# QUANTUM SECURE COMMUNICATION AND 6G CRITICAL INFRASTRUCTURE

***Miloslav Hoschek***
*Ing., PhD., an independent «e-Silk Road» NGO,*
*Bratislava, Slovak Republic*
*ORCID ID: https://orcid.org/0000-0002-3912-1606*

***Tetiana Bukoros***
*Associate Professor, PhD., Dr.h.c., MBA, Honor. Prof.,*
*Public Administration And Project Management Department,*
*State Higher Educational Institution «University of Educational Management», Kyiv, Ukraine*
*ORCID ID: https://orcid.org/0000-0002-4059-2632*

**Abstract.** Cyber warfare poses a real threat to national security, as adversaries hack and disable critical infrastructure systems in other states, and use intelligence databases to obtain valuable information. The attack is not only by conventional military, economic and political methods, but also by cyber operations. The possibility of being revolutionary in defense and national security has given quantum computers and artificial intelligence supremacy. The spectral technologies in mid of 2030s such as THz communication, molecular communication and quantum communication will dramatically improve the data rate. The blockchain will become an important part of a 6G society using smart devices of all of multimedia data, The 6G new paradigm in the sustainable future will shift intelligent materials. The 6G wireless standards could make real time mobile internet speeds of 1 TB per second using massive volumes of data in essentially real time. The 6G will integrate terrestrial wireless and satellite systems for a global network coverage with fully autonomous and self-driving vehicles, robotics, or unmanned delivery drones services.
**Keywords:** *6G quantum security, 5-layer vertical architecture, quantum information, quantum technology, national security, quantum communication, quantum metrology.*

## Introduction

The rise of quantum computing creates challenges, from highly secure communications to faster code-breaks and to strategic utilities detection. It has a profound impact on everything from capabilities to disrupting much of cryptography through data-sensitive public and private networks

and to have a basic understanding of quantum systems and emerging national security challenges.

Quantum computing has the ability to use quantum mechanical engineering in such a way that simultaneous calculations can be performed. With advances in technology and increased innovation, cyberspace is another battleground of endless threats. The possibility of being revolutionary in defense and national security has given quantum computers and artificial intelligence supremacy (Erkmen, Shapiro, 2010). Thus, 6G communication is currently 5G communication further, with the provision of enhanced services in terms of network data availability, mobile data rate, seamless ubiquitous connectivity, 6G communication is accepted in various mobile data categories, and to transmit them through traditional enhanced radio frequency network. Quantum computers are faster and more efficient than any known computer. This is because, in theory, a single quantum computer is more powerful than all the supercomputers in the world today. In theory, if quantum computing is fully mastered by the state, they would be very dangerous to the state because of the very difficult nature of protecting networks, databases, and critical infrastructure and artificial intelligence and quantum computing because of the very nature of protecting their artificial intelligence in the most at all resistance.

Cyber attacks on existing artificial intelligence systems, the implementation of artificial intelligence in conventional military warfare,and greater overall threats to national security, current artificial intelligence systems are starting to see data breaches from unknown sources because of insecure centralized servers that hold valuable information. This makes it easy to target even the most simple hackers with obtortificial intelligence n information in these databases. Cyber attacks on artificial intelligence databases can cause serious destruction for individuals,businesses and governments. Artificial intelligence can also be used to implement weapon systems that can have fully autonomous functions, as well as complex problem-solving and reasoning skills like humans.

The operational and engineering challenges of quantum mechanics and the rapid pace of development of quantum computers have every six months doubled the number of qubits on the processor chips of quantum computers. If this growth pattern continues, the quantum bit processor will crack one of the most widely used cryptos, the Rivest–Shamir–Adleman (RSA) cryptosystem, and will be able to do so in next decade 2030s.

**1. Quantum secure communication services**

Quantum secure communication services improve trust and security, improve network performance by quantum timing, and improve the reliability and security of quantum computing. The use of quantum computers is also likely to increase as planners of defense plans to make large-scale simulations of military deployments, and as scientists may be susceptible to the algorithms that many existing technologies run on quantum computers, with complex chemical reactions to design new materials.

