# How Quantum Computing Will Change the Status quo of Cyber Security

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Abstract: Three of the most popular questions in the private sector around Artificial Intelligence (AI) and Quantum Computers (QC) will be addressed: 1-How will these technologies impact and challenge today's cybersecurity practices? 2-When are these predicted to occur? 3-What does AI coupled with QC mean for future Cybersecurity? As with any new technology, they can serve both positive and negative uses. The yin and yang dynamic has never more present in technology than the advent of Quantum Computers. Organizations are now seeking use cases for internally and externally sourced AI solutions. This examination exposes how today's CPU architectures (RISC/CISC) are unable to compete with Quantum Computers that we are starting to see in the world today. While AI is now a force in the world, it is inhibited by the current CPUs. QC will "unlock and unleash" AI's real potential. This has both good and bad consequences for the world, like to solve a complex medical diagnosis to rendering passwords useless. For one to truly understand how AI can be "unlocked and unleashed", a basic review of chemical-based computing sets the stage for where AI finds the raw compute power to achieve its potential. This examination brings together the concepts of the exponential scale potential of QC by highlighting the first element Hydrogen. It will expose how quantum mechanical properties of an atom enable multi-orbital computing power. Finally, the examination concludes with predictions for how this impacts cybersecurity. Recommendations of resources, strategic considerations, legal impacts, and suggestions on how an organization could potentially proceed with preparing for the impact of this evolving technology**.** Today's CPUs are woefully ill-equipped to handle the massive workloads that AI requires. QC will 'unlock and unleash' AI's real potential by exponentially increasing the amount of data and calculations that can be done. The planet is now 'all in' in a new cyber arms race for Quantum superiority.

**Keywords:** Quantum computing, Cyber security, Artificial Intelligence, Hydrogenaction, Gallium Arsenide, CPU – central processing unit

## 1. Introduction

The research method used for this examination is Applied Research and more specifically a mix of Evaluation Research and Action Research. The research aspect comes from existing publicly available information to enable the readers of this examination to make more informed decisions about how AI and QC can impact their cybersecurity resiliency.

A technological arms race is underway to harness an evolutionary technology: Quantum Computers. Many organizations are asking how technological advancements, such as Artificial Intelligence, will impact their cybersecurity resilience. The first one to dominate the quantum computer tipping point with this powerful new type of CPU wins. They win everything. The implications for cybersecurity from quantum computing enabled Artificial Intelligence *cannot be understated.* The implications of Quantum Computing to the world beyond cybersecurity *also cannot be understated.* Quantum Computing is evolutionarily on par with nuclear technology in terms of its potential to change geo-political, economic, and physical status quos. The AI hidden door has been found and only partially unlocked with the fastest computer chips available today. These CPU's have been limited to silicon, transistors, and are bound by linear growth curves. AI's door is being unleashed as Quantum Computers become more readily available and begin to take over the dominance that today's computers have. AI powered by Quantum Computing is the *holy grail of computing*. It is exciting, frightening, and mindboggling. It is a game changer, a species impacting, planet altering epic-level event.

Legacy RISC and CISC based architectures found the AI door and have started to unlock basic value propositions from AI. RISC stands for Reduced Instruction Set Architecture and CISC stands for Complex Instruction Set Architecture. These are the two architectures that our current day computers rely upon. *"RISC is the way to make hardware simpler whereas CISC is the single instruction that handles multiple work".* (Geeksforgeeks, 2018). Where QC truly changes the computing paradigm is that it is *required* to unleash (blow the door off its hinges) incredibly advanced Artificial Intelligence value propositions nothing like the world has ever seen and only imagined in movies.

