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Trigate: A Quantum Cryptocurrency Project

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ABSTRACT

Herein is proposed a three-staged progressive presentation toward the theoretical prism of creating any functional quantum cryptocurrency system. In the initial phase, a trinary quantum switch-gate will be proposed instead of the commonplace binary qubits as a means of encoding a quantum cryptocurrency. The switch-gate permits the construction of a tetra-helix blockchain that acts as a spherical radius for modeling encrypted data. The second phase deals with geometrically translating this tetra-helix structure on the surface of a Riemann sphere to represent trinary logic as spherical topologies. This projection allows encryption to be made more complex without increasing spatial volume, thereby perfectly suiting quantum coin systems that demand scalability. Phase 3 employs spinor dynamics so that quantum encrypted transaction data are stored as summable vectors within perfect magic number hypercubes, which act as multidimensional "wallets" for secure storage and management of varying denominations of quantum currency. This model provides a fresh landscape to incorporate a tetrahedral tessellation of the Bloch and Riemann spheres on entanglement-based spin quantification with an aim to encourage further investigation into encryption-rich, scalable, and physically realizable quantum financial architectures.

Keywords: quantum cryptocurrency, trinary switch-gate, tetrahelix blockchain, Bloch sphere, Riemann sphere, quantum encryption, spinor dynamics, magic number hypercube, spherical mapping, quantum portfolio

INTRODUCTION

The advent of quantum computation carries deep repercussions in rewriting the very foundations of digital currency architectures. Up till now, cryptocurrencies have been implemented on the binary digital logic with the classical notion of distributed ledgers. These, in the post-classical era, could at best be regarded as limited in scope or at worst be regarded as obsolete. While the Bloch sphere offers a foundational qubit state representation-that is, a probabilistic view of quantum vectors between binary poles $|ø\rangle$ and $|1\rangle$ [11]-such binary representations are inherently limited to a range of true-false, and the quantum uncertainty imposed during measurement limits further any capacity for encryption [1]-[2].

To overcome such limitations, this paper takes on the journey of proposing Trigate-an abstract quantum cryptocurrency model forged in three successive phases. First, a trinary quantum switch-gate is introduced in this phase, modifying the quantum binary architecture into a legitimate four-state logic system geometrically mapped onto the tetrahedron-a 3-simplex with four triangular faces. Encoding each of the states (open, closed, left, and right) onto respective faces, the system constructs a tetrahelix-a non-repeating, face-gluing chain of tetrahedra that form a helical blockchain-like radius [9].

The second phase is based on spherical topology by projecting this tetrahelix structure onto the surface of the Riemann sphere [10]. This yields an octuple subdivision of the sphere surface area: eight sub-quadrants that can, at will, encode eight separate trinary data streams. Thus, data complexity increases exponentially with a fixed total surface area-a paradigm deriving from the dual concepts of geometric tessellation and sphere packing theory [3], [4], [7].

The third phase advances a quantum storage and encryption system based on spinor quantification inside perfect magic number hypercubes. In this scheme, each quantum "wallet" or "account" is depicted as a sphere of entangled qubit-like elements stored in a hypercubic lattice. The spin data from quantum impacts (photons hitting electron-like clouds) is summed up and stored as one-of-a-kind complex vectors used as transaction receipts [5], [6]. These hypercubes stabilize all denominational values within one cubic matrix under symmetry rules of magic number theory [6], [7].

In combining geometry computation, trinary quantum logic, and top-tier lattice encryption, Trigate opens new theoretical avenues toward scalable, secure, and genuinely quantum-native cryptocurrency infrastructures. It thus acts as a glue between abstract models like the Bloch and Riemann spheres [10], [11], hyperdimensional number theory, and topological notions such as the Boerdijk–Coxeter helix [9], providing a foundation for experimental forays into quantum cryptographic systems.

