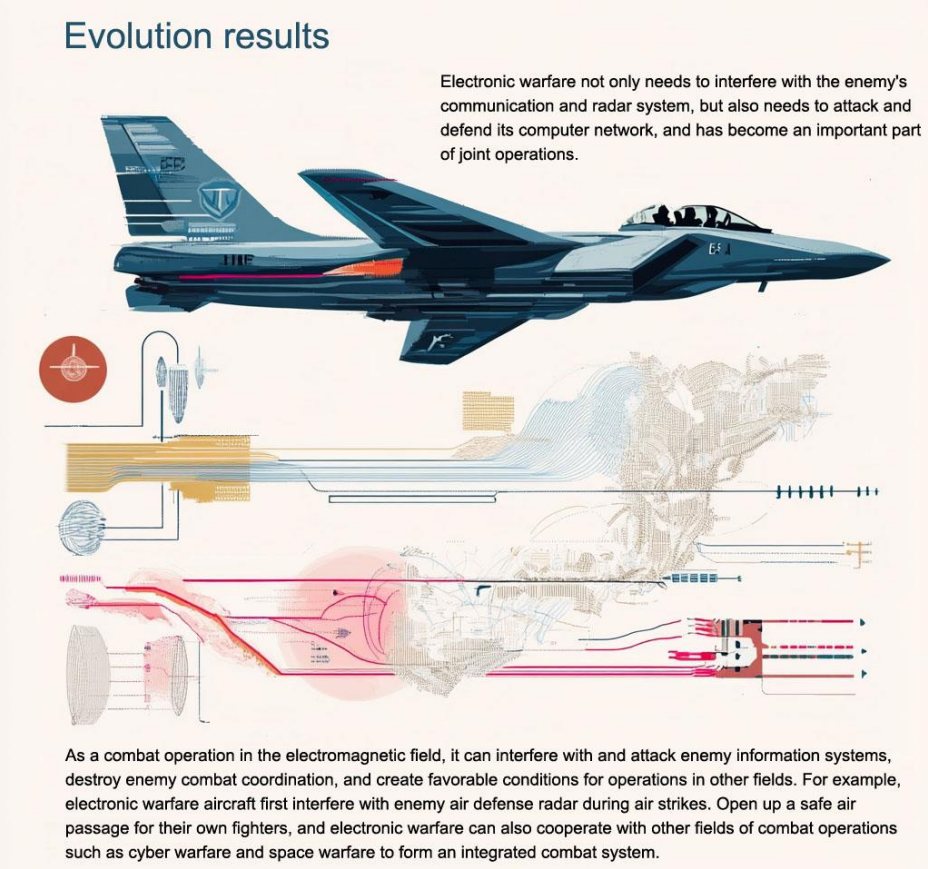
2.1.1 Basic Concepts of Electronic Warfare

Electronic warfare (EW) can be defined as military operations carried out using the electromagnetic spectrum to obtain battlefield advantages by detecting, jamming, attacking enemy information systems and protecting their own information systems. It is mainly divided into attack, jamming and countermeasures. Offensive EW involves hard damage to enemy electronic equipment (such as destroying enemy radar with anti-radiation missiles); Jamming electronic warfare is to send specific electromagnetic signals to disrupt the normal operation of enemy communications, radar and other electronic equipment; Counter-electronic warfare is mainly used to defend and counter enemy electronic attacks (such as using electronic camouflage, anti-jamming technology, etc.). The history of electronic warfare dates back to the early 20th century, with the advent of radio communication technology, and the jamming and interception of enemy communications during World War I, when

simple radio jamming devices were used to destroy enemy communications. During World War II, the advent of radar made electronic warfare more important, and countries began to develop specialized electronic reconnaissance and jamming devices (such as chaff to jam enemy radars). Electronic warfare during the Cold War pushed the development of electronic warfare technology, and countries developed more sophisticated equipment (such as electronic reconnaissance satellites, electronic jamming aircraft, etc.). Entering the information age, electronic warfare has developed from a simple interference countermeasure into a part of integrated information warfare. The rapid development of information technology has promoted its scope to expand from traditional radio countermeasure to computer network, satellite communication and other fields of interaction.

