Quantum Computing Patents/Investments Are Worthless To Their Inventors/Investors

Gregory Aharonian
Publisher, Internet Patent News Service
www.global-patent-quality.com
greg.aharonian@kukaxoco.org
04 March 2021

Abstract: Quantum computing (量子计算) physics is fascinating, and the engineering is fun. Especially if you do either or both with other people's money. But these others are investors or managers who want a return on their capital for funding your innovations, and typically ask that you obtain patents. However, in light of the near impossibility of transnational method patent enforcement, trivial communication burdens for transnational quantum computing transactions, dequantization, hostility of the federal judiciary towards computing patents, and the availability of patent defense insurance against all of these patents -- all existing/future quantum computing patents can be guaranteed to be worthless. And these investments won't be protected by patents.

CONTENTS

(*Note. None of the following applies to patents for quantum dots used for illumination purposes, which are enforceable and have value. None of the following applies to superconducting digital logic circuit patents, which are enforceable and have value.*)

(*Note: this a rough draft. Please critique.*)
This paper available at
www.kukaxoco.org/DOCUMENTS/QUANTUM/WorthlessQuantumComputingPatents.pdf

Patent Insurance Defending Against All Existing/Future Quantum Computing Patents *(discussed below in detail)*

To give legal context to the following problems with protecting quantum computing inventions, later in this paper a global Quantum Computing Patent Defense Policy is discussed, which for a one-time premium of ~$1,000,000, protects a company from all existing and future quantum computing patents issued in all countries, covering legal fees and any infringement damages - guaranteed. For a $20 million grant, we offer this coverage to the entire world - for free. For a $2 million grant, we will insure the world for free from all of IBM's, D-Wave's and Rigetti's quantum computing patents (the biggest patentees). For a $200,000 grant, we insure against all Microsoft quantum patents. The insurance policy implies all quantum computing patents are worthless to their owners, and, investments in the owners' companies worthless to the investors – guaranteed assessments. And we don't even look at the patents, just rely on inadequate global IP laws.

Why Quantum Computing Software Patents are Worthless

(A database of recent worthless quantum computing software patents is available at: http://www.kukaxoco.org/DOCUMENTS/QUANTUM/financial-QC-patents.html)

In December 2020, a quantum computing software paper was published about a significant advancement in quantum chemistry calculations:

> **Even more efficient quantum computations of chemistry through tensor hypercontraction**
> Columbia, Macquerie, Google, U. Washington
> We describe quantum circuits with only O(N) Toffoli complexity that block encode the spectra of quantum chemistry Hamiltonians in a basis of N arbitrary (e.g., molecular) orbitals. ... By laying out and optimizing the surface code resources required of our approach we show that **FeMoCo can be simulated using about four million physical qubits and under four days of runtime, assuming 1µs cycle times and physical gate error rates no worse than 0.1%.**
> arxiv.org/pdf/2011.03494.pdf

Fantastic work of science and programming. Congratulations! Give them a U.S. patent for their invention. But sadly, it will be a worthless patent for reasons neither of physics nor of engineering.

Whether you need **four days**, four hours, or incredibly, just four seconds – a competitor can avoid U.S. patent infringement by using four milliseconds to send the problem outside the U.S. – then do the calculation without infringement in another country - and send the results back in another four milliseconds (or don't send back, and exploit the results outside the U.S.). Global electronic transmissions, and their milliseconds timings, are not a burden on corporate operations. The death knell for this type of patent is that current U.S. patent laws offer no protection against competitors' transmissions of data imported from outside the U.S. that are calculated with a method patented in the U.S. – such as (intensive) quantum computing software methods.

A patent law ruling from 2015 denies most legal efforts to stop infringers of your quantum computing software patent relying on this transnational exploit. This exploit has a long history, where U.S. patent rights mostly stop at the U.S. border (*Brown v. Duchesne, 60 US 183 [1856]*). This did not become an issue for the computing world for over 150 years, until when, in the 1990s and afterwards, the ease of international data transmissions jeopardized enforcement of software patents. A patent lawsuit in the 2010s, decided in 2015, made these jeopardies quite clear.

The technology in the 2015 patent lawsuit involved building dental retainers for correcting positions of teeth. A company, Align Technology, acquired 7 patents for software that uses measurements of your teeth (obtained, say, by a dentist) and generates a 3D CAD model to be used to manufacture the retainer (which the dentist then places in your mouth). The patents' claims are software method claims (claims are the legal language that describes your invention, that you use to sue infringers – the 'deed' to the boundaries of your intellectual property), describing the method of generating the 3D CAD model. Here is a sample claim introduction:

> **Method and system for incrementally moving teeth**
> U.S. Patent 6,217,325
> https://patents.google.com/patent/US6217325B1/en
> Assignee: Align Technology
> Claim 1: "A method for producing a digital data set representing a final tooth arrangement, said method comprising: …"

An infringing competitor, ClearConnect, set up operations whereby a U.S. dentist measures the parameters of your mouth (not covered by the patent), sends the measurements to a computing facility in Pakistan (not covered by the patent), has the facility generate the 3D model (not covered in Pakistan by the patent), and sends the 3D model back to the U.S. (not covered by the patent).

Align Technology sued ClearConnect before the U.S. International Trade Commission (ITC), and won a ruling blocking imports of 3D models calculated by ClearConnect. This seems to be reasonable and commonsensical, blocking ClearConnect's cheap trick of going offshore. But it is not the law. A higher court, the U.S. Court of Appeals of the Federal Circuit ("CAFC", one level below the Supreme Court), ruled that electronic transmissions of data are not protected under U.S. patent law, for not being physical / "material":

> The Commission's [the ITC] decision to expand the scope of its jurisdiction [including blocking imports] to include electronic transmission of digital data run counter to the "unambiguously expressed intent of Congress". ... but commonsense dictates that there is a fundamental difference between electronic transmissions and "material things" [which the ITC can regulate]." *from: ClearCorrect versus*

Align Technology, U.S. Court of Appeals of the Federal Circuit, 10 November 2015, available at: www.cafc.uscourts.gov/sites/default/files/opinions-orders/14-1527.Opinion.11-6-2015.1.PDF.

The decision was 2-1, with Judge Newman dissenting, in part objecting to the two other judges interpreting the 1922 Tariff Act (which the ITC invoked) using dictionaries from the 1920s. The Fifth Solvay Conference which 'ratified' quantum physics was held in 1927. So, imagine a group of quantum-illiterate federal judges in the 2020s using 1920s dictionaries to guess at how to apply "material things" of the 1922 Tariff Act to quantum concepts from the 1927 Solvay conference. Both Thomas Jefferson and Albert Einstein will be rolling over in their graves at this injustice.

To appreciate how devastating this decision is to owners of such patents suffering transnational border problems, but how great it is for infringers, two years later, ClearConnect – the infringer – was acquired for $150 million. Prof. Matthew Rimmer, of the Queensland University of Technology Law School has an excellent June 2020 article on the global IP problems (patent, trademarks, copyright) for 3D printing, "ClearConnect: IP, 3D printing and the future of trade":

(https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3379410)

including a discussion of the ClearConnect/AlignTechnology legal decision. And while many institutions are studying the problem (WTO, WIPO, OECD, WEF), none of the IP problems for 3D printing have been addressed in law. And these IP problems are even more complicated for quantum computing, for which these institutions aren't even studying the problem. It is unlikely there will be any legal solution for quantum computing patent enforcement for decades. And by then, the industry will be passé.

> Note: for patent law nit-pickers. The above cited *ClearConnect* case involved 35 U.S.C. 271(g). One also might invoke 35 U.S.C. 271(f), a law which states if there is a U.S. patent on a product, and you compete by manufacturing the parts of the product and shipping them abroad for final assembly and sale, you are still infringing the U.S. patent. One might argue that the patented U.S. quantum software method is such a product, and writing the code in the U.S., and shipping it offshore for final compilation and execution, is such an infringement. Easy to work-around – set up your quantum software development group offshore in 中国, nullifying *WesternGeco* (and an earlier case, *DeepSouth*). Indeed, an IBM quantum software patent teaches an offshore server that assembles quantum computing algorithms from libraries of 'parts' (this patent is discussed below), which ironically, can be used to defeat the protection of other IBM quantum software patents.

An older legal decision from 2005 that might be relevant is the case *NTP versus Research in Motion (418 F.3d 1282)* (for those of you who remember RIM's Blackberry). NTP had U.S. patents on handling messages sent over wireless networks using mail servers, which RIM was obviously doing. But RIM argued in court that its servers were in Canada (where it is headquartered) and thus not infringing of a U.S. patent. The Court of Appeals of the Federal Circuit turned to a 1976 case, *Decca v. United States (544 F.2d 1070)*, which involved radio navigation systems located outside the United States in light of U.S. patents involving radio navigation systems. In Decca, the court ruled that a radio navigation system with components located outside the United States is not within the United States for purposes of infringement, unless a control point or station of that system is located with the United States (analogy: a hybrid quantum/classical computing system where the 'classical' is inside the United States). The court found infringement because the system was controlled from the U.S. (easily avoidable for quantum) and the "actual beneficial use" was in the United States. For the *NTP v. RIM* case, while it found that RIM violated the device patent claims (because the system was mostly used and controlled in the U.S.), it also found that RIM didn't violate the method claims, because the methods (the server processing) was done outside the United States.

In light of these two cases, if the quantum computing servers are entirely outside the U.S., if the U.S. patented quantum computing algorithms are executed outside the U.S., if the foreign servers are owned by businesses incorporated outside the U.S., it is going to be very hard to assert infringement of U.S. quantum computing software patents, especially if the claims are all method claims. Given the growing hostility to software innovations claimed as devices by the federal courts since 2005 (a method on a known computer device is still essentially a method), there is little protection offered by quantum device claim patents.

