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Abstract

The current geopolitical environment is marked by reduced multilateral cooperation, rising nationalism, and power struggles among major nations. These factors lead to supply chain disruptions, inflated living costs, and greater national debt. Such challenges are exacerbated by demographic changes in developed countries, such as aging populations and decreasing workforces, which are deepening the global wealth divide. In response, advanced nations have implemented broad monetary policies, including quantitative easing, resulting in inflated asset and real estate values. Conversely, developing countries face severe hyperinflation and weakening currencies, compounded by the economic dominance of the US dollar.

In response, the WorldLand project offers a revolutionary solution: a decentralized digital network named 'WorldLand,' which includes a global digital ledger and a universal currency, the WorldLand Coin. This initiative seeks to facilitate direct financial transactions across international borders, promote equality, and counteract the outsized monetary influence of dominant economies. Leveraging the technologies underpinning Bitcoin and Ethereum, WorldLand aims to broaden the reach of decentralized finance with innovative blockchain solutions.

WorldLand envisions a future where digital trade surpasses national boundaries, creating a global marketplace where citizens can routinely trade goods and services within a stable and efficient network. This report details the technical specifications, governance frameworks, and practical uses of WorldLand, presenting a strategy for a scalable, secure, and efficient blockchain future. Initiated by Professor Heung-No Lee and his team, this report highlights a decade of intensive research and development, culminating in the WorldLand mainnet launch on August 8, 2023.

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Keywords

De-globalization; multilateral cooperation; monetary policies; ASIC resistance; blockchain; bridge; interoperability; cryptography; decentralization; digital signature; error correction code; proof of work; low density parity check codes; mobile hyperspectral camera; periodic checkpoint; post-quantum cryptography; proof of stake; quantum resistance; sidechain; variable random function; variable coin toss function; zero-knowledge proof protocols.

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Chapter I. Introduction

1.1. WorldLand

WorldLand™ is a new mainnet whose virtual machine is fully compatible with the Ethereum virtual machine, has quantum-resistant cryptography, novel energy-efficient consensus algorithms, and aims for decentralization. It issues the native WLC currency.

WorldLand is meant to be the next generation blockchain with global reach and scale. This report intends to convey the idea and the realization of it.

1.1.1. Vision

The geopolitical landscape is marked by a lack of multilateral cooperation, rising nationalistic tendencies, and major powers vying for dominance. This has led to supply chain disruptions, increased living costs, and burgeoning national debts.

Demographic shifts, such as aging populations and decreasing workforces in developed countries, contribute to these challenges, alongside the growing wealth gap between the rich and the poor.

Advanced countries have relied on printing money and maintaining low-interest rates to counter economic crises, leading to inflated asset values and real estate prices. Conversely, developing countries face hyperinflation and weakening currencies, exacerbated by the global economic dominance of the US dollar.

The project envisions creating 'WorldLand,' a decentralized digital network that offers a global digital ledger and a universal currency, WorldLand Coin. This system aims to facilitate direct financial transactions across borders, promote equality, and counterbalance the monetary control of major powers.

WorldLand aims to uphold human rights and equality. WorldLand aims to use AI for growth and blockchain for distribution, leading to sustainable social progress. Innovations like Bitcoin and Ethereum have laid the groundwork for decentralized finance, which WorldLand seeks to expand upon with its unique approach.

WorldLand envisions a world where borders fade in the digital trade marketplace. People across the globe will seamlessly exchange goods and services, empowered by a network designed for stability and efficiency.

To these aims, we envision developing a new protocol suite called WorldLand for a global-scale blockchain. The WorldLand network supports a diverse array of applications, nourishing a digital economy woven together by WorldLand's innovation.

The WorldLand suite is quantum safe, energy-efficient, decentralized, secure, and scalable. This network will have a worldwide footprint that includes all five continents, allowing the connection and support of a variety of sidechains, shards, and plasma chains.

1.1.2. LiberVance, the Company

WorldLand project is based on technology developed by LiberVance, a blockchain startup company from a university laboratory founded by Professor Heung-No Lee at Gwangu Institute of Science and Technology (GIST). Professor Lee has pioneered the technology needed for the WorldLand project with support from major national research institutes in South Korea, securing intellectual property rights, academic papers, and patents. LiberVance's research and engineering efforts have been pivotal in driving the project's technological advancements. From 2010 to 2023, the project garnered LiberVance a total of $15 million in research funding, underscoring its strong academic and technological foundations.

1.1.3. WorldLand Foundation & DAO, the Organization

The WorldLand Foundation oversees critical aspects of the project, including DAO administration, coin management, community engagement, and promotional activities, ensuring the project's continuous growth and community involvement.

Members of the WorldLand community collaborate within a Decentralized Autonomous Organization (DAO), which is governed by the WorldLand DAO Articles [1]. This structure allows members to actively engage in the management and development of WorldLand.

1.1.4. WorldLand Mainnet Launch

Building on 6 years of continuous innovation by the team of industry pioneers and academic researchers, WorldLand mainnet was launched in August 2023. This launch introduced advanced features such as EVM compatibility, energy efficiency, and enhanced security measures with ASIC and PQ safety, ensuring a robust and decentralized network. The native WorldLand Coin (WLC) facilitates efficient transactions with a small fee and an approximate transaction time of 20 seconds, making it highly suitable for daily transactions.

A total of 41 million WLC coins were minted at the genesis block, with 20% allocated for long-term endowment and 80% dedicated to the DAO's operations. This allocation, designated as TMG (Total Minted at Genesis), serves as a cornerstone for building a successful new WorldLand ecosystem, ensuring its continued growth and prosperity.

1.1.5. Future of WorldLand

WorldLand is still in the early stages of development, but it is expected to attract attention in the blockchain market in the future due to its various strengths, such as ASIC resistance, an energy efficient consensus mechanism, quantum-resistant cryptography, and decentralization.

1.2. Layered Structure of WorldLand

From its inception in 2018, the House of WorldLand has steadily taken shape. Though young, its future is bright with the innovative theoretical foundation and sound engineering strides. WorldLand not only offers a comprehensive suite of tools, but also empowers a thriving blockchain ecosystem, letting developers to forge their own dApps and tokens.

The WorldLand ecosystem is structured into a multi-layered architecture, depicted as the "House of WorldLand." At the foundation, Layer 1 is the WorldLand Mainchain, which provides the core infrastructure for the entire network. Layer 2 comprises Bridges and Layer 2 (L2) solutions, facilitating seamless integration and scalability with other blockchain networks. Layer 3 includes the Virtual Machine and Smart Contracts layer, enabling the execution of decentralized applications (dApps) and automated agreements. At the top, Layer 4 consists of dApps for Users, which include specialized applications such as AI-DEX, My AI Network, and the WLC Wallet. This layered approach ensures a robust, scalable, and user-centric blockchain ecosystem.

