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SLW QUANTUM COMPUTING WEBINAR MINISERIES: EPISODE 2

Patent Prosecution Strategies in Quantum Computing

April 23, 2026

Panel



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Speaker



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Moderator

Outline

- Recap of Episode 1
- Quantum Patent Landscape
- State of the Law
- Preparation/Prosecution Tips
- Case Studies

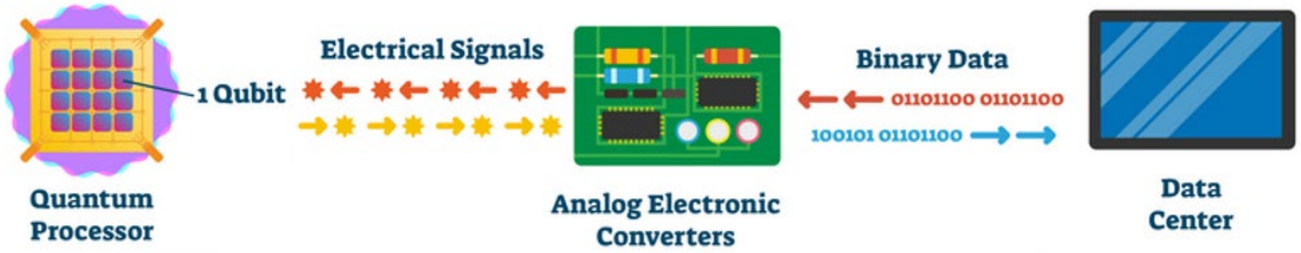
Recap of Episode 1

Recap of Episode 1

- Quantum Mechanics - Concepts
  - Superposition
  - Interference
  - Decoherence
  - Entanglement
- Communication
  - Establishing secure networks leveraging quantum properties
- Sensing and Metrology
  - Using fragile quantum states for ultra-precise measurements
- Computing
  - Solving computational problems through manipulating complex multi-qubit probability spaces

Recap of Episode 1

- The Quantum Computing Stack







The Quantum Computing Stack

- **Layer 4: Software and Application**
  - Quantum Algorithms and hybrid classical-quantum software
  - IP Focus: Use-case specific optimizations

- **Layer 3: Error correction**
  - Algorithms mapping noisy physical qubits to stable logical qubits
  - IP Focus: Syndrome measurement, fault-tolerance

- **Layer 2: Control Systems and Enabling Hardware**
  - Microwave pulses, laser calibration, readout mechanisms
  - IP Focus: pulse scheduling, noise suppression

- **Layer 1: Quantum Register**
  - Qubits
  - IP Focus: Materials, chip/qubit system fabrication