Even more fun for infringers, put your quantum cloud servers on a yacht or balloon, and live the care-free life of traveling around the world. Easily communicate with users of your quantum server by using a SpaceX Starlink terminal. Venue for lawsuits? Forget about it. Security worries? Forget about it. Use quantum fully homomorphic encryption techniques (discussed below).

These decisions (and others) pretty much ring the death knell for quantum computing software patents. Because, as argued below (as exemplified by the above quantum chemistry paper), the only interesting quantum computing software algorithms for use in commerce will be those algorithms that take a lot of time (e.g., more than a minute). And for these algorithms, there is a trivial communications penalty for sending the problem description outside the U.S., do the quantum calculation, and send back the results, as an electronic transmission, to the U.S., a transmission which can't be legally blocked.

Only non-dequantizable quantum algorithms will be of commercial interest

The only quantum software computing patents desirable in commerce will be those for algorithms that can't be de-quantized (many types of quantum algorithms are inspiring the invention of just as fast non-quantum algorithms that run on non-quantum computers). If a dequantized version needs a similar amount of time, and if you run it on an (increasingly) cheap petaflop tensor processor, you don't need to buy/license the quantum algorithm (or buy the quantum computer). Here is a list of significant areas of dequantized algorithm development:

- Quantum Many Particle Systems
- Combinatorial Optimization
- Portfolio Optimization / Technical Analysis of Stocks and Commodities
- Consensus Clustering
- Subset Sum Problem
- Integer Factorization
- Semidefinite Programming
- Matrix Analysis – SVD
- Linear Regression
- Quantum Chemistry
- Physical Simulations: Chemical, Climate, Galaxies
- Simulating Quantum Networks
- Neural Networks
- Machine Learning
- Natural Language Analysis

Even quantum supremacy is susceptible to dequantization. A 2021 paper out of IBM and the Univ. of Waterloo, "Classical algorithms for forrelation" (https://arxiv.org/pdf/2102.06963.pdf), takes one of the most advantageous algorithms for quantum speedup, forrelation, and dequantizes it:

> We study the forrelation problem: given a pair of n-bit Boolean functions f and g, estimate the correlation between f and the Fourier transform of g. **This problem is known to provide the largest possible quantum speedup in terms of its query complexity** and achieves the landmark oracle separation between the complexity class BQP and the Polynomial Hierarchy. **Our first result is a classical algorithm for the forrelation problem which has runtime $O(n2^{n/2})$. This is a nearly quadratic improvement over the best previously known algorithm.**

Thus, the only economically profitable quantum software computing patents will be for those algorithms that take more than a few seconds to execute, since any classical or dequantized algorithm needing a similar amount of time can be done at a lower cost on a traditional computer. Quantum software computing patents only make business sense (to buy/license) where the quantum supremacy is significant in terms of time needed – the really 'huge' calculations.

This quantum supremacy issue creates a currently-unsolvable patent enforcement problem. Any algorithm requiring more than a few seconds can easily be run outside of the country where the national patent was issued. Just securely transmit the problem in a milliseconds across the border, do the calculation infringement-free (assuming there is no corresponding patent in that country - who patents QC in Colombia?), and send back the results. And the vast majority of U.S. quantum computing patents are only issued in the U.S., meaning servers in Toronto, Nassau, Tijuana and Vancouver can cover the U.S. quite reasonably in terms of network latency times. (Similarly, most quantum computing patents in 中国 are only issued in 中国, so put your server in Taiwan).

A group at Xanadu in Canada, in their paper "Quantum-inspired algorithms in practice" (available at: https://arxiv.org/pdf/1905.10415.pdf), review this timing problem, in the context of two commercially important types of quantum algorithms: those for recommendation systems and those for solving linear systems of equations (e.g., for use in portfolio optimization):

> Overall, our results indicate that quantum-inspired algorithms can perform well in practice provided that stringent conditions are met: low rank, low condition number, and very large dimension of the input matrix. By contrast, practical datasets are often sparse and high-rank, precisely the type that can be handled by quantum algorithms.

Throughout the paper, they report times for various implementations of dequantized algorithm, ranging from hundreds of milliseconds to many hours, for two applications: portfolio optimization and movie recommendations. Of course, they report no timings for quantum algorithms on quantum hardware – quantum supremacy still isn't here. For anything less than a minute or so, it is less costly to use in commerce the dequantized algorithms. For anything that takes a few hours to a few days classically, reducing this to a few minutes, or tens of seconds, with a quantum algorithm is nice, but still suffers from the transnational enforcement problem.

And for financial industry uses, (quantum) patent protection is completely useless no matter how fast (even nanoseconds!) you can do large-scale portfolio optimizations with quantum algorithms, because a financial competitor can just set up an entire trading operation in a country where there is no patent protection – the Cayman Islands Quantum Finance hedge fund, where the "beneficial users" and methods and servers are all outside the United States!

Here is an IBM patent for which the title inspires you to move the 'service' to an offshore 'quantum service' server, and to use an offshore 'remote repository' [see claim 1] (which, as mentioned above, can be used to work-around U.S. quantum computing software patents including … IBM's??):

> **Quantum circuit compilation with quantum libraries as a service**
> U.S. Patent 10,831,455
> International Business Machines
> patents.google.com/patent/US10831455B2/en

As quantum computer hardware systems are regularly offered for commercial sale, someone (Google, Amazon, etc.) will create a global network of quantum computer servers. All you need to do, to non-infringingly use some patented quantum computing software, such as this '455 patent, is to send it to a server in a country where it isn't patented. Will any patent be infringed? Who knows, as rightly summed up by a short December 2020 piece from the Canadian law firm Smart & Biggar on cloud computing (which includes quantum in the cloud), a firm which has helped companies (including Google) acquire quantum computing patents in Canada:

> **Cloud computing: a brief overview of IP issues "in the cloud"**
> Patrick Roszell and Robert Baker, Smart & Biggar, 22 December 2020
> … The amorphous nature of cloud computing makes determining how the law will apply – or even *what* law will apply – a challenge. Because IP rights are territorial and a single cloud computing service can touch multiple jurisdictions, it is unclear in many instances what IP laws will apply in the cloud computing environment.
> … Ultimately, patent owners would be well-served [*if they are rich!*] to recognize that cloud computing puts a wide range of jurisdictional possibilities into play and should be sure to construct portfolios that include rights wherever they may be needed. [*note: this is a lousy recommendation, since patents rights will be needed in every country where you can locate a cloud, i.e., every country, which is cost prohibitive.*]

https://www.smartbiggar.ca/insights/publication/cloud-computing-a-brief-overview-of-intellectual-property-issues-in-the-cloud-

Two UK patent lawyers at CMS Cameron McKenna reiterate this worthlessness of quantum computing (and AI and all server and lengthy method) patents:

> **Patenting AI and quantum technologies**
> Caitlin Heard and Rachel Free, CMS UK, 28 February 2020
> Territorial nature of patents versus global nature of technology: Patents are territorial, and in a complex AI ecosystem it cannot be assumed that every step of the process will be carried out by the same entity, or in the same country – servers can be located anywhere. Therefore, one must assess whether the proposed invention is capable of being enforced on a contributory infringement basis (i.e., that the infringer provides the means essential to put the invention into effect).
> https://www.lexology.com/library/detail.aspx?g=2ef6144c-4c24-48f3-abfe-250bbcec35e0

An earlier October 2013 brief article by Christopher Thornham, a UK patent lawyer at Taylor Wessing, raises much the same concerns for all cloud computing patents (not just those quantum-related):

> Modern computing systems – and cloud computing in particular – operate without regard to national borders, with the user linked over the internet to remote computing resources. This poses potential problems when seeking to enforce patents, which are national rights. … [If] the innovation is actually located remotely in the cloud, away from the user, then that may make it harder to obtain granted claims that are focused solely on the user-side. … the English Court's approach in *Menashe*, treating a user in the UK as 'using' the remote computing resources wherever they are located, helps patent proprietors. … [If judges] do not [take the same approach], infringement of many patents for computer-implemented

inventions might be avoidable in Europe by placing the server outside the jurisdiction of the Unified Patent Court [if it ever exists]. https://www.taylorwessing.com/download/article_patents_cloud_computing.html

Note: these few papers on this troubling issue were not written by American patent lawyers. I don't care if you agree or disagree, but their silence is malpractice.

Interestingly, some quantum computing patents in 中国 claim dequantized quantum computing algorithms, but not their quantized versions (some of the huge body of literature around "quantum-inspired" is being patented). For example, there is:

> Unmanned aerial vehicle group task allocation method based on quantum crow group search mechanism
> 中国 Patent CN108549402B
> https://patents.google.com/patent/CN108549402B/en

These types of quantum-ish computing software patents can be easily avoided, not only by using them outside of the home country, but also by using their non-patented quantum versions in the home country.

If you apply for quantum software computing patents, and your patent lawyer hasn't informed you of this huge weakness, sue him or her for incompetence and find another patent prosecution lawyer who understands all of patent law. If you are investing in a quantum computer company, and they are wasting your investment dollars obtaining quantum software computing patents, sue them for incompetence (at least for how they waste money on useless patents).

Now, the U.S. Congress could change the law to make it illegal to import into the U.S. data calculated by a method protected by a U.S. patent (by updating the tariff laws of the 1920s). But this won't happen, and even if passed, won't have much effect. First, such a law starts protecting digital data with patents, something which has never been allowed (ignoring the hypocrisy of Beauregard claims), and will be bitterly opposed by the powerful entertainment industry since it is a prelude to the patenting of art and entertainment data, i.e., movies and music (a factor Judge Newman did not mention in her Align Technology dissent). Similarly, the government of 中国, which has more controls (e.g., firewalls) over data flows across its borders, could block companies in 中国 from these types of electronic data transmissions. But such (encrypted) transmissions, essentially descriptions of technical problems, are much harder to detect than a politically sensitive phrase. In the end, the only solution will be a global patent (see you next century!).

