**1.** **According to the article, how do ambitions for quantum networks differ across nation-states around the world, and why? Include your own convictions about what role quantum networks should play.**

As we already know, quantum networks are responsible for transmitting the information from one quantum central processor to another one. For this communication quantum networks use qubits (quantum bits).

While talking about quantum networks, we cannot mention the first experiment made by scientists in Vienna for checking bank transfers based on quantum encryption, which, unfortunately, turns out to be failed. After some years, they repeated the experiment, but this time they checked for elections in Geneva. After the experiment, scientists found out that everything was secure, and the test was successfully over. During many years, technology developed, due to which they generate more secure links, hard to be attacked and experiments take a new wave. One of the successful experiments was in Switzerland when they tried to send some data to 50 km away from the starting point (from the financial institution to the medical center). The next experiment was in Japan- Toshiba sent genomic data between two points, but this time the distance was smaller than in the experiment being done in Switzerland.

Researchers find more ways for using quantum technology and that was to make the benefit of quantum networks for joining metro networks. This innovation uses South Korea- to connect already existing metro quantum networks, Britain – to connect Cambridge and Bristol, Australia- they build closed government network and China- to connect Beijing and Shanghai, where each connecting point has more than 40 switchboards connecting senders and receivers, such as China Industrial and Commercial Bank, the Xinhua news agency and China Banking Regulatory Commission. These all are so promising and crucially important for our future, but there is a problem, and that is a distance. As photons flies along fibre’s length, the states get rushed and all information that they care is lost. However, the scientist stated, that the most secure length for fiber link is approximately 200 km. There was a need to create secure loopholes and scientist found out that there is only two way of doing so. First is a land-based approach, and they check this by doing an experiment in Calgary and Hefei. They do not change old wavelengths and found out that this innovation can be done by old infrastructures.

And the second approach is air-based, and as it will be done by air, there was no need for fiber links. Scientists do another experiment, on Canary- between 2 islands, and they tried to transfer quantum- encrypted message.

During the last years, China started using another quantum-key-distribution-enabled satellite to connect already excited Beijing-Shanghai network with Urumqi. Canada, Japan, Italy, and 2 more countries try their best to develop this satellite communication.

The transmission of data from one point to another, while surely knowing that it is the most secure way, in terms of attacks, and there will be no data lost is the essential part of our today’s life.

**2.** **Give four reasons why corporations and governments believe "the time for investment, all agree, is now" for quantum computation, according to the article. Comment on which of the reasons you believe are most convincing.**

Even before starting thinking about making quantum computer, the hardware that will sufficiently differs from our tradition computers, scientists already imagined what could do that computer and what will be it’s particularity. They started already segregate algorithms, sequence of steps and problems, which the quantum computers will use and solve.

It turns out, that the main specification of this new computers was not be the abnormal speed, but the fact that those computers will work and solve problems differently. First difference is the availability of superposition, in other words, if our traditional computers can take the value “0” or “1”, quantum computers can take both at the same time. Another difference is entanglement, which opens another big door. While our computers need to completely isolate one bit from others to avoid wrong calculation, for quantum computer carrying multiple qubits is not terrible.

The first reason is why a lot of people think, that the right time for investments is now, is that nowadays there is a huge number of researches and experiments in the field of quantum simulators and even the smaller progress will lead to big innovations and discoveries. According to Feynman, future computers will do the same as nature and if we will take a look at a quantum world, we can understand that this is not only imagination, but it could become a reality. As it is stated, quantum simulators can help in many fields of human life, such as saving money and electricity, while making it transmitted or using it for designing batteries that will become a good substitute for lithium-ion technology. And the second example of usage of quantum simulators is the idea of making new material, for use in aeroplanes, which will be cheaper and faster.

After the Canadian company started selling first quantum computers, community understand, that human being knows only inconspicuous part of the future of computers. The aim of D- Waves is working best on optimization problems.

In its turns, (third reason) Google uses its own gate- model quantum computers, which do calculations faster than any traditional computer can do. And finally, fourth reason- IBM’s Quantum Experience, which claims, that machines’ future will be in the cloud.

All these reasons, mentioned above, leads to thinking that our future is in quantum machine hands and that investing now, we will gain a lot of after some years, but the most persuasive reason for me, is Google gate- model quantum computers- quantum supremacy.

