Vitro Technology

IOT TO Blockchain

Crypto-Authenticated IoT Block Data for
Security and Automated Transaction Processing

2019

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A WORD FROM THE FOUNDER

I first became interested in the challenge of IoT at seminars hosted by key governmental and non-governmental organizations (NGOs e.g. World Bank, the U.S. Commerce Department, and Asia Development Bank). In each case, there was limited visibility into the actual costs, benefits, and externalities of infrastructure projects ranging from water to green energy. The model was generally to procure equipment and then “pay and pray” for service-level agreements to be honored by operating companies. The track record was poor — when results were even collected.

Moreover, governments and NGOs alike targeted the objective of getting out of the business of buying equipment altogether, and transitioning into buying the services delivered by equipment. This model has been successfully implemented in the form of Power Purchase Agreements (PPAs) in the solar energy sector. But the investment banking cost of securitizing PPAs has limited the proposition to only the largest of projects.

The challenge was threefold: first, capture authenticated data from equipment installations, large and small; second, utilize authenticated operating data to authorize service agreement payments on a recurring basis; and third, migrate the equipment-purchasing structure to an efficient, securitized service modeled on PPAs.

IoT addresses the first challenge. IoT is a multi-disciplinary pursuit involving hardware, security, software, communications, hosting, and device management. Finding no viable alternative, Vitro developed an Edge-to-Cloud platform based on open-source, including hardware that directly incorporates Elyptic-Curve Cryptography key storage (ECC) and communications based on OpenSSL with a Root of Trust specifically designed for IoT. The result is a secure path for the transfer of data from sensors to Amazon AWS IoT that takes advantage of the latest innovations in lowered costs and low-bandwidth communications. Finally, Vitro incorporated an innovation that hashes data at the Edge building data into blocks that include Proof of Origin: a trustless, non-consensus-based algorithm leveraging secure hardware ECC crypto at the Edge.

The second challenge of recurring payments brings blockchain directly into the scope of the solution. As much as IoT brings value, it also brings a high burden of transaction verification and processing. Each IoT site incurs recurring monthly processes that carry costs ranging from hosting to connectivity to billing. The clerical burden of these micro-transactions has prevented widespread adoption of IoT despite its obvious benefits. Blockchain technology incorporates smart-contract execution of automated recurring service payments. With Vitro, these payments are based on authenticated operating data that verify what services were delivered and should be paid, while Vitro blockchain preserves an immutable record suitable for audit and financial controls.

The third challenge in securitizing equipment purchases brings XPA service agreements ('X' representing virtually any type of capital equipment) and the token economy into scope: an economy anchored in authenticated operating data stored in the Vitro blockchain. Here, Vitro blockchain data can be leveraged again as the foundation for a transaction-based economy: pairing financed capital goods with service-level agreements.

Vitro is going to change the world served by industry, NGOs, and governments alike: binding capital purchases to the services delivered by specific capital goods on a recurring basis. This model opens the path to XPA financing via the token economy for transactions large and small — something previously inconceivable to only the largest of projects.

We appreciate your interest and welcome your feedback on our efforts to change the world.

Sincerely,
David H. Goodman
Founder & CEO

KEY CONCEPTS:

1. Proof of Origin of IoT Data via ECC.

2. XPA .. delivery of service purchase agreements for various types of equipment for installations large and small. Pairing finance with recurring service delivery and payment.

3.Three Parties:
- **a.** *Funding:* GOV, NGO or even crowd funding the infrastructure.
- **b.** *Equipment:* OEM or service provider (e.g. electricity, water, alerts).
- **c.** *Operator:* Utility company or even consumers receiving and paying for the core value on a recurring basis.

INTRODUCTION

WHAT IS VITRO?

The Vitro Technology Corporation is an Internet of Things (IoT) company leveraging crypto-security and open-source to enable blockchain transactions based on authenticated operating data from remote equipment. Vitro's core service is to deliver IoT Block data including Proof-of-Origin: a non-consensus-based method of IoT data authentication via local ECC crypto hashing and signature. Vitro's revolutionary platform allows customers to control and monitor remote sensors and equipment (e.g., water wells, meters, solar panels, electronic billboards) with authenticated operating data and automated transaction processing.

Founded in 2015 in Austin, Texas, Vitro has developed a full-stack, open-source IoT platform that leverages Elliptic-curve Cryptography (ECC) hardware in every device. ECC is the basis for secure Root of Trust (RoT) data transfer as well as in-device data verification via ECC hashing and signatures. The result is a hardware platform that has qualified for Amazon's AWS highest security rating (HSI[1]) and DigiCert PKI[2] best-practices.

Vitro has successfully executed projects associated with financing from The World Bank, Asia Development Bank, USAID, and other governmental and non-governmental organizations (NGOs). Our technologies have been functioning on the global market for two years, delivering advanced insight and solving problems with IoT device connections in various vertical markets. Installations range from the U.S. to Pakistan, from China to Poland.

OUR VISION

We believe that the devices we all rely on daily can be connected into trusted networks that will expand the availability of services to people all over the world and while making them more sustainable.

OUR MISSION

We build trusted IoT and blockchain technologies to deliver authenticated data that enable innovative financial models, optimize operations, and automate transactions across vertical industries around the world.

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[1] *https://devices.amazonaws.com/search?kw=hsi&page=1*

[2] *https://www.digicert.com/wp-content/uploads/2017/05/Whitepaper_PKISolutionforIoT_4-12-17.pdf*

OUR GOALS

The Vitro team is dedicated to the creating trusted networks of IoT devices linked to blockchain technology in order to:

- leverage open-source technology for transparency and security;
- integrate ECC natively from Edge to Cloud to Blockchain;
- enable service purchase agreements for transactions of all sizes;
- develop vertical market communities;
- continually adopt best practices to achieve our goals.

IOT – OPPORTUNITIES AND CHALLENGES

The IoT market is a fast-growing industry of interconnected devices capable of remote operation. IoT was designed to enable low-cost networking hardware to both monitor and control a wide array remote equipment with limited bandwidth access. While growing rapidly, the IoT market has placed minimal emphasis on security and authentication of remote data. Large industry players have opted in general for security by obscurity (fn Wikipedia), secret code blocks and black boxes designed to be impenetrable. High profile hacks and security failures have plagued nascent IoT projects in industrial and consumer applications.

Civic and industrial infrastructure relies heavily on remote equipment which currently offers limited insight into actual operating data, efficiency, and output of specific hardware elements in the field. Data dependencies for both operating decisions and transaction processing for remote equipment make data authentication a crucial yet largely overlooked vulnerability in IoT.

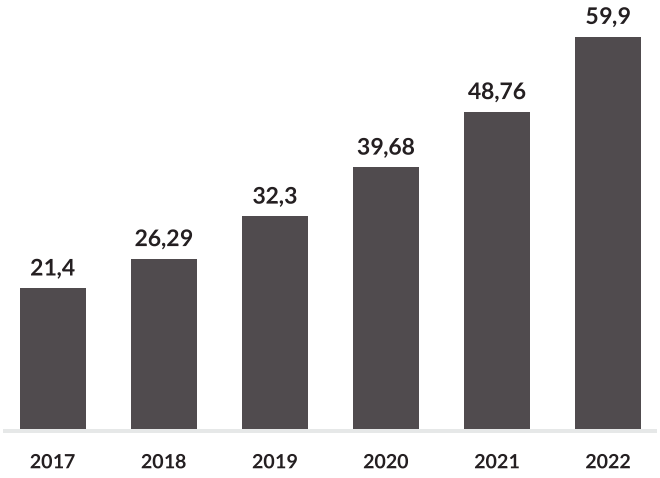


Figure 1. *Global IoT Market in Energy and Utilities Applications in Billions of U.S. Dollars*

Since 2008, the number of connected IoT devices has surpassed the human population. Civic energy and water infrastructure alone have connected millions of devices within the IoT network worldwide; the infrastructure we all rely on daily. The global market for IoT in utility applications alone will reach $59.9 billion by 2022, from $21.4 billion in 2017 at a compound annual growth rate (CAGR) of 22.9% from 2017 to 2022.