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Quantum Patent Landscape

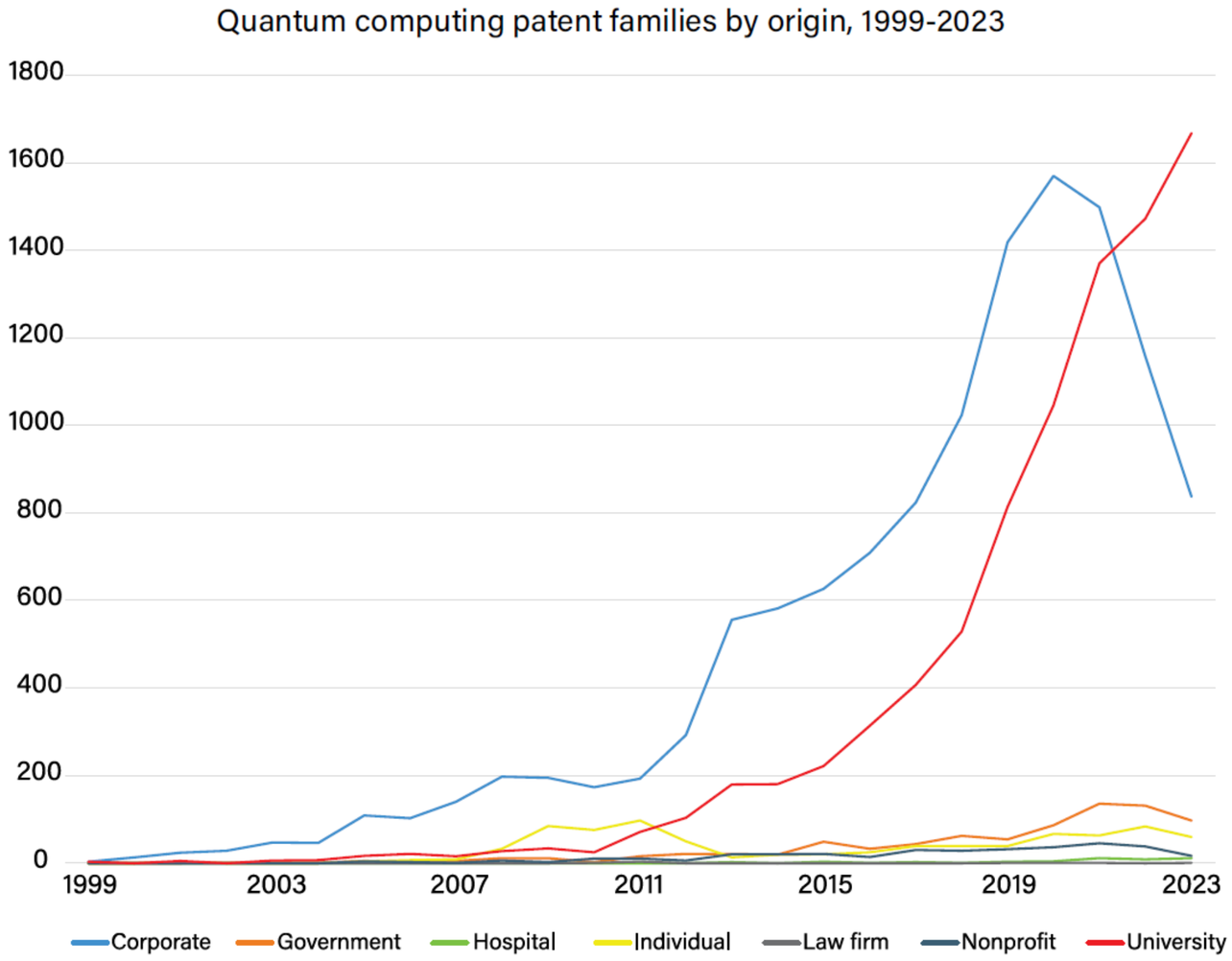
Patent Landscape

"The quantum technology patent landscape has shown remarkable growth and concentration over recent years. Between 2016-2021, quantum computing patent family filings increased by over 300%, while total quantum technology patents grew five-fold from 2014 to 2024. Corporations and universities lead innovation efforts, accounting for 91% of quantum computing patents, with corporations holding 54% and universities 37% of total filings. Geographically, China leads with 60% of patents as of 2024, followed by the United States and Japan."

Ruane, J., Kiesow, E., Galatsanos, J., Dukatz, C., Blomquist, E., Shukla, P., "The Quantum Index Report 2025", MIT Initiative on the Digital Economy, Massachusetts Institute of Technology, Cambridge, MA, May 2025. ("MIT QIR 2025")

Patent Landscape

- “Between 2016-2021, quantum computing patent family filings increased by over 300%, while total quantum technology patents grew five-fold from 2014 to 2024.”
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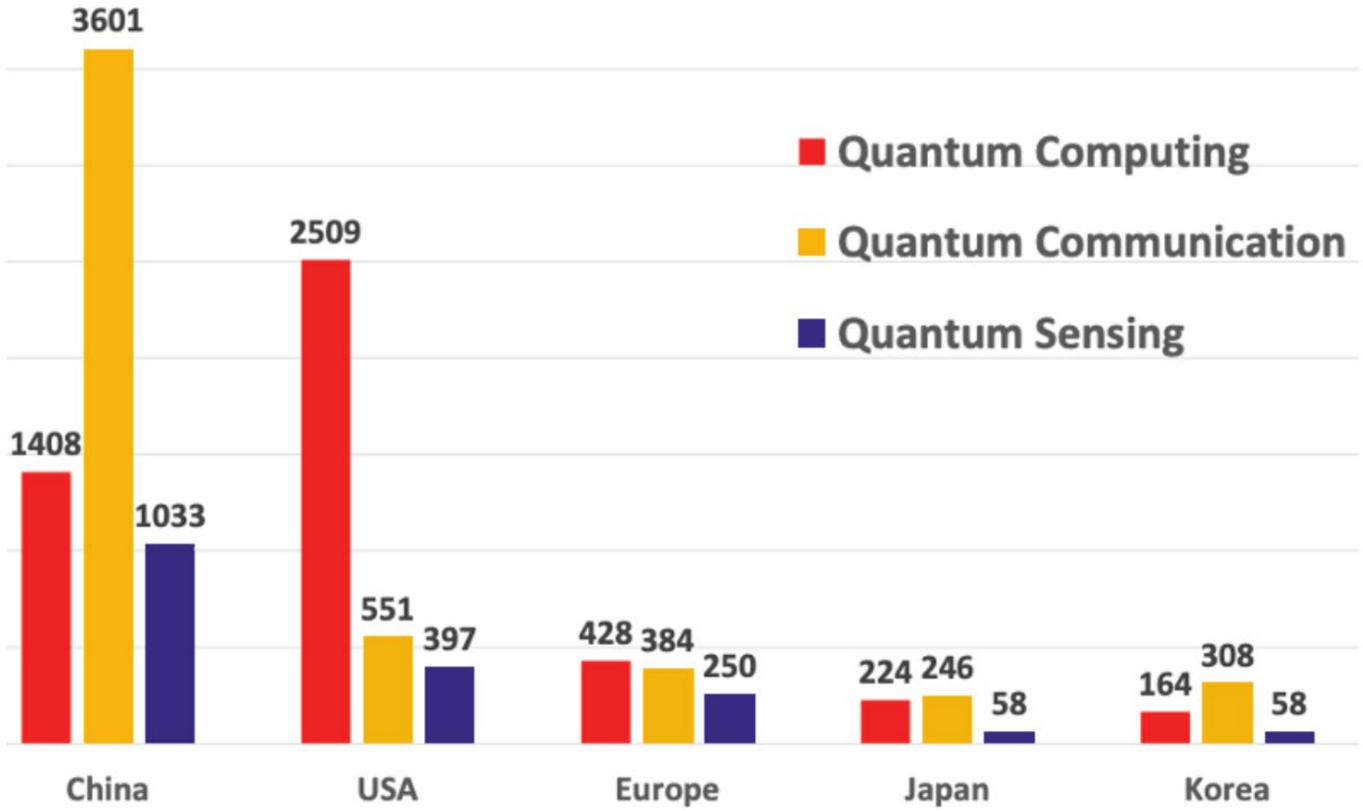


