



# VMware Blockchain for Capital Markets

Launching new ecosystem networks

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## VMware Blockchain

- An enterprise-grade blockchain platform built by a trusted partner
- Trusted by ASX and Broadridge Financial to power new ecosystem networks<sup>1,2,3</sup>
- Transaction volume far exceeds the \$2 trillion cryptocurrency market (early 2022)<sup>4</sup>
- Support for multiple smart contracts with Digital Asset Daml integration and Ethereum Solidity (in technical preview – Q1 2022)

The number of financial institutions exploring enterprise blockchain networks to address multiple market forces is growing. Based on VMware customers and supported by The Value Exchange's 2021 research on 150 financial institutions, the adoption of blockchain-based distributed ledger technologies (DLT) is already underway. According to a recent survey by BNY Mellon of 200 financial institutions, 84 percent said they will roll out blockchain DLT in the next 3 years. This third-party research shows that between 2020 and 2021:

- The number of financial institutions exploring blockchain DLT has grown by 300 percent.
- The importance of blockchain DLT to capital market firms has grown by 10 percent, especially in Asia-Pacific.
- Banks' resourcing on blockchain DLT projects grew by 37 percent.<sup>5</sup>

## Forces reshaping capital markets

Within capital markets, blockchain presents opportunities for exchanges, index providers, and both buy-side and sell-side firms. For financial service providers, blockchain facilitates new product launches that offer significant efficiencies through cost, risk and time savings.

The industry is leveraging these opportunities in different ways. After several years of experimentation and blockchain pilots, the evolution can be broken down into three key phases: establishing the ecosystem, new product opportunities, and market efficiencies. According to The Value Exchange's 2021 research, the majority of capital market players see these three phases as sequential, with market efficiencies unlikely to be the center of focus until 2024–26.

### Phase 1: Establishing the ecosystem

The capital markets space is made up of ecosystems centered around specific asset classes, such as bonds or futures, or around specific activities, such as issuance, corporate actions, or compliance monitoring. As a network proposition, blockchain's scale is therefore heavily reliant on operators being able to leverage or assemble viable ecosystems for their solutions. In this context, the minimum viable ecosystem (MVE) has become the primary consideration for blockchain developments within capital markets and the "make or break" factor in many experiments and proofs of concept.

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1. ZDNet. "ASX brings in VMware for blockchain-based CHES replacement project." Asha Barbaschow, August 25, 2019.
  2. Broadridge Financial Solutions, Inc. "Broadridge Launches DLT Repo Platform to Execute First Bilateral Repo Trades Using Smart Contracts." June 14, 2021.
  3. CoinDesk. "Broadridge Blockchain Repo Platform Is Averaging \$31B a Day." Jamie Crawley, June 15, 2021.
  4. As of March 2022, the global cryptocurrency overall market value stood at specifically \$2.04 trillion, according to CoinGecko.
  5. The Bank of New York Mellon Corporation. "Asset Management: Transformation Is Already Here." Roman Regelman, 2022.

“Co-innovating with market participants, we are able to bring solutions to our network of clients that create the next level of operational efficiencies. Within the repo market, distributed ledger technology and smart contracts have shown that they can play an instrumental role in driving efficiencies, reducing risk, and enhancing liquidity while leveraging the existing legal and account frameworks.”

Vijay Mayadas  
President of Capital Markets  
Broadridge Financial

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These ecosystems are being leveraged and developed in several ways.

**Existing ecosystem operators** – Exchanges, clearing houses, depositories, custodians and central banks have been the hub of financial ecosystems for decades. Therefore, these groups have been among the first adopters of blockchain solutions, looking to leverage their existing connectivity to deliver new products or greater efficiency. It is expected that these operators will continue to make up the vast majority of blockchain operators in the coming years.

**Ecosystem conversions** – In niche areas, technology firms (and some brokers and custodians) have built up de facto ecosystems that might not be market-wide but are nevertheless viable at scale, such as Calastone and Equilend. Similarly, a growing number of collaborative ventures (such as HQLAx, Fnality and Axoni, each owned by 5–12 banking shareholders) have emerged in recent years with the aim of bringing together new networks from their ownership base. In a DLT context, these firms have been able to convert their implicit ecosystems into networked communities using blockchain. As new blockchain case studies continue to emerge, what constitutes an ecosystem and how it can be leveraged continues to evolve, so we can expect more conversions in the future.

**Ecosystem creators** – Although those without existing ecosystems have had difficulty converting blockchain pilots into large-scale platforms, new players do have an opportunity to build ecosystems in new markets and workflows, such as carbon credits or customer due diligence (CDD).