The major factors driving the growth of the IoT market include:

- Demand for data-dependent analytics, including Artificial Intelligence (AI);
- New connectivity solutions including NB-IoT, LoRa and others;
- Network cost reductions from cloud computing services;
- Demand for increased oversight of utilities and infrastructure;
- Governmental and non-governmental interest of IoT solutions.

According to our research, Vitro has determined that the demand for IoT is well documented and encompasses vast total addressable markets across numerous vertical industries. However, the critical missing component is a platform that can deliver secure, authenticated datasets from remote IoT equipment. This challenge is interdisciplinary, and ranges from embedded systems to cryptosecurity to cloud to blockchain.

Vitro is uniquely positioned to be the catalyst in a paradigm shift that will span industries and countries across the world.

THE PROBLEM

IoT is witnessing strong market penetration in many industry-level subsegments such civic utilities, oil and gas, asset tracking, emergency notifications,and more.

Currently, the rapidly-developing IoT industry faces several challenges:

Lack of security for remote infrastructure

IoT is largely targeted to the utilities and service we all rely on daily. However, most IoT solutions suffer from serious, known security vulnerabilities that have generated well documented breaches. Breaches have led to a loss of control over remote assets, falsified operating datasets and weaponized network attacks on equipment owned by other entities.

Lack of access to Service Purchase Agreements

Civic and industrial customers are increasingly demanding Service Purchase Agreements for infrastructure financing. Customers are interested in paying for the services generated by equipment, and not in purchasing and operating the equipment itself. Power Purchase Agreements have taken hold in large scale solar and wind power projects. However, the packaging and sale these instruments depend on investment bankers and consultants that place a huge financial burden that can only be borne by the largest of projects.

Recurring transaction overload

IoT installations deliver time-series data for operating equipment, but also depend on various recurring services themselves, including connectivity, hosting and utilities. Managing these the operating datasets along with service microtransactions on a per-site, per-month basis quickly overwhelms manual audit and payment procedures to verify service delivery to service payments. This is a key limiting factor in scaling IoT installations into hundreds or even thousands of sites.

Lack of Key Performance Indicators (KPIs)

KPIs represent decision-making metrics based on verified operating data. Operating efficiencies cannot be measured without reliable, historic datasets that capture the operating universe at any given installation.

Limited dataset access and controls

IoT datasets represent the key payload of IoT operations. They should hold value for the owner and operator of the equipment, but also for the equipment manufacturer, the financial institutions funding the installation, and insurers. The data can also prove valuable for third parties investigating externalities and the macro effects of operating IoT-enabled equipment (e.g., crop yields, service-level agreements, water table measurement, disease profiles and protocols, population growth, and more).

THE SOLUTION

Vitro seeks to become the largest creator, owner, and operator of a portfolio of targeted business-to-business vertical trade communities focused exclusively on best-practices in the application of crypto-secure IoT technologies to the finance and operation of civic and industrial equipment.

Vitro is addressing the problems of the IoT industry according to the following principles:

Horizontal Technology

Vitro IoT technology is a powerful platform capable of hosting a wide variety of applications. Vitro IoT is a foundation technology targeting security and data authentication for remote equipment. Vitro has invested heavily in building our IoT platform from the ground up using open-source, ECC-crypto and developing core technologies that enable critical services like remote code updates and authentication at every level of the IoT stack.

Vertical Markets

While the development of the IoT platform has been the core activity during the early development of Vitro, the company has recognizes that IoT is a horizontal platform that serves as a base for vertical market solutions: marketplaces in which narrowly-defined industry needs and best practices are assembled.

Each vertical marketplace is an industry-targeted community of buyers, consultants, and manufacturers seeking to enhance the value of their products and practices through the incorporation of Vitro IoT technology.

THE OPPORTUNITY: ESTABLISHING A VERTICAL MARKET OF VERTICAL MARKETS

An Immense Market

The Vitro team has developed deep expertise designing an IoT platform to serve a wide range of industries that we define as distinct vertical markets. This revolutionary new platform serves authenticated data from remote equipment across product categories into a rich virtual overview that is tuned to the needs of each vertical market use-case.

Focus on IoT communities

We refer to the sites serving each of these vertical markets as Vertical Trade Communities (VTC). Each VTC is an industry-specific community of buyers, consultants, and manufacturers seeking to enhance the value of their products and practices through the use of secure Vitro IoT technology.

IoT Block technology

Underpinning each VTC is our innovative, crypto-secure IoT platform serving IoT Blocks: data with Proof-of-Origin using a non-consensus-based method of remote authentication using ECC. IoT Blocks can be assembled into

authenticated time-series data or posted on blockchain for use in the execution smart-contract transactions.

Each VTC contains:

- dashboards
- community forums
- best-practice white papers
- data markets
- operational analytics

Adapting the open-source model, each VTC caters to individuals with similar professional interests: buyers, manufacturers, consultants, telecom operators, data scientists, and governmental and non-governmental agencies. IoT Blocks are product of IoT infrastructure, and Vitro IoT is the vehicle to securely gather, transit, normalize, and store these data sets.

We satisfy the explosive demand in the IoT market, which is not currently being adequately served by traditional channels: trade websites, associations, shows, marketing, and service providers. Our vertical trade communities explore and discuss the best practices in security, data transfer, equipment, cloud hosting, and analytics. This community is a space for buyers, service providers, and sellers to research, source, and interact according to rapidly-evolving best practices in a targeted vertical marketplace.

Vitro believes that we are currently the only company operating a portfolio of business-to-business vertical trade communities built on the foundations of authenticated IoT Block Data, open-source and crypto-secure data transmissions via a certified Root of Trust.

Our portfolio strategy permits us to:

- offer a comprehensive, consistent set of features and functionality across our vertical trade communities, and replicate these offerings to new vertical trade communities;
- leverage infrastructure, technology, marketing, and management resources to achieve economy of scale;
- attract an increasing audience, making our individual sites more appealing to a broad array of buyers, consultants, and equipment vendors.

Our objective is to continue to be the largest creator, owner, and operator of a portfolio of targeted business-to-business vertical trade communities, focused exclusively on best practices in the application of crypto-secure IoT technologies.

Our strategy includes:

- expanding our user base and enhancing user experience with new features, functionality, and content centered on IoT best-practices;
- establishing and expanding multiple revenue streams, including Vitro IoT hardware, software, transaction processing, data visualization and analytics;
- continuing to rapidly develop new vertical trade communities;
- pursuing strategic acquisitions;
- expanding internationally.

We currently generate most of our revenue from:

- the sale of proprietary IoT hardware;
- the sale of IoT-enabled vertical market equipment;
- the sale of metered, authenticated IoT Block data;
- fees for storage of IoT Block data on blockchain, in structured time series, and/or in cold storage.