MIT QIR 2025

Patent Landscape

- “Geographically, China leads with 60% of patents as of 2024, followed by the United States and Japan.”

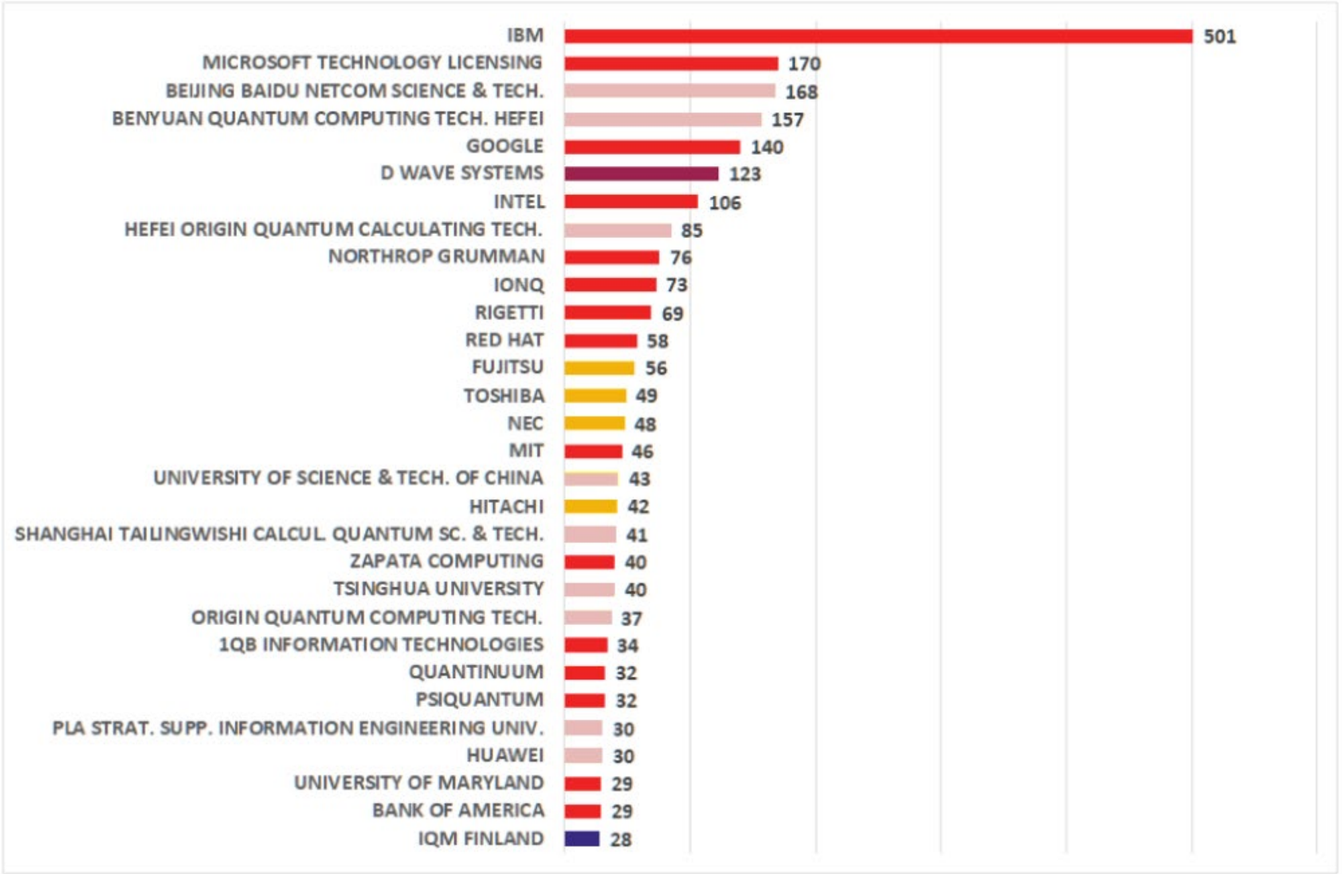
MIT QIR 2025



European Quantum Industry Consortium (QuIC), “A Portrait of the Global Patent Landscape in Quantum Technologies” (QuIC 2024)