In the each of the above cases, it is important to differentiate between ecosystem operators and participants. Across regulated capital markets, operators are often subject to stringent regulatory requirements in providing their services (such as capital requirements and resilience standards), whereas participants can simply transact. As a distributed system, a blockchain network is subject to strict regulatory standards, creating significant entry barriers for new operators and reinforcing the roles of existing ecosystem operators who have compliant ecosystems to build on.

## Phase 2: New product opportunities

For those that have assembled a viable ecosystem, the leading driver of blockchain deployment is to increase revenues by selling new products to new or existing clients.

While proofs of concept for new and different capital market use cases continues, the majority of new product deployments center on an increasingly stable set of use cases as ecosystem operators seek to minimize their commercial risks and maximize revenues by leveraging existing precedent.

So far, most of these use cases have been based on the principle of applying a sophisticated network platform to highly networked (that is, multiple counterparties) but poorly automated ecosystems. From faxes and emails, ecosystem providers have looked to DLT to automate workflows, remove reconciliations and accelerate transactions, and hence facilitate greater market scale and liquidity. For this reason, bond issuance, structured products, and security finance and collateral management have become three of the leading areas of DLT deployments. Loan syndication and private equity will also fall into this category in 2022.

In 2021, ecosystem providers began leveraging blockchain technology to offer their customers and members a new generation of data-intensive securities. The market value of assets, such as green bonds and carbon credits, is entirely reliant on significant volumes of underlying data—from environmental, social, and governance (ESG) credentials to interest calculation methodology. As a result, these securities struggle to exist outside of a DLT environment. Given the significant macro-trends driving the growth of these securities, ecosystem operators are embracing blockchain to support these asset classes.

### Phase 3: Market transformation

The potential for blockchain to deliver significant market efficiencies is clear: facilitating instantaneous transactions, eliminating counterparty risk, removing the need for reconciliations, and reducing fraud. Yet the number of cases in which blockchain has been used to transform existing, liquid securities markets remains small. A lack of precedent primarily drives this. To date, no market operator has demonstrated that highly liquid, complex, dematerialized asset classes, like equities and listed derivatives, can be transitioned onto a blockchain in a highly regulated environment. Because no one has been able to evidence the P&L impact of DLT on specific ecosystems, organizations have de-prioritized the market efficiencies motive.

However, external forces and market changes are driving a shift in this space based on a few drivers.

**Regulatory environment** – Most importantly, increased settlement discipline (T+1 in the United States and India and CSDR in Europe) is driving a fundamental reevaluation of how people trade, clear and settle securities today, with DLT emerging as one of the few likely solutions.

**Compliance** – Increasingly stringent CDD and know-your-customer (KYC) requirements, including shareholder limit monitoring, are emerging as key drivers of institutional change, forcing all market participants to reevaluate their processes and technologies in the face of growing regulatory sanctions. The Value Exchange research in 2021 highlighted this area as the Number One target of investment for sell-side firms.

**Legacy technology and resilience** – The Value Exchange research found that 26 percent of sell-side systems are more than 20 years old, indicating that financial services players face an increasingly urgent transformation challenge, especially in light of growing regulatory pressures on resiliency (for example, the Digital Operational Resilience Act). In the next 3 to 5 years, ecosystem operators such as ASX, HKEX and others, must decommission the systems on which their markets are based, presenting an opportunity for fundamental market restructuring.

**Growing investor sophistication** – Having grown accustomed to transparency around their investments in a retail capacity, today's investment managers are starting to demand similar access in an institutional capacity. Financial services providers need to be able to seamlessly integrate data (for example, across ESG and other sets), provide full look-throughs to track underlying securities in a fund or derivative, and offer automated management of portfolios based on investor preferences.

## Blockchain DLT use cases

VMware documented the most popular use cases that capital market organizations inquire about, have plans to launch or are already live, the current challenges, and why blockchain DLT is suitable as a solution.