Our Target Vertical Markets

- Civic Water Cell Towers
- Power Distribution
- Solar Power
- Water/Energy AMI
- Asset Tracking
- Pipeline Meters
- Access Control Waste
- Processing Tanks/HAZMAT
- Trash Collection
- Digital Signage
- Roadside Lighting
- Traffic Signaling
- Chemical Detection
- Weather Stations
- Emergency Sirens Pollution Monitors
- Refrigeration
- Irrigation
- Container Farming

Civic Water Vertical

Vitro Civic Water IoT was selected as our first vertical market through dedicated pursuit of the World Bank as a development partner. In order to solve the water security challenge, Vitro has established partnerships with:

- NGOs: The World Bank and the Asian Development Bank
- The U.S. iPAWS notification system, which enables government agencies to commandeer digital signage like billboards and airport signage in the event of an emergency
- Equipment manufacturers (OEM)

OUR PLATFORM

Trust and Automation with Proof-of-Origin Data Authentication

Trust distinguishes genuine devices and servers from fakes, and enables automatic execution of complex multi-party supply chains and services via authenticated blockchain transactions. Merging IoT and Blockchain, Vitro has created a revolutionary new platform that will dramatically improve data security and compliance.

Vitro delivers crypto-secure device control and authenticated IoT Block data from Edge to Cloud. This is our core competence. The use of the Proof-of-Origin (non-consensus based method of authentication), allows Vitro to hash and sign data securely into IoT Blocks using local ECC cryptography. Higher-order structures of tokens, blockchain, and smart contracts can be applied to IoT Block data across the broaden spectrum of emerging global token economies.

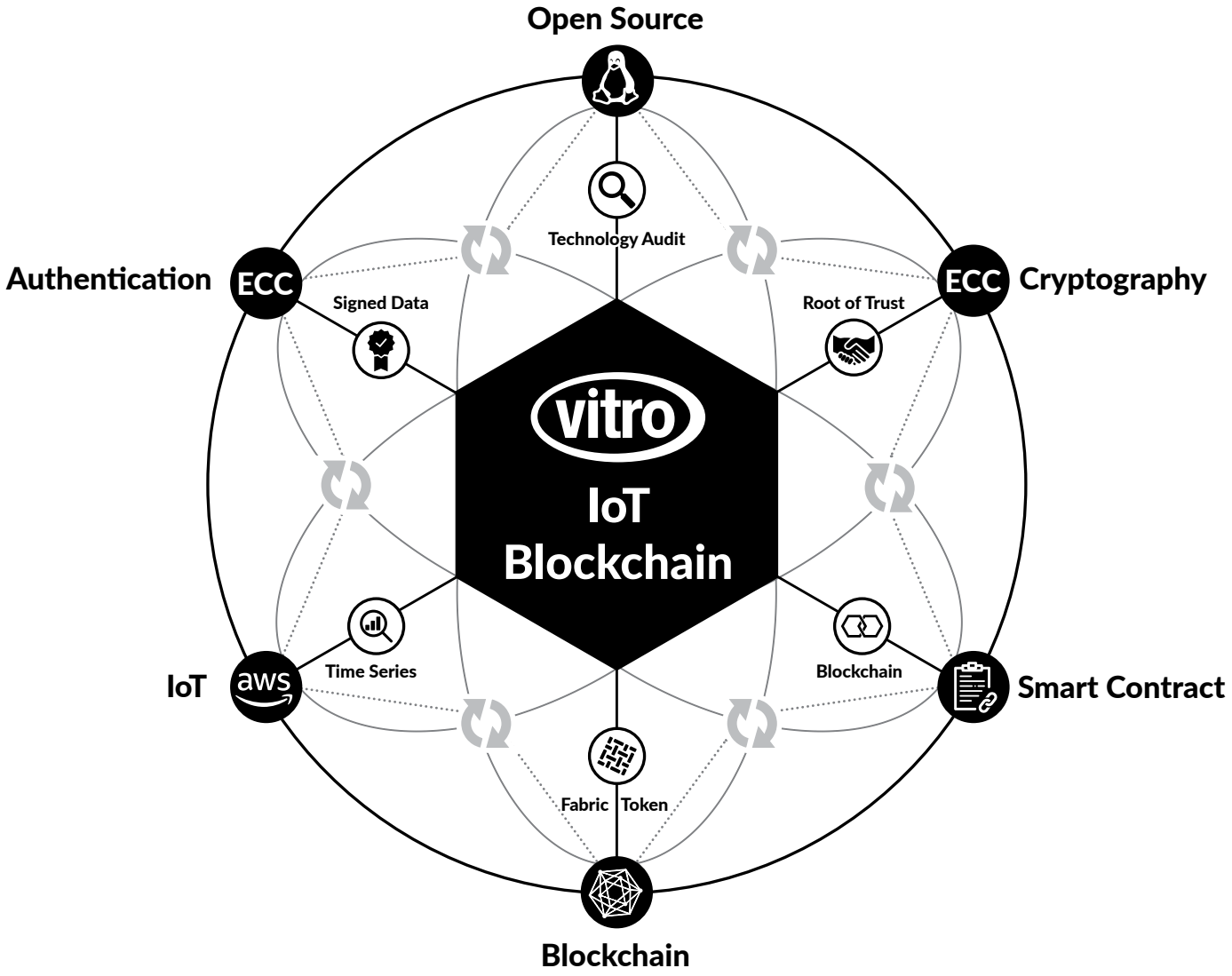


Figure 2. *Vitro IoT Blockchain*

Open-Source

Vitro is one of the only IoT platforms based on Open-Source, delivering transparency and auditability for software while incorporating the latest updates from the Linux community, NIST, and other open-source stakeholders.

ECC Cryptography

The Vitro Crystal Gateway features hardware-based, ultra-secure key storage to ensure that the firmware it runs, the accessories it supports, and the networks with which it connects are not cloned, counterfeited, or tampered with. Vitro security is based on Elliptic Curve Cryptography (ECC), and employs keys generated by each Vitro Crystal remotely in secure, hardware-based key storage. Our IoT platform incorporates hardware-based certificate storage and automated Root of Trust (RoT) provisioning via Digicert.

ECC Authentication

Authenticated datasets are the crucial payload of IoT. Vitro Proof-of-Origin involves authenticating local datasets via local ECC hashes and signatures. Leveraging ECC keys across the multiple applications of Root-of-Trust and Proof-of-Origin is a patent-pending process. This approach ensures trust in data transit and data authentication while being perfectly suited to remote IoT devices.

Amazon Web Services IOT

AWS IoT is an IoT device-management platform specifically designed to manage remote IoT devices with low bandwidth and inconsistent connections. ***AWS IoT can be leveraged as a pure store-forward service for IoT Blocks, ensuring the confidentiality of data transiting the AWS IoT framework.***

Blockchain

Vitro IoT Blocks can be wrapped into a wide variety of public or private blockchain applications. We serve our example of best practices incorporating Hyperledger and Fabric Tokens.

Smart Contracts

Smart contracts leverage Etherium logic and span projects from public Etherium on-chain executions to private Hyperledger applications implemented with innovative techniques like sharding for increased transaction processing speed.

Both Hyperledger with Sharding and smart contract execution as a best-practice guideline are detailed in the Vitro Hyperledger Yellow Paper, a companion document to this White Paper.

WHY BLOCKCHAIN?