The technology is able to protect both classical and quantum attacks, speed up the exchange of cryptographic keys at long distances, and is also able to protect national security communications (*Table 1*). This means supporting research, development and education, bringing quantum to the strategic planning process, integrating its challenges and opportunities to ensure the quantum threat. Connect with industry experts and academia, create a group that shares information, issues, and solutions to help members meet the challenges they are facing, and think about how the organization carries out its mission in the post-quantum era.

Table 1.

**6G HARMONY**

| |
|---|
| Distributed trust |
| Cyber Psychical Security |
| Terraherz Technologies |
| 4D imaging and image projection |
| Automatic Orchestrated Transceiveres |
| Haptic Remote Telepresence |
| Full Spectrum fotonic Signsl Processing |
| Proactive Decissions Making |
| Non Device Centric Communication |
| Extreme URLLC |

| |
|---|
| Consent and Privacy Preserving |
| Data Sharing |
| Support for Ambient Novel Sharing |
| Small Data AI |
| Distributed Learning |
| Informations offering |

*Source: compiled by author Miloslav Hoschek.*

The idea of having robotics in a war inspired many founders of robotics and artificial intelligence to assume the dangers that artificial intelligence poses in a war. Once developed, an armed conflict can be fought on a greater scale than ever before, and faster than humans can understand a national security threat. A cyber attack consisting of a top secret database or a power grid database can result in serious serious infrastructure damage and massive human casualties, and a large-scale cyber attack can cause more damage than the use of hard-force by conventional methods of weaponry.

### 1.1. Quantum computing and Cybersecurity

Cybersecurity could be a threat to quantum computing. Code-breaking and public-key encryption vulnerabilities make the United States more susceptible to cyberterrorism threats. During her research, she discovered that a new type of computer based on quantum physics could break modern cytopathology (Johnsson, Brennen & Twamley, 2016). But this is the complete hypothesis of the worst-case scenario. Today, not all current quantum computers have the processing power to carry out such large-scale threats. Fortunately, any country or cyber terrorist organization will thus require a radical and substantial technological advance to use quantum computing.

The relationship between artificial intelligence and cyber warfare has changed significantly as a direct result of the digital age. Cyber warfare through the use of artificial intelligence has become easier due to technological advances that allow countries to reach beyond national and international borders (Kline, Salvo, 2019). The main cause of cyber attacks can be traced back to software that ensures system errors rather than other causes such as hardware farficial intelligence. The task management errors occur repeatedly and the soft process is wrong thread this type of failure affects many computer programs functions such as firewalls and security programs. The devastation caused by these types of attacks represents an ongoing threat to cyber security.

If an error occurs and many threads are accidentally interrupted, often someone tries to manage this problem through a queue strategy. The importance of this process is the ability to effectively manage multiple concurrent threads while simultaneously performing high-traffic tasks such as data transfer (Boixo, Rønnow, Isakov, & oth., 2014). One of the biggest concern is the delay while the martificial intelligence Artificial intelligence security to minimize delays, the process has a requirement called "efficient feedback control. The purpose of the efficient feedback control is to adapt the idle time to a given value for learning the change of the traffic dynamics by the constitutive intelligence (Merat & Almuhtadi, 2015).

The reason for the exclusion of firewalls is either a passive or active attack that can be initiated within a security perimeter. The capabilities of these threads, whether passive or active, help to identify and protect the artificial intelligence against cybersecurity attacks (Wood, 2002). The sendt thread checks the batch file to create and update the routing table of nodes, and then the message is broadcast. In addition, the sending thread increases the sequence number of this node every few seconds. On the other hand, the receiving thread continually receives messages from the artificial know-how of the routing table at once to create and update messages from other nodes.