2.1.2 Evolution of Electronic Warfare in Modern Warfare

During the transition from the Cold War to informationized warfare, electronic warfare has undergone remarkable evolution. During the Cold War, electronic warfare focused on jamming and reconnaissance of enemy radar and communications systems, and both sides vigorously developed related equipment to obtain intelligence and disrupt the other's military operations. After the end of the Cold War, with the rise of information-based war, electronic warfare has become more and more important, because in information-based war, information acquisition, transmission and processing are the key factors to determine the outcome. Therefore, electronic warfare not only needs to interfere with the enemy's communication and radar system, but also needs to attack and defend its computer network, and has become an important part of joint operations. Close coordination with the army, sea, air and other military operations. In multi-domain operations (emphasizing simultaneous operations in land, sea, air, space, electricity and other fields to gain comprehensive battlefield advantages), electronic warfare plays a crucial role. As a combat operation in the electromagnetic field, it can interfere with and attack enemy information systems, destroy enemy combat coordination, and create favorable conditions for operations in other fields. For example, electronic warfare aircraft first interfere with enemy air defense radar during air strikes. Open up a safe air passage for their own fighters, and electronic warfare can also cooperate with other fields of combat operations such as cyber warfare and space warfare to form an integrated combat system.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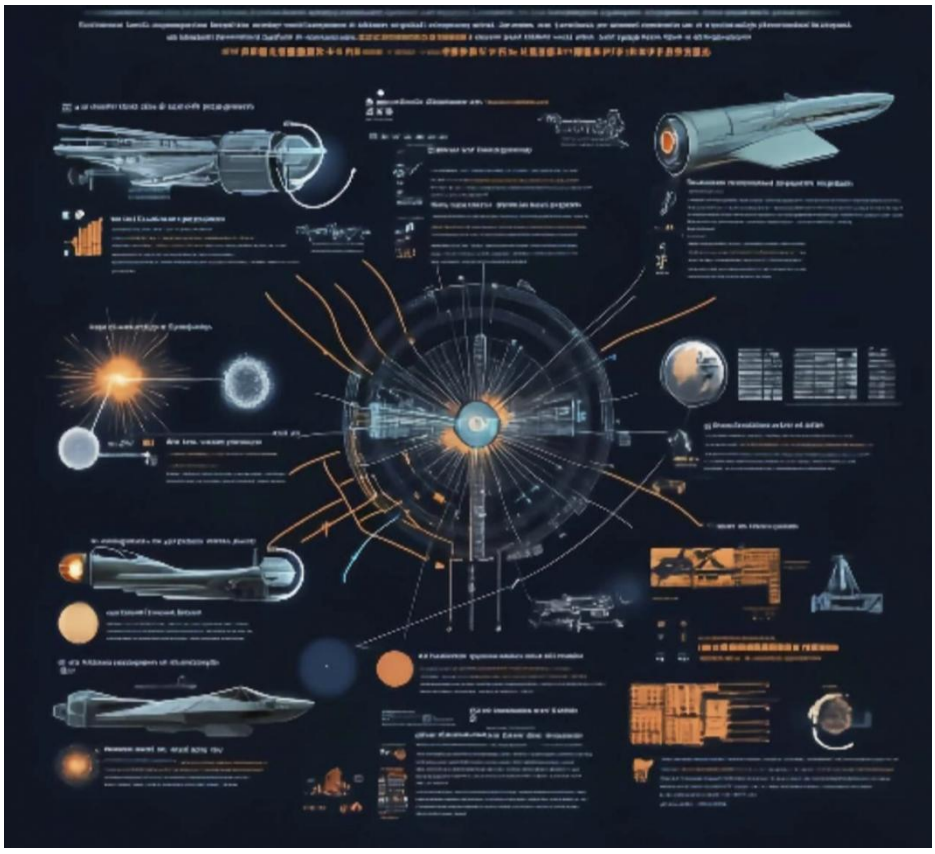

Figure 1. Evolution of Electronic Warfare in Modern Warfare

2.2 Importance of Electronic Warfare

2.2.1 Competition for Information Superiority

In modern war, the ability of information acquisition and processing is one of the key factors to decide the outcome. Electronic warfare plays an important role in the battle for information superiority. By means of its reconnaissance and monitoring of the enemy's electromagnetic spectrum, electronic warfare can obtain key information such as the content of enemy communications and radar signals to provide basis for its own operational decision-making, and destroy its information superiority by interfering with the enemy's information transmission and processing system. Taking naval warfare as an example, the radar signal of an enemy ship can obtain its position, speed and other information to provide target indication for its own ship's attack, and interference with the enemy's communication system can destroy its combat coordination, making it impossible for the enemy to effectively command and control troops. The Gulf War is a typical example of the successful application of electronic warfare. The electronic warfare aircraft of the US military interfered with the Iraqi air defense radar on a large scale, paralyzing its air defense system, and the electronic reconnaissance equipment obtained the communications content and combat deployment of the Iraqi army to provide accurate intelligence support for their own air strikes. However, in some local conflicts, one party is passive because it ignores the importance of electronic warfare. For example, in some regional conflicts,

one party lacks effective means of electronic warfare, and the communication and radar systems are interfered with by the enemy and cannot work normally, and eventually the operation fails.

2.2.2 Improvement of War Situation Awareness

Electronic warfare can obtain real-time battlefield electromagnetic situation information through the monitoring and analysis of the enemy electromagnetic spectrum, which not only provides real-time battlefield situation awareness for combat commanders to assist them to make correct decisions, such as analyzing enemy radar signals to judge their air defense deployment and operational intent. And electronic warfare can also be combined with satellite reconnaissance, unmanned aerial vehicle reconnaissance and other intelligence reconnaissance means to build a comprehensive battlefield situational awareness system. In addition, the intelligence information obtained by electronic warfare can be integrated with other intelligence sources to form a more comprehensive and accurate battlefield situational awareness, for example, the communication content obtained by electronic reconnaissance and the image information obtained by satellite reconnaissance can be more accurately judge the enemy's combat deployment and operational intentions. At the same time, with the help of multi-level situational awareness, electronic warfare can provide battle commanders with battlefield information at different levels. For example, macro monitoring of the enemy's electromagnetic spectrum can grasp the overall electromagnetic situation of the battlefield, while micro monitoring of the enemy's specific electronic equipment can obtain its specific operational information.