LITERATURE REVIEW AND BACKGROUND

Thus, the Trigate quantum cryptocurrency model finds itself at the crossroads of quantum mechanics, cryptographic theory, and multidimensional geometry. To situate this framework, it thus becomes necessary to analyze further instructively the foundational models of the Bloch sphere and of trinary computing logic and the Boerdijk–Coxeter helix and the Riemann sphere-they mathematically and conceptually feed into the three-phase architecture of Trigate.

Quantum Bits and the Bloch Sphere

The Bloch sphere is a geometric characterization of the state space of a single qubit in quantum information. It maps the probabilistic superposition between the basis states $|0\rangle$ and $|1\rangle$ onto points on the sphere, with the state vector ψ being defined by its location [parameters θ (trajectories) and φ (phase)] on the sphere [11]. However, when the vector undergoes measurement, it usually collapses, thus giving just two alternatives of resolution with one being the direction and the other being velocity, never both. The Bloch sphere is an effective visual tool in qubit logic, but it does not allow the data in quantum systems to attain complexity and encryptibility given the binary nature of the Bloch-model perspective [1].

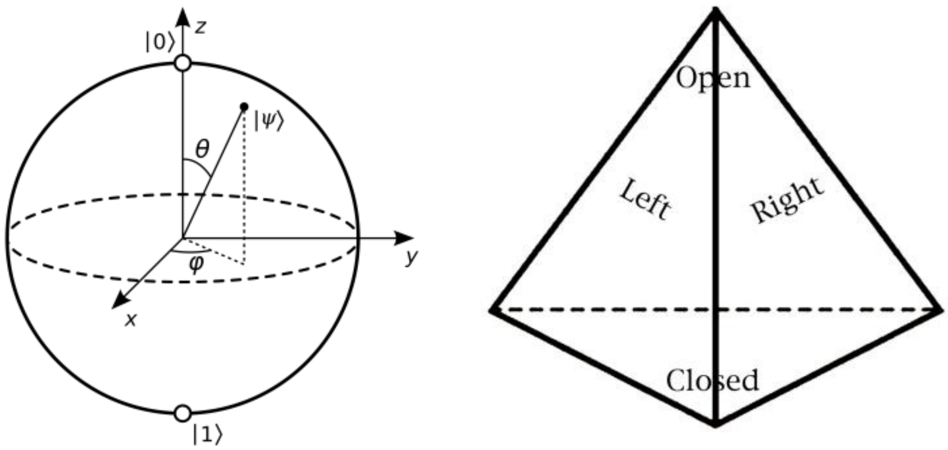

Figure 1: Comparison between a binary Bloch sphere model and the Trigate trinary switch-gate mapped onto a tetrahedron

Trinary Computer and Tetrahedral Logic

Trinary-logic systems, also ternary or base-3, refer to computational frameworks in which each unit or trit is subject to three states, rather than two [8]. In quantum encoding, this trinary switch-gate can represent four states: open, closed, left, and right. These can be mapped geometrically onto the four triangular faces of the tetrahedron-that is, the 3-simplex, the simplest 3D polytope. Linking the tetrahedra in a face-to-face manner results in the Boerdijk–Coxeter helix or tetrahelix, a non-repeating spiral that encodes trinary logic through its rotation and chirality properties [9].

This structure allows for more complex encoding than a simple binary chain. As faces bearing the marks "open" and "closed" connect sequentially, while faces "left" and "right" remain exposed, the tetrahelix performs an encryption that basically confirms an irrational periodicity vastly similar to that of π [3].

