

FROST & SULLIVAN

VMWARE

2022
CUSTOMER
VALUE
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GLOBAL BLOCKCHAIN
SERVICES INDUSTRY

Best Practices Criteria for World-Class Performance

Frost & Sullivan applies a rigorous analytical process to evaluate multiple nominees for each award category before determining the final award recipient. The process involves a detailed evaluation of best practices criteria across two dimensions for each nominated company. VMware excels in many of the criteria in the global blockchain services space.

| AWARD CRITERIA | |
|------------------------|-------------------------------|
| <i>Business Impact</i> | <i>Customer Impact</i> |
| Financial Performance | Price/Performance Value |
| Customer Acquisition | Customer Purchase Experience |
| Operational Efficiency | Customer Ownership Experience |
| Growth Potential | Customer Service Experience |
| Human Capital | Brand Equity |

Blockchain can Overcome Challenges Inherent in Multi-party Transactions, but Implementation of Enterprise-grade Production-ready Solutions is usually a Convolved Proposition

Throughout industry sectors and verticals, enterprises are lurching into a new paradigm of digital transformation and decentralized platforms. In uneven fits and starts, organizations are recognizing that siloed databases and centralized applications are constraining processes and adding inefficiencies. A rising concept of a more open and fluid ecosystem that support dynamic and distributed applications and governance is optimizing real-time data and automation processes. While some thought leaders are calling this new vision for the future “Web 3.0,” the movement represents a collection of ideas and technologies that swing away from centralization and prioritize seamless integration of decentralized technologies.

Distributed ledger technology (DLT, also commonly referred to as a blockchain) is a key enabler of enterprise business models that leverage distributed assets (such as the internet of things [IoT] or digital twins) and multiparty workflows. Distributed data collection and processing can leverage the power of blockchain's decentralized recordkeeping and tokenization. Consequently, distributed applications that depend on multi-party workflows need ways to ensure data authenticity and secure sharing across silos.

Across the globe, financial service is undergoing a transformation to address the complexity of multi-party transactions. These kinds of applications (such as multi-party clearing and settlement use cases or mass IoT deployments) generate massive data volumes each day, necessitating huge storage capacity as

well as constant maintenance and governance updates. Further, these data flows often end up in separate formats and/or disconnected siloes and thus offer limited utility. Alternatively, with centralized architectures, users may question the accuracy and reliability of information delivered by involved parties (such as IoT devices). Data could be tampered with at any point from creation to transit and storage. Cultivating trust in enterprise systems typically involves handing over authority to a third-party arbiter, increasing friction in the system and creating a choke point concentrating power, time, and transparency.

Difficulties often arise in multiparty transaction arrangements when all stakeholders are not equally informed. Some parties hold disparate amounts or types of data, resulting from siloed collection, of unverified quality, and a lack of contextual sharing. At each stage of a transaction journey, these problems leave openings for tampering, market inefficiencies, and added costs. Digital transformation demands that business-to-business exchanges leverage more process automation, improve traceability/proof of identity or process, and streamline connectivity throughout the network and constituent databases. Data exchanges across systems and amongst multiple parties are comparatively slow, and all of the stakeholders would be better served by a single source of truth such as a blockchain. Blockchain solutions feature a shared record that is auditable, less vulnerable to tampering and outages, and that can drive business outcomes.

Enterprises must recognize that blockchain is an integral part of their digital transformation in the always-changing enterprise technology landscape and regulatory environment. Enterprises need help with blockchain strategy, designing, implementing, and often maintaining the system. Service firms have positioned themselves to specialize in some of the complexities, such as security, analytics, management, and connectivity. The technology stack for enterprise-grade solutions involves numerous service providers (providing the hardware, cloud infrastructure, blockchain platform, vertical solutions, databases, business process systems, or application layer). The process for vetting service providers, hardware, and software for security, corporate policies, and regulatory compliance is intensive and time-consuming. These factors result in the extended time to market for bringing new blockchain-based systems into production, in addition to the difficulty of building, integrating, and operating such platforms (to say nothing of the scarcity of experts in the field.) While some cloud providers are repackaging existing open-source blockchain platforms, few service providers can combine aptitude with innovative technology alongside expertise with extensible platforms and robust performance.