Second, imagine a financial quantum patent (one of the few areas of quantum computing with a potential business future), such as Goldman Sachs' "Quantum solver for financial calculations"

(U.S. Patent 10,783,446). Suppose you can make tons of money in the stock market using this solver, and the U.S. has passed a law prohibiting imports of financial data generated by the solver. Well, a Wells Fargo or JPMorgan Chase will just set up a financial trading operation offshore (say in the Cayman Islands, everyone's favorite tax haven as well), invest monies using the solver, and send the money back to the U.S. (or leave it offshore). It would be interesting to know if Goldman's in-house lawyers have informed their management of the lack of enforceability of such patents. This weakness also applies to non-quantum financial investment algorithms (for example, the utterly unenforceable U.S. Patent 8,560,420, "Calculating predictive technical indicators").

Similarly, do you want to use someone's quantum chemistry drug design patent? Setup all of your operations offshore, including manufacture of the drug, which isn't protected by the (quantum) drug design patent (and get protection from *Bayer v. Housey, 340 F.3d 1367* [2003], discussed in a 2011 article, "Importing data does not infringe U.S. process patents"). Even more fun, if the drug you produce is expensive, setup a medical travel business, where you fly patients/customers to your office shore facility, sell them the drug and help them with their initial use of the drug, and let them fly back to the U.S. with enough pills for the treatment (coated in chocolate to make them look like M&Ms). How is anyone going to enforce restrictions on that? All of this illustrates the growing incompatibility between international modern technology and business practices, and nation-based patent laws that have much their foundations based on 19th century concepts – something patent lawyers rarely, if ever, discuss with the clients.

In short, given the decisions of U.S. Federal courts that deny patent protection to transnational data transmissions, and/or ease of establishing all of your business operations offshore (which also makes it harder to prove *Panduit's* lost damages offshore), all current/future quantum computing software patents are worthless. And for companies that have worries, as described below, quantum computing patent defense insurance will give them complete worry-free protection forever.

Why Quantum Computing Hardware Patents are Worthless

(A database of worthless quantum computing hardware patents is available at: http://www.kukaxoco.org/DOCUMENTS/QUANTUM/financial-QC-patents.html)

Quantum computing hardware patents suffer from either/both of two problems, the first being if future commercially available quantum computers are low-priced (say, less than $100,000), and the second being if someone solves a set of equations and constraints that involve negative probabilities that will allow all quantum circuits to be calculated with non-quantum computers, fulfilling the challenge set by Feynman in the 1980s.

LOW-PRICE: First, real quantum computers, if they are ever made commercially available, will most likely have three price points: $10,000 or $100,000 or $1,000,000. The Institute for Defense

Analysis has a 2017 paper in which they use $1000 as the price of one qubit, so a thousand qubit system should be priced at a few million dollars. The price of $10,000 is if someone makes a huge breakthrough with qubits and gates ($10 per qubit). The price of $100,000 is a reasonable price for a piece of laboratory equipment (similar to the cost of a powerful GC/MS machine, for example, to measure the levels of flavoring chemicals in coca leaves). The price of $1,000,000 is pushing it, but with enough qubits, you basically have a supercomputer, so pay the million (D-Wave's 2000 pseudo-qubit system sold for $15 million in 2017 – too much, when you can buy a petaflop multi-core super-duper-processor for the same amount from a company such as Groq and do most (dequantized) quantum calculations classically).

> Side note: a recent paper discusses one commercial weakness of quantum computers – that quantum computers offer no speedup for most matrix-vector calculations (the BLAS world) so important to so many industries, a speedup that is the main offering of the multi-core processing world. If the multi-core processors can evaluate reasonable sizes of quantum computing circuits, the opportunities for quantum computing hardware are much diminished. The University of Maryland paper at: https://arxiv.org/pdf/2102.11349.pdf

These are guesses (one source for skepticism for the entire field is that decades into quantum computing, there are few realistic estimates of what these systems will cost, much like with high temperature fusion reactors). At the same time, traditional computer systems and computationally intensive software continue to get faster, limiting how much you can charge for a qubit quantum computer (I suspect the optical quantum computing people will beat the really-cold qubit people).

A January 2021 paper by a group at beit.tech illustrates how little progress there is with quantum computing hardware. Their paper, "Benchmarking 16-element quantum search algorithms on superconducting quantum processors" (https://arxiv.org/pdf/2007.06539.pdf) achieves a state-of-the-art 16-element unstructured search using 4 qubits. Their website discusses using the D-Wave and Rigetti machines to route 22 and 11 vehicles on a small 11-by-26 grid. A multi-core processor can search for billions of elements, or route millions of vehicles. Now. Another paper from January 2021, "Comparison of cloud-based ion trap and superconducting quantum computer architectures" (https://arxiv.org/pdf/2102.00371.pdf), out of Duke University, sadly demonstrates the slow progress with quantum computing hardware, if this graph is being published in 2021:

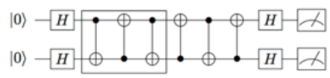

FIG. 7. Circuit for testing two-qubit gate error accumulation. The boxed portion of the circuit (a single SWAP) is repeated, to examine degradation in performance of larger circuits.

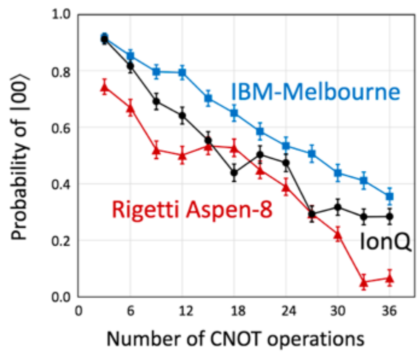

FIG. 8. Measured probability of the state |00⟩ for the circuit shown in Fig. 7 for the IonQ (black circles), IBM (blue squares), and Rigetti (red triangles) machines, as a function of circuit depth. Statistical error bars represent 95% confidence intervals based on 1024 samples per point.

Whatever the prices are in the future for quantum computing hardware (if these machines can ever handle large numbers of qubits), it won't change much the following argument.

At less than $100,000 or so, some cash-rich cloud company such as Amazon, Google, Microsoft or IBM (or Alibaba, Tencent or Baidu) can easily afford to buy hundreds of quantum computers, and create a global network of quantum computing cloud servers. Amazon is offering such quantum server services, Amazon Braket, using D-Wave's and Rigetti's quantum computers (https://aws.amazon.com/braket/pricing/). Which will make it harder for later entrants into the quantum computing market. So, at the most, the quantum computing hardware patents, for only a few companies, will have worth. The rest, probably not in light of this price issue.

And even for these few first companies to the market, the patent system still renders your patent mostly worthless. At $10,000 to $50,000 or so, requiring a straightforward manufacturing process to build your quantum computer, any cloud tech giant can just build your quantum computer, using the Detailed Description in your patent, in the many countries where you don't have a patent, and locate their quantum servers there. And don't argue "*Well, you really can't build our quantum computer from our patent – we left a few goodies out of the description*." A common tactic that patent lawyers collude on, but idiotic, since your patent is worthless for not being enabled (which smarter patent litigators will attack against). And if the breakthrough for a quantum computer is not patented (some university project), even easier for one of the cloud tech giants to hire the university group and build the machines in large quantities without infringement. For example, maybe some future version of the following (unpatented) photonic system could be easily built by any of these big companies (given their tremendous resources):

Deterministic photonic quantum computation in a synthetic time dimension
Bartlett/Dutt/Fan, Stanford University, 19 January 2021
https://arxiv.org/pdf/2101.07786.pdf

Here we propose a scalable architecture for a photonic quantum computer which needs minimal quantum resources to implement any quantum circuit: a single coherently controlled atom. Optical switches endow a photonic quantum state with a synthetic time dimension by modulating photon-atom couplings. Quantum operations applied to the atomic qubit can be teleported onto the photonic qubits via projective measurement, and arbitrary quantum circuits can be compiled into a sequence of these teleported operators. This design negates the need for many identical quantum emitters to be integrated into a photonic circuit and allows effective all-to-all connectivity between photonic qubits. The proposed device has a machine size which is independent of quantum circuit depth, does not require single-photon detectors, operates deterministically, and is robust to experimental imperfections.

So, given these price constraints on future quantum computers, it is difficult to realize much value in existing and future quantum computing hardware patents. The Boston Consulting Group has an interesting paper from May 2019, "Where will quantum computers create value – and when?" (https://www.bcg.com/publications/2019/quantum-computers-create-value-when), but they don't address the issue of whether or not quantum computers will create value for those inventing and patenting the quantum computers, but rather address the issue of businesses and industries that will obtain value. And the most lucrative industry, that of financial investments, is the type of quantum computing application and business easily moved offshore to avoid charges of patent infringement.

But this is boring business tactics to defeat the quantum hardware patents – the boringness of huge companies with huge amounts of money pushing down prices and forcing everyone else out of business with boring quantum computing hardware. Boring!

The second threat to quantum computing hardware patents, much more fun physics and mathematics – indeed, needing a new semantic for physics (including a secularization of axiomatic set theory), is the final breakthrough needed for 'classical' quantum computing – efficient implementations of (now laboratory-measured, non-psuedo-) negative probabilities.

NEGATIVE PROBABILITIES

In recent years, there has been a growing amount of papers in the physics world on the near equivalence of classical and quantum physics (an elaboration of arguments dating back to the 1930s, but long suppressed in the Western physics world). A collection of such papers is at:
http://www.kukaxoco.org/DOCUMENTS/QUANTUM/financial-QC-classical.html

These papers force a conclusion: if there are few mathematical differences between classical physics and quantum physics (*especially if you reject in classical physics the nonsensical idea of infinitely precise measuring that returns non-existent real number measurements*), then there are few mathematical differences between applied classical physics and applied quantum physics, for which a subset is that there are few mathematical differences between classical computing and quantum computing when engineered. You just need the right mathematical formalism to render obsolete all of quantum computing hardware (not just their patents).

