A Pragmatic Road Map For Blockchain

Build Distributed Trust To Enhance Digital Ecosystems With Blockchain

by Charlie Dai
January 30, 2019

Why Read This Report

While blockchain (distributed ledger) technology is still in its early stages, vendor solutions are maturing and leading firms are already using it to build distributed trust and establish digital business ecosystems. This report helps enterprise architecture (EA) pros understand blockchain by defining a technical architecture of enterprise blockchain platforms and analyzing business patterns of blockchain adoption. It also presents key trends in the development of critical technical components including consensus mechanisms, anchoring approaches, and deployment options.

Key Takeaways

Blockchain Is Enabling Digital Ecosystems In The Changing Collaboration Paradigm
Increasing demand and declining trust in intermediaries are driving collaboration between institutions and enterprises. Organizations are incorporating blockchain into digital ecosystems to serve three business goals: effectiveness, ease, and trust.

Enterprise Blockchain Platform Architecture Is Critical For Technology Governance
In Forrester's definition, enterprise blockchain platforms have five layers — infrastructure, platform, application, operations, and security — each of which delivers specific business value.

Consensus, Anchoring, Public Cloud, And Governance Are Key To Blockchain Success
EA pros must take a business-led approach to choosing consensus mechanisms and considering an anchoring solution for asset integrity. Public cloud platforms can accelerate blockchain innovation, and governance is critical for business success.

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Table Of Contents

Related Research Documents

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Customer Trust Is Shifting The Ecosystem Collaboration Paradigm

Empowered customers are fundamentally changing the way businesses operate and people interact. They have high expectations of businesses to provide them with more immediate, personalized, and convenient services in all different channels. Customers show less trust in any kind of intermediary because they have access to more information, options, and opportunities. Increasingly demanding customers have made customer-centric enterprises realize they need to collaborate more with other ecosystem players to provide seamless services and earn customer loyalty. Forrester sees that:

- **Trust in intermediaries is decreasing.** The internet of things (IoT) and mobility are driving consumers and enterprises to manage the digital and physical assets in their lives and businesses in digital channels. However, customers increasingly believe that the services of intermediate providers like property agents and credit agencies are not flexible, secure, and transparent enough to allow them to retain full control over their digital and physical assets. This loss of trust in the authenticity of digital and physical assets results in lower trust in the intermediaries themselves.
- **Demand for digital experiences is exploding.** Empowered customers demand effective, easy, and emotionally satisfying experiences. They want to eliminate intermediaries as far as possible to save time and avoid tedious processes. They want more flexible approaches to using and sharing their digital and physical assets. They want to avoid disputes and trust issues caused by a lack of transparency and security when doing business with unknown parties. They don't care who's behind the scenes; if their trust is broken, the company they engage directly will suffer the brunt of this loss. That may be you!
- **Institutional collaboration is increasing.** The increasing demand for cross-border trading and interactions between consumers and businesses is driving collaboration and enterprise business technology innovation. Firms are leveraging more technology and service partner capabilities to generate value for customers at a lower cost. Government departments are exchanging more data to streamline citizen services, and countries across the globe are increasing international collaboration on services and in verticals such as supply chain, logistics, and finance.

Develop A Blockchain Road Map To Enhance Your Digital Trust

Blockchain synergistically uses technology building blocks to catalyze a long-term shift of trust from centralized to shared consensus models in distributed business environments. It's a natural way for organizations to establish and enhance their digital ecosystem for collaborating, connecting, and transacting with known or unknown parties across organizational or even country boundaries.[1] However, blockchain is still a nascent technology, and a lot of hype and regulatory uncertainty surrounds it.[2] To effectively support the shifting paradigm in digital ecosystems, EA pros and digital business leaders must take a systematic approach to develop a road map for blockchain adoption.