VMware Develops its Own Blockchain Platform, Designs for Privacy, Performance and Scalability

VMware took a different tack compared to most in the blockchain landscape. Rather than refashioning public blockchains for enterprise uses or constructing a single vertically integrated package, VMware impressively developed its own blockchain architecture based on its own internally developed consensus algorithms. Creating a private permissioned blockchain (based on Byzantine fault-tolerant state machine replication), VMware's architecture facilitates enterprises to run distributed, multi-party applications in multiple smart contract languages, with network trust and resilience built-in. VMware delivers enterprise-grade features and functionality on a platform that retains the key blockchain principles.

As early as 2015, VMware's research teams have been exploring Byzantine fault-tolerant replication and consensus, cryptography, and distributed computing. The unique initiative called Concord built a scalable Byzantine fault-tolerant (BFT) consensus model, and prioritized platform capabilities that remain robust and resilient for enterprise use over time. Research teams developed the scalable

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***- Nick J. Baugh,
Industry Analyst***

Byzantine fault-tolerant state machine replication (BFT-SMR) system into the core of the Concord-BFT, the core technology that delivers fast consensus and cryptographically verifiable data integrity, while abstracting the complexity so that enterprises need only to focus on their business processes and the application layer. The core technology operates on virtual execution engines that run on the same replicated state machine and supply all the participants in a multiparty system

with a single source of truth. This single truth provides the benefits of the DLT, or blockchain, in the efficiency of real-time multi-party transactions, tracing and auditability, and minimized risk and disputes. The company offers the core SBFT codebase open sourced as Project Concord, with a commercial VMware Blockchain offering which includes enterprise grade features.

VMware Blockchain thus equips enterprises with a robust and highly efficient platform that does not suffer the main drawbacks of alternative blockchain models. Compared to other blockchain models (such as proof of work mechanism), VMware's approach is highly efficient and sustains massive numbers of nodes and data transactions. The VMware Blockchain Platform is eminently scalable and performance-oriented, with the core BFT-SMR structure producing fast consensus and decentralized trust. A privacy-aware authenticated key/value ledger stores the state of the blockchain and integrates with the smart contract layer and shares only permissioned data to relevant parties in the multi-party workflow. The structure achieves sub-transaction privacy and remarkable performance; for example, it processes upwards of \$30 billion in daily transaction volume in the global repurchase agreement market for financial services firm Broadridge. VMware Blockchain scales to support thousands of complex

transactions per second, with systemic performance that does not degrade under stressful conditions and maintains data integrity. The nature of the distributed systems and BFT ensures that the platform handles faults and resists malicious actors, as well as coupling the data and logic closely together to make the assets smart and more functional. Designed for efficiency and resilience, VMware Blockchain is highly extensible for enterprise use cases and achieves all the additional value and automation capabilities that flow from a single source of truth.