### 1.2. Artificial 6G intelligence

The implications of artificial intelligence and quantum computing are enormous, and because of the enormous capabilities and vulnerabilities of intelligence in these two fields, the debate over cyber warfare can be exploited as a big advantage among new battlegrounds in cyberspace, and without proper protection, they can both destroy our

own digital AI in order to gain an advantage, you have to be a leading national in the field of artificial intelligence and quantum computing (Allen, Chan, 2018). To do that, we need to ensure proper protection and ensure that cyberspace is a safe and resilient Artificial intelligence against cyber attack. In doing so, it is in the national interest of the United States to become a leader in the field of artificial intelligence and quantum computing , because it is better to defend country from cyberwarfare attacks (Wittig, 2011). The evolution of artificial intelligence and quantum computing in modern warfare will also have an impact on security. As a country that wants to lead the world in digital artificial intelligence, we must work to secure cyberspace and resist future attacks. While artificial intelligence can do harm as a weapon, to teach machines. Quantum computers, however, the current encryption measures will be outdated (Quantum Computing: Progress and Prospects, 2018).

Quantum computers exist in multiple "states" at once, exploiting the unique qualities of subatomic particles rather than manipulating bits. Quantum computers can manipulate these particles to perform many calculations at the same time, which speeds up solving complex problems such as cracking encryption.

Traditional algorithms are created by programmers and quant strategists, but these algorithms, based on if/then rules, use machine learning to learn the best trading patterns and pass them on to machines to automatically update the algorithms without human intervention. More and more capital market companies are using machine learning and other tools to build algorithmic trading systems that learn from data without resorting to rule-based systems. With the adoption of data scientists,advances in cloud computing,and access to an open-source framework for the artificial intelligence ning machine learning model, big banks are already developing self-learning algorithms for stock trading.

To forestall quantum surprises, the standardization organization has already planned a new encryption protocol that will reduce the vulnerability of data to quantum computers. The growing need for artificial intelligence, medicine and natural resources in China is poised to increase the threat to Chinese companies and Chinese workers based on foreign soil as a result of the size of the international crisis that the people's Republic of China may face in the near future. Vulnerable countries that acquire Chinese technology and infrastructure and give Chinese state-owned enterprises the right to exploitation of natural resources do not have the ability to guarantee adequate security (Popkin, 2017).

Thus, while China's infrastructure and personnel, facilitated by politically motivated rebels, or criminal organizations that perceive Chinese citizens as wealthy targets, are not new, the privatization and downward cycle of security services is not new impact on the security landscape.

### 1.3. The spectral technologies in mid of 2030s

The blockchain will become an important part of a 6G society using smart devices of all of multimedia data, The 6G new paradigm in the sustainable future will shift intelligent materials. This network outside the terrestrial globe allows for truly intelligent connectivity and penetration of artificial intelligence and enhanced network protocol stack. Quantum repeater will rebroadcast quantum information, can broaden the network's reach. Instead of using satellites to transmit quantum information through the near-vacuum of space, the 6G quantum satellite flies without the loss of optical fiber. China is making the decision to launch its own quantum satellite. China is working with Australian physicists to transmit quantum information between the two satellites (Qichao Zhu, Kun Long, 2019). The Canadian Space Agency recently announced funding for a small quantum satellite. Teams in Europe and the United States are also proposing to put quantum devices on the International Space Station. A network of satellites could someday connect quantum computers designed in labs worldwide.

In theory, even if entangled objects are separated, their unstable quantum states remain linked until either one of them is measured or interfered with that measurement, no matter how far away, immediately determines the state of the other objects. The long string of entangled photons shared between distant locations becomes a "quantum key" that makes communication safe. If you try to eavesdrop on a quantum encrypted message, the shared key will be

destroyed and everyone will be warned about the compromised channel (*Table 2*). The result was an ultra secure communication network and ultimately, a stepping stone to the space-based quantum internet. Entanglement involves placing an object in a peculiar limbo of quantum superposition where the quantum properties of an object occupied multiple states at once, and these quantum states are shared among multiple objects.