In a forthcoming 300+ page paper this spring, I review these formalisms, especially those making use of negative probabilities, a challenge created by Feynman in the 1980s: to use negative probabilities (first introduced by Wigner in 1932 when he created a third, density matrix, formalism for quantum mechanics, the first two formalisms, the Copenhagen orthodoxy, being due to Heisenberg and Schrödinger) to allow all quantum computing circuits to be calculated with classical computers (or classical circuitry such as FPGAs). Feynman's paper at:
https://www.cs.princeton.edu/courses/archive/fall06/cos576/papers/feynman82.pdf

I argue in the paper, that within a year of publicly posting the 300+ page paper, someone will solve a set of equations and constraints that allow all quantum algorithms to execute on classical computers with no exponential blowup for any number of qubits in the circuit. Progress has been steady with such approaches in recent years, but at least one sophisticated mathematical breakthrough is needed to allow these software implementations **to completely render obsolete all quantum computing hardware** (as well as requiring some of the axioms of physics and mathematics to be changed). Interestingly, about ten years ago, the U.S. Navy came close to the breakthrough (they also needed a paper written a few years later).

Upon solution of these equations, software will be quickly written (probably in Python for one of the multi-core architectures being developed at Groq, Graphcore, Nvidia, AMD, Google, Amazon, etc.), and someone (Google, Amazon, Alibaba, Baidu) will create a global network of quantum algorithm servers without need for a single (superconducting, ion trap, microwave cavity, optical system, etc.) quantum computer. And these companies will be glad to do so, since their own quantum computing R&D initiatives are not very serious - they are just diddling around until the moneymaking opportunities present themselves.

A non-quantum computing version of cloud quantum computing is seen, for example, in:

> Simulation of quantum many-body systems on Amazon AWS Elastic Compute Cloud
> Justin Reyes et alia, Univ. of Central Florida, 13 January 2021
> https://arxiv.org/pdf/1908.08553.pdf

When these negative probability-engineered computers are available, all quantum computing hardware patents will forever be worthless (as will be worthless all quantum computing hardware companies). And, if there is some technique in a section of some quantum computing hardware patent that you still want to use, you will be able to do so by coding it up in software and running in on one of these future servers.

If you are applying for quantum hardware computing patents, and your patent lawyer hasn't informed you of this huge weakness, sue him or her for incompetence and find another patent lawyer who understands all of patent law (and negative probabilities). If you are investing in a quantum computer company, and they are wasting your investment dollars seeking quantum hardware computing patents, sue them for incompetence (at least for how they wasted your money on useless patents).

And much like with quantum computing software patents, for those companies that have worries about the quantum computing hardware patents, as described below, quantum computing patent defense insurance will give them complete worry-free protection.

Why Quantum Decryption/Factoring Patents are Worthless

(A database of post-quantum encryption papers and patents is available at: www.kukaxoco.org/DOCUMENTS/QUANTUM/financial-QC-decryption.html)

One early opportunity to get lots of government funding for your quantum startup was to raise the huge/horrible national security threat of quantum computers being able to factor extremely huge numbers quickly (yea! Shor's algorithm), and thus undermine all existing network security systems. A lot of 'progress' is being made with quantum factoring, potentially creating "billion dollar" business opportunities for quantum computing hardware manufacturers. In their dreams.

The problem with this 'huge' business opportunity (the media has to stop touting this nonsense) is that by the time quantum computing hardware is fast and reliable enough to do this type of large-scale factoring, we will have a new generation of post-quantum encryption systems that are resistant to quantum attack (which are also being patented - https://patents.google.com/?q=post-quantum+cryptography). For example, IBM has just made available a toolkit for quantum-safe cryptography – QSC TLS, one reason why IBM doesn't waste its time and money inventing and patenting quantum decryption systems. Their announcement and link to Kyber software is at: https://www.ibm.com/cloud/blog/introducing-quantum-safe-crypto-tls-for-ibm-key-protect

Quantum decryption patents, and justifications for needing quantum computing hardware to use such patents/algorithms, have no value. And those that sell and use quantum encryption will probably use idiotic passwords such as "qubits123".

Why Quantum Network Security Patents are Worthless

Quantum network security is where you use quantum entanglement to securely exchange information between multiple nodes of the network (typically, just the encryption keys are sent using quantum, the rest can be handled more economically with classical communications protocols). For example, you entangle some photons representing your encryption keys at one location, send the photons over fiber optic or free-space transmission channels to a second location, and de-tangle the photons to review the keys. Any attempt by a hostile third party to inject themselves into the circuit will destroy the keys. The second location won't get the message, but neither will the hostile party. A nice review of this technology can be seen in "Security in quantum cryptography", by Portmann and Renner at ETH Zurich (https://arxiv.org/pdf/2102.00021.pdf).

This is all fascinating science and engineering, with the best progress being made in 中国 ("*Researchers in* 中国 *to send an 'uncrackable' quantum message to space*"), having sent an MDI-QKD secure key across 19.2 kilometers of open air in the city of Hefei.
https://www.livescience.com/super-secure-quantum-messages-headed-to-space.html

Not surprisingly, there are many patents for this technology, given the great importance of network security to global commerce and governments (though why in this day and age people are still using idiotic passwords makes a mockery of the technology). But again, most of these patents are worthless where they claim entirely hardware-based systems.

One hybrid approach to quantum network security, allowing more rapid deployment, is called Local Operations and Classical Communication (LOCC). Here you still do the entanglement physically at each node in the network, but exchange information about the entanglement with existing, 'classical', communications protocols. This gets rid of half of the quantum hardware needed for such systems. LOCC protocols are complicated, but progress is being made to automate their creation (see a 2021 paper from Baidu, "*LOCCNet: a machine learning framework for distributed quantum information processing*", available at: https://arxiv.org/pdf/2101.12190.pdf)

The other half, the 'Local Operations', is susceptible to the same patent problems discussed above for patents claiming quantum computing software and quantum computing hardware. That is, patents for the LO half of LOCC, where the LO is implemented in hardware, will either be unenforceable or made obsolete by developments in classically-implemented quantum computing.

A patent owner might try to argue the Doctrine of Equivalents ("Yeah, our patent only claims hardware, but doing it all in software is equivalent"), but that tactic runs into the problem of a growing body of prior art to for use as a defense. Suppose you have a LO-hardware/CC-hardware system, and argue that your patent covers three 'equivalents': LO-hard/CC-soft, LO-soft/CC-hard, and LO-soft/CC-soft. That argument forces you to accept prior art in all three equivalents to be used against your LO-hard/CC-hard patent. An attack you are unlikely to win, except to be left with some narrowly claimed patent worthless for only being defensive in purpose (i.e., you can prevent others from copying you, but can't prevent anyone else from doing the equivalent).

The figure below, from a paper, "Quasi-deterministic secure quantum communication using non-maximally entangled states" (https://arxiv.org/ftp/arxiv/papers/1912/1912.03498.pdf) is a good example of how quantum network security systems can be much de-quantized, leaving just the dashed line to be implemented with some software/hardware quantum computing simulation system.

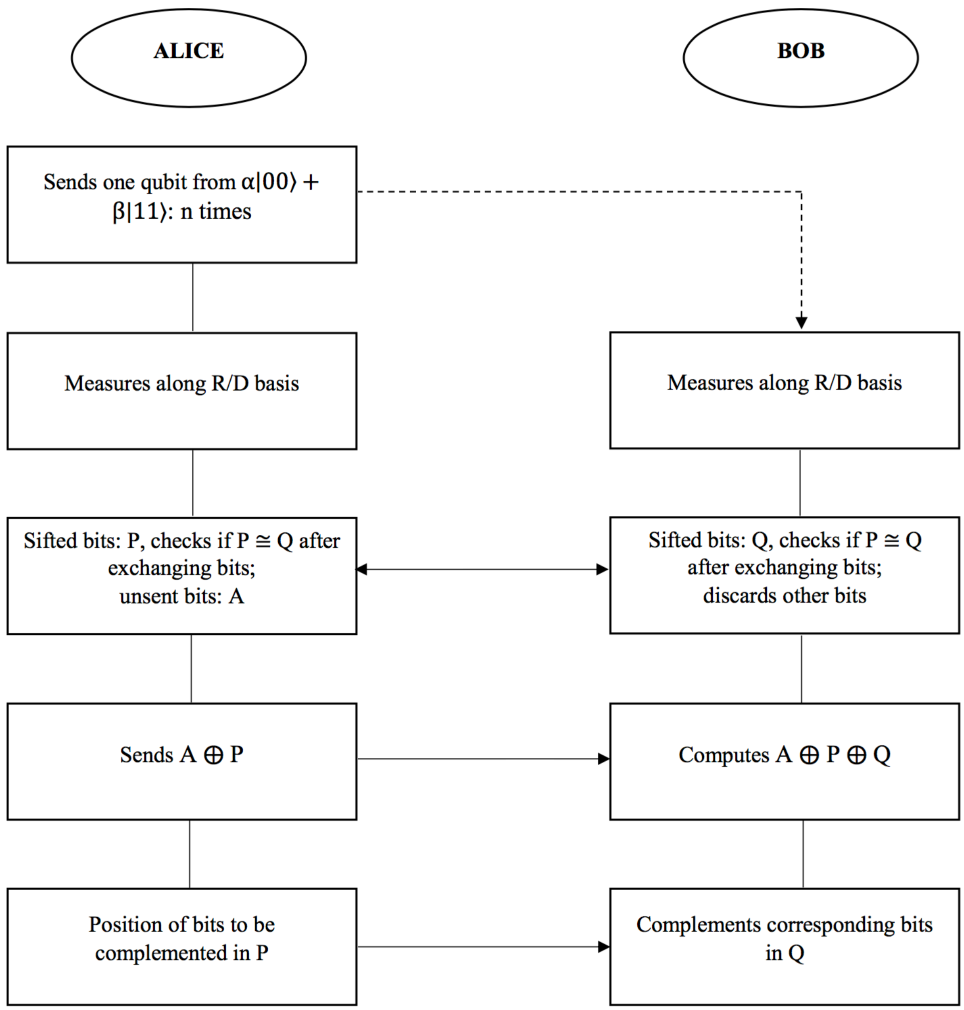

Fig. 1 Quasi-DSQC protocol between Alice and Bob: dashed arrow indicates quantum channel while the normal ones indicate classical channel