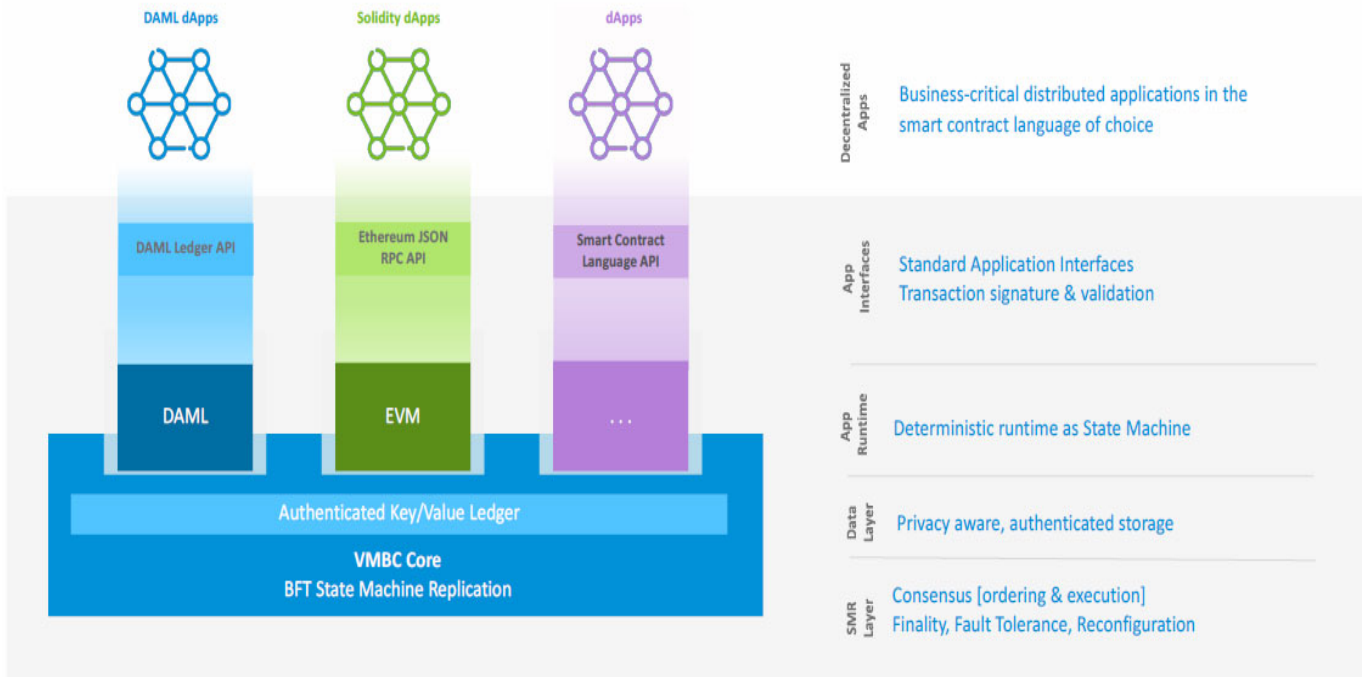
Simple Architecture Enables External Integrations and Enterprise Functionality

VMware designed its blockchain architecture with an eye to simple functional deployments and enabling external integrations. Differentiating with the notable capabilities to support a range of distributed applications as well as customize and update the network, the VMware Blockchain platform runs smart contracts and apps without the customer organization manually setting up and configuring integrations amongst myriad systems, databases, and the blockchain. In this infrastructure, VMware Blockchain decouples the ledger from the smart contract language or distributed app. The VMware platform abstracts the blockchain complexity away from the app. Structured in this way, the VMware Blockchain makes it much easier for customers to extend the platform and use additional applications on the same ledger and for multi-party networks to permit each organization to engage without gaining an entirely new skill set.

Multiple Contract Languages

The underlying blockchain virtually executes functions in multiple smart contract languages, such as digital asset modeling language (DAML) transactions [a native integration] and in Ethereum virtual machine (EVM) [currently in customer trials and soon to come into full production], representing the state change with all the blockchain functions (to verify, store, and save) contained. The apps operate in virtualized environments running on the same blockchain ledger, and the platform deploys the app to multiple nodes. These multiple nodes make up the blockchain in a replicated state (including the computation, ordering, and consensus), and the VMware Blockchain platform furnishes the foundational elements for decentralized multi-party applications, where it all runs on the same state machine replication layer. This facilitates multiple-party transactions with real-time efficiency and a single source of truth, essential in complex simultaneous settlement and tracking scenarios that require auditability for minimizing risk and disputes. Moreover, rather than a message-based system, VMware's platform is application program interface (API)-based for efficiency and industry standardization that permits easily porting over apps from other public blockchains.

Supporting Multiple Contract Languages and dApps on the Same Ledger



Source: VMware

Custom State Machines for New Use Cases

Similarly, VMware designed the platform to abstract smart contract execution (deriving the required state changes) from the underlying consensus and commitment (ensuring the state is changed reliably across the entire blockchain). This separation allows for the creation and integration of custom state change machines that can be highly optimized for specific use cases. In an IoT scenario, for example, a custom state machine could enable external integration providing a guaranteed shared state between edge devices. Abstracting away the blockchain allows the edge devices to view the blockchain as simply a module executing shared logic while the underlying blockchain platform takes care of the consensus, cryptography, block creation and storage. This simplicity opens possibilities for a vast array of value-adding opportunities, where the customer need only focus on the application and VMware Blockchain runs any distributed app and the customer’s chosen smart contract language.