2.2.3 Both Offensive and Defensive Electronic Warfare Strategy

In electronic warfare, both defensive electronic warfare and active offensive electronic warfare play an important role. Defensive electronic warfare mainly uses electronic camouflage and anti-jamming technology to protect its own information system from enemy electronic attacks; Active offensive electronic warfare is to gain battlefield advantage by jamming and attacking the enemy's electronic equipment and destroying its information system. In actual combat, it is necessary to flexibly use the two according to the battlefield situation and balance the relationship between the two, for example, when the own side is in a defensive situation, it needs to strengthen defensive electronic warfare measures to protect important targets, and when it is in an offensive situation, it can appropriately strengthen active offensive electronic warfare to destroy the operational coordination of the enemy. The construction of integrated electronic warfare system is very important to improve the effectiveness of electronic warfare. The system should cover electronic reconnaissance, electronic jamming, electronic attack, electronic protection and other aspects to form an integrated combat capability, and should be combined with the combat systems of the army, sea, air, space and other services to build joint combat capabilities. For example, in air strikes, electronic warfare aircraft can cooperate with fighters and bombers to jam enemy air defense radar to open up a safe passage in the air for their own fighters, and then fighters and bombers to attack enemy targets.

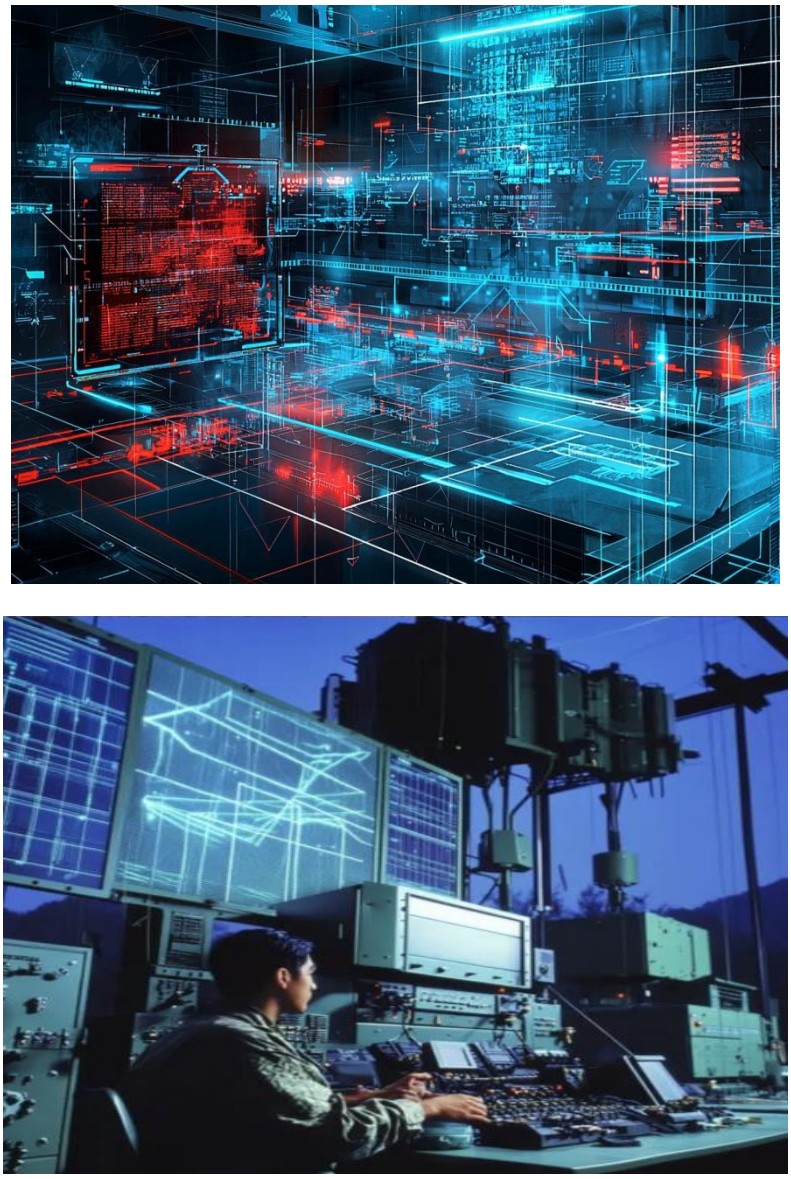

Figure 2. Both Offensive and Defensive Electronic Warfare Strategy

3. Overview of Quantum Communication and Artificial Intelligence Technology

3.1 Quantum Communication Technology

3.1.1 Basic Principles and Key Features

Quantum communication is based on the principles of quantum mechanics, in which qubits are the basic units of quantum information and, unlike traditional binary bits, can be in a superposition of multiple states (as shown in Figure 1). Quantum entanglement is a special quantum phenomenon. There is a special correlation between two or more quantum systems in an entangled state. No matter how far the distance is, the measurement of one quantum system will affect the other entangled systems instantaneously, which provides unique advantages for quantum communication, such as realizing long-distance instantaneous information sharing. Quantum key distribution (QKD) uses the

non-reproducibility and measurement disturbance of quantum states to ensure communication security. In the process of QKD, the communication parties generate shared keys by sending and receiving quantum states. Due to the characteristics of quantum states, any eavesdropping behavior will be detected. QKD has a wide application prospect in military communication, finance and other fields with high information security requirements, and can be used to encrypt military command communications and protect financial transaction data.