Do you feel uncomfortable about sending your quantum computing calculation to a foreign server? Don't worry. Use quantum fully homomorphic encryption (Q-FHE). Classical and quantum FHE enables a third-party server (outside the U.S.) to perform classical and quantum computing on encrypted data without decrypting/re-encrypting the data. Thus, you can use a purely classical software LOCC system for all of your secure network communications, and do your quantum calculations outside some patent's jurisdiction, with those calculations also protected. A paper from the Chinese Academy of Sciences offers an advancement in Q-FHE: "Quantum fully homomorphic encryption without preprocessing" (https://arxiv.org/pdf/2012.04211.pdf). IBM has kindly released a toolkit for all-classical FHE (available at GitHub, and relies on HElib). Paper at: https://www.ibm.com/blogs/research/2020/06/ibm-releases-fully-homomorphic-encryption-toolkit-for-macos-and-ios-linux-and-android-coming-soon/. Can't wait for their Q-FHE toolkit.

Implications for Multi-Core/Tensor-Core Processor Patents

While they are often not discussed together, the multi-core/tensor-core companies are in a battle/race with the quantum computing companies. Both are chasing the same market niches: large-scale deep learning for recommendations, elaborate multi-time series financial models, quantum chemistry, drug design and a few others. Many researchers are writing software for multi-core/tensor-core and for quantum computer software to meet these market needs. This is a race, because at 200+ qubits or so, quantum computers outperform multi-core/tensor-core computers. Unless the multi-core/tensors can 'classically' enable 200 qubits. Bet who is first?

You can see one instance of this race with three papers (of which there are many more), illustrating the race between pure quantum, hybrid classical/quantum, and pure classical:

Quantum recommendation systems
https://arxiv.org/pdf/1603.08675.pdf
A quantum-inspired classical algorithm for recommendation systems
https://arxiv.org/pdf/1807.04271.pdf
Tensor casting: co-designing algorithms for personalized recommendation training
https://arxiv.org/pdf/2010.13100.pdf

The first approach (quantum versus multi-core) to succeed eliminates the need for the other approaches to patent, and sadly, as argued above, the winning approach with the patent (even all three) suffers from the transnational patent enforcement problem. My money (and deep levels of quantum physics) is on dequantized algorithms on multi-core processors as the winner.

If the quantum computers achieve supremacy before software can be written for the multi-core/tensor-core processors, the quantum computers win, rendering the multi-core/tensor-core processor patents worthless. If the multi-core/tensor-core processors win the race by having software written that classically enables 100s of qubits, they win, rendering the quantum computer patents worthless. But they also render their own patents/computers worthless because, and this is speculation, one doesn't need the full power of these chips. Any fast CPU/GPU/FPGA/ASIC will suffice. This illustrates the huge patent and commercial ramifications of solving the set of equations and constraints I discussed above. The solution renders multiple 'cutting edge' computing sectors obsolete, and given the ease of movement of these ideas, creates interesting U.S. national security questions (since the solution probably will come from outside the U.S.).

Indeed, this race is underway. In March 2021, Google announced that it is repurposing its TPU tensor processing units for quantum computing simulations. This is significant because in the same month, a group the Chinese Academy of Sciences published a paper describing a 60 Nvidia GPU (12 A100s and 48 V100s) simulation of Google's Sycamore 53 qubit quantum computer. One breakthrough for quantum simulation on multi-core/multi-tile systems, and quantum computing hardware is obsolete. Articles at: https://arxiv.org/pdf/2103.03074.pdf and https://venturebeat.com/2021/03/10/alphabet-is-repurposing-google-tpus-for-quantum-computing-simulations/.

And sadly, many multi-core/tensor-core patents are as poorly written (especially in light of 35 USC 112) as are the quantum computing patents. Easy to create a patent insurance policy to defend against both sets of patents, for the same reasons – prior art and poor lawyering.

Worthless Quantum Computing Patents by Corporate/University Owner

In the United States, in 2020, there were about 265 issued quantum computing patents. There are six companies that own by half of the patents (and have many more in the past), 3 trying to be serious players, and 3 spinning their wheels waiting for someone else to make the breakthrough that they can commercially exploit. These companies are:

IBM	77 patents
Rigetti	15 patents
D-Wave	13 patents
Google	21 patents
Microsoft	13 patents
Intel	11 patents

IBM gets a lot of patents on everything. Just in case, and for the fun of it. But 77 patents (or 777, with more from prior years), no matter how valuable, won't impact IBM's bottom lines. Their strategy is more like Google/Microsoft/Intel's (discussed below). A Seeking Alpha article has a negative analysis of IBM's potential profits from quantum computing, made in light of IBM's ten-year Quantum Roadmap released in the fall of 2020:

> I have modeled a market scenario through 2030 that hypothesizes even if practical quantum computing is realized, it may not necessarily translate into substantial cash flows for IBM investors. https://seekingalpha.com/article/4386983-ibm-quantum-computing-not-equal-cash

Nor will there be substantial cash flow for Rigetti and D-Wave (and their investors), two companies making huge bets on quantum computing hardware (and have lots and lots of generally worthless patents). These two companies will rise or fall on who wins the quantum computing race – the quantum hardware people, or the classical software people. Neither company is making progress fast enough, and the pseudo-quantum computers of D-Wave not only are threatened by classical dequantization advances, but also by optical versions of their superconducting hardware. If these companies IPO (and they better mention this patent issue in their IPO registration), short their stock – if people doubt IBM can make money from quantum for their investors, Rigetti and D-Wave never well. Starting with not being able to monetize their patents.

In March 2020, Rigetti Computing was devalued during a round of fund raising due to its lack of progress (https://techcrunch.com/2020/03/05/rigetti-computing-took-a-71-million-down-round-because-quantum-computing-is-hard/). Imaging the devaluation if they eventually succeed in manufacturing an off-the-shelf quantum computing that can be manufactured outside of the U.S. (Rigetti has a large portfolio of U.S. patents, but very few non-U.S. patents).

And for a bit over $1 million, as discussed below in the insurance policy section, you can get patent defense insurance against assertions of all of their patents (and all of the other quantum computing patents), which means that these two companies' patents are worthless. And without patent protection, when/if they make the breakthrough, (中国) Big Tech will roll them over.

The other three companies, Google/Microsoft/Intel, are getting quantum computing patents here and there, but none that have much commercial value (though it is nice to see 'Majorana' in a patent title, though it proved to be a retracted failure - https://www.wired.com/story/microsoft-win-quantum-computing-error/). Along with Amazon, I don't think they really care to do so. They are all waiting for someone, quantum or classically, to make the breakthrough for large-scale quantum algorithm execution, and then create quantum computing clouds to make the big bucks offering services.

The remaining companies have handfuls of quantum computing patents, none strategic and none that can overpower the patent insurance policy, and thus all worthless. Some of these companies include: Alibaba, Baidu, Boeing, Equal1.Labs, Northrop Grumman, some of the big banks, and a bunch of universities. Cute, but a waste of money – trophy patents.

Why Many Quantum Computing Patents Are Worthless for Being Invalid

Many quantum computing patents are additionally worthless for the same reason that the majority of electronic patents are worthless: they are invalid in light of the prior art (because too many inventors hold innovation and contempt and refuse to do prior art searches), and/or they fail 35 USC 112 enablement. A good example of this is a recent low/no-quality patent issued to the former Xerox PARC, invalid in light of the prior art (35 U.S.C. 102 and 103):

> Method and system for automated design and design-space exploration
> U.S. Patent 10,853,540
> Palo Alto Research Center
> DATE: filed 31 December 2018, issued 01 December 2020
> patents.google.com/patent/US10853540B2/en

The patent is for circuit design software for (quantum) logic circuits for quantified Boolean formulas. This low/no-quality patent cites NO prior art publications. Seriously? Do these PARC inventors really think that nothing in the last 20 years of tens of thousands of Silicon Valley EDA patents (Synopsys, Mentor, Cadence, etc.) have any relevance? Unlikely to be true, and unlikely to be valid under 35 U.S.C. 102/103. Geesh, walk down Junipero Serra Boulevard and peruse some of the conference papers and journals in the Stanford Engineering libraries. Heard of Stanford?

And try writing, in a reasonable amount of time, software to implement their invention that produces similar results to their invention. You can't, and thus it doesn't satisfy 35 U.S.C. 112 enablement (or what the test for 112 should be). This is a serious defect shared by many more non-quantum electronics patents (a defect the courts should not accept in such patents).

And again, it is easy to move this PARC design system offshore, where you can do the design, and send back just the netlist for the circuit diagram. So even if quantum computing software patents are enforceable, many are still worthless because the patent owner didn't do, or refused to do, an adequate job of searching for earlier, anticipatory publications (the prior art). Patent law is very strict. You have to be the very first to invent so to get a patent, otherwise you are an Elisha Gray.