Flexible Deployment Options

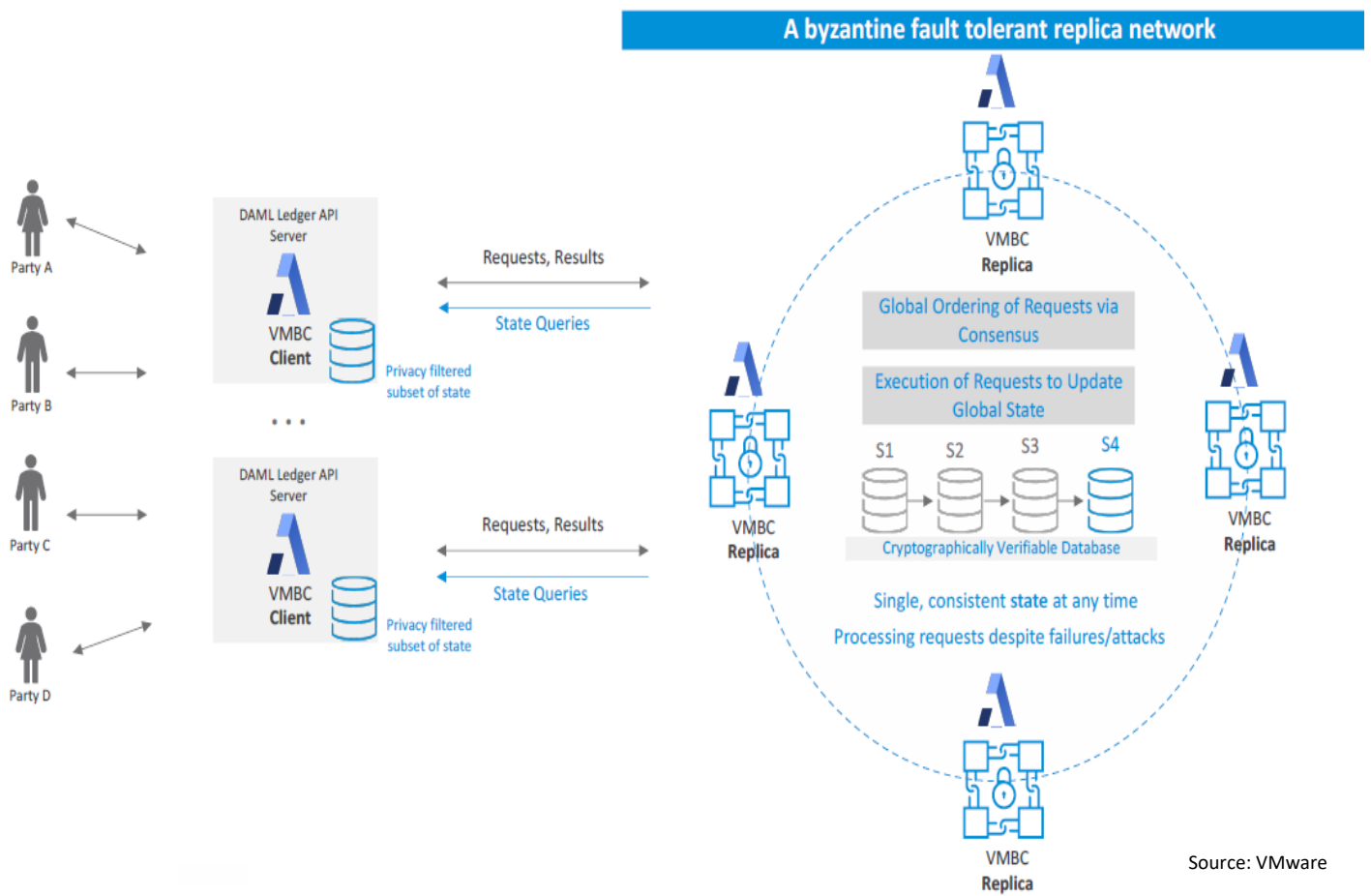
Further, the deployment model for VMware Blockchain is intentionally very simple whether on-premises or in the cloud. Market operators have options for how much responsibility they want to parcel out in the network. First, the market operator can host and manage all the nodes on behalf of participants while managing all the validator nodes. In a second iteration, the market operators can manage only the validating nodes and participants manage their own client nodes. Or in a third style, all of the participants can manage their own client nodes as well as some of the validating nodes throughout the network. The architecture makes scalability easy, simply adding clients and client nodes. In many instances, a single enterprise or market operator will be driving the implementation of blockchain and