| Use Case            | Players  | Challenges  | Why Blockchain DLT?   |
|---------------------|--|---|---|
| Bond Issuance       | <p>Market operators:</p> <ul style="list-style-type: none"> <li>• Issuance and Trading: None, open white space</li> <li>• Custody: International central securities depositories (iCSD) and CSDs</li> </ul> <p>Market participants:</p> <ul style="list-style-type: none"> <li>• Investors</li> <li>• Banks</li> <li>• Brokers</li> <li>• Corporate Trustees</li> <li>• Law firms</li> <li>• CSDs and iCSDs</li> <li>• Custodians</li> <li>• Investment banks</li> </ul> | <ul style="list-style-type: none"> <li>• Over 2,000 manual tasks and approvals in bond issuance</li> <li>• Slow and expensive issuance process that is heavily reliant on paper agreements</li> <li>• Heavy burden of reconciliations between accounts</li> <li>• Registry issues (omnibus accounts distort a clear view of ownership)</li> <li>• CDD and KYC issues: Manual tracking of client eligibility for investment thresholds and so on</li> <li>• Extensive use of bonds for collateral: Accelerated (T+0 and T+1) settlements and earmarking</li> </ul> | <ul style="list-style-type: none"> <li>• Instantaneous agreements and document execution for issuance</li> <li>• Automated ISIN issuance for government debt issuers and greater visibility on holders</li> <li>• Atomic settlement and earmarking using smart contracts to simplify bond settlements</li> <li>• Potential scale into ESG data</li> <li>• Balance sheet benefits of accelerated and more reliable settlements</li> <li>• Scale into complex bonds (for example, sukuk)</li> </ul> |
| Fund Distribution   | <p>Market operators:</p> <ul style="list-style-type: none"> <li>• Technology companies (for example, FundSettle, Vestima, and Allfunds)</li> </ul> <p>Market participants:</p> <ul style="list-style-type: none"> <li>• Investors</li> <li>• Wealth managers</li> <li>• Fund managers</li> <li>• Custodian banks</li> </ul>  |   |   |
| Structured Products | <p>Market operators:</p> <ul style="list-style-type: none"> <li>• iCSDs for structured products (limited usage)</li> <li>• Local CSDs for structured products in some markets (for example, Hong Kong, Germany, United Kingdom)</li> </ul> <p>Market participants:</p> <ul style="list-style-type: none"> <li>• Corporates (for securities products)</li> <li>• Investment banks (arrangers and issuers)</li> <li>• Wealth managers (distributors)</li> </ul>            |   |   |

| Use Case                                   | Players   | Challenges   | Why Blockchain DLT?  |
|--|---|--|--|
| <p>Securities Financing and Collateral</p> | <p>Market operators:</p> <ul style="list-style-type: none"> <li>• Clearinghouses (for in-scope derivatives only)</li> </ul> <p>Market participants:</p> <ul style="list-style-type: none"> <li>• Central banks</li> <li>• Pension funds</li> <li>• Insurers</li> <li>• Investment banks</li> <li>• Wholesale banks</li> <li>• Broker dealers</li> <li>• Custodian banks and tri-party collateral managers</li> </ul>      | <ul style="list-style-type: none"> <li>• Highly bespoke products, making data management and trade matching highly complex</li> <li>• Manual exchange of key trade data, trade entry and settlement (including underlying rates)</li> <li>• No single data standard market-wide, so significant manual trade-matching resources</li> <li>• Decentralized data means heavy pre- and post-trade data reconciliations</li> <li>• No DVP</li> <li>• Data-timing issues make margining more complicated and slower</li> </ul> | <ul style="list-style-type: none"> <li>• Real-time data visibility and synchrony</li> <li>• Standardization of contracts</li> <li>• Automation of contract settlements and removal of matching effort</li> <li>• Smart contracts to manage clearing</li> <li>• Improved margining and collateral efficiency</li> <li>• DVP and real-time trades</li> <li>• Potential for accelerated clearing on T+0 or T+1</li> </ul>   |
| <p>Carbon Credits</p>                      | <p>Market operators:</p> <ul style="list-style-type: none"> <li>• Issuance and trading: None, open white space</li> <li>• Custody: iCSDs and CSDs</li> </ul> <p>Market participants:</p> <ul style="list-style-type: none"> <li>• Investors</li> <li>• Banks</li> <li>• Brokers</li> <li>• Corporate trustees</li> <li>• Law firms</li> <li>• CSDs and iCSDs</li> <li>• Custodians</li> <li>• Investment banks</li> </ul> | <ul style="list-style-type: none"> <li>• Long, manual product issuance process</li> <li>• Heavily intermediated market by wealth managers, meaning complex order routing and KYC</li> <li>• Limited transparency around asset structure, making risk management and valuations very difficult</li> <li>• Bespoke structure makes secondary-market trading highly complex</li> <li>• Manual management of corporate actions and reconciliations on underlying assets</li> </ul>   | <ul style="list-style-type: none"> <li>• Faster creation of products</li> <li>• Improved transparency underlying assets</li> <li>• Improved valuations and price discovery</li> <li>• DVP for transactions direct between issuer and investor (no intermediaries)</li> <li>• Improved secondary-market liquidity</li> <li>• Automated management of corporate actions for underlyings</li> <li>• Ability to securitize anything, such as loyalty points</li> </ul> |

## Why VMware Blockchain

VMware has the trust of financial institutions around the world due to its proven technology innovation, mission-critical support, and neutral position in the market over the past 24 years of doing business. VMware Blockchain is an enterprise-grade blockchain platform that organizations trust to run large ecosystem networks powering business-critical, distributed multiparty applications.