AI however is only in its infancy because it is inhibited by legacy RISC & CISC based architecture that currently dominate computers. Today's AI software algorithms can only go so far due to physics limitations of transistor-based hardware. CISC/RISC based technologies have made significant advancements in the past ~15 years by adding multi-threading capabilities and packing more CPU cores onto the motherboards. These are in almost all our modern-day computers, and they are constrained by the physical limits of transistor-based architecture. Namely, space, heat, and power are three of the challenges among many others. While there has been substantial research on the differences between CISC vs. RISC, that will not be discussed further in this examination. The topic at hand is not which legacy transistor CPU architecture is better. The issue at hand is that *transistors are fading away* and *the dawn of chemical computing is now*. Intel, AMD, Sparc, and others enable 99% of the CISC and RISC based computer workloads of today and are reaching their limit. Moving forward, transistor-based architecture gives way to new Quantum Computer architecture, and this is what AI needs to happen to become unlocked and unleashed.

Organizations are trying to assess the value and impact of these new technologies, as they offer the promise of new capabilities, new products and new value propositions. Faster times to market, reduction in costs, finding new ways of doing old things, and finding new things to be accomplished. These companies must adapt to survive.

## 2. Understanding Artificial Intelligence

Most organizations are asking '*how AI will impact their cybersecurity and whether to use AI internally and/or externally*." This is partially the right line of questioning. The bigger question recognizes the hardware, network, and volumes of data that enable all this quantum magic. This is not mystic, nor is spiritual. It is cyber science. Software requires hardware. This does not change with QC. In fact, science and math are more complicated. Future computer hardware engineers need quantum mechanics skills that traditionally have been in the realms of chemistry and physics. Chemistry, physics, math, and computer science become inextricably intertwined with Quantum Computers driving

AI is specialized software that uses mathematical models or 'algorithms' to analyze very large sets of data. Output from AI gains accuracy as data volumes increase. The more reliable the output, the more value the AI offers. To deliver more value, more accuracy in predictions and patterns, AI & QC require massive amounts of power to churn through those larger data volumes. AI does a better job with larger data sets than it does with smaller data sets. There is a direct relation to accuracy increasing as data volumes increase.

Today's modern CPUs are made with semiconductors and gallium arsenide. For RISC, "*transistors are used for more registers",* whereas CISC *"transistors are used for storing complex instructions*". (Geeksforgeeks, 2018) They are both transistors based. What makes QC different from today's CPU architectures are that QCs are based on the quantum mechanics of chemical elements. They work differently than traditional computing (silicon, gallium arsenide, etc.) by allowing quantum computers to perform many exponentially more operations simultaneously. They can program more 'registers' in less physical space. As shown in Figure 1 below, a Hydrogen atom for example, can have 19 possible programmable operations by utilizing quantum bits (qubits) instead of simple binary numbers of ones and zeros (1, 0) that transistor-based CPUs are bound by. QC allows for subatomic super positions that CISC/RISC computers are not physically capable of. Simply stated, quantum computing has *exponentially more computer horsepower than non-quantum computing*. Transistors vs. quantum mechanics is at the heart of this examination.

| CPU Generation | Algorithm | Programmable Options |
|---|---|---|
| CISC/RISC | Binary | 2 |
| Quantum Computing - Hydrogen | Orbital | 19 |

**Figure 1: CPU Comparisons**

## 3. Understanding Basic Quantum Mechanics

To understand how AI can be '*unlocked and unleashed'*, a basic insight of chemistry sets the stage. Instead of binary ones and zeros, chemical element-based computing (quantum computing) goes beyond just the binary choice of one or zero. Figure 2 below shows the 19 programmable options for Hydrogen. Exponential math (predicated upon quantum mechanics of an atom) is the how Quantum Computers can harness new levels of exponentially raw compute power.