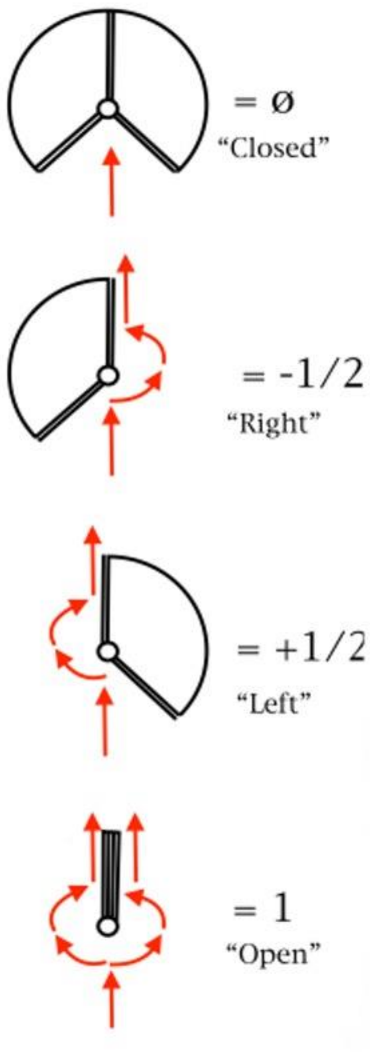

Figure 2: Tetrahedral tessellation illustrating trinary switch-gate face mapping in 3D logic space

Projection of Tetrahedra onto the Riemann Sphere

For higher spatial encoding of the logic states, the Trigate model projects its tetrahelix blockchain onto the surface of the Riemann sphere, a complex-analytical entity representing the extended complex plane ($\mathbb{C} \cup \infty$) mapped onto a 2-sphere [10]. By allotting tetrahedra to eight subdivisions on the sphere, Trigate creates a new kind of encryption: data are not stored linearly but dispersed over spherical surface partitions, with each partition corresponding to a different vector and spin configuration.

Such spherical tessellation shall offer an assistant for high-dimension encryption without requiring growth in surface areas. Mathematical principles behind sphere coverings and tilings in low gyrations support this type of compact yet dense mapping [4], [5].

Quantum Portfolios and Magic Number

Hypercubes The third phase of Trigate entails a conceptualization of quantum wallets or accounts utilizing perfect magic number hypercubes. The perfect hypercubes constitute a higher-dimensional counterpart to magic squares, which are matrices whose sums of numbers in all rows, columns, and space diagonals are equal [6], [7]. In this conceptualization, each cryptocurrency denomination is held in an entangled quantum state characterized by a sphere, with the spin data of each sphere being stored as a single complex vector following photon interactions. These spheres are then positioned within a hypercubic lattice that equitably balances all account values in accordance with magic-cube symmetry.

The system allows for quantum assets to be managed dynamically across a multitude of trinary denominations while maintaining structural uncertainty until a transaction occurs that collapses the system to a readable value. Such a lattice-based entanglement-secured system might constitute a framework for decentralized storage and quantum bank infrastructure.

MATERIALS AND METHODS

This section introduces the Trigate quantum cryptocurrency model in three progressive phases. Each phase depicts a conceptual step toward a fully realized quantum monetary system employing trinary logics encoded by geometric means.

Phase 1: From Binary Qubits to Trinary Blockchain Encoding Qubit or Bloch Sphere as Binary

The Bloch sphere measures the probability of a figurative vector (ψ) on a mathematical construct that represents the space between “ø” and “1,” where “|ø⟩” denotes an absolute “negative” or “closed” state and “|1⟩” denotes an absolute “positive” or “open” state. Depending on the position of ψ on the Bloch sphere relative to either of these poles, that is the probability of the quantum staying in the same state uninterrupted [11].

Currently, quantum vectors are disturbed by measurement (e.g., by collapsing with a photon the electron cloud which forms the source of the quantum vectors) that mostly yield either velocity or direction but never both due to the quantum uncertainty principle [1]. The Bloch sphere interferes with this by combining θ (trajectory) and φ (velocity) into a vector ψ that lies on the sphere. Vectors close to |ø⟩ are called “unreliable,” and those close to |1⟩ are “reliable.” Alternatively, thinking in classical terms, one can say: “Unreliable” means “false” whereas “reliable” means “true” in binary Logic. This is similar to how the Morse code sequences like 01101000 01100101 are mapped to “hello.” The Bloch sphere, then, applies this logic to quantum states as binary sequences of open and closed switch gates.

