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THE NEW STAGE IN THE US-CHINA RIVALRY: THE QUANTUM COMPUTER

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ABSTRACT

This study was written to investigate the race to own fully equipped quantum computer, which is the new competition sphere in the struggle between The USA and China, and the privilege of owning quantum computers. The subject of the existing study was determined to take into consideration the few numbers of researches in this field. Although the existing study does not fully illuminate both the advantages of quantum computers and the US-China rivalry, it is important bringing more attention in the international relation literature to a quantum computer and the competitions of superpowers to own it. In this sense, in the existing two parted study, while current rivalry between the US and China is investigated in the first chapter, the potential advances of quantum computer and the race to own it is explored in the second part of article.

Keywords: The US-China Competition, Cyber Struggle, Quantum Computer, Qubit, Quantum Connection.

ABD-ÇİN REKABETİNDE YENİ SÜREÇ: KUANTUM BİLGİSAYAR

ÖZET

Bu çalışma, ABD ile Çin arasındaki mücadelede yeni rekabet alanı olan tam donanımlı kuantum bilgisayarına sahip olma yarışını ve kuantum bilgisayarlara sahip olmanın ayrıcalığını araştırmak için yazılmıştır. Çalışmanın konusu belirlenirken, bu alanda çok az sayıda araştırmanın yapılması dikkate alınmıştır. Mevcut çalışma, hem kuantum bilgisayarların avantajlarını hem de ABD-Çin rekabetini tam olarak aydınlatmasa da, uluslararası ilişki literatüründe, kuantum bilgisayarına ve ona sahip olmak için süper güçlerin yarışmalarına daha fazla dikkat çekmek konusunda önemlidir. Bu bağlamda, mevcut iki bölümlü çalışmanın birinci bölümünde ABD ile Çin arasındaki rekabet araştırılırken, makalenin ikinci bölümünde kuantum bilgisayarınnın sağlayacağı potansiyel fırsatlar ve ona sahip olma yarışı araştırılıyor.

Anahtar Kelimeler: ABD-Çin Rekabeti, Siber Mücadele, Kuantum Bilgisayar, Qubit, Kuantum Bağlantısı.

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INTRODUCTION

The study, with its general concept, refers to the competition between two world superpowers upon the establishment of quantum computers. Emerging through applying psychic laws to the production of computers, quantum computers, and fewer amounts of studies initiated by major powers in the way of possessing fully-fledged model of quantum computers make this study quite considerable in today's world. Another necessary factor is the significance of having quantum computers considering its crucial contributions that would provide vast opportunities for states. The size of the effort and fighting put by the U.S. and China to become a sole world leader and the vast proportion of investment by both of them on quantum technology in comparison to others helps to define major features of the topic.

The study that analyses the struggle between the U.S. and China in obtaining quantum computing technology consists of two main parts. The first section is based on a theoretical framework to make the work more scientific and explain the phase of competition between two states. Here, the realist perspective based on three main theories that applied to the U.S. and China relations occupies more attention. It is tried to be explained that the realist point of view is that the two states entered into competition in line with the increasing power of China, its expanding goals and security dilemma, stemming from the vicious historical circle and the struggle for life and power as the rule of nature. These three determinants offered by the theory are tried to be analysed through briefcases in the first subsection of the first part. In the second subsection of the first part, various areas of competition between these two states are examined with yielding focus on determining how the rivalry of possessing quantum computing has been involved in the on-going competition.

After the Second World War till 1972, except Korea and Vietnam Wars, these two countries did not frequently face each other, and the mutual relations between them were not developed. As a result of the rapid economic growth of China, especially after the Cold War, an environment of competition between the two states had appeared. The fact that China sees the US as the biggest threat to its own interests and national security and changes to its policies toward the US started with the 1995-1996 Taiwan Strait Crisis (Ross, 2000: 87). As a result of happenings, China has entered into cutthroat competition with the United States in the fields of economics, education, technology, military, space sciences, and ultimately the quantum computer.

The second section, which consists of two subtitles, discusses the race to create quantum computers. While in its first subtitle, the functioning mechanism of the Quantum Computer and its advantages are debated, in the second part, the investments made by the USA and China in quantum technology and their competition to the cutthroat are explored. In the first subtitle, called the quantum computer, it is being explained when the idea of producing quantum computers emerged, what techniques were used in the production of these computers, and how they differ from ordinary computers. Because of qubits and their superposition, quantum computers are considerably faster than ordinary computers (Gupta, 2002: 337).