1.2.1. Layer 1: WorldLand Mainchain

WorldLand is establishing a foundation for a green and decentralized blockchain ecosystem. As the mainchain evolves, it will enhance both security and scalability. Serving as the cornerstone of the WorldLand ecosystem, the mainchain supports the core blockchain network. Here, its distinctive consensus mechanisms are applied, transactions are authenticated, and blocks are generated.

1.2.2. Layer 2: L2 Solutions & Bridges

The cross-chain bridge layer in WorldLand enhances interoperability with other blockchain networks, such as Ethereum and Bitcoin, by enabling smooth transfers of assets and exchange of data across various blockchain systems. These cross-chain bridges are instrumental in increasing liquidity, broadening the range of use cases, and integrating WorldLand into the wider cryptocurrency ecosystem. They provide developers with the convenience to create applications that operate across multiple blockchains. Furthermore, assets like wrapped Ethereum (wETH), wrapped Bitcoin (wBTC), and wrapped USDT (wUSDT) are expected to become accessible through the WorldLand bridges to Ethereum, facilitating a more interconnected blockchain environment.

1.2.3. Layer 3: Virtual Machine & Smart Contracts

The WorldLand Virtual Machine is engineered to align with the Ethereum Virtual Machine (EVM), facilitating developers in crafting smart contracts through Solidity. This compatibility signifies that smart contracts already in operation on Ethereum can be seamlessly deployed on WorldLand without the need for any reprogramming or alterations. Such interoperability is instrumental in fostering the development of the Web3 future society, enabling collaborative efforts among diverse communities.

1.2.4. Layer 4: dApps for Users

The dApp layer in WorldLand acts as the gateway for users to access the platform's functionalities, seamlessly integrating real-world applications along with their favored apps and tokens. Highlights of this layer include:

- The launch of AI-DEX, an innovative AI-supported decentralized exchange, marking one of the primary services available.
- The creation of AI models within My AI Network, leveraging the same infrastructure used by WorldLand miners, to deliver custom AI experiences to users.
- The introduction of WLC, WorldLand's proprietary cryptocurrency, which has been issued and allocated to miners and early adopters of the platform since August 2023. This enables

users to conduct WLC transactions effortlessly using the MetaMask wallet, which is accessible both within the app and on the web.

1.3. Addressing Trilemma of Blockchain

The blockchain trilemma highlights the challenge that refers to the inherent trade-offs between three fundamental properties of blockchain technology: decentralization, security, and scalability.

1.3.1. Decentralization

Decentralization involves spreading out control and decision-making abilities from a single, central authority to various smaller, autonomous groups. In the realm of blockchain communities, this principle is particularly impactful. It allows individuals worldwide to actively engage in the network's governance, moving away from the traditional model of control by a single centralized entity, such as an institution, company, or government. This method fosters a more democratic and fair system for managing and operating the network, ensuring broader participation and representation.

1.3.2. Security

WorldLand implements an innovative Error-Correction Code Proof of Work system [2][3] within its blockchain framework. While Proof of Work (PoW) blockchains are highly secure, they are not completely invulnerable to hacking. A notable risk is the 51% attack, where an adversary gains control of more than half the network's computational power, allowing them to alter the blockchain and manipulate transactions. As such, the security of a blockchain ecosystem can be significantly enhanced by increasing the number of nodes. A larger and more distributed network of nodes makes it much harder for any single party to acquire the majority control necessary to carry out such attacks, thereby safeguarding the system against compromises.

1.3.3. Scalability

Scalability refers to a network’s ability to grow while maintaining transaction speed and output. However, scalability and decentralization often clash. Efforts to scale a decentralized network can compromise security, while security measures may hinder changes necessary for scalability. Balancing these two aspects is challenging.

Achieving a balance between decentralization, security, and scalability remains an ongoing challenge in blockchain design.

WorldLand follows the so called DeSecure approach, a significant contribution in addressing the blockchain challenges of today. In the ever-evolving landscape of blockchain technology, several solutions are being used to address the scalability issue. However, the DeSecure blockchain approach aims to overcome the potential centralization problems that can arise from using such solutions, all while preserving the core principles of decentralization and security. To achieve this, our goal is to replace the SHA-based Proof of Work (PoW) algorithm with a novel ECC-PoW (Error Correction Code PoW) algorithm. Since PoW is fundamental to open blockchain systems, it plays a crucial role in the DeSecure blockchain approach [4].

1.4. Additional Challenges beyond Trilemma

Today, the blockchain landscape faces two significant challenges beyond the well-known trilemma: the substantial carbon footprint associated with minting digital currencies and the issue of blockchain interoperability.

1.4.1. Greenhouse Gasses

Imagine a digital treasure hunt where the prize is solving complex puzzles using vast amounts of computer power. That's essentially how Bitcoins are "mined," but this hunt comes with a hidden cost: Greenhouse Gasses.

The constant electricity required for these calculations manifests a carbon footprint larger than some countries. It's like leaving the lights on in a giant, never-ending room, adding to the environmental burden.

Over the period from 2016 to 2022, Bitcoin's electricity consumption, measured in terawatt-hours (TWh), experienced significant fluctuations, reaching an estimated peak around 2021. At its maximum, Bitcoin's electricity usage approached levels comparable to that of the United Kingdom (300 TWh), with other country equivalents being Spain (242 TWh), Sweden (131 TWh), Argentina (125 TWh), and Israel (56 TWh). This data, sourced from the Columbia Climate School, underscores the substantial energy demands of Bitcoin mining, which have grown markedly since 2016, highlighting concerns about the environmental impact of cryptocurrency operations.

1.4.2. Interoperability

The proliferation of various blockchains—each with unique features, consensus mechanisms, and use cases—has led to a fragmented ecosystem. These isolated chains operate independently, hindering value transfer and data communication between them. Achieving interoperability requires bridging these silos.

The main goal of this project has been to reach to an ideal balance between decentralization, security, scalability, environmental impact, and interoperability of blockchains.