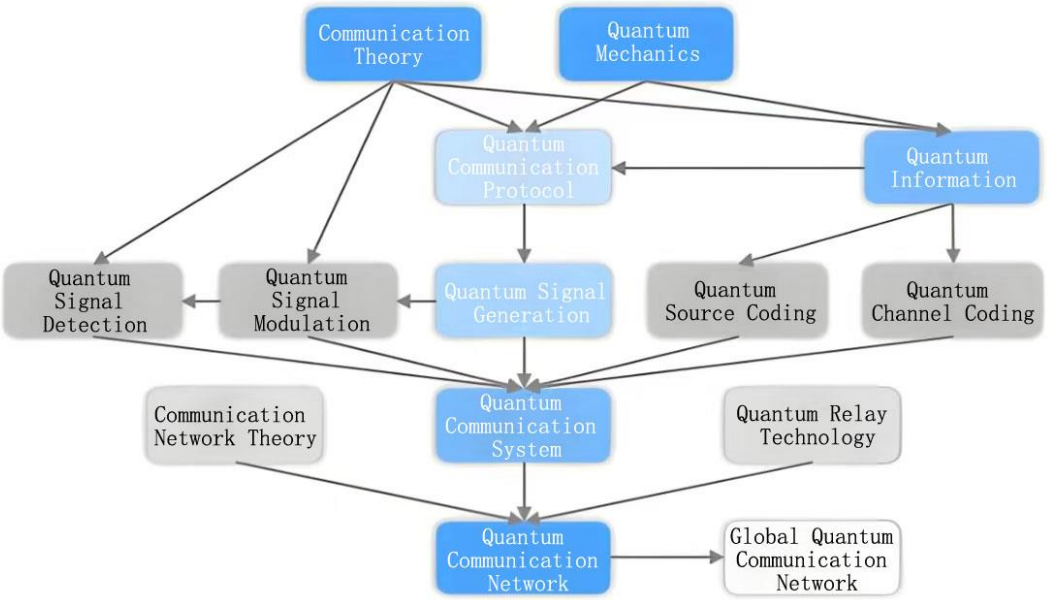

Figure 3. Overview of the Development of Quantum Communication Theory

3.1.2 Security Advantages and Information Transmission Applications

The traditional communication mode is easy to be eavesdropped and attacked because the information is transmitted in a reproducible form. Quantum communication, on the other hand, takes advantage of the non-replicability of quantum states and the measurement disturbance, and once eavesdropping behavior exists in the process of information transmission, it will be detected by the communication parties. Moreover, quantum communication can realize long-distance instantaneous information sharing with the help of quantum entangled states, which not only improves the efficiency of information transmission, but also further enhances the security. In military communication, quantum communication has many potential applications. In the military field, it can provide extremely secure communication means for military command communication, intelligence transmission, etc. For example, on the battlefield, quantum communication can ensure the security of communication between the command center and combat troops, avoiding enemy eavesdropping and interference. At the same time, quantum communication can also be used for encrypted satellite communications to improve the security and reliability of military satellite communications.

3.2 Artificial Intelligence Technology

3.2.1 Development History and Current Situation

The development of artificial intelligence technology has experienced a gradual development from rule-based expert systems to machine learning, and then to deep learning (as shown in Figure 2). In its early days, AI was dominated by rule-based expert systems that relied on pre-set rules to solve problems. With the rise of machine learning technology, artificial intelligence systems have the ability to automatically extract features and rules by learning a large amount of data, thus significantly improving the ability and efficiency of problem solving. As an important branch of machine learning, deep learning has achieved great success in image recognition, speech processing, natural language processing and many other fields by building deep neural networks to automatically learn and process complex data. At present, the mainstream artificial intelligence technology covers machine learning, deep learning, natural language processing, computer vision and so on. Among them, machine learning and deep learning are its core technologies, which can automatically extract features and rules by learning a large amount of data to achieve automatic processing of various tasks. Natural language processing technology can realize the understanding and generation of human language, and computer vision technology can analyze and process images and videos. In terms of tools, there are many popular artificial intelligence development frameworks and tools such as TensorFlow, PyTorch, Scikit-learn, which bring great convenience to the development and application of artificial intelligence.

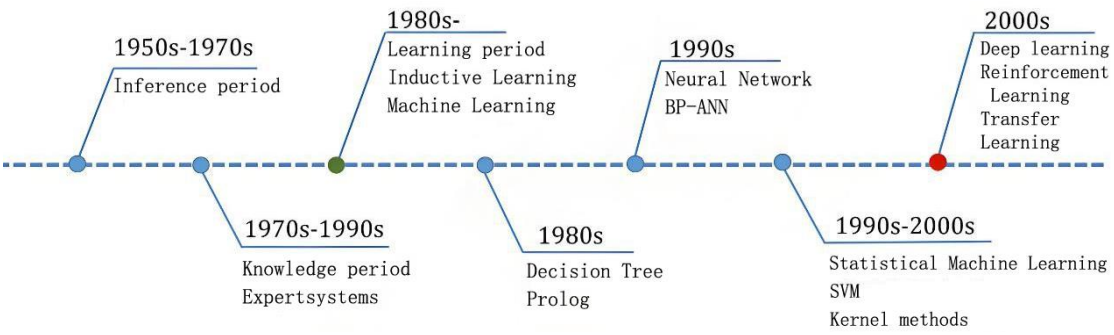

Figure 4. Development History of Artificial Intelligence Technology

3.2.2 Application of Data Analysis and Decision Support

In electronic warfare, artificial intelligence plays an important role in data analysis and decision support. In intelligence processing, artificial intelligence can analyze and process massive intelligence data, quickly identify enemy electronic signals, operational intentions and action patterns, and then provide timely and accurate intelligence support for their own side. For example, the analysis of enemy communication signals can obtain its combat deployment and action plan, and the analysis of enemy radar signals can determine its air defense deployment and target location (as shown in Figure 3). Machine learning is widely used in battlefield simulation and prediction. It can build battlefield models by learning historical battlefield data and predict future battlefield development trends and possible

combat results. For example, by analyzing the combat data in previous wars and establishing combat models, we can predict the effects and risks of different combat schemes and provide references for command decision-making. Machine learning can also be used for real-time monitoring and analysis of battlefield situations to help commanders grasp battlefield dynamics in time and make correct decisions.