Table 2.

| **The 6G potential technologies** | |
|---|---|
| new meta data commands | the cross layer design breaks the end to end principle |
| high precission synchronisation | provides multiplex advanced network functions |
| multipath transmission | new network protocol architecture |
| current internet architecture as TCP/IP | cannot guarrantee future application delivery contrains such as deterministic throughput, metric or security details or ultra low latency |
| Distributed artificial inteligence | includes computation, communication catching control |
| local patterns sent to central cloud | obtaining global model |
| ITU International Telecommunication Union New classification | Terraherz frequency bands, single chip receiver, data link layer DLL, THz wireless radio transceiver |

*Source: compiled by author Miloslav Hoschek.*

According to theforecast by International Telecommunication Union (ITU), global mobile data traffic will reach 5 zettabytes by 2030 (*Figure 1*). In 2018, Finland announced the 6Genesis Flagship programhe U.K. and German governments have invested in some potential technologies for 6G such as quantum technology, and the United States began, an eight-year program research on terahertz-based 6G mobile networks. The autonomous driving could have more stringent requirements for latency and through put, which will work the global mobile data traffic and intelligent connectivity network in 2030.

## 2. Advancing 6G network device communication

### 2.1. The Quantum Internet Alliance

Quantum internet alliance is a multi-node quantum network, targeting the pan-European quantum internet rather it will complement it or become a branch of it. It would be able to take care of some of the problems that plague the current internet. For example, the quantum internet provides much greater protection from hackers and cybercriminals.

Quantum internet blueprint by break-through technological advances. The quantum internet alliance will demonstrate the integration of the first of both sub-systems, pushing the frontier of technologies for both end nodes (trapped ion qubit, diamond NV qubit, neutral atomic quantum bit) and quantum repeaters (rare earth-based memory, atomic gas, quantum dot). This makes the leap from a simple point-to-point connection to the first multi-node network. The major possible features for memory-based quantum repeaters and consequently, include the world's longest such link, the real-world elementary long-range relay relay relay.

A vulnerable cyberattack that does not send a message to the light particles of a network utilizing quantum. Instead of using mathematical complexity to encrypt messages, it depends on the specific rules of quantum physics. With quantum information, you can not copy it or cut it in half, and you can not even look at it without changing it. This allows for much more secure encryption than is available today. The easiest way to understand the concept of quantum internet is through the concept of quantum teleportation. The possibility of a space-based quantum internet where satellites continuously broadcast entangled photons down to the Earth's surface.

### 2.2. Quantum Teleportation

In quantum teleportation, two people who want to communicate share a pair of intertwined quantum particles. Then, through

a series of operations, the transmitting side can transmit any quantum information to the receiving side. It can not do faster than the speed of light, but it is a common misconception. A central research question is how best to distribute these intertwined pairs to people distributed around the world.

Hand in hand with hardware development, the Internet Alliance industry partners to provide fast and reactive control and allow arbitrary high-level application to be realized in platform independent software application protocols and their hardware requirements in the case of use in the real world. The whole stack on the small-scale quantum internet was verified by elementary safety quantum cloud calculation. The design of the blueprint architecture is verified by the large-scale simulation of the pan-European quantum internet.