Patent Landscape

- Top filers:
  - IBM (US)
  - Microsoft (US)
  - Baidu (CN)
  - Benyuan Quantum (CN)
  - Google (US)



QuIC 2024

State of the Law

State of the Law – PTAB

- *Ex parte Alexei Ashikhmin* (Appeal No. 2017-006572; App. No. 13/912,876; TC 2100)
  - 101 ok
- *Ex parte Osama Nayfeh* (Appeal No. 2023-000069; App. No. 16/513,387; TC 2800)
  - 112: not enabled, but not indefinite
- *Ex parte Matthew Hastings* (Appeal No. 2023-003447; App No. 16/286,337; TC 2800)
  - 112: enabled, even though it covers "after-arising technology"
- *Ex parte Aaron Baughman* (Appeal No. 2023-002850; App No. 16/204,784; TC 2100)
  - 112: not enabled, insufficient description, but not indefinite
- *Ex parte Yudong Cao* (Appeal No. 2024-002159; App. No. 16/591,239; TC 2100)
  - 101 ok, 112 ok
- *Ex parte Yili Zhang* (Appeal No. 2025-000614; App. No. 17/651,277; TC 3600)
  - ineligible under 101 (fintech)

See also: Gatto, J., Restauro, B, "Patenting the Quantum Future – Practical Tips Based on PTAB Decisions", Sheppard (2026)

Ex parte Alexei Ashikhmin

- December 2017
- Error checking for qubits of quantum circuit
- Rejection under 101: reversed
  - Claims recite specialized hardware configured for a specific quantum measurement task

Quantum processing

using quantum bits or "qubits" and measuring physical states and syndromes associated therewith, may be esoteric technology, but this does not make the claimed invention abstract or lacking in utility, particularly when we view the claim as a whole.

9. An apparatus, comprising:

an input register connected to receive and store a physical state of n qubits;

a plurality of auxiliary registers, each auxiliary register of the plurality being configured to transmit a preset state of one or more qubits;

a quantum circuit being constructed to transform the preset states based on the physical state received from the input register and to output the physical state to an output register; and

a plurality of detectors, each detector of the plurality being connected to receive a corresponding one of the transformed preset states from the quantum circuit and being configured to produce a value by measuring one or more qubits of the corresponding received one of the transformed preset states; and

wherein the quantum circuit is configured to form the transformed preset states such that the produced values measure bits of the syndrome of the physical state and such that at least one of the produced values measures a parity check bit for the measured bits of the syndrome.

Ex parte Osama Nayfeh

- March 2023
- 112: rejected
  - Not enabled
    - Specification did not enable the full claim scope
    - Only two specific examples fully described (diamond, silicon carbide)
    - Requires undue experimentation to implement full claim scope
  - However: claims are not indefinite
    - Reversed examiner's indefiniteness finding
    - "semiconductor vacancy qubit structure", "semiconductor", "nitrogen-vacancy center" would be understood by POSITA

1. A multifunctional quantum node device, comprising:

a semiconductor vacancy qubit structure;

a superconductor quantum memory nanowire coupled with a spin state of the semiconductor vacancy qubit structure; and

a superconductor qubit logic circuit coupled with the superconductor quantum memory nanowire and the semiconductor vacancy qubit structure,

whereby the device is a hybrid device operable as an interface for computing or quantum-entangled networking.

Ex parte Matthew Hastings

- November 2023
- Method performed on a quantum computer
- 112 rejection reversed
  - Claims cover “after-arising technology”
  - Specifically, a “fault-tolerant quantum computer”
  - Examiner: “a large fault-tolerant quantum computer” is “more than a decade away”
  - PTAB: invention is enabled

> We agree with Appellant. To now say that Appellant should have disclosed the fault-tolerant quantum computer, which on this record did not exist as of the filing date, and whose future existence is purely speculative, “would be to impose an impossible burden on inventors and thus on the patent system.” *Hogan* at 606.

13. A method of operating a quantum computing device, comprising:

performing a first phase estimation technique on a set of one or more qubits in the quantum computing device;

after the first phase estimation, evolving the set of one or more qubits from a first state to a second state;

after the evolving, performing a second phase estimation technique on the set of one or more qubits in the quantum computing device;

evaluating results of the second phase estimation technique relative to an error criteria;

and determining that a solution to a combinatorial optimization problem provided by the set of one or more qubits in the second state is acceptable or not acceptable based on the evaluation of the results of the second phase estimation technique.

Ex parte Aaron Baughman

- January 2024
- Machine learning technique, with final step performed “using quantum entanglement”
- Rejection under 112: affirmed
  - Not enabled
    - Undue experimentation required to implement the quantum entanglement
  - Insufficient description
    - Describes and claims the desired result, not how to achieve it
  - Indefiniteness rejections affirmed in part, reversed in part
    - Claim 1 ok, but “synchronizing … using entanglement” was indefinite due to non-quantum types of “entanglement”

1. A method comprising:

selecting, by a computing device, layers from a plurality of external deep learning models;

concatenating, by the computing device, the selected layers from the plurality of external deep learning models to form a core deep learning model;

training, by the computing device, the core deep learning model; and

synchronizing, by the computing device, layers in the core deep learning model with the layers from the plurality of external deep learning models using quantum entanglement.