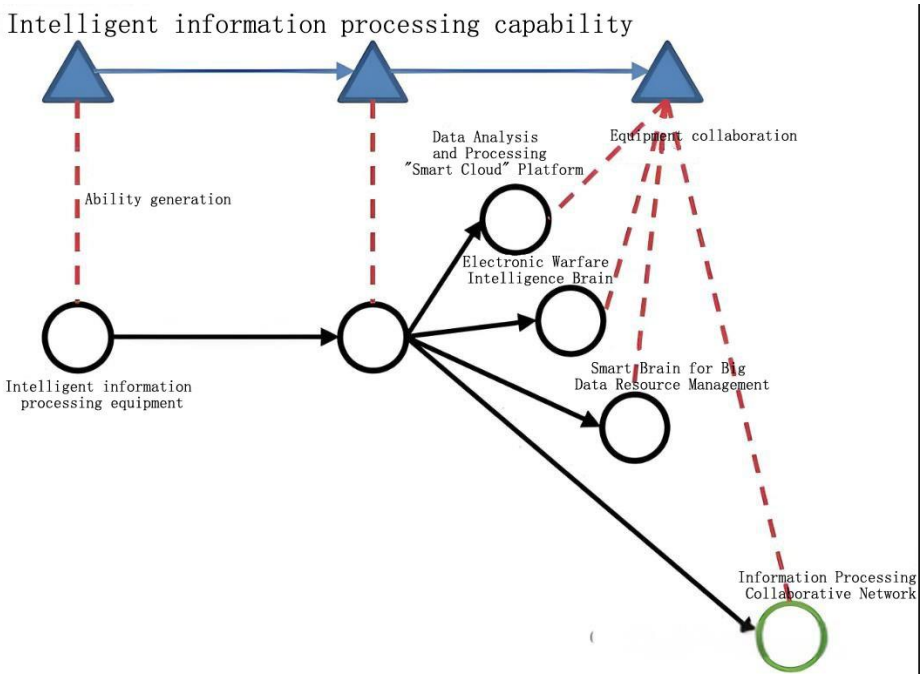

Figure 5. Intelligent Information Processing Capability Generates Links

3.3 Technology Convergence Trend

3.3.1 Combination Potential of Quantum Communication and Artificial Intelligence

Quantum communication and artificial intelligence have considerable potential to combine. In terms of the impact of quantum computing on artificial intelligence algorithms, quantum computing has powerful computing power, which can accelerate the training and execution process of artificial intelligence algorithms. For example, it can speed up the training of deep learning algorithms, thereby improving the performance and efficiency of artificial intelligence systems. In addition, quantum computing can also bring new computational models and methods to artificial intelligence algorithms, and broaden the application scope of artificial intelligence. The application of artificial intelligence in quantum communication networks is reflected in optimizing network performance and management. Specifically, artificial intelligence can automatically adjust network parameters by real-time monitoring and analysis of quantum communication network status, and improve the transmission efficiency and reliability of the network. At the same time, in the security management of quantum communication networks, artificial intelligence can detect and defend against network attacks to ensure the security of quantum communication networks.

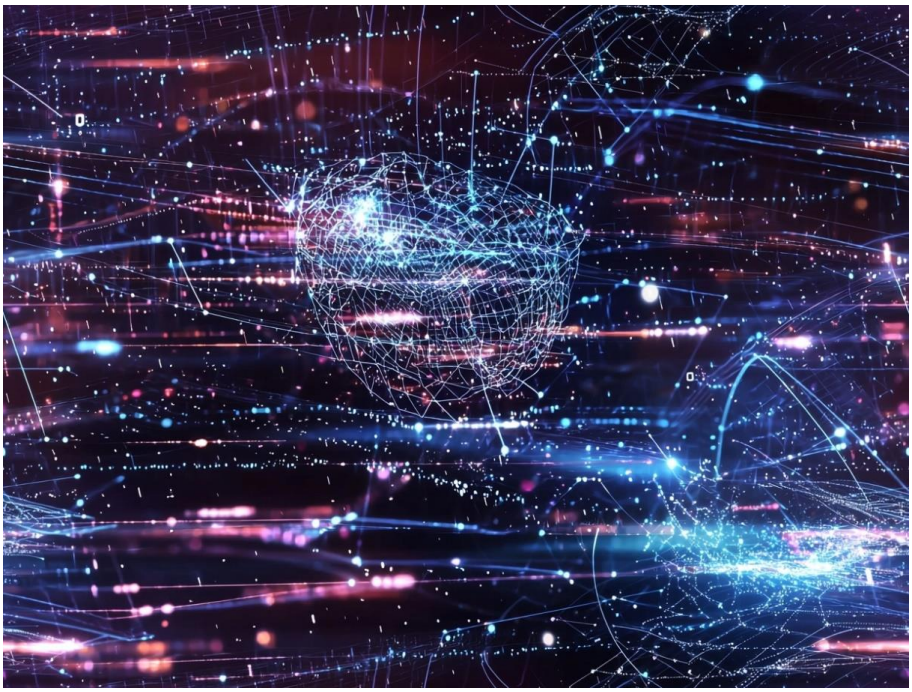

Figure 6. Combination Potential of Quantum Communication and Artificial Intelligence