Understand Key Blockchain Business Patterns For Strategy Alignment

Forrester has identified three blockchain business patterns based on the core customer experience values that blockchain applications aim to achieve. Each covers general-purpose or industry-specific business scenarios. Some blockchain business scenarios fit multiple business patterns, so one can build a digital ecosystem to improve customer experiences on different levels simultaneously. To align blockchain initiatives with business strategies for customer obsession, EA and digital business leaders must understand these patterns and monitor business cases in verticals worldwide (see Figure 1 and see Figure 2). Evaluate which of these patterns makes sense for your own situation:

- **The effectiveness-centric pattern improves efficiency and lowers costs.** Bubi helps Haier Financial Holdings build a platform for issuing and trading credit assets to improve business process efficiency and transparency. Infosys helps ICICI Bank digitize trade finance processes. JD Cloud helps CPIC modernize interparty invoicing processes. NTT DATA helps ABI Lab accelerate interbank reconciliation. PeerSafe and RunChain help China Construction Bank build a forfaiting business management platform to automate transaction processes. Cross-border payments and trading is another scenario: R3 helps HQLAX to create a liquid management marketplace and TradeIX to build a trade finance network.[3]
- **The ease-centric pattern focuses on agility to manage digital and physical assets.** There are two common scenarios: reward exchange platforms and adaptive intelligence platforms.[4] Sunshine Insurance uses blockchain to increase redemption rates and customer loyalty.[5] Alibaba Cloud helps Muheda build an in-car data sharing platform. IBM Trusted Identity helps SecureKey build a digital identity and attribute sharing network. Vertical-specific scenarios include peer-to-peer (P2P) insurance and inventory visibility. Sunshine Insurance allows customers to share aviation accident insurance policies as gifts with friends over a social network.[6] PeerSafe helps Fusion Group realize financing services by reliably controlling goods in warehouse and logistics tracking.
- **The trust-centric pattern builds confidence.** To assure customers that B2B ecosystems are trustworthy, firms use blockchain in three main scenarios.[7] The first is making business networks more transparent. Samsung SDS helps Maritime Logistics Consortium track and share cargo information in real time; Tencent Cloud helps Huajin Online provide a medical supply chain financing platform. The second is ensuring that products and their provenance are traceable. Inspur helps DEEJ ensure that its nutritional supplements are traceable and authentic; KPMG helps Pooley Wines monitor wine production and provenance; and IBM Food Trust helps Walmart gauge product freshness and make food traceable. The third is providing tamperproof asset attestation and protection. DataQin Tech helps Hangzhou Daily Press Group with infringement evidence attestation; Factom helps the Bill and Melinda Gates Foundation record patients' medical information and safely share it between clinics.

FIGURE 1 Blockchain Is Transforming Digital Ecosystems In Three Dimensions: Effectiveness, Ease, And Trust