Ex parte Yudong Cao

- February 2025
- Method for solving linear equations
  - Performed on a classical computer and a quantum computer
- 101 ok: improvement to quantum computers:
- 112 ok: claims and description provided sufficient description to support full claim scope
  - PTAB: examiner's 112 rejection was phrased as insufficiency but resembled an enablement rejection

1. (Currently Amended) A method for preparing a quantum state that approximates a solution x to a linear system of equations $A\vec{x} = \vec{b}$ for a matrix A and a vector $\vec{b}$, comprising:

In particular, we agree with Appellant that the additional element integrates the abstract idea of mathematical relationships into a practical application of enabling noisy quantum computers, which have limited circuit depth, to practically solve linear systems—a technology improvement. *See* Appeal

Ex parte Yili Zhang

- November 2025
- Method for “calculating risk” using quantum computer
- Ineligible under 101
  - “Calculating risk” is an abstract idea
  - Not integrated into a practical application

1. A computer-implemented method for calculating risk, the method comprising:

using a number of processors to perform the steps of:

receiving, at a first time, respective deterministic values for a number of factors;

generating, over an evolution time interval starting at the first time, respective stochastic quantum values for each factor from the deterministic values, wherein each factor is represented by a respective N-qubit quantum circuit, wherein each qubit represents a risk level;

combining the quantum values for the factors into an intermediate quantum risk value at a second time at the end of the evolution time interval;

modifying the intermediate quantum risk value according to a number of classical parameters; and

generating, from the modified intermediate quantum risk value, a final stochastic quantum risk value at the second time.

Preparation/Prosecution Tips

Preparation/Prosecution Tips

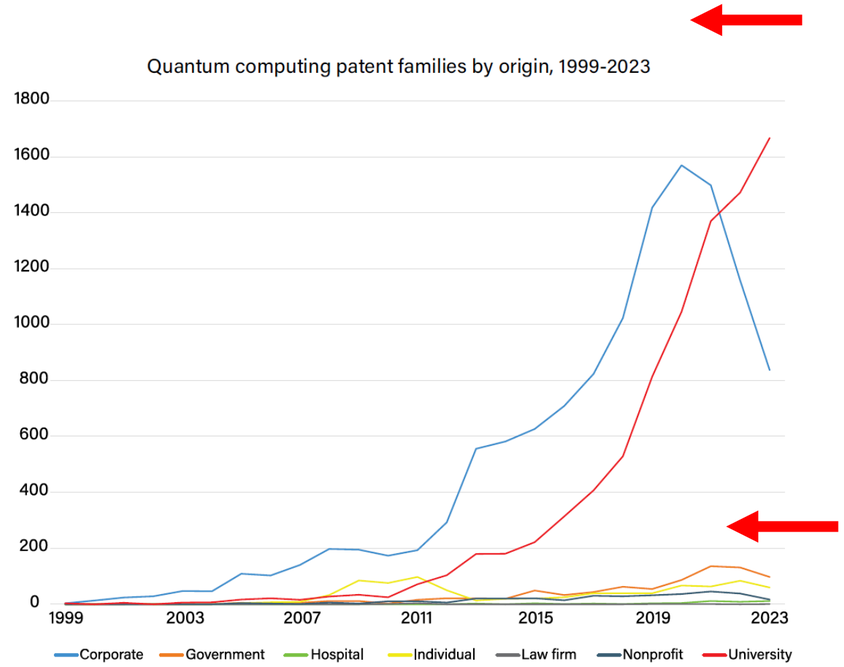
- Enablement
  - New technology area
  - Specification should educate the examiner / court
  - Very detailed background discussion is appropriate
  - Full scope of claims must be enabled (*Nayfeh, Baughman*)
    - Describe as many example implementations as possible
    - Try to limit claims to what you've described
  - But apparently you can claim methods that require future computing platforms (*Hastings*)

Preparation/Prosecution tips

- Subject matter: “quantum” or generic?
  - Many inventions will also have non-quantum applications
  - Consider adding “quantum” context in dependent claims
  - For QC, consider if “quantum” language helps with 101
    - You can still get rejected if the algorithm itself is deemed “abstract” (e.g., “calculating risk” in *Zhang*)
    - But if the algorithm improves the quantum computing platform, you may be okay (*Ashikhmin, Cao*)

Preparation/Prosecution Tips

- Inventors
  - Remember the corporate/university graph from earlier?
  - Quantum inventors are mostly academics
  - Educate inventors on patent practice vs. academic publishing
    - Public disclosure
    - Citing references (no 100-reference bibliographies)
    - Writing style / voice



MIT QIR 2025

Preparation/Prosecution Tips

- Conflicts and Client Management
  - Complex, diverse technology stack
  - Clients may be working on one small part of the stack
  - First-order overlap is unlikely
  - Be judicious in managing clients