3.3.2 Current Converged Application Instance

At home and abroad, there are some application cases of the integration of quantum communication and artificial intelligence technology. For example, a country uses the combination of quantum communication and artificial intelligence technology in military communications to improve the security and efficiency of communications. At the same time, some scientific research institutions are also actively exploring the integration of the two applications, such as the combination of quantum computing and machine learning to carry out a number of experiments and research. The fusion of quantum communication and artificial intelligence technology has a remarkable effect in practical applications. On the one hand, the security of quantum communication provides a reliable communication guarantee for the data transmission and processing of artificial intelligence system; On the other hand, the powerful data analysis and decision support capabilities of artificial intelligence strongly support the optimization and management of quantum communication networks, thus improving the performance and reliability of quantum communication networks.

3.3.3 Challenges and Future Development Direction

At present, quantum communication and artificial intelligence technology are in the process of development, facing the problem of poor technical maturity and low standardization. Specifically, quantum communication technology still has some technical problems to be overcome in the aspects of long-distance transmission and key distribution. Artificial intelligence technology also needs to be further improved in terms of algorithm interpretability and security. In addition, when quantum communication and artificial intelligence technology are integrated, it is necessary to build unified

standards and specifications to ensure the compatibility and interoperability of technologies. As the integration of these two technologies advances, some regulatory and ethical issues have arisen. For example, the security of quantum communications may prompt changes in security regulations; The autonomy of AI decision-making may raise ethical questions. Therefore, it is necessary to strengthen the regulatory and ethical research on the integration application of quantum communication and artificial intelligence technology, and formulate corresponding regulations and ethical guidelines to ensure the safe, reliable and sustainable development of the technology.

4. Technological Innovation of Electronic Warfare Equipment

4.1 Overview of Electronic Warfare Equipment

4.1.1 Evolution and Development Stage

The development process of electronic warfare equipment is from the traditional single function equipment to the modern intelligent system. In the early days, electronic warfare equipment was mostly radar jammers and communication jammers, which were specialized for a specific frequency range, and their functions were relatively simple. However, as the technology continues to evolve, digital signal processing, software-defined radio and other technologies are incorporated, enabling multi-functional integration of electronic warfare equipment. At present, driven by quantum communication and artificial intelligence technology, electronic warfare equipment is moving toward intelligent and autonomous development, and it is more powerful in perception, decision-making and execution capabilities. In this development process, the breakthrough of key technologies is of great significance to electronic warfare equipment. For example, high-performance radio frequency chip technology, advanced antenna design and efficient signal processing algorithms, etc., the continuous breakthrough of these technologies has greatly improved the performance of electronic warfare equipment. Moreover, with the maturity of technology, these key technologies are gradually becoming practical and are widely used in various types of electronic warfare equipment.

4.1.2 Function and Demand Changes of Traditional Equipment

Traditional electronic warfare equipment has some limitations in function and performance. For example, the traditional radar jammer mainly relies on transmitting high-power jamming signal to suppress the enemy radar, which is easy to be dealt with by the enemy anti-jamming technology. Traditional communication jammers have similar problems, and the jamming effect on encrypted communication is not good. In addition, the operation of traditional electronic warfare equipment is complex, requiring professional and technical personnel to operate, and it is difficult to adapt to the rapidly changing battlefield environment.

With the continuous development of modern warfare, there is a new demand for electronic warfare equipment. Specifically, electronic warfare equipment needs to have a higher level of intelligence, so that it can autonomously identify enemy targets and select the best jamming strategy; Need to have a stronger anti-interference ability, in order to work normally in a complex electromagnetic environment;

It also needs to have higher information security performance to prevent enemy eavesdropping and attacks. In order to meet these new needs, electronic warfare equipment has carried out a series of technological innovations, such as the introduction of artificial intelligence technology, quantum communication technology and so on.

4.2 Demand Analysis of Technological Innovation

4.2.1 New Requirements for Electronic Warfare Equipment in Modern Warfare

Modern war presents multi-dimensional characteristics, covering land, sea, air, space, electricity and many other fields. In this multi-dimensional combat environment, electronic warfare equipment must have good adaptability to achieve collaborative operations with other combat forces (see Figure 4). For example, during air strikes, electronic warfare equipment should cooperate with fighters and bombers to provide electronic cover for them. In naval warfare, it is necessary to cooperate with ships and submarines to give electronic countermeasures support. With the continuous development of science and technology, new threats such as hypersonic weapons and UAV clusters continue to emerge, and electronic warfare equipment needs to build capabilities to counter these new threats. For example, the guidance system of a hypersonic weapon could be disabled by interfering with enemy communications and navigation systems, or the control signals of an enemy drone could be interfered with to cause the drone cluster to lose control.