Therefore, quantum computers perform rapid calculations over and over again. Besides its speed in the calculations, quantum encryption techniques and its importance are also mentioned in this subtitle. In this subtopic, the difficulties in the production of the quantum computer and the potential of the power in obtaining the quantum computers are explained.

The other subsection of the second chapter mentions the level of effort put by the U.S. and China in order to attain access to quantum computing. The first initiatives were experienced through the emergence of thought on the implementation of quantum psychics in computer systems in the early 1990s with the aim of producing quantum computing in the U.S. However, in China, the same initiatives were come to practice in the early years of the twentieth century. Although China stepped up lately towards the progress in quantum technology comparing with the U.S, nowadays, we can witness the tense competition between two powerful actors. The level of investments by China and the USA and the successes of these two states in the field of quantum computers and future investments are tried to be explained in this subtitle.

1. THEORETICAL APPROACH TO U.S-CHINA RIVALRY AND BASIC FIELDS OF THE RIVALRY

Before passing on an explanation of the theoretical framework of the U.S-China rivalry, there is a strong need to shed light on the importance of referring to the concept of rivalry in this study instead of focusing on the concept of conflict. The latter specifies incompatibilities and mutual misunderstandings between two actors. Parties in the conflict are in making great efforts to lead counterwork and hinder the affairs of the counterparty in order to reach and possess certain power, source, status, and targeted missions and realize actions. For instance, according to Sean Byrne and Jessica Senehi, conflict is the development of incompatible goals between actors, groups, and nations (Byrene and Jessica, 2009: 3). On the other hand, the rivalry is the competition between two sides or among many with regard to reach a certain goal and keeps ahead of each other. Although this description is in a way similar to the definition of the conflict, the most important factor here is that the parties are in the sole race. According to Skultety, the rivalry is the struggle of two or more sides to dominate each other in the line of a certain goal (Skultety, 2011: 435). As it is explained in the conflict, the main reason behind the presence of conflict can be understood in a way that the parties perceive each other's actions as a threat to them and take counter-actions. In fact, like the 1995-1996 Taiwan case, this conflict has reached the crisis point time by time. However, since the efforts put by two sides to reach advanced quantum technology and create advanced quantum computers meant basically dominating each other in this area, the concept of rivalry was focused instead of the concept of conflict in this study.

1.1 Theoretical Approach To The Us-China Rivalry

Relations between the USA and China are generally evaluated under three contemporary international relations theories: Liberalism, Realism, and Constructivism.

These three theories have both optimistic and pessimistic approaches to the mutual relations of the US and China. In this sense, pessimistic realism approaches with an optimistic liberalism approach are the most compared from these perspectives. According to the optimistic liberalism notion, the factors of economic interdependence, international organizations, and democratization keep the relations of these two countries in a peaceful atmosphere. In contrast, the defenders of the approach of pessimistic realism consider the struggle of power and survival as an inevitable rule of nature. While liberalism explains history as a gradually growing line (Sandikli and Kaya, 2012: 138), realism considers it as a vicious circle (Simon, 1995: 7). According to the view of the advocators of realism, the growing power of China, its expanding goals, and security dilemma are the main sources of rivalry between two states (Friedberg, 2005: 16).