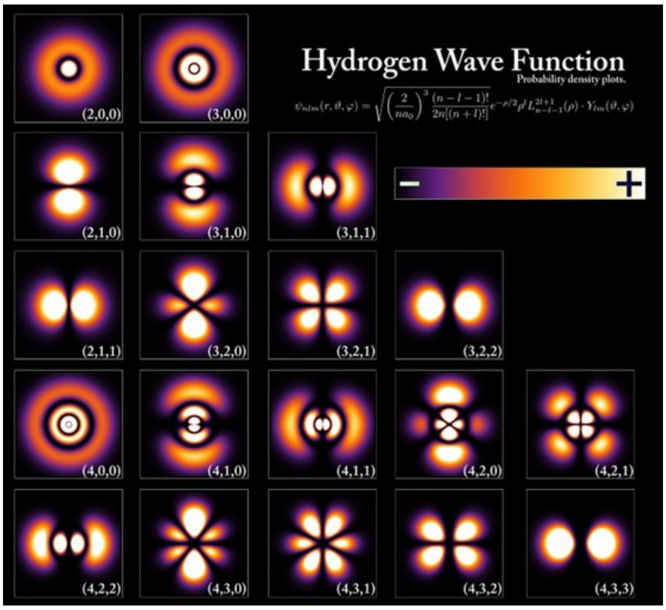


**Figure 2: Hydrogen Wave Functions – 20 potential states**

As RISC/CISC is limited to binary options only, they must link a huge number of binary values together to derive more programable values. This takes ever increasing numbers of transistors to be miniaturized to achieve CPU improvements. This requires physical space. Transistors can only try to get smaller and more densely packed together on the semiconductor wafer. Increasing compute power relies heavily on more transistors packed together. One way the world has increased computer horsepower is by adding multi-threading and multi-CPU architecture. These techniques have reached a point with diminishing returns. It is not computationally efficient. It is also labor and capital intensive. There is a physical limitation of diminishing returns to how small we can shrink these transistors and ultimately limitations to real estate space on the semiconductor wafers.

With QC, millions of *transistors are all working together* in a fraction of the physical space. The ions surrounding the atoms work like transiters and are already much smaller than semiconductor wafers. Nature has already provided the atom, so we benefit from leveraging its quantum mechanics vs. having to engineer semiconductors out of compounds. The bigger the atom, the more transistors theoretically possible. The nature of the atom does the '*transistor packing'* at a subatomic level. This is how quantum mechanics unleashes AI to be incredibly efficient, fast, and powerful. AI is software, so think about the implications for Cybersecurity when any software you want can be unleashed.

As of 2024, there are 118 elements on the Periodic Table as shown below in Figure 3. More are expected to be discovered and or created. Chemical elements are the building blocks of our physical world and atoms are their building blocks. Accessing the quantum mechanical properties represents how new computers will drive massively increased ability to process larger sets of data beyond what the binary bits like CISC/RISC utilize.