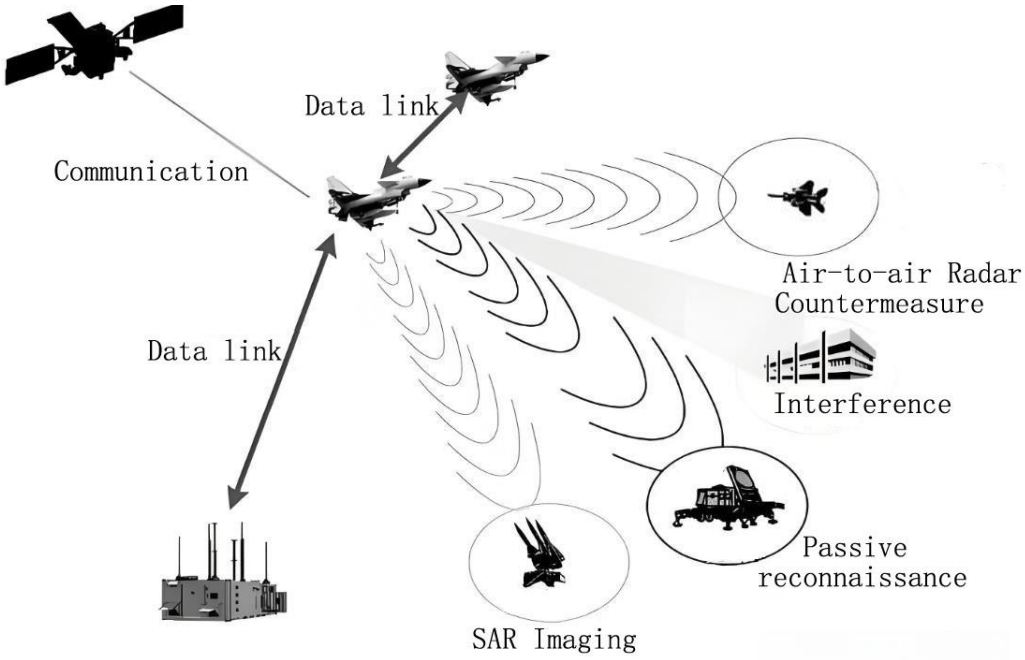

Figure 7. Integration Trend of Communications Electronic Warfare

4.2.2 Application Prospect of Quantum Communication Technology

Quantum communication technology has the characteristics of non-cloning and anti-interference, which can provide higher information security for electronic warfare equipment. In electronic warfare,

the importance of communication security is self-evident, quantum communication technology can be applied to encrypted communications, so as to prevent enemy eavesdropping and attacks, and can also be used to verify the identity of both communication parties, to avoid enemy impersonation. In modern war, command and control is at the core of operations. Quantum communication technology can provide a more secure and reliable communication method for command and control, for example, with the help of quantum communication network, the command center can grasp the battlefield situation in real time and issue combat instructions to ensure efficient coordination of combat operations.

4.2.3 Innovative Application of Artificial Intelligence in Electronic Warfare Equipment

Artificial intelligence technology can build an autonomous decision-making system for electronic warfare equipment, so that it can independently select the best jamming strategy according to the battlefield situation. For example, when analyzing the enemy radar signal, the autonomous decision-making system can judge the type and working mode of the enemy radar, and then select the corresponding jamming mode. In addition, AI technology can also be used to develop intelligent jamming and anti-jamming technologies. With the help of machine learning algorithms, electronic warfare equipment can automatically learn the enemy's jamming patterns and take corresponding countermeasures. At the same time, the electronic warfare equipment uses this technology to evaluate the jamming effect, so as to adjust the jamming strategy in time to improve the jamming effect.

4.2.4 Prediction of Equipment Performance Improvement by Quantum and Artificial Intelligence Technology

The convergence of quantum communication and artificial intelligence technologies can significantly improve the overall performance of electronic warfare equipment, and this improvement can be quantified in many ways. For example, the improvement of communication confidentiality, the enhancement of interference effects and the improvement of decision-making speed can reflect the quantitative improvement of equipment performance. Moreover, simulation experiment and actual combat test can be used to verify the effect of technology fusion application. Not only that, the application of quantum communication and artificial intelligence technology can also enhance the tactical flexibility of electronic warfare equipment. For example, electronic warfare equipment can adjust jamming strategies and communication methods in real time according to changes in battlefield conditions, thereby improving combat effectiveness. At the same time, it can also cooperate with other combat forces to achieve a more flexible tactical combination.

4.2.5 Future Prospects of the Integration of the Two Technologies

The integration of quantum communication and artificial intelligence technology has become an important trend in the development of electronic warfare equipment. In the future development process, quantum communication technology and artificial intelligence technology can be deeply explored to explore a more effective way of integration. For example, research on the combination of quantum computing and artificial intelligence algorithms to improve the computing power and efficiency of artificial intelligence; Explore the integration of quantum communication network and artificial

intelligence decision system to achieve more secure and efficient command and control. The convergence of quantum communication and artificial intelligence technologies covers multiple disciplines, which highlights the importance of interdisciplinary cooperation. Experts in many fields, such as physicists, communications engineers, and computer scientists, must work together to solve technical problems. In addition, it is also necessary to strengthen international cooperation and share technological achievements, so as to promote the development of electronic warfare equipment technology.