According to realists, China's growing strength is the most important reason affecting the relations between the two countries. China's growing strength is related to its economic growth, and this growth is happening very quickly. When looking at the historical background of the economic growth of China, it is seen that the economic reform initiated by the People's Republic of China (PRC) in 1978 enabled the Chinese economy to grow rapidly (Gray, 1998: 140). In this sense, according to the approach of the realists, this growth is a threat to the interests of the US, which became the world's strongest economy after the Second World War and the only superpower after the Cold War. The existing rapid growth of the Chinese economy can almost end the US hegemony in the world economy. Looking at the statistical data, it is seen how fast China is growing economically. China's Gross Domestic Product (GDP) has increased significantly in the 21st century, and China has become the second-largest economic power in the world. According to the IMF's 2018 data, while the GDP of China was 13.457 trillion US dollars, this index was equal to 20.513 trillion US dollars in the United States of America (www.imf.org., 2018). In February 2007, The USA experienced traumatically how much the Chinese economy posed a threat to its own economy and how these two economies could affect each other. On February 27, 2007, on the Shanghai Stock Market, the 9% decrease, which is the biggest decline of the last ten years, was witnessed. This sudden and unexpected decline shook the Asian market and then the European and US stock markets. While the Paris stock market fell by 3%, Wall Street experienced the biggest decline after 9/11. Dow Jones Industrial Index lost 3.29% of its values (www.foxnews.com., 2007). Called "Shanghai Sneezing" and creating a hurricane effect in the US and European economies, the existing event showed how strong China could affect the world economy. Furthermore, in comparison to China, the existing pandemic of COVID-19 demonstrates the weakness of the American Economy and deficiencies of the American Government measures. For example, in comparison to the first quarter of 2019, in the same period of the current year, The US economy decreased 4.8 per cent (Rena and Milner, 2020: 1). Furthermore, the measures taken by the American Government in order to prevent the expansion of the existing pandemic and its vital economic damages are insufficient. In this context, it can be said that the US will suffer more from COVID-19 in the other quarters of 2020.

By contrast, the pandemic prevention strategies have been realized successfully by the government of China, and therefore, PRC has been able to elude fewer damages than the United States from the new types of coronavirus. Taking into account the current situation of the US and China, it can be estimated that about a few years later, China can outmanoeuvre the US in economic aspects.

According to realist thinkers, the state's growth capacity allows its leader to pursue a broader policy of interests. As a result of the increase of its power, a state is able to use easier access to better markets and to protect its citizens who live outside of the state borders, beyond securitizing the state sovereignty. It endeavours to realize its interests by interfering with political developments in neighbouring states and in the world. With the strengthening of states, the expansion of their targets is seen by other major states as obstacles to their own interests. Accordingly, the growing and expanding goals of one state can be perceived by the other state as a threat to its national security. In other words, in this kind of situation, the states experience a security dilemma. If a state sees the increased security initiatives of the other state as a threat to its own security, and that it attempts to increase its own security, these counter-attempts, this time, are perceived by the first state as a threat to its own security, and it may initiate new attempts to protect its own security. These mutual security enhancement actions are referred to in the literature as a "security dilemma" (Emmers, 2003: 138).

In this sense, on the one hand, the rapid growth of China and setting new worldwide targets for itself are perceived as a threat to both its economic and other interests by the US. On the other hand, as it grows, China also sees the UA as its biggest rival and the biggest threat to its goals and interests.

1.2. 1995-1996 Taiwan Crisis Perception of Violence of the Threat and Spread of the Rivalry to Every Field

The security problem in the U.S-China relations has seen different cycles since the year 1996. Prior to 1996, the U.S. and China came to face-face in 1950-1953 and afterward during the Vietnam War. After the formation of PRC, the U.S. did not build up diplomatic relations with them. Officially mutual relations between the two states were improved during the two secret visits of Henry Kissinger in 1971 and Richard Nixon's visit on February 27 1972, and all U.S. presidents after Richard Nixon have visited China till today (Chinese Law & Government, 1975: 11).

Taiwan was occupied by Japan in 1895 and was returned back to China after the Second World War. However, in the aftermath of the Second World War, there was an inner conflict in China. Under the head of Mao Zedong, while Communists were getting the victory in the war and forming the PRC, Chan Kay's government were forced to flee to Taiwan and establish here the PRC (Yao, 2018: 305). Rightfully PRC saw Taiwan as its own lands and accepted this issue as "national pride". From another perspective, the economic, financial, educational, production, and political centres of China are on the Pacific coast. Therefore, Taiwan and the U.S. bases in the Philippines pose a significant threat to the security of China.