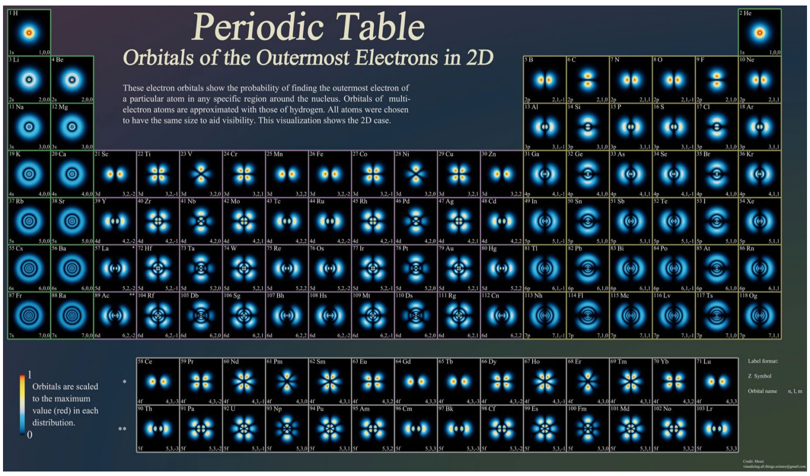


**Figure 3: Periodic Table of Elements**

Quantum introduces a new concept beyond multi-core and multi-threading to a new concept of *multi-orbital exponential power*. By basing CPUs designs on chemical elements, we can now take advantage of subatomic particles orbiting the nucleus of an atom. Instead of packing more and smaller transistors onto a wafer, we can simply utilize a larger atom. As the elements get larger (moving up the periodic table of elements), so does the count of electrons in orbit. These atoms have more than just two programmable states and in fact they can have many different states giving increasingly more programmable option. Hydrogen, element # 1, can exceed a binary state and in fact has 19 possible states. (Boyd 2020). If element #1 yields 19 programmable options, just think Oxygen (element #16) or even Moscovium, element #115, discovered in 2003. (Helmenstine 2024). Obviously, 19 is > 2. At this basic level, the first quantum computer is already out producing a CISC/RISC computers ability 19:2. One vendor, currently viewed as a leader in this space claims their new "*4,400+ qubit processor demonstrates 25,000x faster problem-solving speed*" than a previous version. (D-Wave 2024) Now imagine the programmable options with larger chemicals like say Oxygen that has sixteen electrons vs. Hydrogen's one electron. Then consider Moscovium with 115 electrons. The math is big, exponentially so.

Contrast to modern CPUs that increase compute power by packing more transistors together. Miniaturization is the main method more power. As size shrinks, it becomes harder to take the next step to a point where the shrinkage could approach the size of atoms. Instead of trying to miniature transistors into the size of atoms, using the atoms themselves unlocks exponentially more potential for computer power.

## 4. How Will QC Impact and Challenge Today's Cybersecurity Practices?

As QC begins to unleash AI, new cyberweapons, new offensive tools, and new defensive tools will emerge. This includes software, hardware, TPP and new thinking. As quantum is now at record breaking levels, it can be anticipated that new methods of attack are being invented today. Encryption, passwords, and other security countermeasures we take for granted today will likely be rendered incapable of defending against quantum-based attacks.

Cyberwarfare exists at an unprecedented global scale. Nation-state actors are typically at the apex of capabilities. That status quo will be disrupted by QC powering AI. Adversaries are already investing in this new technology and training human resources to accomplish their goals. QC driven AIs are becoming new weapons they seek. There will be quantum encryption, quantum bots, quantum firewalls, quantum IPS & IDS, and so forth. It will *not be a single big quantum bang.* Rather, quantum will start with computers based on early generation quantum CPUs. The software will then quickly evolve to make use of this new compute power. As time continues, new form factors, and new applications for quantum fueled applications will emerge. At a tipping point, QC will unleash AI to a point where the computers are designing themselves and that is a major risk. We will also start to think of data sets in post or pre-AI processing. Meaning, some datasets will be processed by AI and saved in the post process state to offer value. One example would be actuarial tables for insurance. A post AI processed actuarial dataset will provide more insight and value than raw data or pre-AI processed data. This distinction will grow between the two sets of data. Another use case is for attackers to utilize QC and AI to advance their attacks with greater sophistication and speed.

These kinds of attacks exist today and will become the bane of existence for ill-prepared organizations. It has the potential to destroy organizations who are not prepared with a fraction of the time. Hacking, attacking, financial, espionage, deep fakes, bio-metric hacking, and many other nefarious capabilities drive their motivation. QC provides for more powerful tools to pursue their goals and objectives. Investments in these new weapons are trivial when comparing the rewards and the cost. For "*educational purposes a simple desktop NMR machine with 2 or 3 qubits might cost around $5,000. However a research suitable device with many more qubits might set you back around $1,000,000.*" (Quant 2023). The ROI exceeds their cost already and is a nominal expense for most nation state actors today and is within reach for well-funded lower tier level actors. Most of their targets are ill or totally not prepared today.

One of the goals of this examination is to highlight this risk to the community at large. Here are some major considerations coming with QC.

- Lowers technological barriers for everyone: to have more capabilities through advanced automation. Example: Vendors using AI to conduct business with you. Proposals, invoices, quotes… is this good?
- Reduces cycle time: Results are achieved faster. There will be exponential leaps forward as each underlying QC iteration becomes productized. Workload compute times will drastically decrease, and datasets will substantially increase. Results will become increasingly more accurate through the calculations based on larger data sets. Computer power and AI results will increasingly be easier to

achieve as the periodic table is escalated. AI's micro-second timeline vs. humans real (linear) time. AI will not compute linearly and instead will compute multi-dimensionally.