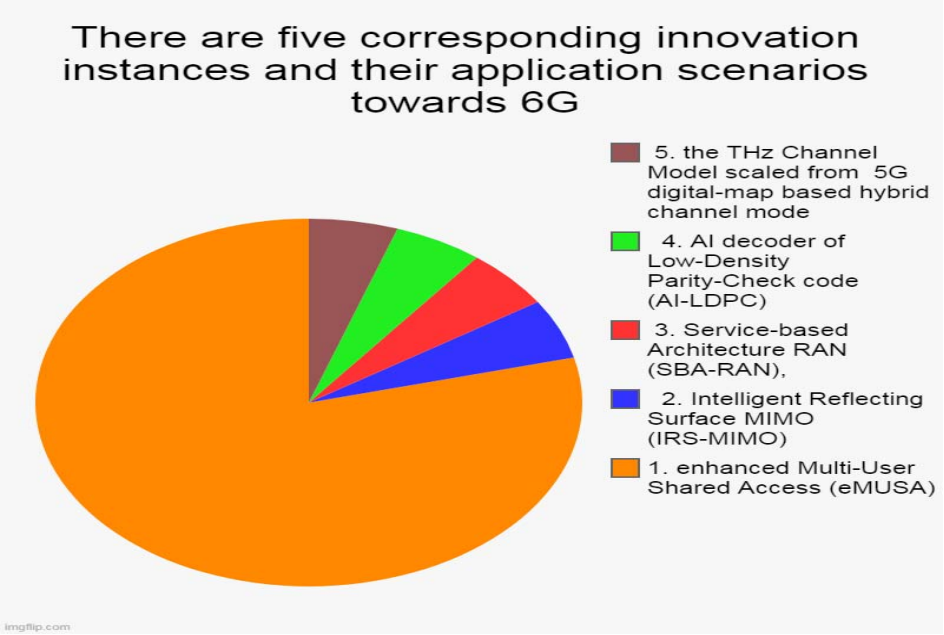


*Figure 1*

The Internet of the future is based on these quantum principles (Durak, Jam, Dindar, 2019). The future quantum internet will make use of quantum bits of quantum information that can take an infinite number of values. Quantum internet is the platform of the quantum ecosystem, and computers, networks,sensors, sensing, communication,and computing are literally one and the same.

Advancing 6G network device communication is a high-placed inconsecquential thing from the propagation of empirical models. This situation underlines the need for a radical change from two-dimensional to three-dimensional, which is necessary to take into account the height of the communication nodes, anticipating changes in the 6G environment, some of the notable technologies that have already incorporated this dimension are satellites, unmanned aerial vehicles and underwater communications (*Figure 2*). Therefore, an analytical framework designed for 2D wireless communication derived from probability geometry and graph theory needs to be readjusted in a 6G environment. Considering the height of the device, it can lead to the realization of the elevation beamforming with a full-dimensional architecture, and it can be used in different applications to achieve network optimization.

### 2.3. Holographic 6G communication

Holographic communication makes it possible to transmit a virtual vision of people, events, and real sights near the environment. These technologies allow you to easily implement tactile touch using a communication network. Realizing this technology may lead to the abolition of the open system interconnection network model and the adoption of the inter-layer communication system design.

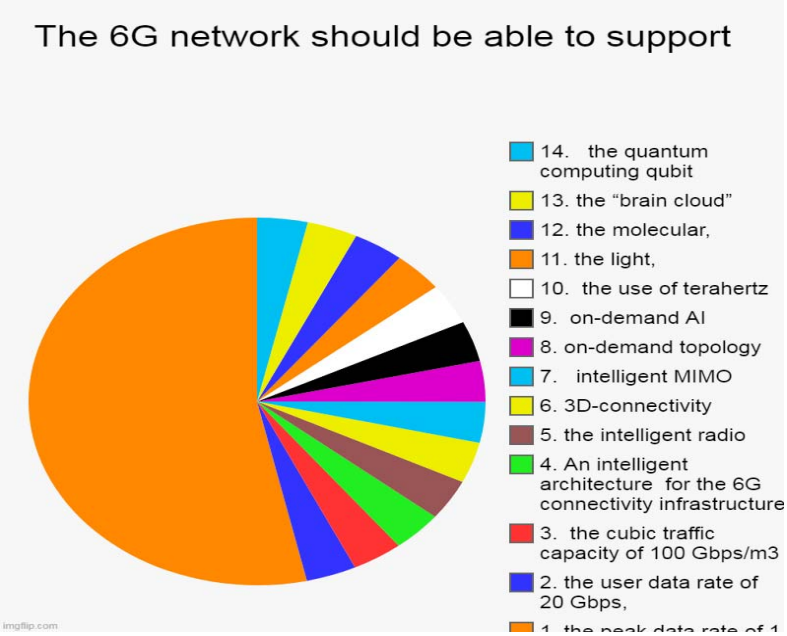


*Figure 2 (by author Miloslav Hoschek)*

But you should tackle the following aspects holographic, tactile, human-corporate bonds. Holographic communication, such as holographic communication is one aspect that adds charm to the age of 6G. A hologram is a 3D technology that manipulates the light rays emitted by an object and captures the resulting interference patterns using a recording device. In practice, sending a 3D image without a stereo sound is not enough to depict face-to-face presence characteristics. In the 6G era, the reconfigurable stereo audio can be leveraged on the development platform and used for multiple physical presence in each setting. In other words, there is enough freedom for the entity to interact and modify the holographic data or video received as needed. It is a reliable network link that consumes holographic data and requires high bandwidth.