Coming to the year of 1995, president of the Chinese Republic (Taiwan) Lee Teng-hui was invited to give a lecture in the U.S. at Cornell University on the topic of "Experience of Democratization of Taiwan". The U.S. firstly have not given a visa to Lee Teng-hui but later allowed his entrance to the country (He and Feng, 2009: 510). As a logical response to the U.S act regarding visa procedure, China has begun the ballistic missile experiments in Taiwan Strait. On July 21-26, PRC has sent missiles to the 60 km north of Taiwan, and the People's Liberation Army (PLA) has also begun to sea operations in August (He and Feng, 2009: 511). PRC called Taiwanese not to vote Lee Teng-hui in the presidential elections that were going to be taken place in Taiwan. PLA on March 8-15, in 1996, has sent missiles to Taiwan sea areas. China was not trying to increase tension in the region; however, growing U.S. influence and intervention in the region made China react through the above provisions. The U.S. placed two cargo fighter jets in Taiwan under the name of protecting its strategic partner. It was the biggest military decal of the U.S. in the Far East since the Vietnam War (Ross, 2000: 111). Unlike the U.S. growing intervention and military support in the region, China has avoided an aggressive stance and sought compromises with the U.S. in order to solve the crisis in the region.

On January 11, 2007, the U.S-China rivalry passed into the new stage. PLA implemented an anti-satellite missile test. Testing for the first time since the year of 1985, China has shot its satellite with a ballistic missile. This test has been official confirmed by the U.S. National Security Department on January 18 and five days later by the Chinese Foreign Ministry.

China began to develop an anti-satellite security system apart from ballistic missiles and launched a new laser system to blind satellites. With this new system, China has enough power to blind satellites of the U.S and other countries (Oliphant, 2017).

Another significant step taken by China towards gaining more power in the rivalry with the U.S. is to increase electromagnetic spectrum capacity. In the South Chinese Sea, electromagnetic tension between the U.S. and China has increased compared to previous years. In general, the electromagnetic spectrum emerges as a result of a nuclear explosion. An electromagnetic war, unlike nuclear fight, causes not a massive human loss; thus, it is still being developed nowadays. These electromagnetic waves are able to destruct the entire electronic system of the enemy, destroy the power of the air and maritime attacks (Thomas-Noone, 2006).

As it can be observed from above, the U.S. and China are in the solid rivalry in almost every field. Naturally, the level of technological development reached by two states makes this rivalry more substantial in the global arena. Since 2010, Cyber Attacks launched by China led the rivalry between the two states to the new level (Ormrod and Turnbull, 2016: 274). Through the development of technology, especially in developed countries, banking details, state documents, and other sensitive materials are able to be accessed in the digital area. In this sense, cyber-attacks pose a significant threat to the security of the states.

The fight that is carried out within the internet field actually aims implementation of military and similar missions. The U.S. Cyber Command Captain Admiral Mike Rogers, with his Vision Report (2015) called "Beyond the Building", emphasized the likely possibility of offering cyber options for all stages of operations. In the report, it is pointed out that cyber-attacks are as effective as other measures in military operations. Furthermore, the Chinese air defence determines cyber-attacks on intelligence and surveillance assets as successful attacks in the first phase of cyber warfare. Together with carrying out cyber-attacks, the U.S has to level up its ability to prevent cyber-attacks that would potentially come from the Chinese side (Austin, 2016).

The latter does also make relevant sense for China. For this reason, both states are in search of innovations in order to win the cyber-attacks. So-called innovation is Quantum Computing processing with Quantum technology. The competition over possession of Quantum Computing is the new stage of the rivalry between the U.S and China.

2. THE US AND CHINA'S ENDEAVOURS TO REACH A FULLY-EQUIPPED QUANTUM COMPUTER

James Liley, the former head of the CIA in Asia, described how the war of the USA and China is by his words, "To win the war without the men lose is the best victory" in the BBC's documentary (www.youtube.com., 2016). This war is a war without gunfire and covers all the competition areas between the two countries. The race to have a quantum computer, which is one of the new areas of struggle, is very important for determining the winner of the cyber war between the two states. Although other major states also strive to have a Quantum Computer, The US and China are the main actors of this race and their rivalry accelerates the preparation of the quantum computer.

2.1. Quantum Computer

The idea of applying quantum physics to computers was voiced for the first time in 1959 by Richard P. Feynman. However, it was a fact that it was impossible to realize this idea because of the lack of technological developments in the 1950s and 1960s. By the 1970s, the idea of creating a quantum computer came to the agenda of the world of science again (Gupta, 2002: 336). In the 1990s, attempts to create computers by applying the rules of quantum physics started to be made by large states.

In order to better understanding the opportunities and real capacities of quantum computers, it should be explained the difference between them and ordinary computers. The operating systems of ordinary computers consist of bits (binary digit). In this sense, 1 bit is either 0 or 1 (Poonia and Kalra, 2016: 280).