Trinary Quantum Switch Gate Mapping a trinary quantum switch-gate onto the surface of a tetrahedron involves translating the binary poles of ψ into a four-faced geometric logic unit. The four triangular faces of the 3-simplex (tetrahedron) correspond to four trinary states: “open,” “closed,” “left,” and “right.” The polar traits of velocity (ø = closed or slow; 1 = open or fast) and trajectory (clockwise = right, counterclockwise = left) are mapped to opposing faces, allowing trinary circuits to be expressed geometrically.

Within the tetrahedral logic, the sphere can be subdivided into eight sub-quadrants using three great arcs (equator and two meridians). If one tetrahedron corresponds to one trinary switch-gate, and eight such tetrahedra tessellate a sphere, then this trinary logic potentially has better encrypting capabilities than standard qubits [3], [9].

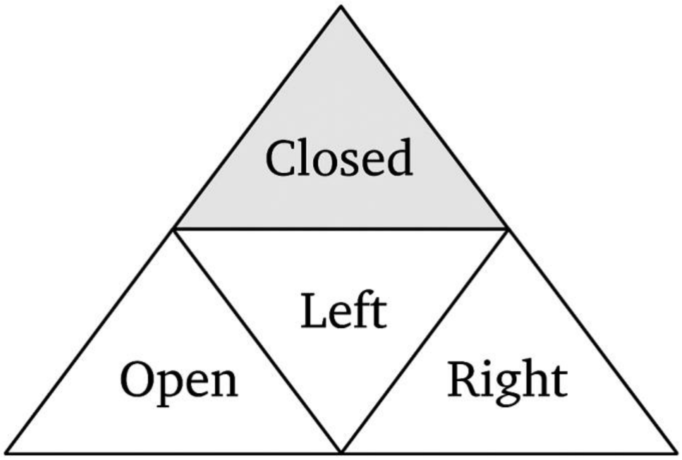

Figure 3: Trinary switch-gate logic visualized using partial rotations. Each of the open, closed, left, right states correspond to a partial rotation configuration

Tetrahelix Blockchain Radius In the tetrahelix structure, tetrahedra are joined face-to-face in a linear spiral. The left and right faces remain exposed as an open face on one unit joins with the closed face of the other. This gives the blockchain radius a form of rotational chirality: "open-to-closed" represents a clockwise (left-handed) vortex, whereas "closed-to-open" is counterclockwise (right-handed).

This structure cannot repeat itself accurately, thereby simulating the irrational transcendental periodicity (like π). While the tetrahelix cannot thus represent the binary axis of the Bloch sphere, it perfectly maps onto the two radii comprising the diameter of the Riemann sphere [10]. One radius of a hemisphere—ø to |1|—is the left-handed tetrahelix of length -½, while the other—|1| to ∞—is the right-handed tetrahelix of length +½. Both converge at |1|, the achiral "genesis block" at the centroid of the Riemann sphere. Together, the full tetrahelix encodes complex encryption over a mathematically infinite domain.

Phase 2: Spherical Mapping of Trinary Blockchain Logic: 8 Qubits of the Riemann Sphere

The mistaken idea of a Riemann sphere is that it models an extended complex plane, i.e., it represents an entire set of complex numbers and maps all these on the surface of a sphere. In the Trigate model, such a structure is used to facilitate the projection of a trinary blockchain radius (given in Phase 1) in a spherical format for increased encryption potential without increasing spatial footprint [10].

The sphere has two poles, zero (ø) down at the bottom and infinity (∞) up at the top. On the vertical axis linking these poles is positioned the "absolute value of one" (|1|), which is treated as the system genesis block. On the equatorial plane of this sphere, there lie four scalar values: +1, -1, +i, and -i, whose meaning corresponds to real and imaginary vector states evolved from the |1|.

Trigate maps the eight Bloch spheres-as-eight "Qubits" onto eight sub-quadrants of the Riemann sphere, with each sub-quadrant occupying one corner of a virtual cube. These are split into:

Four "true" Qubits (below |1|): (ø, +1), (ø, -1), (ø, +i), (ø, -i)

Four "pseudo" Qubits (above |1|): (∞, +1), (∞, -1), (∞, +i), (∞, -i)

The result is a network of eight entangled spheres—each mapped onto a sub-quadrant—yielding high-dimensional cryptographic encoding potential across spherical and cubic systems [2], [3], [10].