1.5. WorldLand Tackles Blockchain Hurdles

After years of intensive development, WorldLand has launched a new blockchain that tackles several challenges aforementioned facing the crypto world. Here's what makes it special:

- Easy Integration: WorldLand works seamlessly with Ethereum, a popular blockchain platform. This makes it easier for developers to build applications on WorldLand.
- Energy Efficient: WorldLand uses less energy than some other blockchains. This is better for the environment and reduces costs.
- Future-Proof Security: WorldLand is built to withstand future hacking threats, even those based on powerful quantum computers.
- Decentralized Power: WorldLand remains committed to decentralization, a key principle of blockchain technology. This means no single entity controls the network.

To highlight, WorldLand Blockchain has four key features. Firstly, it offers EVM Compatibility, allowing all dApps and smart contracts on the Ethereum Virtual Machine (EVM) to operate seamlessly on WorldLand, providing a new way to experience Ethereum dApps. Secondly, Energy Efficiency is achieved through WorldLand's Green VCA technology, which significantly reduces energy consumption in the mining process by randomly selecting miners. Thirdly, Post-Quantum Security is ensured by the ECCPoW consensus algorithm, which utilizes coding theory to protect against potential threats from emerging quantum computers. Lastly, the network is Decentralized, addressing issues of centralization in the existing Proof of Work (PoW) system by reducing the efficiency of ASICs, thus defending the blockchain from centralization by ASIC devices.

Chapter II. Technology in Concept

2.1. WorldLand Approach

2.1.1. PoW

WorldLand protocol aims to build a decentralized, scalable, and secure solution for an immensely large network of nodes, even as the number of participating peer-to-peer nodes reaches a massive scale. A novel and technologically advanced solution is needed.

PoW was a significant technological innovation. It enabled the creation of a globally synchronized and immutable database, which was virtually impossible using other methods. It made widespread trust on internet possible without cumbersome intermediaries. But it came with an insatiable energy bill.

Decentralized consensus is achieved while each node simply does its own work of validating transactions, forming a new block, and attaching Proof-of-Computation (PC, a term used here to generalize PoW) to the block. This process is repeated for each new block, resulting in a simple algorithm. Finality is determined by the amount of energy stored in the blockchain. In the case of two blockchains, a node will choose the one with the most energy stored inside and add the new block to it.

2.1.2. ECCPoW

ECCPoW is a fascinating concept implemented in WorldLand. It combines two critical components:

- ECC: The error correcting codes (ECC) enhance data reliability by detecting and correcting errors during transmission.
- PoW: The traditional consensus mechanism where miners compete to solve computation-bound puzzles to validate transactions and generate new blocks.

ECCPoW introduces error-correction codes into the PoW framework, creating a novel approach to mining cryptocurrency. It replaces the standard hash PoW used in Bitcoin and other cryptocurrencies. It maintains the symmetry of PoW blockchains while resisting ASIC dominance. By integrating ECC, ECCPoW enhances security, decentralization, and fairness in the mining process.

2.1.3. Verifiable Coin Toss (VCT)

At the heart of WorldLand, the PoW consensus mechanism has three major functions, VCT (Verifiable Coin Toss), VC (Verifiable Computation), and DS (Digital Signature). The VCT functions are implemented as post-quantum secure VRFs (Verifiable Random Functions).

The purpose of VCT is to deactivate a specific portion of the base set of nodes; thereby conserving energy. For example, if the proportion is set to 90%, energy-savings would be around 90%, although it may not reach full capacity due to machines continuing to operate at their base level even when not actively mining. VCT functions as a VRF and operates transparently. Therefore, the decision-making process for becoming a WorldLand node is simple.

Each node possesses its own unique (secret key and identification) coin for toss. Prior to the VCT, every node tosses its coin. VCT then produces a single output, either Pass or Fail. It takes two inputs: the unique key of the node and the header of the previous block. As a result, each node is compelled to conduct this VCT once and only once per block.

The WorldLand Blockchain is built on five major components, each contributing to its robust and secure infrastructure.

1. VCT (Verifiable Coin Toss), controls the overall energy consumption of the WorldLand network, ensuring efficient use of resources.

2. VC (Verifiable Computation), comprises VeriComp and SolComp, which are responsible for validating blocks, inserting them into the blockchain, and solving cryptographic puzzles to maintain the network's integrity.

3. DS (Digital Signature), involves the implementation of novel PQ-ready cryptographic suites suitable for WorldLand. This ensures secure key generation, signing, and verification processes.

4. VRF (Verifiable Random Function), extends the functionality of digital signatures by providing verifiable randomness and privacy-preserving features, enhancing the overall security and reliability of the network.

5. ECC (Error Correction Code) with LDPC (Low Density Parity Check) serves as an enabler for ASIC and PQ resistant Proof of Work (PoW) while remaining energy-efficient. The ECC encodes plain data before transmission to provide error correction at the sender's end and decodes it at the receiver's end to identify and correct any transmission errors.

Together, these components ensure that WorldLand Blockchain remains secure, efficient, and resilient against emerging threats.

2.2. ECCPoW as Blockchain Game Changer

ECCPoW (Error Correction Code Proof of Work) has been introduced as a novel alternative to the traditional hash-based Proof of Work (PoW) algorithms used in networks like Bitcoin. ECCPoW merges the efficiency found in error correction codes with the resilience of PoW mechanisms. While PoW is recognized for its superiority over other consensus mechanisms, its benefits have not been universally acknowledged by the global community. PoW enables a vast network of nodes to achieve consensus, as evidenced by the uninterrupted operation of the Bitcoin network. This is attributed to two key reasons:

1. The PoW consensus mechanism's simplicity, where each node independently proposes and verifies each and every new block.

2. The lack of need for nodes to communicate to reach a consensus, as each one focuses on solving the cryptographic puzzle independently.

This simplicity, facilitating millions of nodes to agree on each block without fail, is PoW's most innovative aspect. ECCPoW builds on this strength, presenting an obstacle to the development of ASIC mining equipment, thereby slowing the trend towards centralization. WorldLand is exploring the integration of ECCPoW with other verifiable computational algorithms to enhance decentralization further, including the implementation of a verifiable coin toss function.

2.2.1. What is ECCPoW?

Error Correction Code (ECC) is a sophisticated mathematical method designed for detecting and correcting errors in data during transmission across noisy channels. Among these methods, the Low-Density Parity-Check (LDPC) code stands out as particularly effective, closely approaching the Shannon limit, a theoretical maximum efficiency for data transmission [5].

ECC involves two main components: the encoder and the decoder. The encoder's role is to encode plain data before transmission, while the decoder's purpose at the receiver's end is to identify and correct any errors that have occurred during transmission. The effectiveness of the code is proportional to the computational effort required to correct errors; the more errors it aims to correct, the more computationally complex the decoding process becomes. Once errors are corrected, the output data matches the original encoded data.