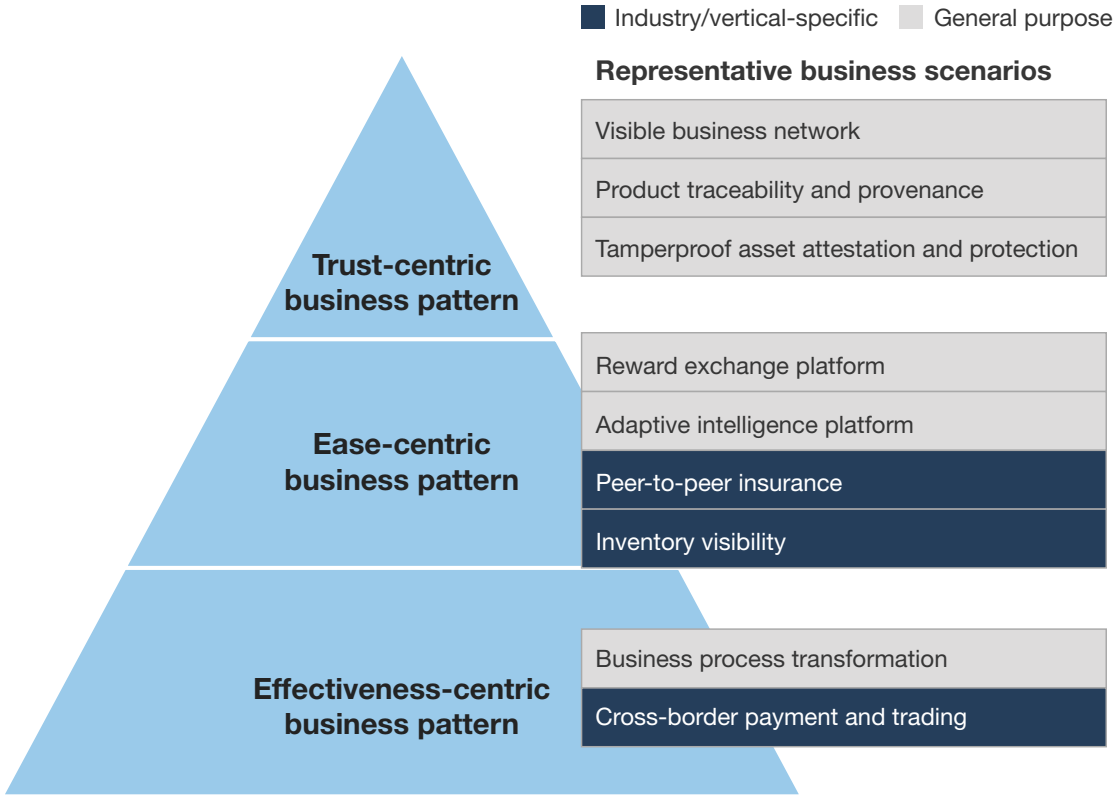


FIGURE 2 Business Cases Worldwide Are Proving The Value Of Blockchain Across Industries

Vendor	Customer	Business pattern	Key business case scenario	Business case overview
Alibaba Cloud	Tmall (retail)	Trust	Product traceability and provenance	Trace products from an overseas factory through international logistics to the domestic eCommerce platform
	Muheda (high-tech)	Ease	Adaptive intelligence	• Drivers contribute driving data collected by in-car or mobile devices with immutable data ownership • Reward and credit drivers
Bubi	Haier Financial Holdings (finance)	Effectiveness	Business process transformation	• Issue and trade credit assets on a dedicated platform • Improve business process efficiency and transparency
	CITIC Group (banking)	Effectiveness	Business process transformation	Share data and resources to allow users of all subsidiaries to access services seamlessly
	China Re (insurance)	Effectiveness	Business process transformation	• Transform reinsurance business processes by exchanging reinsurance data at a low cost • Cover life, property, and other reinsurance categories
DataQin Tech	Hangzhou Daily Press Group (legal)	Trust	Tamperproof asset attestation and protection	Attest to evidence of infringement for lawsuits
Factom	Equator (high-tech)	Trust	Tamperproof asset attestation and protection	Ensure the validity, integrity, history, and ownership of documents, data, files, and database information
	US Department of Homeland Security (government)	Trust	Tamperproof asset attestation and protection	Secure IoT data by creating device and identity logs on the blockchain
	Bill and Melinda Gates Foundation (healthcare)	Trust	Tamperproof asset attestation and protection	• Record patient medical information on a blockchain for sharing between clinics • Create and secure an individual patient's medical identity

FIGURE 2 Business Cases Worldwide Are Proving The Value Of Blockchain Across Industries (Cont.)

Vendor	Customer	Business pattern	Key business case scenario	Business case overview
IBM	SecureKey (high-tech)	Trust	Adaptive intelligence platform	• Create a digital identity and attribute sharing network • Allow customers to instantly verify their identity for services like new bank accounts, driver's licenses, and utilities
	Walmart (retail)	Trust	Product traceability and provenance	Part of IBM Food Trust, a global retailer/vendor ecosystem; help stores gauge product freshness, trace ingredient provenance, and improve food quality for efficiency and cost savings
	CLS (financial services)	Effectiveness	Cross-border payment and trading	Bilateral payment netting service for more than 120 currencies; optimize intraday liquidity, improve operational efficiency, and reduce risk
	we.trade (financial services)	Effectiveness	Cross-border payment and trading	Trading platform developed with nine major European banks to ease trading for small and medium-size businesses; serves 13 European countries
Infosys	ICICI Bank (banking)	Effectiveness	Business process transformation	Digitize trade finance business processes with Infosys Finacle including validating ownership, certifying documents, and making payments
Inspur	DEEJ (consumer goods)	Trust	Product traceability and provenance	Ensure that nutritional supplements are traceable and authentic
	Jing Yang Gang Liquor (consumer goods)	Trust	Product traceability and provenance	Ensure that liquor sold in different channels is authentic, undergoes the same production and selling process, and has the same price

FIGURE 2 Business Cases Worldwide Are Proving The Value Of Blockchain Across Industries (Cont.)