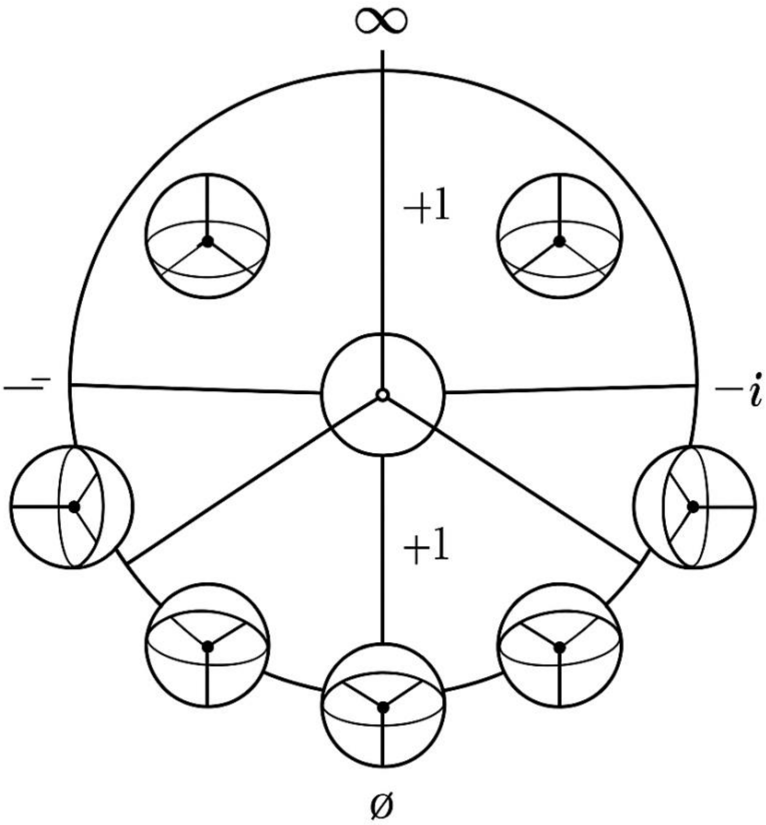

Figure 4: Mapping eight trinary Bloch spheres onto the Riemann sphere

Mapping Tetrahedra onto Spheres

The tetrahedron being the simplest form of the three-dimensional polytope is considered the central element in trinary logic. By joining tetrahedra into a tetrahelix and projecting this object onto the Riemann sphere, the Trigate model sets up a radial blockchain meant to encode logic on a curved surface [4], [9].

The system, importantly, allows for the expansion of radius but keeps the volume the same. For instance, two spheres, one mapped with a single triangular face and the other mapped with an N-face (where $N \rightarrow \infty$), can coexist in the same volume. Hence, the surface complexity can scale up, but without any increase in the physical size of the data system. This enables several denominations of quantum cryptocurrency, each encoded by its own radial tetrahelix mapped on a Riemann-like sphere.

Thus, Trigate attempts to and indeed can offer a quantum, encrypted, trinary-logic-based alternative to the virtually infinite minting found in today's digital cryptocurrencies [5], [10].

Phase 3: Spinor Quantification and Hypercubical Encryption

Spinors - Quantifying Spheres as Sums

Stabilizing a trinary quantum network requires quantum entanglement and a quantum memory facility to store and manipulate massive numbers of qubits. In Trigate, this is accomplished at the conceptual level by encoding these quantum "wallets" or storage nodes as spherically mapped spinor systems.

Each sphere stands for one quantum cryptocurrency denomination stored in superposition of trinary circuits. The entangled state residing inside each sphere can again be measured by instilling spin—say, as the entangled cloud is struck by an outside photon. In this way, the system collapses for a nanosecond, allowing the registration of the transaction, through an expression of a unique complex vector sum (ψ), as a cryptographically safe single-event transaction key [5], [11].