In the context of a Proof of Work (PoW) consensus mechanism, the work required to be done by the decoder can serve as a challenging PoW puzzle each node has to solve. Once a node finds a PoW, that node can present the found word as the proof of work. Other nodes verifying if the presented word is a codeword or not. This verification can be completed very quickly. ECCPoW integrates this principle as follows:

1. Utilizing the decoder as the PoW mechanism, starting with an erroneous word, a successfully decoded, error-free codeword serves as the proof of work, presented by the node.
2. The verification process to determine whether a presented word is a codeword is simple and efficient.
3. Adjusting the puzzle's difficulty can be achieved by modifying the error correction capability, such as altering the codeword's length. Longer codewords can correct more errors but require more extensive decoding efforts.
4. By potentially increasing the codeword's length to a very high degree, the development of specialized ASIC hardware for mining becomes prohibitively expensive, if not entirely unfeasible.
5. Introducing variability in the code used for each block adds an additional layer of complexity.

These pioneering strategies are at the heart of ECCPoW's consensus mechanism [6], offering a novel approach that leverages the intricacies of error correction to ensure both the security and integrity of the blockchain network.

2.3. Resolutions of Trilemma & Beyond in WorldLand

2.3.1. Decentralization

Decentralization is a core principle that braces the core strengths of blockchain technology, offering enhanced security, transparency, and open user participation compared to traditional centralized systems. However, it's important to note that achieving true decentralization in practice can be challenging.

a) WorldLand Insists on PoW for Decentralization and Security

WorldLand maintains PoW as its consensus mechanism, which promotes decentralization by allowing widespread participation, securing the network through distributed mining, and incentivizing diverse stakeholders. It remains as the fundamental mechanism for achieving trust and resilience in WorldLand blockchain ecosystem.

b) ECCPoW is ASIC Resistant

ECCPoW impairs ASIC miners by dynamically adjusting the parameters of the LDPC code over time. This time-varying capability makes it challenging for specialized ASIC mining devices to dominate the network and maintains a balanced distribution of power within the network further promoting decentralization of the blockchain network.

Two representative papers published by Professor Heung-No Lee and his team on ECCPoW as a PoW algorithm are:

- ECCPoW: Error-Correction Code based Proof-of-Work for ASIC Resistance [7],
- Time-Variant Proof-of-Work Using Error-Correction Codes [6].

2.3.2. Security

WorldLand blockchain runs on the common PoW mechanism and maintains all the characteristics of traditional blockchain security constraints. Additionally, ECCPoW‘s goal is to resist ASIC mining dominance and improve overall network security.

a) Tamper-Resistant Transactions

ECCPoW ensures the integrity of transactions by requiring miners to perform cryptographic computations. Any attempt to tamper with a transaction would be computationally expensive and detectable. The use of error correction codes adds an additional layer of protection against unauthorized modifications.

b) Sybil Attack Mitigation

Sybil attacks are a form of security threat on a network where an attacker generates numerous fake identities or nodes to gain a disproportionate level of influence over the network. ECCPoW (Error Correction Code Proof of Work) combats this risk as a PoW (Proof of Work) mechanism by necessitating significant computational effort for each participating node. Miners are required to demonstrate their contribution by successfully solving ECCPoW puzzles, a process that demands substantial computational resources. This requirement serves as a deterrent to potential attackers, as it becomes impractically challenging for them to mount a successful Sybil attack without amassing a collection of nodes that exceeds the computational power of the legitimate network. Essentially, ECCPoW leverages the inherent computational complexity and resource requirements of its puzzles to maintain the integrity and security of the network against such attacks.

c) Consensus Stability

ECCPoW maintains consensus stability by relying on established cryptographic principles. The use of error correction codes ensures that the consensus process remains robust. Stable consensus prevents forks and ensures the network's reliability.

d) Quantum-Resistant Approaches of WorldLand

Quantum-resistant algorithms, also known as post quantum algorithms, are cryptographic methods designed to withstand attacks from powerful quantum computers.

Researchers worldwide have been working on developing quantum-resistant algorithms to safeguard the digital infrastructure. These algorithms rely on mathematical problems that are believed to be hard even for quantum computers. Examples include lattice-based cryptography, code-based cryptography, and multivariate polynomial systems.

ECCPoW, a code-based cryptography, is specifically engineered to remain secure even when faced with the computational capabilities of quantum machines. By leveraging error correction codes, WorldLand enhances its resistance to quantum attacks, as ECCPoW-based signatures remain secure even against quantum adversaries.

WorldLand's ECCPoW not only addresses quantum computing challenges but also provides a solid foundation for secure, efficient, and reliable blockchain operations. As the project evolves, its commitment to security remains at the forefront.

2.3.3. Scalability

WorldLand acknowledges the inherent limitations of single standalone blockchains and proposes an innovative approach to overcome the blockchain scalability challenge by deploying off-chain solutions, and other techniques.

a) Off-Chain Solutions: Layer 2 Solutions and Sidechains

WorldLand leverages Layer 2 solutions to offload certain operations from the main blockchain. These solutions enhance scalability by reducing congestion and improving transaction throughput. Examples of Layer 2 solutions include state channels, Plasma, and Rollups. These allow users to conduct transactions off-chain while maintaining security and later settling the results on the mainnet.

WorldLand's use of sidechains significantly, while it is a sidechain of the Ethereum mainnet, enhances its blockchain infrastructure by allowing transactions to be processed in parallel. These sidechains function autonomously, yet they possess the capability to connect with the other larger mainnet whenever required. This architecture enables WorldLand to scale effectively, ensuring that an increase in transaction volume doesn't come at the expense of security. Furthermore, this setup provides a seamless mechanism for users to transfer assets between the mainnet and the sidechains, facilitating a fluid and flexible interaction within the WorldLand ecosystem.

e) Dynamic Block Size

WorldLand dynamically adjusts block sizes based on network demand. This flexibility allows scalability accommodating more transactions per block when needed.

f) Periodic Checkpoint Technique

To bolster the security of sidechains and Layer 2 solutions, which generally operate with less inherent security than the mainchain, layer 2 blockchains may utilize the periodic checkpoint technique. For example, WorldLand can utilize periodic checkpointing at the Ethereum mainnet.