Blockchain is a decentralized data ledger that serves as a means of storage and distribution of digital information while managing relevant transaction flows in a secure, transparent way. Vitro is targeting Hyperledger as a best practice in Blockchain. Combined with ECC cryptography, IoT Block data delivered to and stored in blockchain is secured from end to end.

The true value of blockchain is in making business processes faster, safer, simpler, and more secure. Vitro will utilize blockchain technology to:

1. ensure process transparency: all IoT Block data can be easily verified, tracked and managed through controlled access;
2. enable IoT applications to strongly contribute operational and transactional data to the blockchain;
3. allow smooth, efficient application of AI and ML on IoT Block data;
4. provide an immutable and irreversible system of data storage;
5. ensure a high level of security for IoT Block data protection with cryptographic hashing and encryption;
6. radically decrease paperwork and operational expenses;
7. ensure fast, secure transaction processing.

SMART CONTRACTS

A smart contract is a set of codes running on blockchain that controls transactions between parties and ensures that all contract conditions governing transactions are met.

Within the context of IoT, a critical challenge is the management of recurring transaction verification and processing. Each IoT site incurs recurring monthly processing fees that carry costs for everything from hosting to connectivity to billing. In addition, each IoT site has local service level performances that must be monitored and recorded for billings. The clerical burden of these micro-transactions has limited widespread adoption of IoT despite its obvious benefits. Smart-contract execution of automated recurring service billings and payments is based on authenticated IoT Block data that verifies that services were received and delivered. Blockchain preserves an immutable record of operating data, service data, and smart-contract logic and execution. This blockchain structure is suitable for audits and financial controls in virtually any application.

Smart contracts can also serve as a transaction engine to deliver securitized equipment purchases to a wide variety of vertical industries. XPA service agreements ('X' represents virtually any type of capital equipment) convert the purchase of equipment into the purchase of services yielded by the equipment. A common example is

the PPA, or Power Purchase Agreement. This model has permitted the solar power industry to flourish by pairing power consumers with equipment producers. PPAs are securitized agreements for power produced by solar equipment. Smart contracts play the role of pairing the verification of power produced with the matched price per kilowatt hour. Demand for this type of securitized agreement spans many industries, from civic water plants to telecom cell towers. Building a securitized blockchain structure on the crypto-secure Vitro IoT platform will open this purchasing model to multiple vertical markets, expanding demand for equipment manufacturers, operating companies, and customers.

A WIN FOR EVERYONE: VITRO STAKEHOLDERS

Vitro IoT technology serves a diverse group of stakeholders, each with specific interests and ownership over the authenticated IoT dataset payload stored on the blockchain.

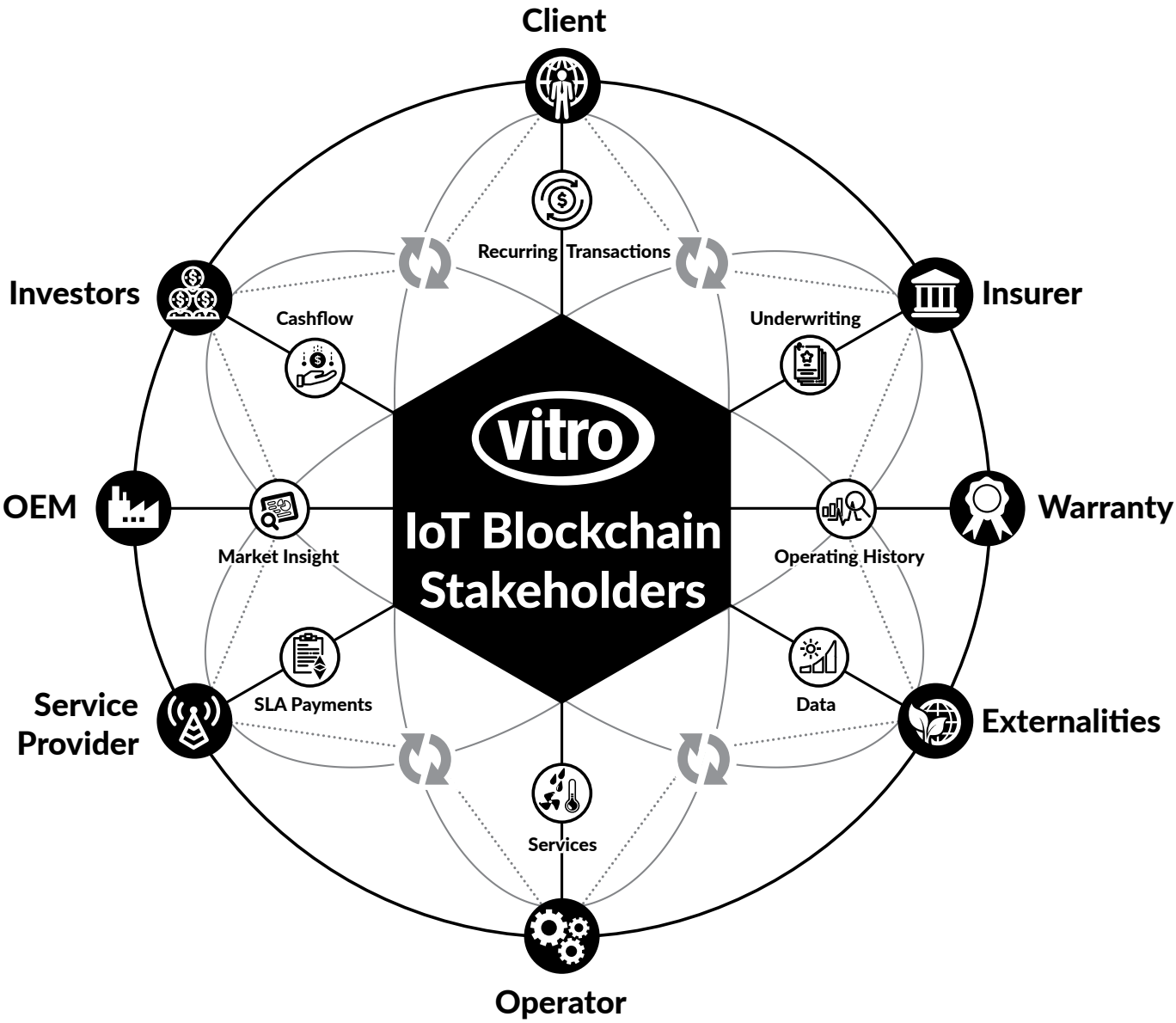


Figure 3. *Vitro IoT Blockchain Stakeholders*

Client

Equipment ownership is one of the key gating factors in the modernization and development of infrastructure in the developing and post-modern world. Currently, no entities are designed to purchase and own equipment, but rather to generate and deliver the services created by the equipment. Securitizing these assets passes ownership into the public investment sphere, where risk and pricing can be established by the market. Vitro IoT enables this transfer through authenticated IoT Block data, gathered directly from operating assets. This trusted IoT Block data can then be relied upon for automated transaction processing via smart contract, delivering clear, immutable data to investors, governments, NGOs, and consumers.

Operators

Equipment operation brings another lens onto the IoT Block dataset collected at equipment sites. Operators are concerned with both efficiency and maintenance to maximize the output of capital equipment over the long term. AI and machine-learning techniques are designed to maximize uptime, minimize unplanned failures, and build key performance indicators (KPIs), which are used to determine when equipment has reached the end of its useful life.