be willing to take on the obligations for managing and operating all of the nodes for their supply chain vendor or distribution centers and facilitate the entire network to gain the benefits of blockchain. However, shifting the model to share responsibly for validator nodes in a multi-party landscape is relatively simple in the VMware blockchain landscape and equips customers in whichever fashion they desire.

Enterprise Grade Suitable for Highly Critical Financial Market Infrastructure

From prototype to production, VMware Blockchain bolsters enterprises with important configurability and upgrade capabilities that alternatives make highly onerous. The platform features capacity management abilities, to prune data (when all parties are in agreement) when necessary. Capacity management holds down storage requirements (terabytes of data add up quickly) and is essential to remain in compliance with the European Union’s General Data Protection Regulation (GDPR) mandating certain legal frameworks for data privacy and data removal. Further, VMware planned the platform for future network reconfigurations and updates. Whether adding clients, upgrading nodes, changing network settings or security rules, the platform has straightforward consensus mechanisms in place.

Architecture Designed for Simple Deployment and Robust Performance



Source: VMware

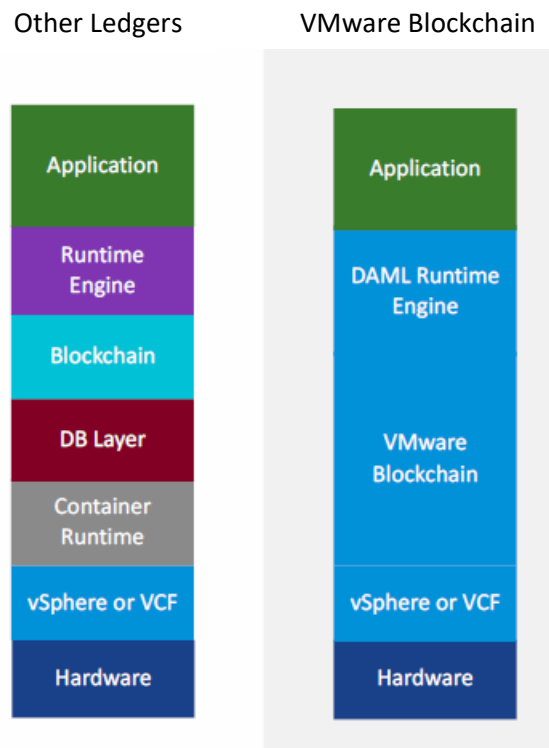
Leveraging a Depth of Experience and Consolidated Support

Coming to blockchain with unique expertise gained from its background in virtualization, VMware combines the learnings from solving customers’ most difficult problems to create an exemplary solution. The platform addresses the top pain points organizations experience, reducing the complicated integrations required and featuring simple deployment and reconfiguration along with enterprise-grade support. VMware designed the platform so that organizations gain the advantages of blockchain with the simplicity and ease of use of virtual execution environments. With flexibility, VMware can manage as a service or furnish the platform on the customer infrastructure and step out of the picture. Rather than acting as their own systems integrator (dealing with infrastructure, building containers, setting up database integrations, and configuring runtime engines), platform users have a real private permissioned blockchain on-premises, with the benefits of rapid deployment and leveraging the enterprise-grade operational capabilities built-in.

Drawing from VMware’s virtualization background, the blockchain platform abstracts the complexity so that users can focus on the application and business logic. Experience with decentralized infrastructure is a core differentiator and a fundamental building block of the Concord technology basics. The company’s virtualization technology equips organizations to deliver applications faster and with security and reduced cost. Deploying VMware Blockchain is exceedingly quick with an easy-to-use orchestration tool that creates instance nodes as virtual machines on the proven vSphere technology. Indeed, enterprises that already have vSphere installed can have a VMware Blockchain up and running in a matter of hours; turning on a VMware blockchain node is as easy as turning on a VMware virtual machine.