This technique establishes fixed points (checkpoints) within the sidechain, signifying states that are irrevocably finalized. By implementing the periodic checkpoint technique, these checkpoints are established at regular intervals and subsequently recorded as transactions on the mainnet. This process effectively inherits the robust security of the mainchain and extends it to the sidechain, enhancing its overall security posture.

If a group of network participants controls more than 50% of the total computational power in the network, they can manipulate the blockchain. Therefore, any initial PoW blockchain networks with low computational power are vulnerable to block forgery attacks. Utilizing a smart contract-based checkpoint method can enhance security during the initial phase of blockchain development.

In a checkpoint method, participants periodically record the hash of the block headers in an Ethereum smart contract. The recorded checkpoint block header can be used to validate the blockchain. Participants reject blocks that deviate from the recorded checkpoints. Our method ensures the integrity of blocks up to the height of the most recently generated checkpoint, reducing the risk of double spending.

The work is currently underway, and the first release is planned at the first quarter of 2025.

2.3.4. Energy Efficiency

Recognizing the problem of explosive energy consumption of PoW blockchain, WorldLand has developed a consensus mechanism that achieves energy efficiency by leveraging the Verifiable Coin Toss Function and error correction code PoW.

a) Verifiable Coin Toss Function

WorldLand prioritizes both robust security and decentralization inherent to PoW while minimizing energy consumption. To achieve this, it has implemented a novel "coin toss" technique that streamlines the consensus process.

Instead of every node burning electricity on computationally intensive puzzle-solving, only a predetermined percentage (e.g., 10%) are randomly chosen through a verifiable coin toss mechanism. These selected nodes then partake in the energy efficient ECCPoW mining, significantly reducing overall energy footprint.

This approach aims to strike a delicate balance between security, decentralization, and environmental responsibility, ensuring a sustainable future for the blockchain ecosystem.

2.3.5. Cross-Chain Interoperability

The challenge of cross-chain interoperability in the blockchain landscape is multifaceted and crucial for the seamless functioning of decentralized networks.

WorldLand has taken significant strides by implementing cross-chain bridges. These bridges serve as vital connectors between different blockchain networks, enabling seamless data transfer and interoperability.

a) Consensus Heterogeneity, Scalability and Throughput

Different blockchains employ diverse consensus algorithms (e.g., Proof of Work, Proof of Stake, Delegated Proof of Stake). Integrating them seamlessly while maintaining security and trust is challenging. Cross-chain solutions must handle consensus heterogeneity effectively.

Scalability remains a critical issue. As more transactions occur across interconnected chains, the overall throughput must increase. Ensuring efficient data flow without compromising security is a delicate balance.

b) Inter-Blockchain Communication (IBC)

WorldLand's cross-chain bridges leverage IBC protocols. These protocols allow secure communication and data exchange between separate blockchains. By establishing IBC channels, WorldLand can interact with other chains, share information, and facilitate cross-chain transactions.

c) Decentralized Validators

WorldLand's cross-chain bridges rely on a network of decentralized validators. These validators verify and relay transactions across chains. Their consensus ensures the integrity and correctness of cross-chain data.

d) Asset Transfers

WorldLand's bridges enable the transfer of digital assets between different blockchains. Users can move their assets from one chain to another seamlessly, enhancing liquidity and utility.

e) Smart Contracts and Oracles

WorldLand integrates smart contracts and oracles to facilitate cross-chain interactions. Smart contracts execute predefined logic, while oracles provide external data to trigger cross-chain events.

f) Security Measures

WorldLand ensures the security of cross-chain bridges by implementing cryptographic techniques, threshold signatures, and multi-signature schemes. These measures prevent unauthorized access and maintain the integrity of cross-chain transactions.

WorldLand's cross-chain bridges play a pivotal role in creating an interconnected blockchain ecosystem, fostering collaboration, and expanding the reach of decentralized applications.

2.4. Mobile Hyperspectral Camera & ZKP

2.4.1. What is Mobile Hyperspectral Camera?

An RGB camera captures visible light and produces color images by combining the red, green, and blue channels. A spectrometer measures the intensity of light across a wide range of wavelengths from ultraviolet to infrared. It provides detailed spectral information of the incident light, not just as RGB intensity values.

Professor Heung-No Lee and his team have developed an ultra-small snapshot mass-producible spectrometer camera that can fit into mobile phone devices. For example, it can be used for more precise face recognition and digital identification purposes. It took them over a decade of research and development efforts to achieve this feat.

A secure and portable authentication device will be essential for future payment methods. Many applications are adopting face recognition as the primary authentication method for financial and payment applications. However, the traditional face recognition based on RGB cameras is susceptible to presentation attacks (PA). PA attempts to deceive the authentication device by presenting printed images or masked faces.

To tackle this issue, some mobile applications adopt additional sensors, such as near infrared radiation (NIR) cameras or Time-of-Flight (ToF) sensors. However, adopting these sensors, increases the complexity and cost of the hardware configuration for authentication devices.

The team has built a tiny yet effective spectrometer prototype that can be integrated into mobile devices. It uses Multilayer Thin Film (MTF) filters to disperse the light source into many spectra, along with computational spectrometer techniques employing DLL. The team has shown the feasibility of producing snapshot mass-production-enabled MTF spectrometers for mobile applications.

2.4.2. Strategy to Address Face Authentication Issues

Addressing these issues, the team also introduces the computational hyperspectral imaging enhanced with the Zero-Knowledge Proof (ZKP) protocol:

1. The computational hyperspectral camera consists of an MTF and CMOS sensor to achieve a compact size and a low production cost.
2. The computational hyperspectral imager encodes the wavelength information across visible and NIR bands.
3. The deep learning-based face recognition model encodes the spatial information as the key.
4. Authentication is conducted using the encoded information from the computational hyperspectral imager.
5. Encoded information is irreversible, so privacy is contained and enhanced via ZKPs.

The Zero-Knowledge Proof (ZKP)-based biometric authentication system, integrated with a compressive analog-to-digital scanner, begins with the Prover presenting biometric data (such as handprint, iris, voice, or facial features) along with a secret key. This biometric data is converted from analog to digital form by the scanner. The digitized data then undergoes Zero-Knowledge

Proving, which involves feature extraction, classification, and similarity checks against stored templates. The results are compiled into ZK proofs, along with the Prover's public key.

These ZK proofs are submitted to the Verifier, who performs Zero-Knowledge Verification without revealing the actual biometric data, thus ensuring privacy. The verifier uses the ZK proofs and public key to authenticate the Prover's identity. If the verification is successful, the system accepts the authentication; otherwise, it declines. This process enhances security and privacy by keeping sensitive biometric information confidential while ensuring accurate identity verification.