### Trust and security

VMware has partnered closely with financial services companies, including ASX and Broadridge, to launch blockchain networks that drive net-new growth opportunities, standards and industry-wide efficiencies. These new ecosystems, powered by VMware Blockchain, are transacting greater volumes than the entire crypto market combined, demonstrating their scalability.

The VMware Blockchain Scalable Byzantine Fault Tolerance (SBFT) algorithm is optimized for decentralization and can handle more than 200 active replicas in a real-world-scale deployment. This protocol ensures the consistency of the data, even in environments where less than one-third of the replica nodes are down, not synchronous, or even malicious. VMware evaluated SBFT in a world-scale geo-replicated deployment with 209 replicas withstanding  $f=64$  Byzantine failures.<sup>6</sup>

### Privacy

VMware Blockchain provides hierarchical privacy. Client nodes maintain a highly granular, privacy-filtered subset of the ledger. Replica nodes maintain the full state of the ledger and are trusted for privacy. Client node groups provide physical data segregation. Party-to-client node mapping is maintained at the replica network and used for privacy-filtered state transfer.

### Performance at scale

VMware Blockchain can drive a high throughput of complex transactions on the platform to support business-critical workflows at scale without sacrificing trust using VMware's optimized consensus engine, execution engine, and authenticated storage for performance. Some of the key features and improvements enabling VMware Blockchain to reach high throughput numbers include:

**Consensus algorithm** – VMware Blockchain SBFT provides the highest degree of trust without sacrificing performance and scalability. VMware research shows that SBFT provides 2x more throughput and 1.5x less latency relative to the Partial Byzantine Fault Tolerance approach.

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6. "SBFT: a Scalable and Decentralized Trust Infrastructure." Guy Golan Gueta, Ittai Abraham, Shelly Grossman, Dahlia Malkhim, Benny Pinkas, Michael K. Reiter, Dragos-Adrian Seredinschi, Orr Tamir, and Alin Tomescu.



## Next steps

- Set up a briefing with our Blockchain experts by emailing [ask\\_vmware\\_blockchain@vmware.com](mailto:ask_vmware_blockchain@vmware.com)
- Learn more by visiting <https://www.vmware.com/products/blockchain.html>
- Follow us on Twitter at VMware Blockchain ([@vmwbblockchain](https://twitter.com/vmwbblockchain))

## Quoted resources

[ASX brings in VMware for blockchain-based CHES replacement project](#)

[Asset Management: Transformation Is Already Here](#)

[Broadridge Launches DLT Repo Platform to Execute First Bilateral Repo Trades Using Smart Contracts](#)

[Blockchain Repo Platform Is Averaging \\$31B a Day](#)

[SBFT: a Scalable and Decentralized Trust Infrastructure](#)

[The ValueExchange Research](#)

**Storage layer** – With a high volume of complex business transactions, it is possible to accumulate over 300GB of data per business day. To handle this data and I/O load, the authenticated key/value ledger in VMware Blockchain categorizes keys resulting from smart contract execution and stores the keys in various structures, depending on their requirements.

**Batching** – Because most workflows do not require millisecond finality, configurable batching has been added to client requests and consensus to increase system throughput.

**Pre-execution** – Parallel transaction execution increases throughput and eliminates non-determinism.

## Future proof

With VMware Blockchain, customers can use Ethereum Solidity and Digital Asset Daml to build smart contracts without having to deploy another blockchain stack to meet different application requirements. VMware is also continuously gathering data on customer requests for additional smart contract languages.

## Enterprise ready

VMware has built a reputation for its enterprise-ready platform that over 600,000 customers trust for their digital infrastructure, including VMware Tanzu, VMware Cloud™ Services, VMware vSphere®, VMware vSAN™ and VMware NSX®. VMware Blockchain extends this rich heritage and excels in moving customers from experimentation to pilot to production in rapid succession by offering enterprise functionality and support.

**Deployment** – VMware Blockchain Orchestrator automates the configuration and deployment steps for vSphere, VMware Cloud Services or AWS.

**Capacity management** – VMware Blockchain supports archive to object store and delete stale keys from blockchain networks. The Pruning feature enables ledger operation with bounded storage in high-volume use cases. Pruning also enables implementation of GDPR-compliant, right-to-be-forgotten semantics.

**Upgrade, backup and restore** – VMware Blockchain has only two types of nodes, resulting in simpler topologies and management. The platform enables easy upgrade, backup and restore processes for the distributed ledger layer. VMware Blockchain also stores smart contracts on chain to facilitate smart contract updates and migrations.

**Production support** – VMware is committed to delivering enterprise-class, worldwide support with a single objective in mind: customer success. The 24x7 support includes unlimited support requests, online access to technical resources, product updates and upgrades.