Additionally, VMware includes a wide-ranging surface area of support for customers: from the vSphere infrastructure to the runtime engine and DAML components. VMware ensures that customers need only focus on their application and hardware; in comparison, with alternative blockchain solutions the organization must integrate the pieces, create and test the technology stack themselves. Minimizing the hurdles to adoption, VMware serves as a single point of contact throughout the relationship. Finally, the blockchain platform includes support from VMware’s 24x7x365 global team, access to case management tools and subject matter experts.

Simple Architecture Provides Ease of Deployment and Consolidated Support



Source: VMware

Conclusion

Digital transformation initiatives are bringing together multiparty systems and complex value chains, but these new use cases need ways to ensure trust and verifiably. Blockchain, or distributed ledger technology, enables modern distributed applications that provide for automation and smart contracts in executing complex workflows.

VMware spent years in research and development on the core consensus technology to create VMware Blockchain. The VMware Blockchain platform offers a private permissioned blockchain for enterprises that does the heavy lifting to allow customers to get into production quickly. Designed to solve

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scalability and usability issues, VMware Blockchain abstracts the complexity of blockchain solutions for easy deployment and includes needed enterprise features for upgradability, monitoring, and maintenance. The architecture supports multiple smart contract languages and distributed IoT applications on the same ledger. VMware approaches the problem with expertise in

distributed computing and leverages vast experience in virtualization, offering a consolidated solution that permits organizations to gain the benefits of blockchain quickly and with flexibility.

With its in-house technology innovation, platform designed for extensibility and robust performance, VMware earns Frost & Sullivan’s 2022 Global Customer Value Leadership Award in the blockchain services space.

What You Need to Know about the Customer Value Leadership Recognition

Frost & Sullivan's Customer Value Leadership Award recognizes the company that offers products or services customers find superior for the overall price, performance, and quality.

Best Practices Award Analysis

For the Customer Value Leadership Award, Frost & Sullivan analysts independently evaluated the criteria listed below.

Business Impact

Financial Performance: Strong overall financial performance is achieved in terms of revenues, revenue growth, operating margin, and other key financial metrics

Customer Acquisition: Customer-facing processes support efficient and consistent new customer acquisition while enhancing customer retention

Operational Efficiency: Company staff performs assigned tasks productively, quickly, and to a high-quality standard

Growth Potential: Growth is fostered by a strong customer focus that strengthens the brand and reinforces customer loyalty

Human Capital: Commitment to quality and to customers characterize the company culture, which in turn enhances employee morale and retention

Customer Impact

Price/Performance Value: Products or services provide the best value for the price compared to similar market offerings

Customer Purchase Experience: Quality of the purchase experience assures customers that they are buying the optimal solution for addressing their unique needs and constraints

Customer Ownership Experience: Customers proudly own the company's product or service and have a positive experience throughout the life of the product or service

Customer Service Experience: Customer service is accessible, fast, stress-free, and high quality

Brand Equity: Customers perceive the brand positively and exhibit high brand loyalty

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The Growth Pipeline Engine™

Frost & Sullivan's proprietary model to systematically create ongoing growth opportunities and strategies for our clients is fuelled by the Innovation Generator™.

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Key Impacts:

- **Growth Pipeline:** Continuous Flow of Growth Opportunities
- **Growth Strategies:** Proven Best Practices
- **Innovation Culture:** Optimized Customer Experience
- **ROI & Margin:** Implementation Excellence
- **Transformational Growth:** Industry Leadership



The Innovation Generator™

Our 6 analytical perspectives are crucial in capturing the broadest range of innovative growth opportunities, most of which occur at the points of these perspectives.

Analytical Perspectives:

- **Mega Trend (MT)**
- **Business Model (BM)**
- **Technology (TE)**
- **Industries (IN)**
- **Customer (CU)**
- **Geographies (GE)**