Investors

Equipment securitization transforms the financing of capital goods into a verifiable stream of payments for services rendered by the equipment. Investors demand trust and visibility into the services rendered, and payment for these services in order to price the income stream generated. Disintermediating the institutional layer will bring higher efficiency to the market by increasing returns to actual investors while reducing costs to the consumers of the services being purchased. Using the trusted automation of smart contracts, smaller projects will have wider access to capital for the investment, and investors will yield greater social and financial returns, leading to a better world for all.

Insurer

Insurance underwriters, similar to operators, rely upon baseline IoT Block operating data to price risk. The availability of immutable IoT Block operating data will create greater efficiency and accuracy in the pricing of risk. In addition, a larger pool of operating equipment will permit the distribution of risk across a larger number of installations. Transparency leads to improved accuracy in pricing risk, which, in turn, leads to higher efficiency through competition in the market.

Warranties

Warranties are largely based upon generic estimates of equipment life. Standard industry contracts built according to the calendar year or operating-hour metrics are little more than guesses based on theoretical tolerances. Verification of installations, operating uptime, service events, and the like create burdensome paperwork for owners, operators, insurers, and warranty holders. Building warranty models based on actual operating records transfers the transactional burden to the blockchain and smart contracts, where efficiency can be maximized. In addition, trusted records lead to more accurate warranty pricing.

OEM

Equipment manufacturers are generally starved of field operating data for their own products. Paid access to this data creates revenue potential for investors and/or operators while building intelligence for the manufacturer of the actual equipment in the field. Manufacturers, armed with this new insight, will be able to better analyze root causes for failures, refine service cycles, improve designs, reduce marketing expenses, and maintain operating relationships with live customers. Following and developing KPIs in conjunction with operators, manufacturers will also have the market intelligence to determine when specific equipment replacement will create efficiencies that will offset new equipment purchase costs.

Service providers

Telecoms and utilities play an integral role in the monitoring and operation of capital equipment in the field. These industries are migrating toward service-level agreements (SLA), in which both the operator and the service provider need to agree and rely upon SLA records. Generally, these records are far from perfect, leading to disagreements. Costs for arbitration and eventual settlements add inefficiencies that can be avoided through the use of authenticated operating data, driving the simple execution of billing based on agreed-upon SLAs.

Externalities

Both government and non-governmental agencies have a vested interest in the control of externalities based upon the operation of equipment. One example is solar water pumps. The operation of solar water pumps exerts a positive impact on crop yields, but it has also led to irresponsible water consumption. Given that solar power is free, solar pumps are often left to operate while the sun shines. IoT data from solar wells can monitor and control the amount of water delivered, and tie that

production to targets. As a result, crop yields tied to water production create a KPI that can be refined over time to maximize yield while minimizing the impact to limited groundwater. In all instances, authenticated data and crypto-secure equipment encircle a wide range of applications to build decision-making based on facts.

CASE STUDY: THE CIVIC WATER VERTICAL

Vitro Civic Water IoT was selected as our first vertical market through dedicated pursuit of the World Bank as a development partner.

In order to solve the water security challenge, Vitro has established partnerships with:

- NGOs: The World Bank and the Asian Development Bank
- The U.S. iPAWS notification system, which enables government agencies to commandeer digital signage like billboards and airport signage in the event of an emergency
- Equipment manufacturers (OEM)

The Water Security Challenge

Another relevant challenge concerns water security for many countries that are coping with complex water issues cutting across sectors. Over 660 million people in developing countries have considerable access restrictions to clean drinking water. In total, more than 800,000 deaths are caused per year by poor water, disease, and sanitation problems[3]. We believe that modern IoT solutions are capable of fighting this huge problem. Water is considered to be the most valuable asset in the world according to WHO predictions: by 2025, at least half of the world's population will be living in water-stressed areas[4].

Currently, approximately 2 billion people globally lack safe drinking water access.

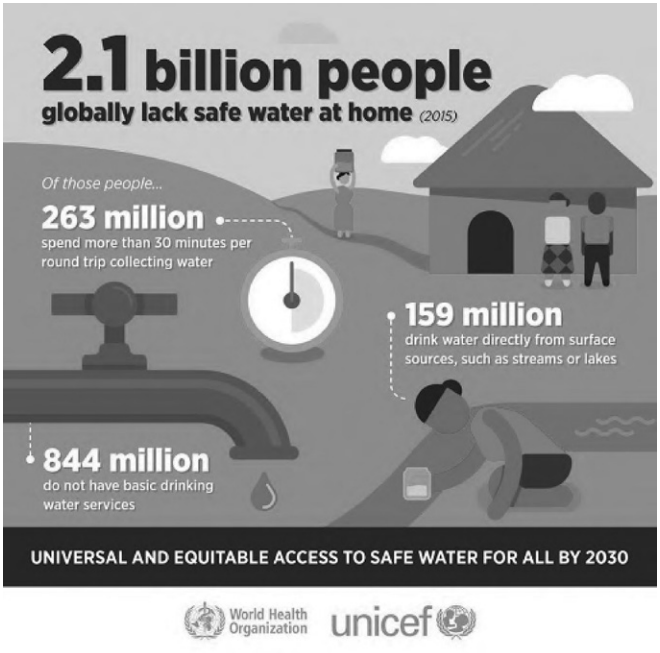


Figure 4. *Access to safe water*

IoT is the perfect solution for fighting water sanitation issues and shortages. IoT implementation in developing countries relies on purchases, management, and control over the infrastructures serving rapidly-expanding populations.

Clean water, as one example, is the product of layers of physical equipment. Changing the model from a capital purchase to a recurring service model in the production and quality of drinking water would be a dramatic disruption.

The Vitro team addresses water sanitation issues, and plans to connect IoT devices by delivering crypto-secure device control and authenticated data payloads from Edge to Cloud.

[3] *https://ueaeprints.uea.ac.uk/51904/*

[4] *http://www.who.int/mediacentre/factsheets/fs391/en/*

Water is the new oil, and our world needs more information about its use and its preservation.

It is our good fortune that Irfan Mian, our GM MEA, is living in Islamabad, Pakistan, the largest World Bank water client. This gives us excellent visibility into active projects and the agency personnel controlling them. This local insight led us to capture the key elements of civic water installations (see image below).