The information uploaded to the computer is stored in these bits. Calculations and other functions are also performed through bits. Bits are produced in transistors, and there are billions of transistors in every computer. According to Moore's Law, transistors in a silicon chip increase twice every two years (Reichardt, 2006: 118). The higher the number of transistors leads, the faster the computer's operating speed.

However, the applying of quantum physics to computers caused significant changes in physical construction, the inner systems, and working principles of quantum computers in comparison to ordinary ones. For example, in the calculating, data transfer, and other operations, the quantum computers use qubits (quantum bit) instead of bits. In lieu of existing transistors to produce bits in ordinary computers, there are fiber lines in quantum computers in order to produce qubits. In this context, qubits are formed by aligning the ions by means of lasers. In the ordinary computer, a bit is equal to 1 in the condition of electrons pass through the transistor; otherwise, the equivalent of a bit is 0. Therefore, one bit can only be 0 or 1. By comparison, in quantum computers, the status of qubits is different. Qubits, unlike bits, are not only 0 and 1, but also get the smallest and largest form of 0 or 1. Moreover, it can be both 1 and 0 simultaneously. This situation of qubits is called "superposition" (Prince, 2014: 156). The superposition state of qubits allows quantum computers to perform transactions and calculations fairly quickly. The opportunities of qubits' superposition can be explained more clearly with an example taken from the speech of Gershon Talia about the introduction to quantum computing in IBM (Gershon, 2017). There are more than 3,600,000 different forms of seating of guests at the 10-person guest table in the wedding hall. Ordinary computers equipped with bits calculate all more than 3,600,000 possibilities one by one. The superposition states of the Qubits give the quantum computer the possibility to do these calculations at the same time.

In another example, in ordinary computers, at the same time, we can do several operations like to listen to songs, write, and calculate. In fact, these processes are performed in a certain order, not at the same time. Even our modern-day ordinary computers perform these operations so quickly that we think that they happen simultaneously. However, in theory, quantum computers can perform these operations simultaneously with the qubits getting superposition.

The other feature that makes quantum computers so important is that, besides performing calculations at an extraordinary speed, its incredible fast performance in the process of both create and break encryption techniques. Nowadays, encryption systems consist of different combinations of bits. Although current encryption techniques are at a high level, there is no 100% guarantee that these passwords cannot be cracked, and the protected information cannot be compromised. In this sense, states, international organizations, other institutions, and even individuals are always under the risk of cyber-attacks. Therefore, there is a need for a stronger and more advanced, even an ideal encryption technique.

As it has already been mentioned above, in the modernizing world, the information in computers and other databases is protected through various encryption techniques. For instance, RSA cryptosystem which was created by Ron Rivest, Adi Samir and Leonard Adleman in 1977 and called with the combination of the initial letters of its creators' surnames. The other popular public-key cryptosystem is PGP (Pretty Good Privacy) developed by American cryptographer Phil Zimmermann in 1991 (Buchanan and Woodward, 2017: 2).

Although it is possible to break these two and other encryption techniques, in some conditions, it takes a long time to crack these cryptosystems on today's computers, and sometimes it is almost impossible. However, in theory, cracking these encryption systems with quantum computers will become a very easy and fast process. Therefore, having a quantum computer for one of the parties will pose a great threat to the national security of the other party. Thus, the importance of the rivalry to have a quantum computer has once again been clear. On the other hand, among the features of quantum computers, along with breaking the encryption techniques used today, creating a quantum encryption technique is also included. Unlike current encryption techniques, the quantum encryption technique is considered impossible to crack, even with a quantum computer. The reason for the unbreakability of the quantum encryption technique is explained by the fact that qubits have superpositions, and their state called entanglement. Entanglement is a state where qubits are in unbreakable relationships and interdependence. In other words, each qubit does not exist independently of the other.

The Quantum encryption technique is applied in line with the Quantum Key Distribution (QKD) system. QKD is shared between the sender and the recipient before the secret message. With this technique, it becomes impossible to capture the secret message by a third party. An example is given to explain that the quantum encryption technique is unbreakable. Alice, Bob, and Eve are three fictional characters. Alice wants to send a secret message to Bob. With the quantum encryption technique, first, Alice sends Bob the quantum key, then the secret message. Meanwhile, Eve tries to crack the code to read the secret message Alice sent to Bob. The quantum cipher key detects this situation, and with the entanglement feature of the qubits, the qubit cipher key transfers the cipher to the other qubit, thus making it impossible to crack the cipher. As a result, Eve cannot access the secret message Alice sent to Bob (Hurst, 2015).