Vendor	Customer	Business pattern	Key business case scenario	Business case overview
JD Cloud	Suqian Administration for Industry and Commerce (government)	Effectiveness	Tamperproof asset attestation and protection	• Blockchain tracking platform to store business license information • Information-matching to accelerate enterprise verification
	JD Mall (retail)	Trust	Product traceability and provenance	• Product tracking for brands, industry associations, enforcement bodies, and government regulators • Blockchain tracking for more than 35,000 SKUs and 1.2 billion points of tracking data
	CPIC (insurance)	Effectiveness	Business process transformation	• Tracking system to bolster e-invoice security governance • Process invoices in blockchain for invoice recipients and invoice service providers
KPMG	Pooley Wines (consumer goods)	Trust	Product traceability and provenance	Use blockchain, IoT, smart labels, and AR/VR to monitor wine production and provenance
	Luxembourg Stock Exchange (retail)	Effectiveness	Business process transformation	• Market fund order processing engine based on distributed ledger technologies and smart contracts • Manage processing and decentralization of information for asset managers, asset servicers, and investors
	Cathay Century Insurance (insurance)	Effectiveness	Business process transformation	Set up checks of actual flight schedules, notify customers of delays, and automatically pay claims for travel delay insurance
NTT DATA	LIFULL, Zenrin, Zenhoren (real estate)	Trust	Visible business network	Real estate information sharing system involving real estate, map information, and utility companies
	ABI Lab (banking)	Effectiveness	Business process transformation	Help with interbank reconciliation

FIGURE 2 Business Cases Worldwide Are Proving The Value Of Blockchain Across Industries (Cont.)

Vendor	Customer	Business pattern	Key business case scenario	Business case overview
PeerSafe	China Construction Bank (banking)*	Effectiveness	Business process transformation	• Forfaiting business management platform • Automate transaction process execution with data synchronization on both sides
	CITIC Group (banking)*	Effectiveness	Business process transformation	• Link banks and create electronic credit letters • Cash management using a mutual credit-based mechanism
	Fusion Group (logistics)	Ease	Inventory visibility	• Map physical and digital assets in Fusion warehouses • Ensure reliable, effective risk control of warehouse goods for financing qualification
	Backpack Travel (tourism)	Ease	Adaptive intelligence platform	Electronic identity authentication tokens for tourists to check into hotels, board flights, rent cars, and make insurance payments
R3	HQLAX (finance)	Effectiveness	Cross-border payment and trading	Liquidity marketplace for large-scale, cost-efficient collateral transfers across the global financial ecosystem
	TradeIX (finance)	Effectiveness	Cross-border payment and trading	Open account trade finance business network
	TradeWind Markets (finance)	Trust	Tamperproof asset attestation and protection	Platform for trading, settlement, and ownership of vaulted precious metals

*PeerSafe contracted with partners to provide the underlying blockchain platform.

FIGURE 2 Business Cases Worldwide Are Proving The Value Of Blockchain Across Industries (Cont.)

Vendor	Customer	Business pattern	Key business case scenario	Business case overview
Samsung SDS	Korea Federation of Banks (banking)	Effectiveness	Business process transformation	Interoperable blockchain authentication among 18 commercial banks in South Korea
	Maritime Logistics Consortium (logistics)	Trust	Visible business network	• Track and share cargo information (e.g., temperature and humidity) in real time • Network participants include shipping firms, financial institutions, and government departments
	Samsung SDI (manufacturing)	Trust	Tamperproof asset attestation and protection	Trustworthy electronic contract system
Tencent Cloud	Huajin Online (finance)	Trust	Visible business network	Supply chain financing platform for medical industry
	Aixin Life (financial services and insurance)	Trust	Visible business network	• Connect insurance companies, medical institutions, and regulatory bodies • Safely share medical and insurance data and automatically verify and settle insurance claims