The Patent System Hates “Abstract”/Software Inventions, and Quantum is Both

In 1972, an engineering-illiterate U.S. Supreme Court issued a ruling, Gottschalk v. Benson (409 U.S. 63), which judicially-legislated (which is unconstitutional) the ‘abstract’ test to destroy software process patents. If the patent claims in your software patent are only describing an ‘abstract’ software idea, you cannot get a patent (or if your patent has issued, a federal judge can wave his or her hand, chant ‘abstract’, and invalidate your patent). I suppose that makes some sense, you don’t want some generalized, vague description to be given patent protection.

But since no one on the Supreme Court, then and now, understands abstract data structure engineering, they have no idea what they are ruling upon. They relied in part on an earlier 1874 decision of theirs, Le Roy v. Tatham (55 U.S. 175), in which they waxed philosophic: “*A principle, in the abstract, is a fundamental truth; an original cause, a motive; these cannot be patented*, …” (and yes, protection for your 21st century invention rests on legal ideas about commerce from the 19th century that have no consideration of 20th science revolutions, such as the quantum).

Here is the problem that has stolen billions of dollars of technology from inventors and companies. With authoritarian contempt, the U.S. Supreme Court, the U.S. Court of Appeals of the Federal Circuit (one level below the Supreme Court, and handles a larger number of patent cases than the Supreme Court), the U.S. Patent Office, and the U.S. Congress (all with the full support of the patent bar and patent lawyers) have refused for 50 years to define what is meant by ‘abstract’ (the European system plays this abuse game with ‘technical effect’). In a recent 2014 decision, Alice Corporation v. CLS Bank (573 U.S. 208), Judge Thomas explicitly refuses to define ‘abstract’:

> In any event, we need not labor to delimit the precise contours of the ‘abstract ideas’ category in this case. It is enough to recognize that there is no meaningful distinction between the concept of risk hedging in Bilski and the concept of intermediated settlement at issue here. Both are squarely within the realm of “abstract ideas” as we have used that term.

Why this is utterly meaningless jurisprudence, as countless lawyers and even federal judges themselves have stated in other rulings, is that the Supreme Court and Court of Appeals of the Federal Circuit have given the term ‘abstract’ so many different meanings that the semantic union of the set of holdings and dicta of their decisions gives no region for an interpretation to be “squarely within the realm of” – Judge Thomas deliberately lied here. Collectively all of their reasoning about ‘abstract’ is so self-contradictory, and cross-contradictory to science and engineering, as to self-cancel. Indeed, in 2019, Judge Moore of the Federal Circuit expressed in an opinion how much of their ruling is based on lying and violating the Constitution:

> **Our decisions have ignored the truth** that claims to specific, narrow processes, even if those processes involve natural laws, are not directed to the natural laws themselves. And contrary to the "elementary [constitutional] principle that … [we must] 'give effect, if possible, to every clause and word of a statute.", **our Section 101 jurisprudence has largely ignored Congress' explicit instruction** that a discovery be the basis for a patentable invention.
> *Athena Diagnostics v. Mayo Collaborative, U.S. CAFC, 3 July 2019 (page 15)*
> *http://www.cafc.uscourts.gov/sites/default/files/opinions-orders/17-2508.Order.7-3-2019.1.pdf*

And on page 83 of the PDF filed, Judge O'Malley accuses the Supreme Court of authoritarian betrayal of the Constitution's Separation of Powers, and Due Process Public Notice:

> I write separately, however, because I believe that confusion and disagreements over patent eligibility have been endangered by the fact that the **Supreme Court has ignored Congress' directions** to the courts to apply 35 U.S.C. 101, et seq as written.

Two years later, in February 2021, the same CAFC expresses contempt for both innovators and the U.S. Patent Office (in cxLoyalty v. Maritz Holdings, page 14, footnote 1):

> Throughout its Final Written Decision, the Board repeatedly referred to the USPTO's 2019 Revised Patent Subject Matter Eligibility Guidance (*84 Fed. Reg. 50, 07 Jan. 2019*). We note that this guidance "is not, itself, the law of patent eligibility, does not carry the force of law, and is not binding on our patent eligibility analysis". (*In re Rudy, 956 F.3d 1379, 1382, Fed. Cir. 2020*). And to the extent the guidance "contradicts or does not fully accord with our caselaw, it is our caselaw, and the Supreme Court precedent it is based upon, that must control." *Id at 1383.*

This a double violation of the Constitutional right for Due Process Public Notice as to the demands of the law. A patent applicant should not have to guess at how to apply two sets of inadequate guidance (here for 35 U.S.C. 101) to prepare their patent applications. That the USPTO guidelines are inadequate flows from the fact that not even the USPTO, experts in patent law, can make sense of the incoherency of CAFC/SCOTUS caselaw. The USPTO is forced to guess as to which rules to impose on patent applicants. The USPTO's sets of guidelines are thus inadequate for having to guess. That the CAFC's guidelines are inadequate flows from their own confessions that they ignore the truth about science and the law, and they ignore the superior authority of Congress in the statutes passed by Congress. Together, 35 USC 101 is unconstitutionally vague, an attack on inventors and the Progress Clause of the Constitution. Which does nothing but aid and abet this country's enemies.

These judicial unconstitutionalities and complete unaccountability have destroyed businesses when their software patents were deemed 'abstract' (and let's be frank, this is a threat to U.S.

national security – something the DoD ignores, and motivation for startups to move to countries with less authoritarian patent systems, such as in 中国). Of course, law firms do not provide refunds in such cases for not having written non-'abstract' claims in the first place. "After all Greg, how can we guarantee our work, when the judicial guidance we rely on is totally incoherent? I suppose we could spend some of our billable hours seeking real reform by ….. hahahahahahahaha, just joking."

So how do you prepare a quantum computing patent application, how do you prepare patent claims, for your quantum computing invention, an invention resting on many 'abstract' quantum mechanical principles (anyone have a definition of 'particle' or 'measurement' or 'entanglement' that everyone agrees on?), how do you prepare these texts in a way that insures that the language you use isn't 'abstract'? You can't. Your lawyer (who really doesn't understand the quantum – see below) basically has to guess (at your expense, and if he or she gets it wrong, no refunds for having bought a defective commercial product). If the patent examiner is amenable to your invention, you get a pass. If not, the patent examiner can just declare that your invention is 'abstract', without having to explain why or explain what he or she means by 'abstract'. You basically spent a lot of money to give an invention to the public (i.e., it was stolen from you).

You can appeal in the Patent Office, and then into the federal courts, but all of the judges involved have to rely on the same Supreme Court and CAFC decisions that provide absolutely no Due Process Public Notice (the 14th Amendment) guidance as to what is meant by 'abstract'. The lack of guidance forces the judges to guess at how to apply 'abstract', and that guessing is so arbitrary as to also violate Due Process (since when you file your patent application, you can't know what future definition of 'abstract' will be applied).

Consider entanglement, a very abstract concept (e.g., exactly which physical phenomenon enables the entanglement - tachyons? :-) which is an important aspect of quantum computing – entangled qubits. Is entanglement a physical phenomenon (Copenhagen), or a mathematical consequence (Wigner)? There is not a single patent judge who understands entanglement (to be consoling to the judges, not a lot of physicists fully understand entanglement). To him or her, it is mostly likely an 'abstract' idea ("You mean entangled like my shoelaces? You mean, like the entanglement between Rader and Reines?"). PATENT DENIED! Or consider the word 'particle', the particles in your qubit or quantum dot. There are least six schools of thought in physics as to how to define 'particle'. Definitely an 'abstract' idea. PATENT DENIED!

> Side note: And if you survive the 'abstract' test, you then have to pass the 'obvious' test, that your invention isn't 'obvious', also just as dangerous a gauntlet since the patent system refuses to define 'obvious'. The only definition is a non-authoritative Congressional report from the 1952 stating something is not 'obvious' if it is significantly different from prior inventions, and something is significantly

different from prior inventions if to a skilled inventor, it is basically … not 'obvious'. Circular semantic nonsense – your Congress inaction.

If you think this isn't a big issue, consider the following threat to huge numbers of future patents, again, another threat to U.S. national security.

U.S. patent law has the concept of a PHOSITA – "person having ordinary skill in the art". Using such skills to make an invention is an obvious thing to do (e.g., adding a third seat/gears to a bicycle built for two to invent a bicycle built for three). If you have two software systems with a fair amount of overlap – it is 'obvious' (and thus not patentable) to integrate them. Back in the 1940s, the Supreme Court invented the "flash of genius test" (without defining what they meant) as the test for obvious. It is was so heinous that in 1952, the U.S. Congress created a law (the end part of 35 U.S.C. 103) that banned such use (the Supreme Court, ignoring the superior authority of Congress, waited 60 years, and in a 2007 decision (KSR v. Teleflex, 550 U.S. 398), jammed their nonsense back into the patent system, but using different, undefined, language "predictable").

Here is the threat. Is it an ordinary skill - something expected, routine practices, what you should be doing if you don't want to get fired - for a PHOSITA to use an AI drug/circuit/structure design tool? The power of AI design tools has grown considerably, including some that autonomously design new drugs, invent new materials, design new (quantum) circuits, etc. Is it obvious for a PHOSITA to use such tools? If so, there is a good argument that the output of those AI tools, new inventions, are not patentable for being the predictable outcome of a PHOSITA using the tool. At some point in the future, the irrationality/incoherence of obviousness court decisions such as KSR will sink to such levels as to intersect the rising power of AI design tools. And at that point, all such inventions are pretty much unpatentable. You might be able to waste money getting a patent, but it will never survive in the gauntlet of the patent courts.

One last note of national security interest. As the U.S. Federal courts, continue to increase their hostility to patents and innovators, especially for the everyone and everything that aren't Big Tech, this will discourage innovators for some of the technologies that the military needs, and/or force these U.S. innovators to move to Europe or 中国, whose patents system are much more favorable to innovators. U.S. military intelligence services should plant a few bugs at 717 Madison Place.