- Passwords, even highly complex and lengthy ones, will soon be insufficient to prevent access. MFA is now required with today's RISC/CISC computers and may help with QC. QC will present massive challenges for current authentication models. Deep fakes, bio-synthetics hacks, and other defensive measures relied upon today will crumble. New defenses to prevent circumventing authentication will need to emerge.
- More data will be generated than ever before thanks to QC and AI. Greater results will be available in that AI will not only answer questions, but it will also ask questions and create new answers/results.
- Dark data will be discovered. Data hidden within organizations is both sensitive and will be discovered to have hidden values. If the bad actors find this first, they will exfiltrate it and manipulate it. There will also be opportunities to find and safeguard this information or simply dispose of the dark data to save costs and potential legal action if breached. The first to find this data wins the control of it.
- Infonomics will become more common. Organizations will be able to collect, store, analyze, and protect data. Further, organizations will be able to quickly identify and label the economic value of their information. The cost will drop, and Information Governance will be permeated throughout organization to better govern information.
- Computational records will be broken multiple times. The rate of this growth will be dependent upon the ability of the QC workloads to harness the specific naturally occurring element. The growth rates are expected to be very non-linear.
- Economic impacts will be profound: FortunebusinessInsights (2024) stated the "*global quantum computing market size was valued at USD 885.4 million in 2023 and is projected to grow from USD 1,160.1 million in 2024 to USD 12,620.7 million by 2032, exhibiting a CAGR of 34.8% during the forecast period. The North America region dominated the market with a share of 43.86% in 2023. The quantum computing market growth is driven by advanced problem-solving, AI advancements, and global investments*." In another 2024 assessment by the Boston Consulting Group *"predicts that by 2040, quantum computing could generate between $450 billion and $850 billion in economic value, making it potentially worth more than the current GDP of many countries*." (BCG Global 2024) Changes will impact on all sectors of the economy differently.
- Computers will design computers instead of humans only. AI will create AI. New computer designs will be made by Quantum Computers. This will be a significant risk to human existence.
- Massive amounts of energy will be required according to Barrons (2025). "*A renewable-energy company and nuclear- power start-up is joining forces to decarbonize power-hungry artificial-intelligence data centers*." Substantial changes to how, where, when, and levels of baseload generation will be required by data centers and large energy users. Operational flexibility will be mandatory as AI workloads can change power demands instantaneously.
- Computer Science merges with Quantum Physics – New computer form factors will manifest as QC's development matures. They will be physically smaller than traditional computers. "*Scientists have used the famed "Schrödinger's cat" thought experiment to come up with a way to remove errors from future quantum computers*." "The new method encodes quantum *information onto an antimony atom, which has eight possible states that enable data to be more safely stored than in a standard two-state qubit, or quantum bit.*" (Turner, B. 2025).
- Computer Science will require Chemistry knowledge like Electrical Engineering is needed today. Managing Quantum Mechanics stability will be essential for QCs to advance and be reliable. Robert Coucher (2024) studied physics as the University of Utah as said *"You Have to have an extremely stable environment for a qubit, or you get errors. Error correction is a big topic in QC. It is a great challenge. Stability is a must for thermal, electromagnetic, and physical. So, no heat, no electromagnetic interface, and no vibration."* All these must be solved each step of the way from 2-4-8-16 qubits and so forth. Chemical elements have different properties.

### 4.1 When are These Predicted to Occur?

Early versions of QCs have already begun to find business use cases. We are in the early stages to productize these into offers. The timeline for artificial intelligence is difficult to predict simply because of the exponential nature of technology. However, some workloads have begun to migrate QC and way from RISC/CISC, thus the timeline has begun.