Preparation/Prosecution Tips

- Government regulations
  - Security clearance
  - Foreign filing / export control
  - Foreign inventors
  - Geographical locus of inventive work
  - DELAYS
  - Be prepared to improvise, especially when filing non-US national applications

Case Studies

Case Study: Superconducting Circuit

- Assignee: D-WAVE SYSTEMS, INC. (Vancouver, Canada)
- Priority date: 01 Dec 1999

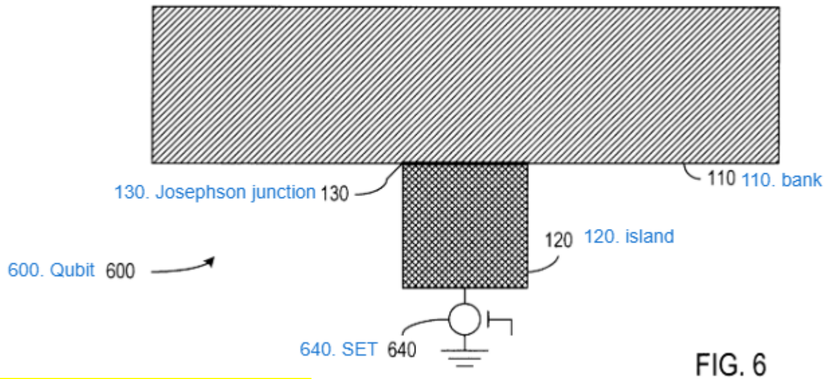


FIG. 6

1. A quantum computing method comprising:

cooling a structure including a superconducting bank and a superconducting mesoscopic island to a temperature that suppresses thermal excitations in said structure sufficiently to suppress thermal sources of decoherence, the structure including a clean Josephson junction between the superconducting mesoscopic island and the superconducting bank;

establishing a quantum state of a supercurrent at the junction, wherein the quantum state is an admixture of a first state having a first magnetic moment and a second state having a second magnetic moment;

allowing the quantum state of the supercurrent at the junction to evolve according to probabilities for tunneling between the first and second state; and

measuring magnetic flux at the junction to determine a result of the quantum computing.

Case Study: Cryogenics

- Assignee: OXFORD INSTRUMENTS NANOTECHNOLOGY TOOLS LIMITED (Oxon, UK)
- Priority date: 03 Jul 1998

1. A dilution refrigerator comprising:

a still;

a mixing chamber;

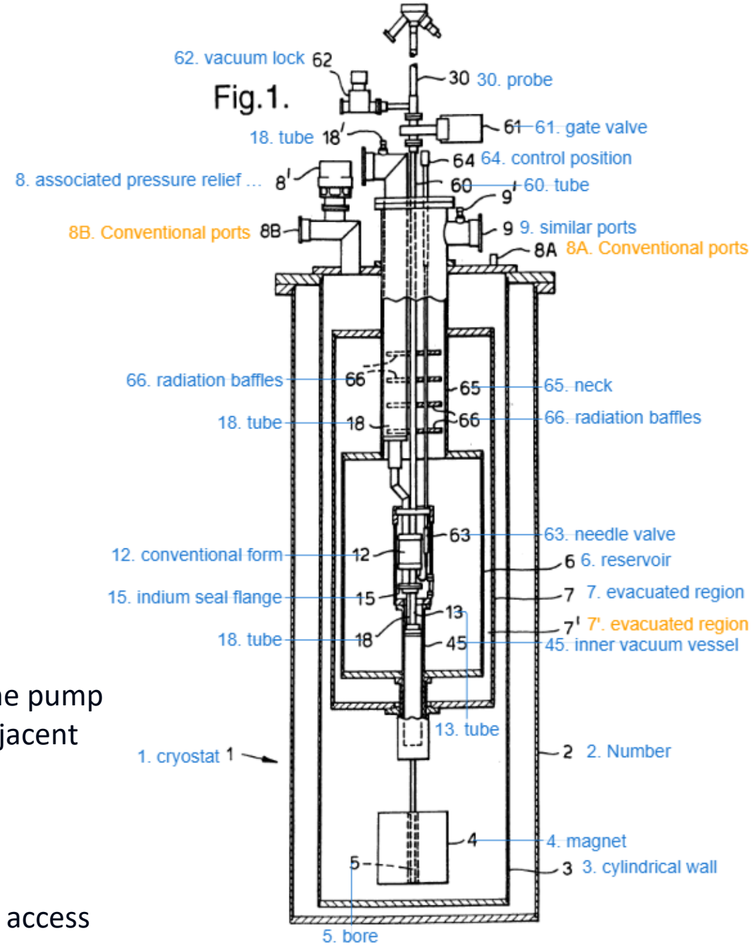
a pump to pump coolant from the still through a still outlet port;

a heat exchanger connected between the still and mixing chamber whereby coolant flows under the assistance of the pump from the still to the mixing chamber and from the mixing chamber to the still through respective first and second adjacent paths in the heat exchanger;

means for defining an access path extending to the mixing chamber, wherein the means for defining an access path comprises an access tube which extends through the still;

a probe to insert along the access path, the probe having a displacer which substantially fills the cross-section of the access path in use; and

means for allowing any coolant from the mixing chamber which flows along the access path past the displacer to flow from the access path into the still, wherein the still outlet port is separate from the access path and wherein the means for allowing coolant to flow from the access path into the still comprises an aperture extending through the access tube.