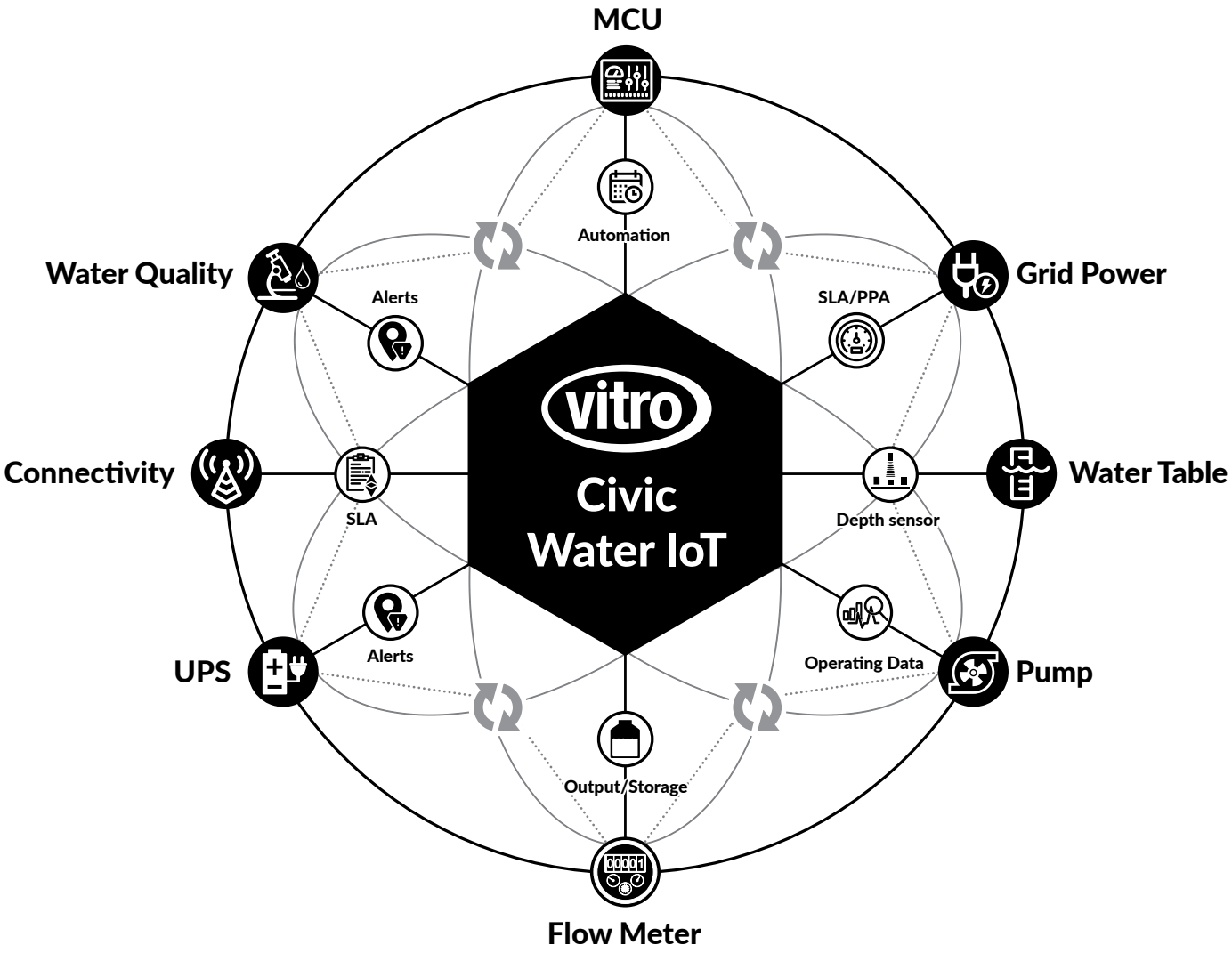


Figure 5. *Civic Water IoT*

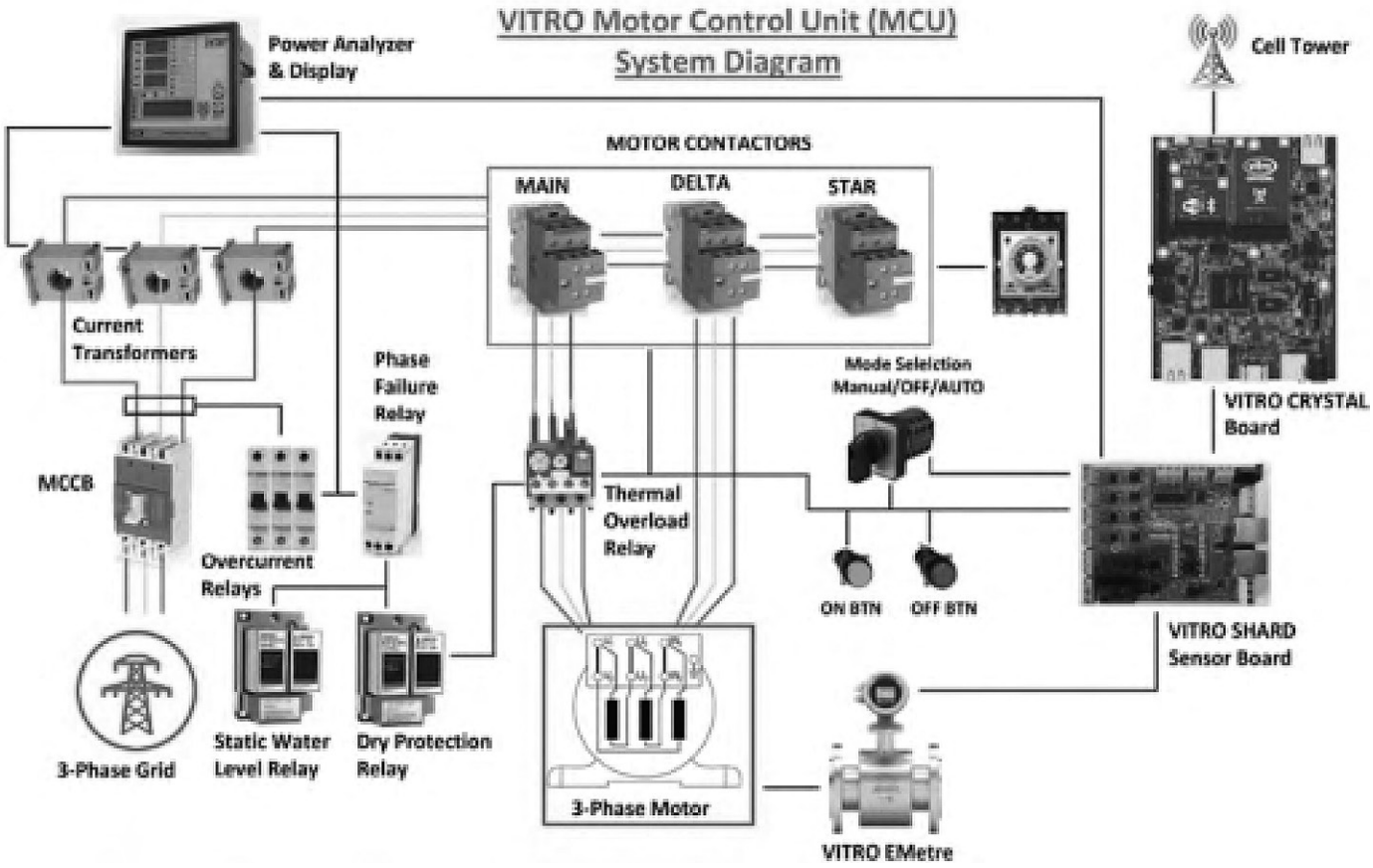


Figure 5. *Vitro MCU diagram*

Motor Control Unit

Within the civic water IOT, the Motor Control Unit (MCU) delivers local and remote control over the pumping equipment. The MCU houses the Vitro Crystal and Shard boards that control the equipment and sensors. It provides authenticated data to Vitro water IOT.

Grid Power

Grid Power is included in the MCU as a power analyzer. This analyzer feeds data for the total amount of energy consumed and the current state of grid power. Vitro has developed a Shard UPS for battery backup and reporting for states of emergency. In addition, Vitro is developing an over-voltage breaker designed to protect the installation in the event of a sustained power surge and to report this event via IoT.

Shard UPS

Vitro Developed Shard UPS in order to maintain a connection with equipment during power outages and load-shedding, and to report critical failures. The UPS protects the Vitro Crystal Gateway, switching from grid to battery power seamlessly while reporting power events over IoT.