The Spectrometer Camera Module with MTF, CMOS and MLA (Micro-Lens Array) has been implemented by the team, and the study has been published in 2022 [8].

Professor Lee has made significant contributions to the field of MTF-based computational spectrometers.

2.4.3. Potential Use of Computational Spectrometers:

A snapshot computational spectrometer could be employed for anti-spoofing in facial recognition:

- Spectral Information: By capturing detailed spectral information, it can distinguish between real skin and spoofing materials (such as printed photos or masks).
- Unique Signatures: Real skin exhibits specific spectral signatures due to its composition (melanin, blood vessels, etc.).
- Challenges: Efficiently integrating this technology into mobile phones without compromising user experience.

While the concept of using computational spectrometers for anti-spoofing is promising, practical implementation and seamless integration with mobile devices remain key challenges.

Chapter III. Landscape & Coinomics

3.1. WorldLand Landscape 2024

Within WorldLand's ecosystem, every participant plays a vital role, contributing unique value in their own way. The blockchain and its native coin, WLC, act as a secure and streamlined conduit for the exchange of values they generate. As the network expands and participation grows, the collective value blossoms leading to an appreciation in WLC itself. WorldLand envisions this value radiating outwards, creating a global impact and ensuring equitable and fair distribution among all participants.

Key participants include Users, who utilize MetaMask Wallet, My AI Agent, and AI-DEX for interactions within the network. Miners play a crucial role in maintaining the blockchain by validating transactions and securing the network. The WorldLand Foundation and DAO (Decentralized Autonomous Organization) govern the ecosystem, ensuring smooth operations and strategic growth. LiberVance, the founding company, provides essential technological support and innovation for the network. WorldLand dApp Developers create decentralized applications that enhance the functionality and user experience of the blockchain. Additionally, the ecosystem integrates with other blockchains, exchanges, and external data sources, represented by icons for Bitcoin, Ethereum, Binance, and others, facilitating interoperability and data exchange across platforms. This diverse group of participants collectively ensures the robustness, innovation, and seamless operation of the WorldLand Blockchain.

In this section, we dive deeper into the diverse roles each member plays within the network.

3.1.1. WorldLand Blockchain: Test & Main Network

WorldLand is a blockchain mainnet that was successfully launched in South Korea. WorldLand project is a collaborative effort between the GIST Blockchain Intelligence Convergence Center and startup LiberVance. WorldLand has been operating Seoul Main Network and Gwangju Test Network.

Since the genesis block in August 2024, 1.6 million blocks have been generated with 6.4 million WLC's minted averaging a new block at every 10 seconds at the time of writing in February 2024.

The WorldLand networks have been running in a very stable condition without a glitch. This achievement signifies a giant step toward providing next generation blockchain services on a global scale.

3.1.2. End Users & Subscribers

They will invest in WLC and make use of dApps. Their contribution is the livelihood of the network.

Their value lies in shaping the network's direction, provoking innovation, and ensuring long-term sustainability of the network. It is the goal of the project that this user community grows to a sustainable magnitude.

3.1.3. Miners

Miners invest in hardware, electricity, and time to secure the network. Their computational power ensures transaction validation, block creation, and overall network security. The value they generate lies in maintaining the integrity and reliability of the blockchain.

Since the launch of WorldLand in August 2023, the number of mining nodes has increased steadily. At the time of writing this report, it has reached 780 nodes.

The mining puzzle is to solve the error correction code. This puzzle cannot be solved with formulae. The answer must be found by trial and error, which makes it a perfect puzzle for the block validation PoW. Solving a puzzle requires a huge number of vector multiplications, and it is very advantageous to use GPU machines.

3.1.4. WorldLand Foundation

WorldLand Foundation serves as a guiding force, provoking collaboration, research, and responsible development within the WorldLand blockchain community. The foundation supports and engages with the WorldLand community. It provides resources, educational materials, and assistance to users, developers, and miners. The WorldLand Foundation participates in governance decisions. It collaborates with stakeholders to shape the network's future through proposals, voting, and consensus.

3.1.5. LiberVance

LiberVance has played the key role in launching the WorldLand mainnet as the engineering arm. The mainnet, based on ECCPoW and PQ-resistant cryptography, is a critical milestone for the community.

LiberVance actively contributes to the development and maintenance of the WorldLand blockchain. It provides technical expertise, research, and innovation to enhance the ecosystem. LiberVance collaborates with other stakeholders, including developers, miners, and users. It conducts research, explores new technologies, and contributes to the growth of WorldLand.

3.1.6. WorldLand DAO

Anyone can join DAO by owning WLC. There are many ways to earn WLC, such as mining, receiving awards, and purchasing WLC.

WorldLand DAO solicits project proposals from the community. These proposals can cover various areas of interest, such as protocol upgrades, ecosystem improvements, or research initiative.

The Articles of WorldLand DAO are periodically updated and enacted through community voting. These articles define the DAO's structure, governance rules, decision-making processes, and WLC Coinomics.

3.1.7. WorldLand dApp Developers

Their contributions drive innovation, enhance functionality, and adoption. They provide the real daily use cases for end users. Their adoption of WorldLand is the primary goal of the project.

They design and develop new applications writing smart contracts, decentralized protocols, and user-friendly interfaces, enriching the ecosystem. By building useful dApps, developers attract users and investors. Their work expands the WorldLand ecosystem, making it more robust and appealing. The dApp developer community adds value by driving innovation, expanding the ecosystem, and enhancing user experiences. Their role is pivotal in shaping WorldLand's success.

3.2. WorldLand Coinomics

3.2.1. Minting & Halving Schedule

The economic model of WorldLand leverages the mining of WLC to support the ecosystem's expansion, the development and operation of dApps, and the maintenance of the mainnet infrastructure. The issuance of WLC is primarily managed by researchers and engineers represented by the WorldLand Foundation, who launch and operate the mainnet. At the genesis block, 40,996,800 coins were minted, an allocation referred to as TMG (Total Minted at Genesis), which will be used for the ecosystem.

Miners compete to validate transactions and secure the network by solving computational puzzles. As a reward for their efforts, new WLC are minted and distributed to the winning miner at every new block generation.

- Block Generation Interval: New blocks are generated approximately every 10 seconds.
- Reward Halving: The WLC reward for mining a block follows a 2-year halving schedule. This means the reward starts at a certain amount and is then cut in half every two years, perpetually.
- Initial Reward: The reward for mining a block in the first 2-year period is 4 WLC.
- Asymptotic Supply: The total amount of WLC that will ever be minted gradually approaches 50,457,600 through the halving schedule. This means WLC has a capped supply, similar to Bitcoin.