### *4.1.1 Historical perspective*

In 1930, Polish mathematician Marian Rejewski, led the first decoding of the Enigma, essentially accomplished with brute force advanced mathematics done with pen and pencil to paper and chalk to a board. That was the one-dimensional computing, if you will. Two-dimensional computing came less than two decades later. The Enigma key was broken a second time in June 1941, by British intelligence. Still, in 1941 there was one big computer that would work on one big problem. Solving more than one problem at a time would require a second computer that did not exist. (Brittanica, 2025)

On Feb. 14, 1946, the world's first general purpose electronic computer was introduced to the world. The Electronic Numerical Integrator and Computer or 'ENIAC', constructed at the Moore School of Electrical Engineering (now Penn's School of Engineering and Applied Science). (C.H.M. 2019)

The evolution of computing has moved from the abacas to the vacuum tube, to the transistor, and now to subatomic particles rotating around the nucleus of an atom. As we jump from gallium arsenide & silicon to hydrogen, we suddenly access hundreds of billions of gates on a chip. All of this has transpired in about 80 years. In 5 to 7 years, or less as we migrate our Quantum Computing times, innovations will continue to shrink.

### *4.1.2 Future perspective*

Today in 2025, Hydrogen, the first element on the periodic table, is where we begin with Quantum Computing. These are now being deployed by vendors for the first time. The next 3 years will yield larger commercially viable quantum computers should be commercially available in the ~5-10 Qbit range.

The next 5-10 years will yield exponentially more powerful computers, and they could reach ~10 Qubits or more. Guesstimates beyond that are certain to be even more questionable due to the exponential change in quantum mechanics offered to compute power. New technologies will be created that do not exist today. AI written software.

By 2030, we will see QC offerings in the cloud. As these will be very expensive at first, only larger, well-financed organizations will be able to afford them. Public clouds will be available for the rest. By 2035, we can expect to see Quantum Computers move farther along on the periodic table of elements. We may even have one at home. All these educated personal predictions. (Bobier, 2024) (MSN, 2025)

## 4.2 What Does AI Coupled with QC Mean for Future Cybersecurity?

Stakes for cybersecurity have never been higher. The ones who get to the dominant QC tipping point first will win. Each iteration of QC will serve as an inflection point towards the QC tipping point. It starts off as a small inflection, then a larger one, and then an even larger one. At some point, the infection will reach a tipping point where that specific iteration is so advancing, it overpowers all previous iterations. There will also be unintended consequences.

There will be unintended consequences. The next human generation will see both expected results and unanticipated outcomes. This should be both exciting and alarming. The first test of a nuclear weapon had the US Infantry staring at the attack to see what it would do. It was exciting that it could end World War II. It was alarming for a company of US Infantry soldiers who were deployed at ground level to observe the test physically. Many died later of radiation related causes.

In another experiment on its civilians, the US Government released radiation in Washington State to test the effects. "*Green Run was a secret Air Force experiment that released Hanford's largest single dose of radioactive iodine-131. On the night of December 2, 1949, at the behest of the military, scientists at Hanford let 7,000 to 12,000 curies of iodine-131 into the air, where it rode the wind as far as 200 miles.*" This later became known as '*Down Winders Syndrome*'. (hrsa.gov. n.d.).

Quantum Computing can be expected to be used in cyberwarfare as a strategic weapon and a game changer. It can be potentially as game changing as the atomic bombs dropped on Nagasaki and Hiroshima. Use AI fueled QC to completely hack an enemy's systems: Air, land, sea, and space. It can be used to completely digitally and physically paralyze an enemy to prepare for an attack. The free world needs to be ahead of this one, not behind. Here are some cybersecurity resilience considerations.

- AI detection will become increasingly more difficult and important. The lines between what is real vs. what is AI generated are already starting to blur.