In contrast, these spheres remain in fact not isolated: they are meant to go into multi-sphere networks, where each denomination is entangled and only quantifiable during active transaction events. At any other time, their state remains uncertain for purposes of privacy and intrusion resistance.

Perfect Magic Number Hypercubes

To store these encrypted spheres, the model posits a perfect magic number hypercube—a multidimensional lattice in which the sums of values for each axis-slice, row, column, and space-diagonal are equal to one common constant. Each dimension of the hypercube stores a quantum sphere with these spin vectors being measured only under access [6], [7].

For example, if there were 5 coins of one denomination and 10 of another in an account, instead of reading these as integers, the system would quantify each coin type by its spin value and map it onto a magic hypercube cell. The "balance" thus generated is the sum of all spinor-derived values across the lattice. Yet, it is not a balance to which one has continuous access-like a cryptographic lock, it will only be readable during photon-induced transactions.

When not being accessed, these spheres keep their spin configurations locked in quantum superposition. Upon being accessed, they temporarily collapse into an arrangement that satisfies the magic constant of the hypercube, and after the event, the values get re-randomized to keep up with the system's cryptographic uncertainty [7].

This kind of paradigm presents a physically based quantum-secure analog for mainstream blockchain storage. Each wallet, held in a quantum server or distributed cloud, contains one or more trinary denominations encoded as spherically entangled atomic clouds with trinary circuit configurations (i.e., "qubits") arrayed across a hypercube grid.

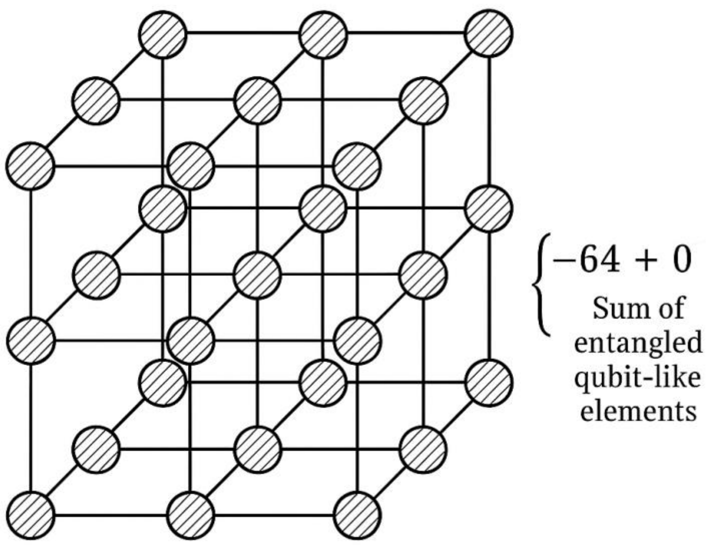

Figure 5: Perfect Magic Number Hypercube

A 4×4×4 hypercubic lattice showing entangled qubit-like elements (spheres) arranged to maintain a constant vector sum across all orthogonal slices, rows, columns, and diagonals. Each transaction event temporarily collapses the superposition into a measurable sum (e.g., −64 + 0), representing a secure and balanced quantum account state.

RESULTS

Trigate poses a structured, multi-phase approach to the problem of designing secure, scalable quantum cryptocurrency architecture. Every phase produces a key component of the system, namely: encoding logic, spatial mapping, or quantum storage, which are, together, woven into one infrastructure able to transact in ternary quantum operations.

Encrypted Radius Construction

Using Tetrahelix Chains Phase 1 ends in the formulation of a dynamic blockchain radius using the trinary switch-gate encoded as a tetrahelix. Whereas binary blockchains chain one bit after another in a flat line, the Trigate tetrahelix chains four-state logic gates face to face along a three-dimensional helical arrangement. This radial structure is:

- Non-repeating, preserving unpredictability
- Chiral, allowing directional encryption
- Expandable, having no inherent max-cap constraint

This higher entropy system is able to signify logical values in more dimensions than the classical binary chain [3], [9].