3.2.2. Coin Minting Balance

For the next five years, the network supply of WLC coins to miners will be 40,996,800 coins, matching the number issued in the genesis block (TMG). This balance between TMG and the total of mined WLCs is intentional, and the intent is to maintain decentralization of the network between the Foundation and the mining community.

3.2.3. Coin Distribution Schedule

The WorldLand Foundation will play a role in the early stages but aims to gradually diversify its stake. TMG is justifiable because of years of funding and R&D effort by INFONET research lab at GIST . The Foundation will manage TMG distribution with decisions made at DAO.

The TMG is first divided into the long-term endowment (LTE) fund and ecosystem development (ECO) fund, 20% and 80% respectively of the total. The Foundation's Long-Term Endowment (LTE) stake in the Genesis Block is 20%. 80% of the shares issued in the Genesis Block are ECO Funds. The ECO Fund will be used to expand the WorldLand ecosystem.

The main projects for ecosystem expansion include Wallets, NFT/Game, Voting/Bridge, My Al Network, Mainnet, Research, Education, and Investment.

The ECO fund will be used in the following proportions: 30%, 30%, 20%, 10%, and 10% per year for 5 years. After five years, the foundation's LTE will be left at 10% level, and this shrink-down in fund will further nourish decentralized and community-driven ecosystem.

By implementing these coinomics principles, WorldLand aims to encourage participation, ensures a stable coin supply, and generates a decentralized and sustainable development ecosystem for dApps on the platform.

The distribution plan for the Long-term Endowment (LTE) fund and the Ecosystem Development (ECO) fund spans from 2023 to 2028. The LTE fund consists of 8,199,360 WLC, while the ECO fund comprises 32,797,440 WLC. The ECO fund is allocated over five years, with 30% distributed in the first two years (9,839,232 WLC each year), 20% in the third year (6,559,488 WLC), and 10% in the fourth and fifth years (3,279,744 WLC each year). Each year's distribution is divided equally into four quarters, ensuring a gradual and steady release of funds to support the ecosystem's development and long-term sustainability.

3.3. Charter & Governance

The WorldLand Charter is a document that aims to promote fundamental human rights, equality, and peace. It also encourages the use of digital technologies to promote economic and social advancement.

3.3.1. Charter of WorldLand

WE THE PEOPLES OF The WorldLand aim:

•to uphold faith in fundamental human rights, believe in the dignity and worth of the human person, promote equal rights of men and women, of nations large and small,

- to facilitate social progress and better standards of life in larger freedom,
- to live together in peace with one another as good neighbors, and
- to unite our strength to maintain international peace and security, and
- to employ digital technologies such as Al and Blockchain for the promotion of the economic and social advancement of all peoples, and

HAVE RESOLVED TO ACCOMPLISH THESE AIMS via a global digital network to be known as WorldLand.

3.3.2. WorldLand Governance

WorldLand's governance design principles focus on legal compliance, transparency, decentralization, and scalability. Here are the key principles:

1. Legal Basis: WorldLand follows regulatory procedures and adheres to the laws of sovereign countries with well-established crypto-related systems, ensuring institutional transparency. It

may establish legal entities, such as DAO LLC, in jurisdictions that recognize DAO as an economic entity.

2. Transparency of Asset Execution: WorldLand emphasizes transparency,

3. decentralization, and sustainability in asset execution, ensuring that decisions are made with the consent of various stakeholders.

4. Securing Decentralization through ETH-WL DAO: WorldLand utilizes the concept of a decentralized autonomous organization (DAO) to govern the project. Asset execution and major decisions for project development are determined through voting, following the method programmed in the DAO Smart Contract. WorldLand DAO functions as a non- profit organization involved in the project, attracting, and managing global investment proceeds through a smart contract on the Ethereum platform.

5. Ecosystem Support: The foundation supports developers and provides resources for the continuous improvement of the WorldLand project and ecosystem.

6. Usability: Governance processes are designed to be clear, easily understandable, and accessible to all stakeholders. Mechanisms for active participation and voting are made simple and intuitive to encourage engagement. The governance system aims to be efficient and effective, enabling timely decision-making and implementation.

7. Scalability: The governance framework of WorldLand is designed to scale as the platform grows in scope, complexity, and stakeholder diversity. It can adapt to accommodate an increasing number of participants and evolving requirements.

8. Decentralization: WorldLand's governance ensures the participation of all stakeholders in decision-making processes. The foundation plans to gradually reduce its coin holding rate over time, aiming to decrease it to 17% or less after five years, thus avoiding concentration of power and promoting decentralization.

By adhering to these governance design principles, WorldLand aims to establish a robust, transparent, and inclusive governance structure that promotes community participation, sustainability, and the long-term success of the platform.

Chapter IV. Roadmap

In this chapter, the future plans of WorldLand for the next two year period have been compiled from the detailed inputs from the project team. The roadmap is illustrated in five categories:

4.1. WorldLand Marketing & Business

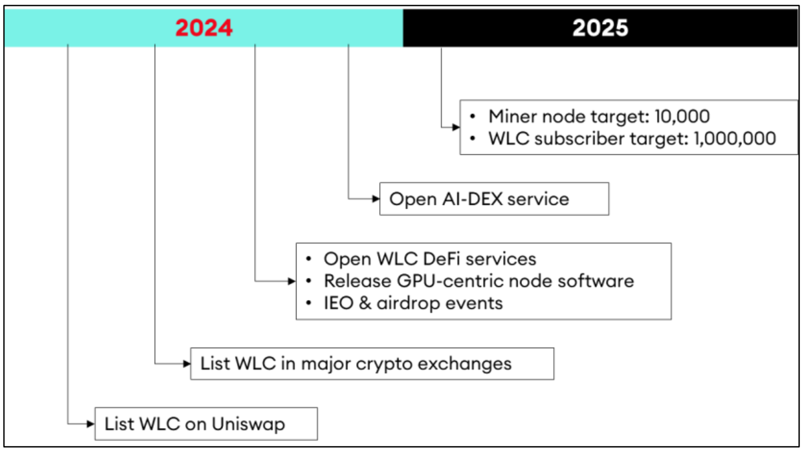

Figure 1 The project marketing and business goals.