As it is seen, although theoretically, quantum computers will have no trouble breaking existing codes, and codes generated by quantum computers will be impossible to crack. Therefore, the rivalry of superpowers to get quantum computers becomes quite meaningful. However, the cost of owning a fully equipped quantum computer is quite high. For the formation of qubits, the ions must be aligned by the lasers. In this process, very high temperature occurs. Therefore, existing quantum computers are cooled to more than minus 120 degrees with liquid hydrogen in an oxygen-free environment (Liu and others, 2010: 748). Because of the extremely inconvenient condition of the qubits formation process, scientists can create a few qubits in existing quantum computers in comparison to billions of bits in ordinary computers.

Nevertheless, some international organizations and powerful states like the US and China are in the endeavour of the formation of fully equipped quantum computers.

2.2. U.S and China Investments on Possession of Quantum Computing

After the Cold War, especially since the 1995-1196 Taiwan Strait Crisis, China has considered the U.S the largest threat against its security. Therefore, China has entered in hot competition with the U.S in every field. Despite the fact that initiatives in establishing Quantum Computing in the U.S and Western world begun in the early 1990s, China joined this competition from the first years of the twentieth century.

In the year of 2001, Chinese Scientific Academian Guo Guangcan built up the Key Lab of Quantum Computers in the University of Chinese Science and Technology in Hefei (en.physics.ustc.edu.cn., 2011). This lab has become the most significant quantum science research center in the country. In January 2006, Guo claimed to set up quantum computers in the next 15-20 years in spite of having initial steps in this field. Head of the Department of Quantum Physics and Quantum Information at the Hefei National Laboratory for Physical Sciences, located in Mirkroskeyl, at the University of Science and Technology of China, Dr. Pan Jianwei, in his speech in 2007, predicted that China would have the first fully equipped quantum computer in the world. Unlike his 2007 speech, in his 2010 article, Dr. Pan Jianwei gave more space to quantum communication and the technique of quantum encryption in relation to this communication than the quantum computer. He pointed out that quantum communication is closer to implementation and stated that it is much more necessary to obtain fully equipped quantum computers (Hurst, 2015).

By 2013, the solid-state quantum research team from the University of Science and Technology of China was able to perform the quantum logic gate operation on a single electron in a time of 10 picoseconds, nearly 100 times faster than previous world records. Previously, the US and Japanese research institutes had acquired the electrically controlled semiconductor logic gate at 1,000 picoseconds. This new experience of Guo and his companions improving the previous one by 100 times, and shrinking the process to 10 picoseconds, was an important step in upgrading the quantum computer from laboratory representation to practical use (en.people.cn., 2013).

China’s attempts on quantum communication and quantum encryption technique, which Pan Jianwei touched in his article published in 2010, began in 2006 on a large scale. In 2006, Chinese scientists reported that a two-particle system performed quantum teleportation. Five hundred sixty-five academicians of the Chinese Science Academy specified that this development is the biggest achievement in the area of Chinese scientific-technology for that year. In 2007, Chinese officials declared that they created the world’s first quantum route. With this route, they successfully transferred encrypted information among four computers. This route proved the possibility of a quantum communication network. By May 2009, the Chinese media stated that China had established a government-grade communication network with the quantum encryption technique, which was the first in the world.

According to the report published in the press, this quantum communication network was established in China's Anhui province, Wuhu City, for trial purposes, and this communication network was intended to be used in eight government offices (Xia, 2009).

In 2012, China transferred multiple photons over a lake from a distance of 97 kilometres. With this, China demonstrated that it is close to reaching global quantum communication.

Scientists talked about the possibility of global quantum communication in the future, using satellites. In 2016, China claimed to send satellites to space for quantum communication, and a few months ago, it had transferred encrypted and unencrypted quantum information from a distance of 1200 kilometres (sputniknews.com., 2017).