- Cyberwarfare battlefield matures: A cyber arms race has already begun. Rock> Spears > Arrows > Muskets > Gatlin guns> modern warfare> nuclear > Stuxnet/Colonial Pipeline/SolarWinds >>> Quantum Cyber>>> (QFAITP). Quantum Cyber is an inflection point like the Atomic Bomb was. It's not a linear leap, it's an exponentially expected one.
- Quantum enabled AI Encryption: high functioning quantum computers, >24K qbts. Complex calcs for encryption. Programmable. We post a problem to that computer, who do we use what we know to throw AI. How do we take what we have learned from stabilizing an QC advance designs.
- Quantum Arms race to control molecules – Big science is needed. Instead of using a single trapped ion. We are going to use 10 to 24 of those on a single computer. Then 30 to 50 and so on. "*Photons require a large space. Keeping enough free space and cold enough is a challenge. Whoever figures out how to keep the environment's stable enough use will win*. R&D infrastructures needed.
- Quantum Hacking – Humans can direct a QC to attack targets, and the AI will build cyber-attack chains. Attacks will become more asymmetric. Hacking will become more autonomously unattended.
- Quantum Computer driven digital personal assistants. It will be FB, Ticktock, linked in, email, internet searches on steroids. It will mimic what the functionality is from the Star Trek series in that you can have conversations, interrogatories, and other interactions by voice with a computer interface that serves as a digital personal assistant. We are already seeing the early stages of this in google with a basic search. Like our smartphones, they can help us or be used against us.

## 5. Unresolved and new Questions for Future Research

- Are humans Quantum Computers? - I contend that we are. The human brain is composed of atoms, molecules and compounds working together to create the human brain. Human brains are not made of Gallium Arsenide. We are carbon-based life.
- Close Encounters of the 1 and 2nd kinds -The fact of the matter is that it has now been publicly admitted that we have evidence of DOD Examining Unidentified Anomalous Phenomena (UAP), formerly known as UFO's (Unknown Flying Objects). These incidents have evidence of highly advanced technology. The world cannot explain how these objects can move and maneuver at speeds and forces that modern aircraft and spacecraft are simply not capable of. If this is an advanced technology, it would likely be leveraging Quantum Computing and larger sized molecules such as Element 115.
- Compound computing vs. element computing. We can get away from vibration. We can freeze it to zero – 273C. We still have electronic interference. There will be significant interference at the elemental level that will need to be resolved. We do not fully understand yet what challenges are coming, let alone solve them. One step forward at a time. There could be a day when QC moves from single elements to compounds like a water based computer. Compounds have exponentially more programmable options than a single molecule.
- Cyberlaw and regulations will lag research and development of Quantum Computing. Currently the US FTC (Federal Trade Commission) acts as the de facto Cyber Police in the US. This 120+ year trade agency already lags far behind today's technological capabilities. This gap is only expected to increase causing more confusion, frustration, and legal issues for the US and other countries.

## 6. Conclusion

Often, new technologies have negative and unintended consequences that result as their developers try to gain knowledge and understand all the impacts. If history is any indicator of the future, the world will see both negative and then ultimately positive outcomes for Artificial Intelligence as cases that are fundamentally enabled by Quantum Computers and not RISC/CISC based computing. If we take our eye off the ball, we can lose. NATO can lose, the US can lose, freedom enjoyed in democracies can be quickly lost because the first to the reach the 'Quantum/AI Tipping Point' will achieve global dominance. Once a nation achieves global dominance, the others are by default non-dominant and subject to that status.

Quantum Computing massively condenses the timeline from innovation to results and this timeline has already begun with CISC/RISC CPU's opening the AI door and taking it as far as we have seen today. However, with the transition of the world to Quantum, if we are not careful, we can lose it all. We can lose everything. May this examination serve as a warning. Quantum will wield tremendous power. How that power is converted is up to humans. Be careful what we turn over to automation. Be careful who controls Quantum and AI. Be careful what we wish for and invent.

When organizations ask how AI will impact them, it is important that they understand the expansion potential that quantum brings over traditional computers of today. While AI and QC are closely related, they are not the same. AI is the fuel. QCs are the engines. Having all the fuel in the world (data) but lacking sufficient compute engines is the current problem by the limits of transistor based architectures. That is all about to change. Organizations will all be impacted by this. The question is are they going to react and play catch up, or get ahead of the curve and be part of the race to the tipping point? Cybersecurity reliance in the future will quickly rely upon quantum proofing your infrastructure if that is actually possible.

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Leonardo da Vinci has been attributed "These are the principles for the development of a complete mind: Study the science of art. Study the art of science… Realize that everything connects to everything else." For this author, that includes Terminator, Wargames, The Matrix, Star Trek, Transcendence, just to name a few.

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