5. Strategic Impact of Electronic Warfare Equipment Innovation

5.1 Evaluation of New Electronic Warfare Equipment on Military Strategy and Tactics

The introduction of new electronic warfare equipment provides a new perspective for military strategy and tactics, and its technical advantages significantly enhance the combat effectiveness in complex environments. With its non-cloning and anti-interference ability, quantum communication ensures the security and reliability of information transmission, and reduces the risk of communication interception and interference. This improves the accuracy and immediacy of operational command decisions, thus deepening the efficiency of strategic deployment. At the tactical level, AI's fast learning and decision making capabilities provide real-time response capabilities in dynamic battlefield environments, optimizing attack and defense strategies. By analyzing battlefield data, AI algorithms can predict the enemy's path of action and formulate the optimal strategic plan, which greatly improves the flexibility and innovation of combat. The application of this technology integration makes electronic warfare equipment no longer a simple information equipment, but a key element affecting the trend of the war, which has a far-reaching impact on the implementation of the overall strategy. The emergence of this new type of equipment has redefined the information advantage in military operations, promoted the diversification of tactics and strategic innovation, and become a new focus of strategic competition. The balance of global military forces is being subtly changed by these innovative technologies, reflecting the trend of the evolution of future warfare patterns.

5.2 How does Innovative Equipment Change the Way Modern Warfare is Fought

Innovative equipment combines quantum communication and artificial intelligence to significantly change the way modern warfare is fought. Quantum communication ensures the confidentiality and reliability of information transmission by providing a secure and anti-interference communication link, making data transmission more stable. Artificial intelligence improves battlefield situational awareness and response speed through autonomous learning and rapid decision making, and can analyze large amounts of sensor data in real time to accurately identify and locate potential threats. The electronic warfare equipment based on these technologies can realize automatic and intelligent combat command and improve the effect of tactical execution. The use of this equipment will shift the existing tactical model to a more flexible, dynamic and intelligent direction, promote seamless cross-domain operations and multi-platform collaboration, and enhance combat effectiveness in complex environments.

Technological advances have given the military greater adaptability and strategic advantage, taking the initiative on the battlefield and redefining the operational logic and mode of operation of modern warfare.

5.3 Discussion on the Role and Strategic Position of New Equipment in Future Conflicts

The role and strategic position of new electronic warfare equipment in future conflicts are mainly reflected in its profound changes to the military pattern. Quantum communication gives electronic warfare systems higher security and anti-interference ability, making information transmission reliable and difficult to be stolen by attackers. Combined with the rapid decision-making and adaptive learning capabilities of artificial intelligence, these devices can analyze and respond to various threats in complex battlefield environments in real time, improving overall combat effectiveness. The new equipment makes the command and control system more intelligent, helping to achieve precision strikes and dynamic defense. Its strategic position is not only to improve the chances of winning a single battle, but also to affect long-term strategic planning, and may become an important factor in balancing the strategic relations between great powers. Countries need to pay attention to this trend in order to maintain their dominant position in the international security landscape.

6. Closing Remarks

Through the systematic analysis of the fusion application of quantum communication and artificial intelligence in the prospect of electronic warfare in the 21st century, this paper reveals the profound impact of this technological innovation on the strategy and tactics of electronic warfare. First, the non-clonality and anti-interference characteristics of quantum communication combined with the high-speed decision making and processing capabilities of artificial intelligence provide a more secure and efficient communication and decision support system for modern electronic warfare. This integration not only greatly improves the operational effectiveness of the electronic warfare system, but also promotes the overall upgrade of electronic tactics. However, the progress of technology has also brought new strategic security considerations, and the new global strategic security pattern caused by the integration of technology needs the joint response of the international community. In the face of possible risks and opportunities in the future, this study suggests that the future research and development of electronic warfare equipment should focus on the balance between technological advantages and ethical regulations to ensure the harmonious development of technological innovation and global security strategy. Further research on the application of AI in electronic warfare is needed to fully understand and exploit the potential of this technology. Overall, the combination of quantum communication and artificial intelligence will inevitably promote the innovation of electronic tactics and strategy, and will have a significant and far-reaching impact on the future development of electronic warfare equipment and global strategic security.

References

Fei Hualian. (2020). Application of Artificial Intelligence in the field of Electronic Warfare. *Aerospace Missiles*, *2020*(04), 41-45.

Li Gaoyun, Kuang Shengyu, Jiang Guo, He Huan, & Tang Jiqing. (2022). Discussion on Development path of Intelligent Electronic Warfare Equipment. *Journal of China Academy of Electronic Science*, *17*(01), 7-11. (in Chinese)

Liu Ling. (2021). Outlook of Future Electronic Warfare. *Electronic Information Countermeasure Technology*, *36*(06), 30-33.

Norman Friedman. (2022). Maritime Electronic Warfare. *Modern Ship*, *2023*(06), 82-91.

SU Zhou, Liu Fei, Xu Xiaojian, & Han Jun. (2023). Research on the development of intelligent Electronic Warfare Equipment. *Ship Electronic Countermeasures*, *46*(04), 9-13.

Wang Yu, & Chen Lei. (2021). Analysis on the development and application of Electronic Warfare Equipment of U.S. Army. *Electronic Information Countermeasure Technology*, *36*(06), 27-29.

Wu Cong, Cheng Ruosi, Zhao Shuang, & Wang Xueyu. (2021). Analysis of Electronic Warfare Equipment of Indian Army and its operational characteristics in Mountain operations. *Aerospace Electronic Countermeasures*, *37*(01), 60-64.

Yang Peng. (2020). Overview of Russian Electronic Warfare Equipment. *Electronic Engineering Information*, *2020*(03), 13-26.

Zhang Hao. (2020). Future Outlook of American Electronic Warfare. *Electronic Engineering Information*, *2020*(05), 1-15.

Zhu Song, & Wang Yan. (2019). Analysis of American Electronic Warfare development strategy. *Aerospace Electronic Countermeasures*, *35*(06), 1-4. (in Chinese)