China's latest initiative for government-grade quantum research has made a splash around the world. China stated that it had started the construction of a research centre for quantum initiatives, with a value of 10 billion dollars, on an area of 37 hectares in the city of Hefei, Anhui province. According to the National Center for Quantum Computing Sciences, the research center, which is planned to open in 2020, aims to create a fully equipped quantum computer (Wang, 2017).

China is investing in this field in the private sector, along with its initiatives on the state-level quantum computer and quantum communications. Alibaba, known as China's largest e-firm in the international market, announced that it plans to build research bases in Israel, the USA, Russia, and Singapore to increase its claim in the fields of logistics, cloud technology, and electron commerce, and it aims to invest $ 15 billion for this plan (Vincent, 2017). These research bases will concentrate on artificial intelligence and quantum systems, as well as on the internet and data analysis. Jack Ma, the chairman and founder of Alibaba, said in a statement that he started the construction of the quantum computer laboratory in partnership with the Chinese Academy of Sciences. The aforementioned laboratory will focus on quantum theory, explore high-protection security techniques for electron trade and databases, and work on increasing the performance of computers. One of the most crucial objectives is to develop a system similar to traditional computers but processing with quantum computing power within five years. In order to achieve this goal, the Alibaba Group Company announced that it would sponsor the laboratory for the next five years and bring important scientists to work here. At the end of the five years, Alibaba and the Chinese Academy of Sciences have evaluated the results and stated through the media that they would work on a further 10-year investment plan. With this step, China aims to develop its own products and speed up its programs, considering that most of the products it has purchased so far come from foreign companies (Van der Steen 2015). China's future planning and investments in the field of intelligence and technology to take the lead still worry the U.S officials and scientists. In the next 3-4 years, making China a key player in the fields of computing, biotechnology, and digital industries is one of the foremost goals of Chinese government officials (Katvala, 2018). The most important example of these studies is the intense efforts on Exascale (Information system).

With the completion of the first project in this area in 2018 as planned, China has a computer system that makes billions of calculations per second (Giles, 2018). The same project is planned to be finished in 2021 in the U.S. Considering that the United States maintains its leading position in international competition in the fields of economy, military, and technology, in order not to reverse this trend, the U.S must once again put itself forward in the field of developing technology. In order to realize it, one of the most important steps is to ensure development in the field of quantum science. In the U.S, unlike China, private companies are making more efforts to own quantum computers than the state. Currently, D-Wave is on record as the only company to sell Quantum computers. The company was established in 1999 in Burnaby, British Columbia, Canada, and is the most important US investment in quantum computing so far. The company works not only with US investments but also with joint ventures of Lockheed Martin, Google, NASA, USC, USRA, Los Alamos National Laboratory, Oak Ridge National Laboratory, Volkswagen, and other companies.

Today, the company has labs in Vancouver, British Columbia, Palo Alto, California, Hannover, Maryland, London, and Tokyo (www.dwavesys.com). The D-Wave company announced in early 2017 that it had produced a new 2000-qubit computer, worth $ 15 million. This is twice as powerful as the previous quantum computer and is revolutionary for quantum computers (www.dwavesys.com., 2017).

Other U.S vendors such as IBM and Google and organizations such as NASA are setting up public-private research groups in this area. For example, IBM helped innovate in this area by making quantum computing capabilities available in the IBM Cloud in 2016. Also, in March 2017, IBM announced to the public on the national stage a new division, IBM Q-y, aimed at commercializing universal quantum computers for both commercial and scientific uses.

Continuing its initiatives, IBM announced on January 8, 2019, at the “2019 Consumer Electronics Show” held in New York, it plans to open the first IBM Q Quantum Account Center for commercial customers in 2019 in New York Poughkeepsie (https://newsroom.ibm.com., 2019). Besides IBM and D-Wave, other giant technology organizations in the U.S, for example, Google, Microsoft, Raytheon, are investigating various fields on quantum algorithms, software and tools, and encryption techniques. Apart from this, the University of Southern California, Delft Technology, Waterloo, and Maryland Universities and Yale Quantum University are the most important research institutions in the field of quantum computers in the U.S.

In the quantum field in the U.S, although private companies stand out more, the US government continues its research on quantum science. In the field of science and technology, in line with the National Science and Technology Policy, Organization and Priorities Act, the Office of Science and Technology Policy (OSTP) was established in 1976 to advise the US president on budget planning and new initiatives (National Science and Technology Council, 2016). The director of the OSTP also took a responsibility of being the US president’s vice-president in science and technology and leading the National Council of Science and Technology (NSTC).