The fault building in order to connect to the server can be a tough need for these technologies. This situation can cause the design of a new physical layer scheme that enhances the signal system design and the implementation of waveform multiplexing. Another aspect that requires attention is that procedures such as buffering, queuing, scheduling, handover, and protocols that eet the needs of the 6G network are obviously not able to meet these needs, and therefore the existing wireless communication systems need to be analyzed by the fiber-optic system.

The futuristic present of the 2030s is predicted, featuring holographic calls and haptic internet for non-existent wireless communication scenarios. The 6G provides the same reliability as a wired network with a low bit error rate when considering supported application types. Key features for the future 6G i THz wireless communication systems, AI and programmable intelligent surfaces are listed prominent among all the blocks these innovations welcome the fundamental depar-ture practised in the mobile wireless tele-communications industry (Montanaro, 2015).

Human-to-corporate 6G bond technology focus on communication expect to have access to physical features, to share them, and to express physical phenomena as they are (*Table 3*). This project will always involve the five senses of human beings. As an example of this technology, there is a"*communication by breathing*" project, it is possible to express the exhaled air up to the interaction with the human body by inhalation using volatile organic compounds. As a result, such technologies facilitate the diagnosis of diseases, the detection of emotions, the collection of biological features and remote interaction with the human body. Designing a communication system that mimics the human senses requires interdisciplinary research cooperation. Such research has led to the creation of a hybrid communication technology that extracts various physical quantities and distributes them to the desired receiver through a secured channel.

Table 3.

**Key features for the future 6G THz wireless communication system**

| |
|---|
| The evolution of connectivity such as ultra-high speed, large capacity, and low latency |
| Development of new frequency bands including terahertz frequency |
| Providing ultra-low energy and ultra-low cost communications |
| Functions including large devices-connectivity and sensing |

*Source: compiled by author Miloslav Hoschek.*

Comprehensive, reliable, effective, and reliable cyber security of all the network elements but an important component of internal and external testing. There are industry-standard equipment vendors,network operators,and service providers that are certified to perform independent external testing. The potential for new services supported by future "6G" technologies to be launched by 2030 is that the 6G network, which is more demanding on key performance indicators (KPIs) of the 6G network, it's a very intelligent architecture. The6G research team and 6G network architecture, In addition, 3D connectivity, intelligent MIMO, on-demand topology, on-demand AI, 6G network 6g network corresponding to the innovation instance and its application scenario and THz channel model scaled from 5G digital map-based hybrid channel model.

Artificial intelligence and machine learning, built on distributed data sets and shared information, dynamic and psychological based on behavioral and automated investment services the adoption of such technologies will be critical for leading financial institutions to efficiently manage their client base and investment portfolios. The combination of predictive and cognitive abilities is a trend that involves technology partners, as observed in the case of IBM's Watson and Google's AlphaGo (Hartnett, 2019).

The first mover to work with technology companies within the ecosystem will change the game to look forward to the next generation of quantum computing. The explificial intelligence will fill another book, but it is difficult to specify what quantum mechanics means at all, because it is so powerful that IBM expects to see artificial intelligence and machine learning be done exponentially faster if Google is building a quantum computer as well, and it works reliably (Google’s Sycamore Machine and Quantum Computing, 2019).

Quantum computers will accelerate the automatic investment in simulation, optimization, and among many other services in the coming years ultra-fast and robust cloud computing will impact how the world and things are done and the industry as these machines are integrated into the financial services ecosystem.

## Conclusions

Quantum communication, a practice that uses the principles of quantum mechanics to secure communication. Quantum key distribution is one of the most developed approaches. What is special about Quantum key distribution is that the eavesdroppers of the quantum channel can safely share the key without the possibility of stealing the key. They should have at least a general idea of what quantum science is. As technology advances grow, the attack rate of cyber warfare also rises. Artificial intelligence and quantum computing are two large enhancers of the cyber domain. Due to their capabilities, they will have a significant impact on cyber warfare, but the potential to significantly increase the number and threat level of adverse cyber attacks.