The Patent System is Draconian with Semantics, and Quantum is a Semantic Mess

There are many judicial decisions that illustrate how the current patent system is hostile to inventors' rights. All of these decisions deny justice by narrowly applying the law, patent laws many of which are poorly written. A minefield for the quantum.

One judicial decision from 2004, a denial of justice, illustrates this hostility, and complicates the process of preparing a patent application for your quantum invention, especially in preparing the language of the description of your invention. If you have the slightest of problems with the wording of your patent, especially the patent claims, they will destroy your patent.

The case/company was Chef America, and suffered its patent (U.S. Patent 4,761,290, "Process for making dough products") for a bread recipe being destroyed for the trivialist of reasons – "to" versus "at". If the patent system has problems with bread recipe semantics and 'to/at', how are they going to handle 'entanglement' of qubit 'particles'? In this case, Chef America had obtained a patent for a new recipe for making a new type of bread. No one denied it was a legitimate incremental innovation – people are always coming up with new bread recipes.

A competitor, Lamb-Weston, started using their invention to make bread, so Chef America sued for patent infringement. And Chef America lost, with the following argument, my recreation of the essence of what went on in court:

> Judge: I am ready to hear motions.
> Defendant's Lawyer: We move you dismiss this case for non-infringement.
> Judge: For what reason?
> Defendant's Lawyer: Our client, the defendant, only, I say only, makes bread.
> Judge: I am confused. The patents claims are for making bread. I say "guilty".
> Defendant's Lawyer: No, your honor, the patents claims are for making bricks.
> Judge (and the rest of the universe): Huh? Explain.
> Defendant's Lawyer: The claims require cooking the bread to 400 ^{o}F.
> Judge: Seems reasonable – my wife often sets the oven to such temperatures.

Note: the field of patent law is mostly dominated by (old) white men. Indeed, the old white man who was the presiding judge in this case was later kicked off the court for accepting a bribe.

> Defendant's Lawyer: But look at the claim. It uses "to".
> Judge: So?
> Defendant's Lawyer: Anything you cook "to" 400 ^{o}F is another brick in the wall.
> Defendant's Lawyer: Anything you cook "at" 400 ^{o}F is bread you eat with your meat.
> Defendant's Lawyer: The claims use "to" not "at". They are claiming making bricks.
> Judge: I say you can't eat a brick. … The lawsuit is dismissed for lack of infringement.

Here is the actual reasoning of the appeals court (the decision is: *Chef America v. Lamb Weston, U.S. CAFC, Case No. 03-1279, 20 February 2004*):

> In formulating the amendment to the claims to specify the temperature limitation, the patentees had two models before them: the heating "to" limitation of the specification and original Claim 6 or the heating "at" limitation of the example. They chose the "to" limitation which, as we have shown, plainly and unequivocally refers to the temperature to which the dough and not the air in the oven will be heated. It thus appears that the patentees consciously selected "to" rather than "at". There is nothing to indicate that in doing so they intended "to" to mean "at".

This is a classic example of how highly-paid patent litigators exploit the system and language to destroy your patent. I can just imagine the arguments of litigators when quantum computing patents hit the courts, because there are much more fun quantum words to abuse than "to" and "at". "*Your honor, the patent owner did not declare which quantum sect he belongs to: the Copenhagens or the QBists or the Bohmians or the 't Hooftians. Thus, it is impossible to determine what the patent's use of 'measurement' means. Thus, the patent description is not fully enabled under 35 U.S.C. 112. Please rule the patent invalid*." And if you don't understand this sectarian battle, you shouldn't be writing quantum computing patents.

The judicial commentary reflects another abuse in the patent system. By "patentees", the court is presumably referring to Chef America and its inventors, and presumes that they were in control of the patent preparation and examination process. But Chef America, like most companies, relied on an outside law firm to control the patent preparation and examination process, lawyers who actually wrote the language and interacted with the Patent Office, and too often lawyers at outside law firms don't explain this with their clients. So, if the court wants to be honest, they should have written "*the patentees' lawyers*" to truly assign blame. When a patent is invalidated in court for being 'abstract', the judge should make critical reference to the law firm that wrote the defective patent (who should offer a refund for the fraud that they committed).

So, if you are going to apply for a quantum computing patent, pay careful attention to everything that the lawyers write in your patent application, and everything that they communicate to the U.S. Patent Office. You can't rely solely on the patent system to prevent such mistakes, especially when it comes to quantum inventions. Better yet, just don't waste your money with this charade.

Why Most Patent Lawyers are Quantum-Incompetent

There is an application for a quantum computing hardware patent being examined by the USPTO that I know is both invalid in light of the prior art, and completely non-enabled in the Specification. But if you read the Office Actions and Responses (exchanges between the Patent Office and the inventor's lawyer), you see the typical exchanges being the lawyer and examiner on the road to an issuance ("You missed a period here, a comma there."). It is quite clear - the lawyer doesn't understand enough about quantum mechanics to be involved with this patent application. This is the type of quantum mechanical device that you need at least a Masters in computational physics and quantum mechanics to be qualified enough to write the patent application, search the prior art, and/or examine the patent. The lawyer doesn't have such a qualification. He is not competent to be involved with this patent application. And I see this across many quantum computing patents. Too many lawyers don't have the necessary physics training to be involved.

Indeed, I have a list of a dozen quantum questions, not overly complicated physically and mathematically to state, but complicated conceptually. If a lawyer or investor can't reasonably answer most of them, they shouldn't be involved in quantum computing. Here are some of the easier questions:

- Is quantum mechanics a mathematical tool, or a physics theory?
- If the mathematical differences between classical and quantum mechanics are next to do nothing, should the engineering differences between classical and quantum computing be next to nothing?
- How can prime numbers be used to eliminate the need for quantum computing hardware?
- What occurs less than never, and why is this a question of physics?
- Which is more 'spooky', the double slit experiment or traditional Boolean logic?
- Can you construct definitions for 'set', 'particle', 'system', 'wavefunction', 'measurement', 'string' and other quantum concepts without using circular semantics?
- What useless [not needed in any patent as a term] religious concept must be removed from the axioms of set theory?
- How many empty sets are there?

And these questions address the challenges of writing descriptions of quantum mechanics in a patent application, when some patent lawyers get wrong. But worse is when they get the basics of patent law wrong in a quantum computing patent. Take for example, a quantum computing patent issued in 2020 in 中国:

> **一种隐身目标探测装置及方法**
> Stealth target detection device and method
> 中国 Patent CN107688176B
> https://patents.google.com/patent/CN107688176B/en

In the two independent claims, there appears a phrase: "*quickly locking the airspace grid where the target is located by using* ***a binary search method***". There is a definite no-no in drafting patent claims – to exactly specify something that doesn't need to be exactly specified. In the context of this invention, any search method could be used. So, if a competitor uses a different search method, they do not directly infringe. Now in the United States, and probably 中国, there is the Doctrine of Equivalents, where if you use an equivalent search method (say in terms of time and speed) you still infringe. But still, this is an easily avoidable liability, so the patent lawyer should have used a more generic term, and then in the Detailed Description stated that one such search method is binary search. The concern is that if your patent lawyer has troubles with the basics of being a patent lawyer, who knows what problems they have understanding quantum mechanics.

A list of quantum computing patents issued in the U.S., 中国, Canada and Japan, for 2020 and 2021 is at: http://www.kukaxoco.org/DOCUMENTS/QUANTUM/financial-QC-patents.html.

It is unlikely that any of the patent lawyers involved in these patents can pass the above test. One of the problems is that unlike quantum computing science and engineering, where the Copenhagen philosophical dogma is sufficient - "Shut up and calculate", quantum computing patenting requires claim construction, i.e., "Shut up and define" – reasonably clear definitions of important terms in the patent, and trust me, most of the fundamental quantum mechanical terms can't be constructed. And there is no liberal-arts trained federal judge competent to decide a quantum mechanical claim construction – these concepts are definitely not a matter of law (the justification that scientifically/technology inexperienced judges use to deem themselves fit to adjudicate patents).

Some law firms are repeatedly listed in the lists of patents at the above link, especially those that handle lots of patents for the above companies. These firms include for: IBM: Amin-Turocy-Watson, Garg Law Firm, Cantor Colburn; Rigetti: Henry Patent Law Firm; D-Wave: Cowen O'Connor; Intel: Patent Capital Group; Google: Fish & Richardson; Microsoft: Klarquist Sparkman, Northrop: Tarolli-Sundheim-Lowell-Tummino; and others.

For example, let us discuss the Henry Patent Law firm, which manages and prosecutes a large number of (worthless) patents for Rigetti. In December 2019, Michael Henry, the founder of the law firm, published a paper, "*How cloud, edge and fog computing could affect your patent strategy*". Nowhere in the paper does he discuss the many enforceability problems with (quantum) cloud computing patents. It doesn't matter how well-written the patent is (as he discusses in the paper), if the patent isn't enforceable. Has Michael informed Chad Rigetti about these very serious problems with his quantum computing (software) patents? Paper at:
https://henry.law/blog/cloud-edge-and-fog-computing-patents/

None of these law firms have sufficient expertise with quantum mechanics and quantum computing to write/prosecute large numbers of such patents. And none of these firms understand patent insurance and transnational patent enforcement to realize how a coupling of the two can render worthless many technology areas being patented.

Advice for Foreign Countries' Quantum Computing R&D

For companies in countries such as 中国 and Europe, you are wasting your monies investing in quantum computing hardware. Let the Americans do all of the research (much funded by the U.S. government), then let other Americans disrupt the protection of all of that research. You can buy patent insurance, and freely use all of the technology without having to invest (or steal, an idiotic accusation given the global patent databases). Indeed, a review of the quantum computing patents issued in 中国 in 2020 to mostly companies and universities in 中国 shows most of their patents are for quantum computing software.