For showing what they found they compare their quantum processor with traditional computers’ processor. The task was sample the outcomes of pseudo-random quantum circuit, and they explain their choice of this task. So, they make a circuit, which entangle set of qubits by repeating single and two=qubit logical operations. And the sampling quantum circuit’s output make a set of bit strings, and according to research, quantum processors did this faster and easier. Even more, they use cross- entropy benchmarking method, to compare how often each bit string was detected. So, after all this research I honestly believe that this reason was more persuasive than others.

**3.** **The article quotes** [**IBM vice president Dario Gil**](https://researcher.watson.ibm.com/researcher/view.php?person=us-dgil) **saying, "The power of quantum computing is rediscovering all the problems that computers cannot solve, and having a path to solving them." Discuss three ways "quantum software" addresses this idea and argue whether one should believe Dr. Gil's statement (or not).**

As I already mentioned in the previous question, there were no hardware innovated, but scientists already started of thinking what algorithms and interfaces they will use. However, as times goes, scientist understood that even if they will discover the hardware part of quantum computers, they will not be able to use them, as they do not familiar with the software part of that computer.

Nowadays, it's not a secret, that a huge number of experiments are going on, for creating software and algorithmic parts of quantum computers, including graphical interface, programming language, algorithms and problem solutions. The main part of language, that will control quantum computer is partially, known, and do not have much difference from traditional computers’ language, without counting the fact that quantum computers will use superposition for qubits. So, many companies try to figure out the code for those machines, and some companies, at the same time, tries to find the minimum amount of time and qubits for this or that problem that quantum computer will need to solve. The example is Microsoft’s quantum- software team, who already found out that the reaction for making fertilizer will take 100 logical qubit quantum computer hours of days, but the supercomputer will need billions of years.

Another promising field of using quantum computing is collaborations with banks. Partners see the usage of quantum algorithms in finances and trading. For example, QxBranch and 1Qbit trying to find out how quantum computing can improve businesses, such as better optimizing trading strategies or spot cyber-attacks.

The last project that going to be the branch of future quantum computing, is the development of post-quantum ciphers (PQCRYPTO). They want to create ciphers that even future quantum computers will be unable to hack, or for doing so, they will need too much memory or difficult computations. Even America’s National Security Agency announced that they will do everything to make their cryptography quantum computer proof. Google, too, tries its post-quantum cryptography test via Chrome, while protection was done by both elliptic- curve encryption and New Hope (by PQCRYPTO) and the speed of communication was millisecond longer.

In my opinion, there is no reason for not believing Dr. Gil's statement as we already got familiar whit nowadays innovations in the field of quantum computing. We just cannot deny the fact that the reaction, that will last billions years, after the discovery of quantum computing will give the answer after days, or the fact, that due to the speed of quantum computers, Google’s experiment give a difference of 1 millisecond.

**4.** **The article states "subjects that used to be mere footnotes to physics will rule, and engineers (and perhaps even consumers) will have to learn to speak quantum." How is this point presented in the article (cite corporate and government examples), and can you give examples from your own experience?**

As it is stated, quantum technology finds the spheres and fields in which it can be developed and share its fruits with a scientist- it acts like artificial intelligence acts. After some years of innovation, it is now known that first atomic clocks were discovered due to quantum technologies, as at that time no one wondered that there is a mechanics such as superposition or entanglement.

Already being familiar with all these things, technology is moving forward and leads to many types of research. As it is stated in the article, quantum technologies will not be something confidential and private as it was with a global positioning system, behind the government's closed doors. To not become the last person, who found out the latest innovation at the quantum technology field, many companies inviting corporate participants to hear their ideas and viewpoints. However, there is a group of people, who think that quantum technologies are still risky in many industries.

To speak about why engineers, need to start learning to speak quantum, let me bring some examples, especially, those, that will introduce how much impact quantum has and how technologies changed, for instance, materials.

First material innovation: Intel suggested to build quantum bits into silicon, to ride along on existing fab. infrastructures, however, they will need to produce pure material.

The second one is about diamonds. Element Six, make sensors from the diamonds, curving out the slot with “nitrogen vacancies”- lack. They also stated that silicon carbide is quantum-amenable, too, however, they do not have much experience with it.

To mention another example, let’s talk about firm Bosch. Engineers of that company suggested making the combination of autonomous vehicles or the internet of things, for which will be needed quantum sensors, quantum cryptography, and quantum computing, for gathering sensitive readings, securely transmitting data and gathering insights, accordingly.

Despite the fact, that I am, personally, far from innovating something which really will help in the quantum world, however, during Quantum computing class, we started speaking quantum and understand everything from another point of view, from a quantum point of view, and generating quantum algorithms gives us understanding that, even between Yes (1) or NO (0) there is another option- both of them, at the same time.