The 6G communication is currently 5G communication further, with the provision of enhanced services in terms of network data availability, mobile data rate, seamless ubiquitous connectivity, 6G communication is accepted in various mobile data categories, and to transmit them through traditional enhanced radio frequency network. such an unusual process allows a novel radio transmission of emotions with the presence and participation of a virtual.

Quantum computers have enormous capabilities, but they also have a lot of self-constrained intelligence in their own systems. Quantum computing artificial intelligence must be understood in the context of other technological advances like block artificial intelligence and quantum computing. Data is one strategy open paradigm for business drivers privacy laws and data-sharing agreements are always part of the game if it comes to the data of the client.

**References**


1. Erkmen B. I., Shapiro J. H. (2010). Ghost imaging: from quantum to classical to computational. *Advances in Optics and Photonics*, Vol. 2, Issue 4, pp. 405-450, https://doi.org/10.1364/AOP.2.000405
2. Johnsson M. T., Brennen G. K., Twamley J. (2016). Macroscopic superpositions and gravimetry with quantum magnetomechanics, by Scientific Reports volume 6, Article number: 37495 Available at: https://www.nature.com/articles/srep37495
3. Kadir Durak, Naser Jam, and Cağri Dindar (2019). Object tracking and identification by quantum radar", Proc. SPIE 11167, Quantum Technologies and Quantum Information Science V, 111670N (19 September 2019); https://doi.org/10.1117/12.2550479
4. Boixo S., Rønnow T. F., Isakov S., Wang Z., Wecker D., Lidar D. A., Martinis John M., & Matthias Troyer (2014),Evidence for quantum annealing with more than one hundred qubits, by Published: 28 February 2014, Nature Physics volume 10, p. 218–224
5. Hartnett K. (2019). Google and IBM Clash Over Milestone Quantum Computing Experiment. TheAtlantic.com. The Quanta Newsletter National Quantum Computing Centre. October 23, 2019 Available at: https://www.quantamagazine.org/google-and-ibm-clash-over-quantum-supremacy-claim-20191023/
6. Google's Sycamore Machine and Quantum Computing. Available at: https://www.manifestias.com/2019/11/01/googles-sycamore-machine-and-quantum-computing
7. Qichao Zhu, Kun Long (2019). How will artificial intelligence impact Sino–US relations?, China International Strategy Review June 2019, DOI: 10.1007/s42533-019-00008-9. Available at: https://www.researchgate.net/publication
8. Kline K., Salvo M., Artificial Intelligence and Quantum Computing are Evolving Cyber Warfare Wed, March 27, 2019, Cyber Intelligence Initiatives. Available at: https://www.iwp.edu/cyber-intelligence-initiative/2019/03/27/how-artificial-intelligence-and-quantum-computing-are-evolving-cyber-warfare/
9. Allen, G., Chan, T. (2018, June 28). Artificial intelligence and National Security. Available at: https://thebulletin.org/2018/02/artificial-intelligence-and-national-security/
10. Merat S. & Almuhtadi W. (2015). "Cyber-Awareness Improvement Using Artificial intelligence Techniques." International Journal on Smart Sensing and Intelligent Systems,8(1), 620-636. doi:10.21307/ijssis-2017-775
11. Montanaro A. (2015, November 25). "The Past, Present, and Future History of Quantum Computing." Available at: https://people.maths.bris.ac.uk/~csxam/teaching/history.pdf
12. National Academies of Sciences, Engineering, and Medicine 2018. Quantum Computing: Progress and Prospects. Washington, DC: The National Academies Press. https://doi.org/10.17226/25196.
13. Wood S. (2002). Bioterrorism and Political Violence, ISBN-13: 978-0789019646. Published by The Haworth Information Press, 10 Alice Street, Binghamton, NY 13904-1580 USA, The Haworth Press, Inc.
14. Wittig T. (2011). Understanding Terrorist Finance. Published: 26th July 2011, ISBN: 9780230291843 Number Of Pages: 238pp., Palgrave Macmillan UK.
15. Popkin G. (2017). China's quantum satellite achieves 'spooky action' at record distance. Jun. 15, 2017, 2:00 PM, Available at: https://www.sciencemag.org/news/2017/06/china-s-quantum-satellite-achieves-spooky-action-record-distance