Especially for companies in countries such as 中国, stop wasting your monies acquiring U.S. patents, especially quantum computing patents. Your patents are rendered mostly worthless by the U.S. patent system – especially software patents which U.S. courts love destroying, so all you are doing is paying the U.S. to acquire patents you can't enforce, letting them steal your technology.

The Quantum Computing Patent Defense Policy (QCPDP)

(A database of worthless quantum computing hardware and software patents covered by the QCPDP is available at: http://www.kukaxoco.org/DOCUMENTS/QUANTUM/financial-QC-patents.html)

With colleagues at the leading patent insurance company in the U.S., we have designed a Quantum Computing Patent Defense Policy. This is a standard patent defense policy, in that it guarantees coverage for all of your patent litigation fees and any potential damages (there is a deductible, and an upper limit of coverage to the policy, but given the above analysis, neither will be a big worry).

This QCPDP policy will allow you to freely use any/all of the technology, not only in all existing quantum computing patents in every country in the world now, but also use any/all of the technology in quantum computing patents in every country in the world, no matter how they are written in the future. Included in the policy is an advisory service to help you modify your IT practices so that they can take advantage of quantum computing algorithms in the future with few to any worries about patent infringement). Get sued? Call up the insurance company, and let them work with your lawyers to shut down the lawsuit.

The policy is tentatively priced at a one-time fee of about $1,011,021.12 (since the policy is based in part on the unconstitutionality of 35 U.S.C. 101/102/112). Pay that, and you have worry-free access to billions of dollars of technology disclosed in all present and future quantum computing patents - guaranteed. The global patent system is that useless for protecting quantum computing inventions - because of a conflict between the space/time network transmission requirements of desirable quantum algorithms and border enforcement defects of patent laws.

And keep in mind that this is a legally-binding guarantee – that is the power of patent insurance. If your patent lawyer, or patent valuation firm, argues to the contrary ("The policy is not serious. Greg is an idiot, he doesn't really know the law, or quantum, or anything."), ask them just one thing: "Will you guarantee your assessment? Will you guarantee the validity of the patent you prepare for me? Will you guarantee your billion-dollar assessment of my quantum computing patent? Will you put your money where your mouth is?" Of course, they won't, they well know how incoherent the patent system has become.

Now, one of the powers of insurance is that it rests on risk minimization, not risk elimination. The above arguments that all quantum computing patents are worthless do rest on some assumptions. But they are reasonable strong, if not strong, assumptions, meaning the risk of insuring against them is minimal (which in insurance circles means that the risk is minimal, so that less will be paid in damages and claims against the policy than is collected in premiums).

There are more general Patent Defense Insurance policies available. If you have interest, if your patent lawyers have never mentioned such insurance policies and their many financial benefits, please contact us for more information.

Why All Quantum Computing Patents/Investments are Worth Less than $1,000,000

Sadly, for such companies (such as Rigetti and D-Wave), just the existence of this quantum patent insurance policy means that the hundreds of millions of dollars spent acquiring quantum computing patents has been completely wasted, and that billions of dollars invested in quantum computer R&D is being left with no protection for the investors, due to poor legal and technological management.

If, for just many millions of dollars, industry can protect itself against all quantum computing hardware and software patents, then this values all of these patents at many just a few millions of dollars, since a patent is worth no more than the cost of buying protection against its assertion in court. Since hundreds of millions of dollars were/are/will be spent on acquiring these patents, and billions of dollars were/are/will be spent on developing the technology, it is reasonable to conclude that in light of this insurance policy, and the problems of transnational electronic transmissions of the results of patented methods, that all quantum computing patents are worthless.

Indeed, for a $20 million grant, we will protect all companies, for free!, from all existing and future quantum computing patents – guaranteed (once they implement our guidelines). For a $2 million grant, we will insure everyone for free from IBM's quantum computing patents (the biggest portfolio out there – great tech, unenforceable patents). For $200,000, we will insure everyone for free from Microsoft's quantum computing patents (okay, $20,000). This values all quantum computing patents at $0, since given this protection, no one needs to buy or license any patent, nor worry about litigation. Heck, for a $50 million grant, we are will to protect all companies from all existing and future quantum computing, tensor/multi-core processing, and artificial intelligence patents (another technology area where the patents are mostly worthless for reasons similar to above). But wait, there's more! The grantors will also get 10% of our coca leaf soda startup. Now this latter offer sounds a glib, a bit of a joke, but is actually very serious because of the power of patent insurance, the multiple defects of the (transnational) patent system, and the malpractice of patent lawyers not discussing these enforcement issues with their clients.

Useless Law School Papers on Useless Quantum Computer Patents

Just as bad as patent lawyers working on quantum computing patents without truly understanding quantum mechanics (and its many semantic problems that impact claim construction) and patent law (transnational enforceability problems), are lawyers at law schools writing articles about quantum patents without truly understanding quantum mechanics (and its many semantic problems that impact claim construction) and patent law (transnational enforceability problems).

What follows are some idiotic law school papers on quantum computing patents. It is your time to waste if you read them.

> **Regulating transformative technology in the quantum age: intellectual property, standardization and sustainable innovation**
> Mauritz Kop, Stanford Law School, 14 January 2021
> https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3653544
> Abstract: The article demonstrates that strategically using a mixture of IP rights to maximize the value of the IP portfolio of the quantum computer's owner, potentially leads to IP protection in perpetuity. Overlapping IP protection regimes can result in unlimited duration of global exclusive exploitation rights for first movers, being a handful of universities and large corporations. The ensuing IP overprotection in the field of quantum computing leads to an unwanted concentration of market power. Overprotection of information causes market barriers and hinders both healthy competition and industry-specific innovation. In this particular case it slows down progress in an important application area of quantum technology, namely quantum computing.

None of this is true, because of the transnational enforcement problem, and to the extent that there are legal problems, the patent insurance policy will make sure that nothing "slows down" in quantum computing research.

> **Quantum technologies: a review of the patent landscape**
> Mathew Alex, Relecura Technologies, 10 February 2021
> https://arxiv.org/pdf/2102.04552.pdf

Note: Relecura is one of the many technology patent analysis companies that do not fully understand neither technology nor patent law, but do generate lots of pretty pictures. This 25-page report is lots of pretty pictures on the demographics of quantum patents, without a single discussion of patent quality (except for the meaningless use of citation analysis) nor of patent enforceability for these complicated technologies. But it does have pretty pictures.

Quantum computing research helps IBM win top spot in patent race
Stephen Shankland, CNET News, 12 January 2021
https://www.cnet.com/news/quantum-computing-research-helps-ibm-win-top-spot-in-patent-race/
Note: nothing in this paper is discussed in this news article. And sloppy news reporting. "*The company wouldn't discuss how many of the patents were related to quantum computing*." Geesh, just go to any patent text database, and type in the query "ASSN: IBM and ABST:quantum".

Quantum technologies, patents, publications & investments
Michel Kurek, QuantX, Ecole Polytechnique, Paris, September 2020
https://lelabquantique.com/wp-content/uploads/2020/09/QuantumTechnologiesPatPubInvLandscapes.pdf
Note: this is mostly a demographic analysis of quantum patents for all quantum technologies, but about half of the first 35 pages is devoted to quantum computing patents. The remaining 13 pages are devoted to the public and private investment landscape for these types of patents. The report has lots of pretty pictures to impress management, but does not mention (low) patent quality (a huge problem around the world for all patents) nor does mention transnational patent enforcement problems – especially for quantum computing software patents. If you want something pretty that is printed in Paris, go to the Louvre.

Quantum patents
Brian Haney, B.U. Law School Journal of Sci & Tech, August 2020
https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3554925
Note: this first half of this marketing report is background information on quantum computing. The second half is demographic data on issued U.S. patents, explanations of some concepts of patent law, with pages 46 to 55 devoted to "Valuation". Devoid of discussion of the problem of enforcing quantum computing patents across borders, the Valuation section is informative. Appendix C is an amusing list of Top Ten Most Valuable Quantum, none of which are valuable if they can't be enforced.

Three indicators a software patent may be unenforceable
Joseph Saltiel, Marshall Gerstein Borum, 14 May 2019
https://www.marshallip.com/insights/three-indicators-a-software-patent-may-be-unenforceable/

Note: he writes that your software patent may be unenforceable if the software is not described as a process, not described as a specific process in the claims, and the software claims should not mention hardware innovations. All true, and all avoidable by the few good software patent lawyers out there. But supposing your patent meets his three tests, for many software patents, they are still not enforceable for the transnational problems described above. Saltiel does not discuss this at all.

Conclusion

The economics and commerce of quantum computing more clearly raises the problem of how do you protect inventions with national patents when there is a trivial data transaction cost to make use of the invention in another country. That is, where you can electronically transmit the specification of your quantum computing problem to be solved to a quantum computing server outside the U.S., use the U.S. patented algorithm in this other country, and send the results back as an electronic transmission to the U.S. For future quantum computing applications useful in commerce, they will require many minutes or more of execution time, making the milliseconds cost of the trans-border electronic transmission to be negligible. **Thus, all present and future quantum computing software patents are worthless,** a worthlessness guaranteed by patent insurance**.** And as argued above, there are at least two reasons why all present and future quantum computing hardware patents are useless.

Combine these devaluations of QC patents due to technological reasons, with the failures of the patent system to handle QC technology (e.g., lawyers, examiners and judges not competent in quantum mechanics; judicial decisions that have created a draconian, hostile atmosphere opposing all computing patents; patent defense insurance to remove all doubts about infringing all QC patents) – and the message is clear: **it is a complete waste of time and money to obtain quantum computing patents** – they have no value, and it is dangerous to invest your monies in such technologies because your future returns are not protected.