Water Quality

Water quality is provided with the use of the water table, the measurements of which are critical in the operation of water pumps. Water pumps, flow meters, and water KPIs (key performance indicators) allow for enhanced IOT connections and clearly demonstrate the value of IoT: actionable business data gathered from separate but related systems delivering a service.

Water Table

Water table measurements are critical to the operation of water pumps, as the static water level drops in the tube well when the pump is engaged. Vitro IoT provides operators and NGOs with the critical dataset needed to regulate production and ensure that technology refrains from doing more harm than good.

Water Pump

Vitro has partnered with KSB Pumps AG of Germany in Pakistan. Working together, Vitro is building an operating history across regions, well depths, and diverse conditions. This operating data is hugely valuable to KSB and the operator. And it is a potential source of revenue for the World Bank and other customers installing this equipment, as we will see in the Blockchain section.

Flow Meter (Vitro EMeter)

In Pakistan, water can contain fine silt as a result of glacial runoff. This silt affects motors after certain periods of time. The silt actually reduces the pumps' efficiency gradually. False readings cannot be verified, and false data leads to poor assumptions and predictions. Vitro worked in China with an OEM to adapt an electromagnetic flow meter with no moving parts and a silicone-lined tube surface. Vitro integrated Shard data reporting into the equipment, delivering our EMeter and accurate readings rated for 10 year of operation with the dirtiest water or sludge.

Connectivity

Vitro has partnered with Zong, a division of China Mobile, for IoT connectivity in Pakistan. Zong is the largest GSM operator in Pakistan, and China Mobile, along with other network operators across the world, is also interested in NB-IoT, an extension of GSM. This narrow-band (NB) signal is low-cost and low-speed: perfect for IoT.

CONCLUSION

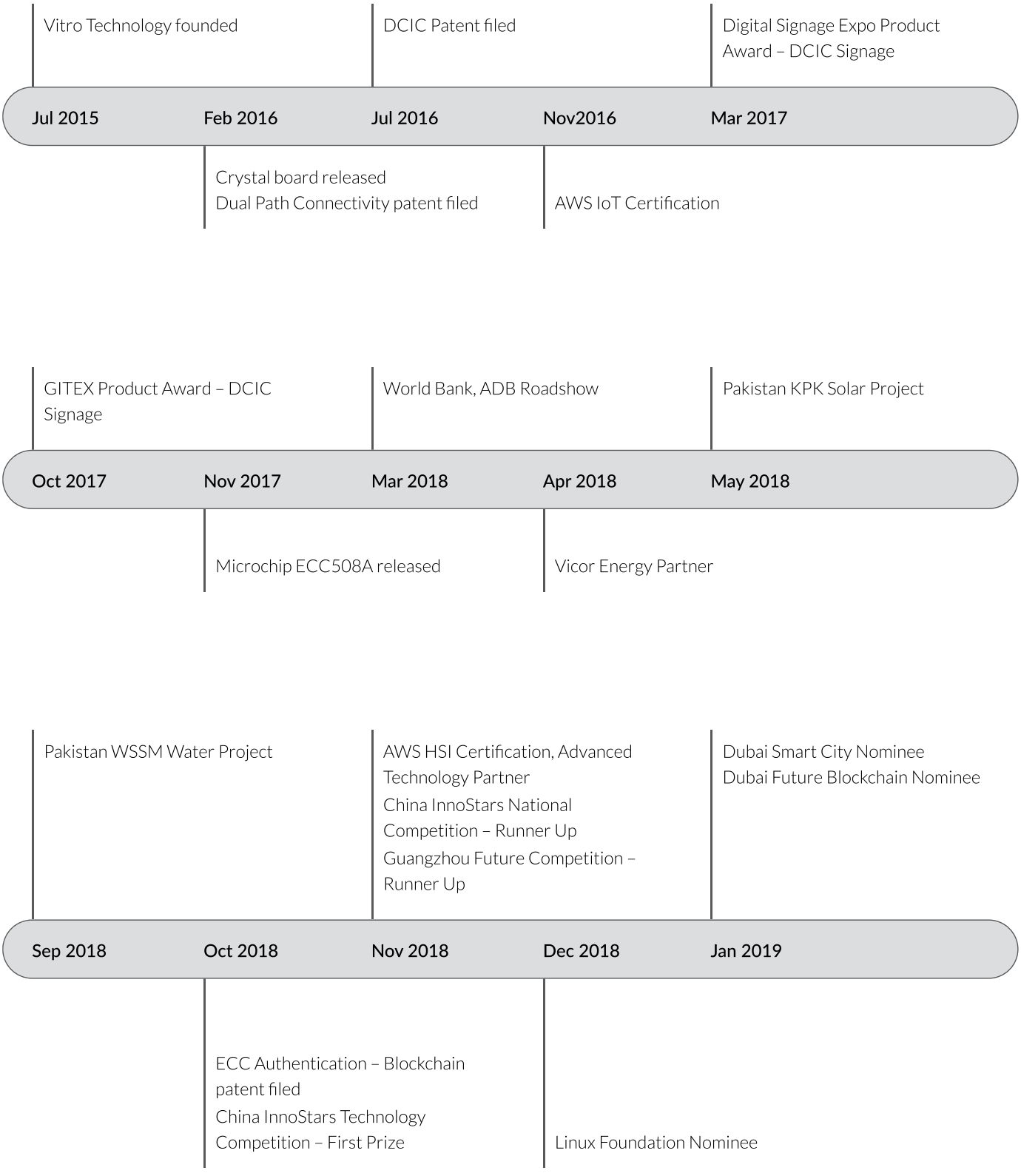
Vitro IoT blockchain ecosystem is uniquely established to function as a decentralized, crypto-secure platform for the administration and management of remote civic and industrial equipment based on authenticated IoT Block datasets.

Addressing the coordination of open source, ECC cryptography, Proof-of-Origin authentication, AWS IOT, and blockchain technologies, Vitro delivers the mission-critical IoT Block datasets to the appropriate stakeholders through blockchain, secure time-series datasets and controlled access.

Detailed technical description of the Vitro Hyperledger platform functionality and workflow can be found in Vitro Blockchain Best-Practices Yellow Paper.

ROADMAP

VITRO HISTORY



DEVELOPMENT STEPS

1Q 2019

• Establishment of partnership network

2Q 2019

• PoC Development:

  – *Basic functionality identification and testing assumptions*
  – *AWS environment set-up*
  – *Chaincode development*
  – *Finalization of PoC development*

• MVP Development:

  – *Basic functionality development*
  – *Minimal viable product (MVP) with beta user testing*
  – *MVP: introduce to users*
  – *Clients provide users for beta testing*
  – *Resolve all known bugs and update tool.*
  – *Partner with design and compliance team members to highlight/expand elements that are key benefits of the tech for investors and possible clients*
  – *Visualizations / improvements to the process outputs*

3Q 2019

• Finalization of the platform
• Onboarding of corporate partners
• Initiation of first deals in the blockchain-based environment

4Q 2019

• TBD

OUR TEAM

David Goodman (CEO)

Founded Vitro Technology in July 2015

Mr. Goodman and his family live in Austin, Texas. Mr. Goodman brings his unique insight for both hardware and SaaS platforms to Vitro Technology. Previously, Mr. Goodman developed hardware-SaaS companies which were successfully sold to leaders in their respective fields. Key Ingredient, founded in 2005, developed a recipe-sharing social media platform that grew into the largest recipe database outside of Japan.