Sphere-Based Encoding

Using Riemann Mapping The end result of Phase 2 is to transform linearly encoded logic onto spherical surface encryption by Riemann sphere mapping. The tetrahelix gets projected onto the sphere, dividing it into eight Bloch sub-domains, each containing:

- A pair of quantum poles (like ∞ and +i, or ø and -1)
- One trinary logic gate encoded by rotational chirality
- Dynamic spin-based logic patterns

This spatial configuration enhances encryption density and symmetry by simultaneously encoding different cryptocurrencies into the shared geometric domain [4], [10].

Secured Quantum Storage via HyberCube Lattice

The third phase sees each encrypted Riemann-encoded sphere becoming a data node in the lattice: the perfect magic number hypercube. Whenever a transaction takes place:

- A photon collapses the electron-like cloud.
- The collapse is measured as the spin vector (ψ).
- The value of the collapse is stored as a tentative hash inside the cube.

The lattice remains in a state of superposition far from transaction events, thereby maintaining randomness and posing computational difficulty to decrypt. The system also supports multi-denomination wallets, whereby each cell in the cube stores a different type of currency mapped by trinary logic [6], [7].

Cumulative System Properties

Table 1: Summary of Key System Properties in the Trigate Quantum Cryptocurrency Model

Property	Outcome
Encryption Strength	Increased by trinary logic + rotational uncertainty
Scalability	Supports infinite coin types and growth with no volume expansion
Security	Entanglement and spinor measurement only accessible during transactions
Efficiency	Layered logic reduces overhead and removes linear growth constraints

This table highlights the cumulative outcomes of the Trigate architecture across encryption, scalability, security, and computational efficiency, as achieved through its trinary, spherical, and spinor-based framework.

These are a few reasons explaining why Trigate is not just mathematically interesting but also geometrically efficient and quantum-native in its setup. In every direction, it goes beyond classical-type or even quantum-type models and employs topology, ternary state logic, and spinor encryption as instruments with which to technically reinvent what a blockchain could resemble in the quantum computing era.

DISCUSSION

Trigate offers an ambitious and futuristic redefinition of the eventual shape a financial system could take in the quantum age. From theoretical mathematics and geometric encoding, the design moves past the ordinary binary blockchain by proposing a quantum-native architecture that embeds trinary logic inside spatial structures, setting limitations of its own on classical and early-phase quantum cryptographic systems.

The heart of the advancement offered by Trigate constitutes a conceptual shift in the various possible ways in which digital assets can be conceptualized, communicated, and secured. The trinary quantum switch-gates mapped onto the four faces of a tetrahedron immediately distinguish it from binary qubit models as represented on the Bloch sphere. While binary systems are restricted by dichotomous true/false logic and are stored in a linear manner in time, Trigate's tetrahedral encoding enriches the logic landscape in four separate states: open, closed, left, and right, each assigned to one triangular face. Choosing this geometric approach goes beyond the symbolic; it integrates into the model's computational backbone in lieu of blockchain: the tetrahelix.

The tetrahelix, as a never-repeating, chiral chain of linked tetrahedra, exhibits structural behavior that closely approximates irrational periodicity, as one would encounter with transcendental numbers such as π. This quality grants it a degree of unpredictability, a very welcome characteristic from the point of view of cryptography. The open/closed face connection logic generating the chaining of the tetrahedra yields two tetrahelix: one being left-handed, the other right-handed, depending on the direction of linkage. These chains do not merely form an abstract construct; these chains constitute radial encoding lines projected onto the surface of a Riemann sphere, which in turn defines the broader encryption topology of the system.

The choice of mapping these chains into the trinary logic onto a Riemann sphere introduces yet another very deep conceptual change. Now unlike flat or linear ones, the Riemann sphere carries out logical operations and encryption over a bounded yet infinitely divisible space. Each tetrahelix radius from the center ($|1|$) to a pole, either zero or infinity, becomes a carrier for one trinary blockchain strand. The sphere subdivides into eight topological domains, or somewhat Bloch-like subquadrants, each harboring one of the extended quantum logic domains laid out by mixes of real and imaginary values. This spatial organization is the basis for concurrent processing and the differentiation among various quantum coin denominations while maintaining a steady spherical boundary: the solution that scales without physically growing.