Together with this development, in 1970s the thought of applying quantum psychics on quantum computers in U.S has become widespread (Gupta, 2002: 336). But the most important step by the U.S government in developing quantum computers was that the NSTC committee established the Inter-agency Working Group on Quantum Computing Sciences (QIS), under the supervision of the Subcommittee on Physical Sciences. The group's goal was defined as establishing mutual understanding between federal agencies and determining how to translate agency-level efforts to the government level. In addition to this group, the Joint Quantum Institute was established in 2006 and the Joint Center for Quantum Computing and Computer Science in 2014, with the support of the government (National Science and Technological Council, 2016: 12). According to a report by NSTC in 2016, the federal government allocated average of two hundred million dollars every year for research related to QIS (Ambrose, 2018).

With the arrival of Donald Trump as the head of the country, the federal budgets for scientific research would be cut, which caused great concern among American scientists. In addition to this, the biggest competitor of the U.S in the field of quantum technology, China, is planning the completion of construction of the national quantum lab worth ten billion on March 2020, sending Micius quantum satellite to space in 2016 and transferring encrypted quantum information from Shangai to Being; thus these were greater concern among American scientists. All these developments urged Capitol Hill and the White House to new budget planning in quantum science (Herman, 2018). The outcomes of these developments led to the approval of the Quantum Computing Research Act by Senate in 2018.

The law aims to harmonize the efforts of the U.S government, academic and private sectors, and to ensure that the best technologies are used for the defence of the U.S. On the second Thursday of September 2018, the House of Representatives passed the National Quantum Initiative Act (Russel, 2018). Under the law, the U.S government has agreed to budget $ 1.275 billion over the next five years for the development of quantum technology. Although this decision shows the U.S contribution to quantum science, in a five-year period, it amounts to 255 million dollars government support thence, it is quite less in comparison to China.

CONCLUSION

This two-part study aimed at examining quantum computers becoming a new challenge in the US-China rivalry has produced some results. Firstly, it should be mentioned that the existing study proves the rivalry or conflict between two superpowers in accordance with the realist perspective. As three main requirements, vicious historical circle, the struggle for survival and power asserted by realist theory in order to occur a conflict between two countries are testified in the current study. In this context, the rapid economic growth of the PRC since the end of the Cold War can be considered as the first factor of the existing rivalry. Furthermore, the competition of reaching the world strongest economy between these superpowers reinforces the current conflict.

Moreover, the state, which is in economic growth, has a tendency to strengthen in other areas. Subsequently, the interests of the state are also changing. The goals of the gradually strengthening state are growing, and the areas are covering its goals are expanding. For example, it seeks new markets for its manufactured products like technological items, textiles goods. In this condition, the interests of the former market leaders are threatened. In this sense, it can be said that the rapid growth and strengthening of China in line with the economic development plan prepared in 1978 and the growth of its targets cause a conflict of interest with the USA. Another factor put forward by the realist thinkers is the emergence of a security dilemma between the two states, which is also observed in US-China relations.

In line with the information examined in the first part of the study, it can be concluded that the existence of competition between China and the USA is correct in accordance with the realist theory's approach to the existence of competition between two states.

As can be seen in the examples in the second part of the study, the investments of both the USA and the PRC in the field of quantum science are quite vast. Despite the fact that researches on quantum science have begun earlier in the U.S than in China, the Chinese Government has made significant investments in this field since the early 2000s and obtained substantial outputs since then. Although the law ratified with the government support by the House of Representatives in September 2018 was the counter-reaction of the U.S against China in the field of quantum science, the budget allocated by the U.S side was quite less compared to China. Private Companies like D-Wave, IBM, and Google in the U.S close this gap of the Government. On the opposite side, private companies such as Alibaba have entered into this competition. Taking all these developments into account, it can be said that China is still one step above the U.S in terms of possessing fully-equipped quantum computers and developing quantum technology. The most noteworthy issue is that the state which will possess quantum technology will get an immense power over other states. Evidently, the significance of the quantum computers is equal to and even more than possessing atomic weapons in the Second World War and sending sheep to space during the Soviet-U.S rivalry.

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