This SaaS was then leveraged to the market for the first kitchen-safe touchscreen recipe reader on the market in 2008. The Demy (Key Ingredient Recipe Reader) was successfully sold on Amazon and QVC as well as Sam's Club. Over 25,000 units were sold before the company began strategic financing with Groupe SEB (CAC: SK. PA) in 2011. The company was acquired by Groupe SEB in 2014. Mr. Goodman also founded the e-Vend Corporation (Stitch Networks) in 1996. e-Vend built an SaaS on a Sun-Oracle NOC, targeting the vending machine market. The company offered hardware, software, and services to process credit card transactions wirelessly at vending machines. e-Vend built partnerships with Aeris (connectivity provider to Blackberry) and Maytag (the largest vending machine manufacturer at the time), and delivered a wireless card reader and processing hardware in 1998. The company was funded by $13 million from Safeguard Scientifics and Maytag in 1998. The system was used for RFID payments from athletes and corporate guests at the 2000 Winter Olympics, and gained mass adoption across Coke and Pepsi vending operators nationally. The company was sold in 2002 to USA Technologies (NASDAQ: USTT), currently the market leader in non-cash vending payment systems and services.

Piotr Król (CTO)

Joined Vitro Technology in August 2016

Mr. Król and his family live in Gdańsk, Poland. Mr. Król has extensive embedded systems training and previously worked at Intel in Poland, developing BIOS for various processors. An active member of the open-source community, Mr. Król is also uniquely qualified to lead the AWS team with his extensive experience with 2lemetry, a company acquired by Amazon in 2015 to form the foundation of AWS IoT. Vitro Technology hardware was developed under Mr. Król's direction, and operates on a custom Linux kernel that is very close to mainline distribution. The SaaS is based on AWS IoT for device connectivity; and AWS and Odoo for CMS and CRM. Mr. Król leads of team of 8 engineers based in Gdańsk. The engineering team includes embedded Linux/Qt, AWS, and DevOps, with most members of the team crossed-trained to understand the full stack.

Irfan Mian (GM MEA)

Joined Vitro Technology in January 2016

Mr. Mian and his family live in Islamabad, Pakistan. Mr. Mian has extensive experience in sales, sourcing, and quality control. Prior to Vitro Technology, Mr. Mian worked for 7 years for Sony Ericsson as a member of the sales, sourcing, and quality-control teams based in Beijing, China. Mr. Mian later worked for 5 years for a division of Koç Holding, a conglomerate based in Istanbul, Turkey. Mr. Mian and Mr. Goodman worked together while collaborating with Koç Holding in Shenzhen, China. Together, they managed contract manufacturers for plastic injection, PCBA assembly, and regulatory approvals in the development and shipment of the Key Ingredient Recipe Reader. Mr. Mian is fluent in 6 languages, including Chinese.

Wendy Wong (GM Asia)

Joined Vitro Technology in February 2017

Ms. Wong and her family live in Wuhan, China. Ms. Wong has extensive experience in engineering, manufacturing, and sourcing.

Ms. Wong worked for 5 years with Delta Power, one of the largest power supply manufacturers in China targeting industrial and commercial customers. Ms. Wong later worked for 7 years at SMT, a large PCBA contract manufacturer, and collaborated with Mr. Goodman and Mr. Mian as the product manager in the successful launch of the Key Ingredient Recipe Reader. Recently, Ms. Wong worked with CSOT, based in Wuhan, one of the largest LCD manufacturers in China. While at CSOT, Ms. Wong was responsible for both open-cell and OEM LCD sourcing, quality, and manufacture.

Sohail Akram (Hardware Architect)

Joined Vitro Technology in June 2016

Mr. Akram and his family live in Melbourne, Australia. Mr. Akram previously led the hardware development team at Streaming Networks in Pakistan. Mr. Akram developed several of the iRecord products for security video and audio feeds, including iRecord Mobile, iRecord LPR, and iRecord Pro 2. Mr. Akram has extensive experience in the development of ARM embedded hardware systems and media streaming platforms. His expertise includes complete layout, bring-up, testing, and design for manufacture and hardware optimization.

Mike Woster

COO / CRO, The Linux Foundation

As a founding executive team member of the Linux Foundation, Mike has worked for over 10 years as a leading executive at the Foundation and in the Linux community. He developed and executed the long-range vision for the Foundation while building multiple profitable product lines and organically growing the organization from $5 million to $135 million.

Ihor Pidruchny

CEO, Applicature

Ihor Pidruchny is co-founder and CEO at Applicature. In addition to managing the company, Ihor coaches blockchain companies and helps strategize tokenization across various industries. An experienced technology manager and advisor in the blockchain arena, Ihor has been involved in many blockchain projects, Token Sales, and technical development projects.

Andrew Zubko

CTO, Applicature

Andrew is a Blockchain Architect with impressive experience. Having successfully completed his first Blockchain project in 2014, he participated in technical support for token sales and the cryptocurrency ecosystem before it became mainstream. His technology stack includes, but is not limited to, C++, Java, JavaScript, Python, Solidity, and more.

Ihor Bauman

Business Analyst, Distributed Technologies Expert

While working at PricewaterhouseCoopers as a Business Analyst of Advisory Services, Ihor gained deep experience in a wide range of industries (IT, agriculture, development, logistics, retail, and public sector) across the CEE region. From the beginning of his career at Applicature, Ihor has been responsible for strategic and operational advisory services, digital transformation of businesses, smart-contract business logic set-up, and the overall blockchain injection process into existing businesses.

Olga Hryniuk

Business Analyst, Blockchain Consultant

Olga has been with the Applicature blockchain agency for several years, working with blockchain technical solutions and assisting startups and companies interested in blockchain implementation. Olga is responsible for helping the company decide which strategy is the best match in terms of strategic development. This includes the recognition of product necessity within the market, finding the best blockchain platform to satisfy platform and user needs, and development of technological onboarding strategy along with implementation of smart-contract and token-economy logics.

PARTNERS

Amazon Web Services

Vitro is an Advanced Technology Partner with HSI (High-Security Interface) status. Vitro is a pioneer in AWS IoT, and has implemented one of the most comprehensive solutions on the market, which includes Just-in-Time-Registration (JiTR), ECC Security, and IoT best practices.

DigiCert

DigiCert is the world's leading security certificate vendor. Vitro is the only ECC hardware manufacturer capable of allocating and authenticating ECC keys on the fly via Digicert API.

Microchip

Microchip is the world's leading ECC security hardware vendor. Vitro is the only hardware manufacturer capable of allocating and authenticating ECC keys with Microchip ECC508A hardware.

Vicor

Digicert is the world's leading supplier of smart, low-voltage power supplies for server and LED applications. Vitro is a strategic partner, and has developed LED power supplies with embedded IoT. This platform has delivered real-time power signatures that clearly demonstrate the benefits and efficiencies of DC-DC power. Vitro and Vicor are drafting an industry white paper in order to publish this finding.

ZONG

CMPak Limited d/b/a Zong is a pan-Pakistan mobile network operator headquartered in Islamabad, offering voice, data, and IoT services. ZONG is Pakistan's second largest GSM mobile service provider and third largest mobile service in terms of its subscriber base: 31 million. It has a market share of 21% among cellular operators in the country.

Applicature

Applicature is a blockchain development agency that works on projects in the blockchain industry involving the development of smart contacts and the research, deployment, and customization of blockchain solutions. Applicature serves as a technical advisory to blockchain companies and as a technical consultancy for token offerings.

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