Case Study: Error Correction

- Assignee: STMICROELECTRONICS S.R.L. (Agrate Brianza, Italy)
- Priority date: 09 Mar 2000

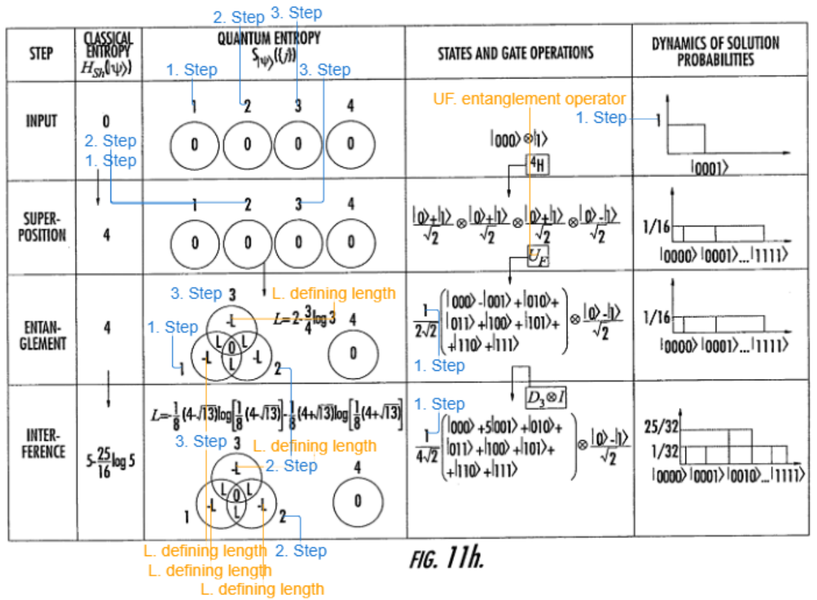


FIG. 11h.

1. A method for controlling a process driven by a control signal for producing a corresponding output, the method comprising:

generating an error signal as a function of a state of the process and of a reference signal;

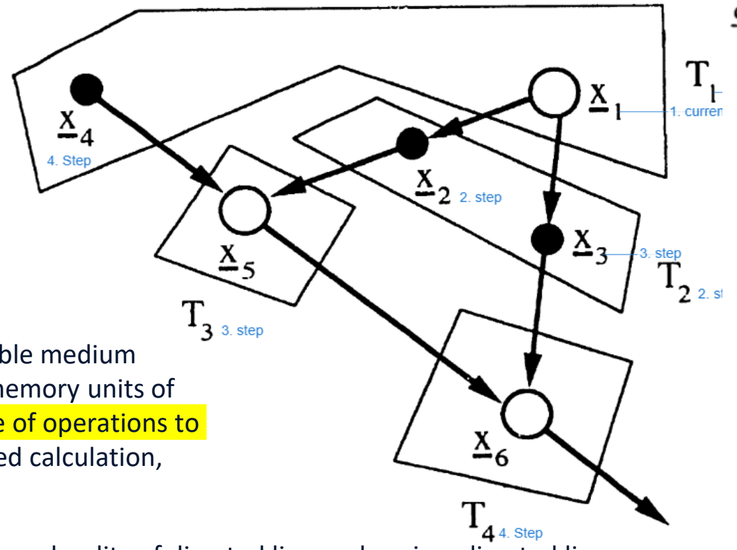
generating a control signal as a function of the error signal and of a parameter adjustment signal and providing the control signal to the process;

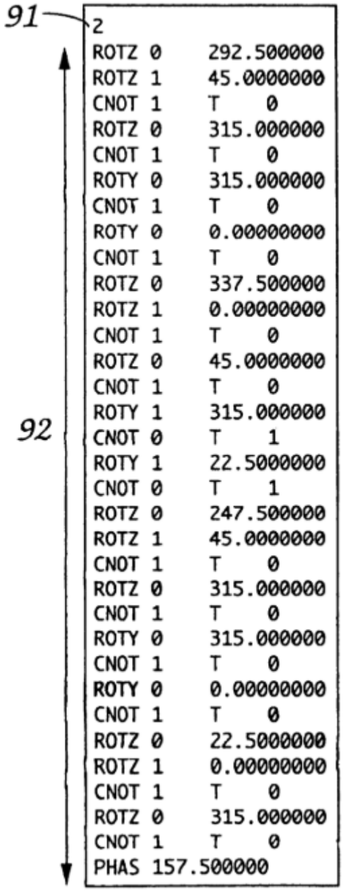
generating a signal representative of a quantity to be minimized by processing paired values of the state of the process and the control signal; and

generating a correction signal from a set of several different values of the control signal that minimizes the generated signal to be minimized, the correction signal being periodically calculated by a Quantum Genetic Search Algorithm comprising a genetic algorithm and a quantum search algorithm merged together.