Perhaps the most daring use of spinor quantification and perfect magic number hypercube is in defining processes for digital storage and transactions. Solving problems that plague traditional server farms and static digital ledgers, Trigate quantum storage nodes offer scintillating "electron-like" clouds whose vector states can only be read once at the moment of a transaction. Upon the fall of a photon on such a quantum sphere, it momentarily collapses into a measured complex vector that interprets the transaction sum. The quantum spheres are then positioned inside a hypercube—an n-dimensional lattice whose rows, columns, and diagonals conform to the conditions of a magic constant. Hence, each quantum account becomes a self-contained, probabilistically locked entity that reveals the balance only at the time of authorized access.

This model of quantum encryption fits well into the developing research scene of post-quantum cryptography, especially in its resistance to the circumvention of its protocols and its introduction of a probabilistic mechanism for locking. Using architectural forms whose geometric states are intrinsically uncertain unless measured, the logic gates are protected not only by means of complicated equations; hence, they resist static assaults and preserve rolling integrity.

Real-world concerns loom ahead for what Trigate proposes. In its actual manifestation, the distributed network of entangled quantum spheres would keep, store, communicate, encode, and vector sum in complex ways, and, to date, this scale of existence has yet to come into being. Quantum computers running entangled multi-qubit chains hang somewhere in development limbo; the quantum internet construction needed for distributed quantum wallets is far out in tall ambition as opposed to an attempt at realization today.

Nevertheless, the Trigate model opens several ripe avenues for future inquiry. It challenges us to rethink blockchain from being linear data structures to truly topological processes where logic is encoded within multi-dimensional geometry. It begs us to envision account balances not as static numbers in a ledger but as dynamic quantum states embedded in spinor lattices. And it invites cryptographers to dust off the old mapping manuals and lecture on Riemannian and hypercubic surfaces for security and symmetry.

Thus, the Trigate acts as both a proposed system and a philosophical pivot—a thought experiment that bridges pure mathematics, quantum physics, and digital finance. Its value is not merely based on what it asserts to solve, but in fostering an entirely new set of questions for others to explore: How should quantum systems represent value? How do we secure something probabilistic? And can mathematics not only describe but also contain digital trust in the quantum age?

CONCLUSION

The Trigate project is a theoretical framework of the architecture for quantum-native cryptocurrency under trinary logic, spherical geometry, and hyperdimensional encryption. By questioning some of the classical assumptions of digital finance, the model posits that instead of binary encoding, trinary encoding could be implemented via a tetrahedral switch-gate system, while linear blockchain structures are replaced with tetrahelix chains here projected onto a Riemann sphere. From this foundational point of view, the defining systems change from sequence to topological, from deterministic to probabilistically secure, and from finitely scalable to infinitely scalable within an assigned spatial object.

In every step of the Trigate framework, a critical component for the quantum integrity of the system exists: the first instances the logic gate structure through tetrahedral tessellation; the second maps this logic spatially onto the Riemann sphere to achieve compact but complex surface encodings; and the third encapsulates them through the magic-number-perfect hypercube secure for quantum storage at spinor collapse-based events.

Hence, despite being impossible to implement today due to current difficulties in scaling server technology and entanglement, the theoretical consistency and architectural clarity of the Trigate perspective make the model a novel contribution to the speculative boundaries of quantum cryptography. By showing how logic, structure, and encryption can be united into geometric and probabilistic space, this paper lays the foundation on which the future can be built independently through research and experimentation or jointly developed across many disciplines in quantum finance.

The pathway to a real quantum cryptocurrency cannot be confined to dressing classical systems in post-quantum suitcases for survival; it must reconstruct the very grammar of value, security, and transaction. Trigate is a first attempt at writing in that new language.

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