4.2. ECCPoW, Checkpoint & DID

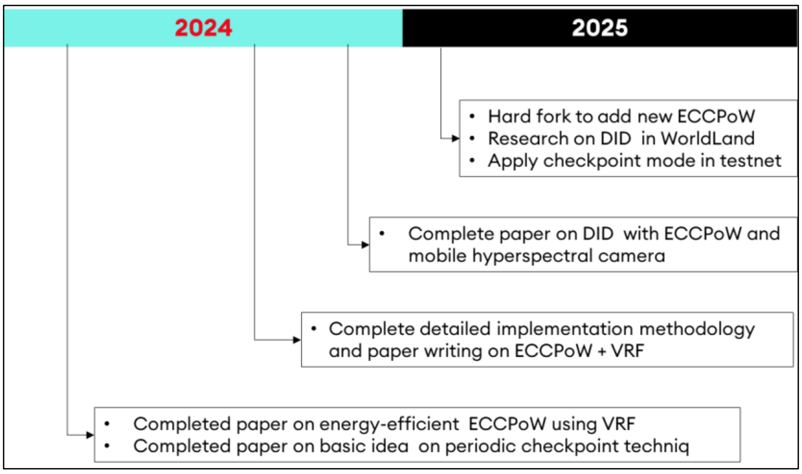

Figure 2 Engineering goals of ECCPoW, Checkpoint and DID.

4.3. Post-Quantum Cryptography

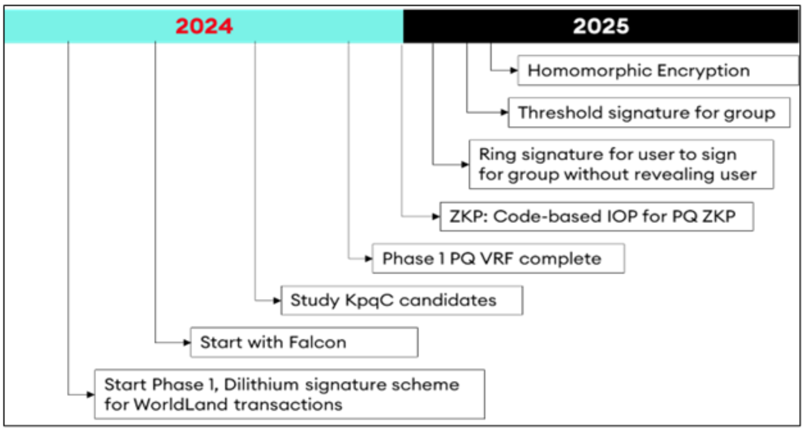

Figure 3 Engineering goals of Post-Quantum cryptography.

4.4. Spectrometer with ZKP & DID

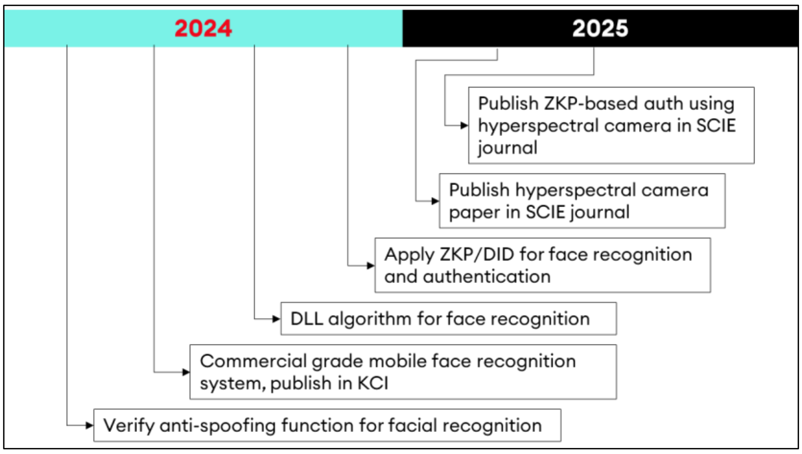

Figure 4 Engineering goals of spectrometer with ZKP and DID.

4.5. AI-DEX & Bridge

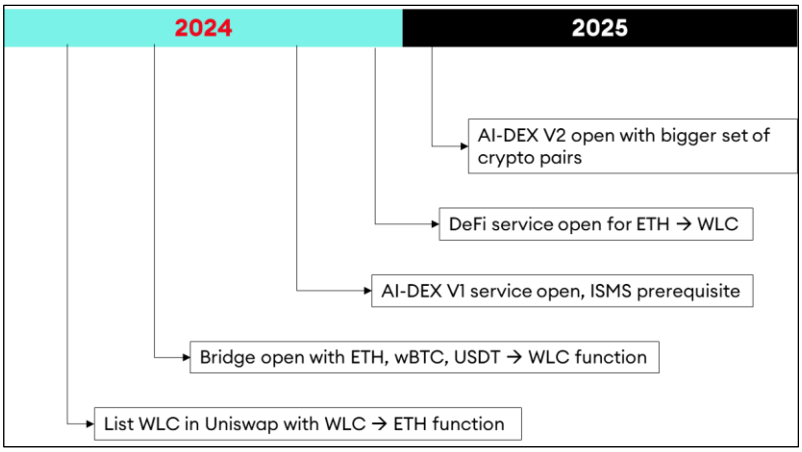

Figure 5 Engineering goals of AI-DEX and bridge.

Chapter V. Team

CEO Heung-No Lee

GIST Professor in the Department of Electrical and Computer Engineering
CEO of LiberVance, Co. Ltd.
Director of the ITRC Blockchain Intelligence Convergence Center (Ministry of Science and ICT)
Former Full Professor, the University of Pittsburgh, PA, USA
Former Specialist Committee Member of the Presidential Committee for Policy Planning

Published over 400 domestic and international research papers and hold 60 patents
Associate Editor of IEEE Transactions on Cybernetics (a top 4% SCI Journal) and serves on the editorial boards of several international journals
Recipient of the Haedong Academic Award (2019)
Recipient of the GIST Research Award and Distinguished Technology Award (3 times), Scientist of the Month (January 2014)
Recipient of the Prime Minister's Commendation (April 2022)

CTO Young-Sik Kim

Professor at DGIST
Former Professor at Chosun University
Former Senior Researcher at Samsung Electronics:
Ph.D. degree from Seoul National University

Expert in Cryptography, Homomorphic Encryption, and AI Security
IEEE Globcom2022 SAC Cloud, Technical Program Committee Member: Contributing to the technical program committee for IEEE Globecom 2022, specifically in cloud computing.
Published Research on Homomorphic Encryption in EUROCRYPT 2022/2021 and Other Domestic and International Journals: Has authored over 160 research papers related to homomorphic encryption.

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