Case Study: Quantum Compiler

- Assignee: TUCCI, ROBERT R. (Bedford, Massachusetts)
- Priority date: 05 May 1998





1. A method of operating a classical computer, wherein said method must be stored in a computer readable medium which said classical computer can read, wherein said method must be stored in the external or internal memory units of said classical computer, to calculate a sequence of operations with the purpose of applying said sequence of operations to a quantum computer comprising an array of qubits, to induce said quantum computer to execute a desired calculation, said method comprising the steps of:

storing in said classical computer a QB net (Quantum Bayesian net) data-set comprising:

(a) graph information comprising a node label for each node of a plurality of N nodes, and also comprising a plurality of directed lines, wherein a directed line comprises an ordered pair of said node labels, wherein one member of the label pair labels the source node and the other member labels the destination node of the directed line,

(b) state information comprising, for each jε{1, 2, . . . N}, a finite set Σ_j containing labels for the states that the j'th node {circumflex over (x)}$_j$ assumes,

(c) amplitude information comprising, for each jε{1, 2, . . . N}, a representation of a complex number $A_j[x_j|x_{k\ 1},x_{k\ 2},\ldots,x_{k\ S_j}]$ for each vector $(x_j,x_{k\ 1},x_{k\ 2},\ldots,x_{k\ S_j})$ such that $x_j\varepsilon\Sigma_j$, $x_{k<sub2>1</sub2>}\varepsilon\Sigma_{k<sub2>1</sub2>}$, $x_{k<sub2>2</sub2>}\varepsilon\Sigma_{k<sub2>2</sub2>}$, . . . , and

$x_{k\ S_j}\in\Sigma_{k\ S_j}$, wherein $(\hat{x}_{k\ 1},\hat{x}_{k\ 2},\ldots,\hat{x}_{k\ S_j})$ are the $|S_j|$ nodes connected to {circumflex over (x)}$_j$ by directed lines entering {circumflex over (x)}$_j$, wherein said directed lines entering {circumflex over (x)}$_j$ transmit the state of their source node, wherein said $|S_j|$ is an integer greater or equal to zero,

composing with said classical computer and using said QB net data-set, a data-set that specifies a unitary matrix V_{in}, wherein V_{in} is equivalent to the unitary matrix $U_{|T|}\ldots U_3U_2$ of Eq. (**20**), and V_{in} describes the quantum-state evolution for the situation described by said QB net data-set,

calculating said sequence of operations using said classical computer, wherein said sequence of operations and said V_{in} both would, if applied to said array of qubits, produce equivalent transformations of the array of qubits.

Case Study: Quantum Algorithms

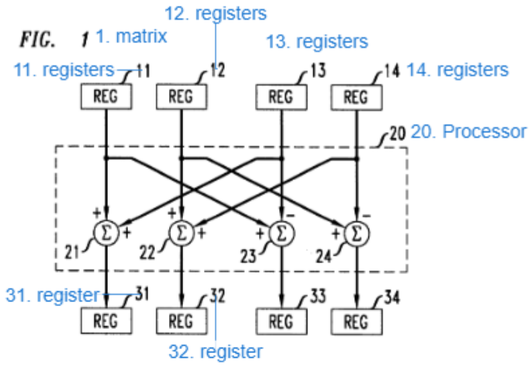
- Assignee: LUCENT TECHNOLOGIES INC. (Murray Hill, New Jersey)
- Priority date: 02 Nov 1998

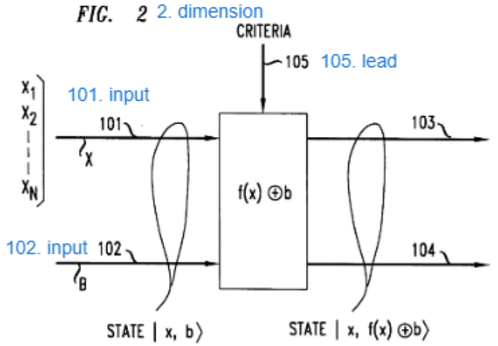
1. An arrangement comprising:

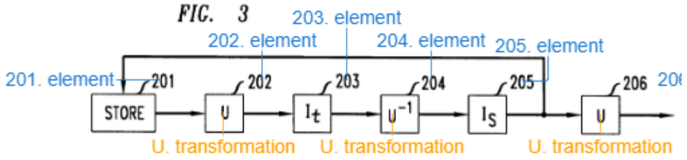
a data store capable of containing one or more of 2^n states;

a processor for transforming data contained in said data store a preselected number of times with a transform Q having the form $-I_s\ U^{-1}\ V^{-1}\ I_t\ VU$, followed by a transforming of data contained in said data stores with a transform having the form VU,

where U is a unitary transformation, V is a unitary transformation, I_s is a diagonal matrix that characterizes a starting state s of data stored in said data store, I_t is a diagonal matrix that characterizes a terminating state t of data stored in said data store, which corresponds to a desired solution, where either said starting state is any state other than the zero state, or said transform VU is any transform other than the Walsh Hadamard transform.







Any Questions?

Thank you

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