Define The Enterprise Blockchain Platform Architecture For Technology Governance

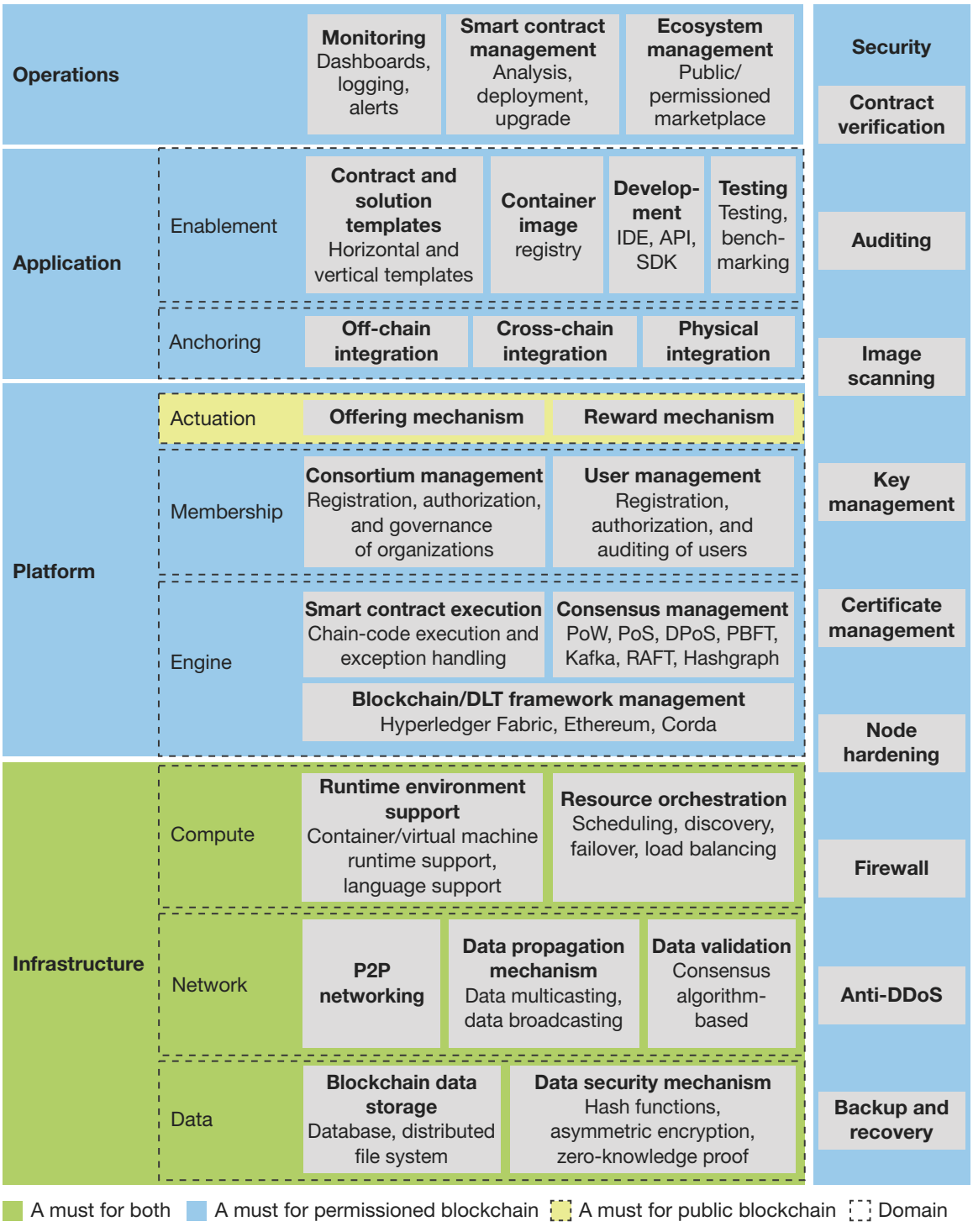
Blockchain is not a single technology, and there's a large gap between what enterprises need from it and the capabilities of products on the market. This includes public blockchain platforms like Bitcoin and Ethereum and open source frameworks for permissioned blockchain like Hyperledger Fabric. To execute a strategic blockchain business plan and ensure the necessary technology governance, digital business leaders must define a holistic blockchain software architecture. Forrester separates enterprise blockchain platforms into five layers, each of which delivers specific business value. The infrastructure layer is common to both public and permissioned blockchain; the actuation component is essential for public blockchain; and the rest are critical for permissioned blockchain (see Figure 3).

› **Infrastructure lays a scalable foundation for blockchain platforms.** This layer has three domains: compute, network, and data. In the compute domain, runtime environment support aids chain-code execution via containers or virtual machines; resource orchestration enables job scheduling, resource discovery, failover, and load balancing. In the network domain, P2P

networking establishes a P2P network among nodes; data propagation mechanisms support data transmission via multicasting or broadcasting; and data validation validates data on the node. In the data domain, blockchain data storage stores data in distributed databases or file systems; and data security mechanisms ensure data security using methods like hash functions, digital signatures with asymmetric encryption, and zero-knowledge proof.

- **Platform enables core platform features for blockchain execution.** This layer also has three domains: engine, membership, and actuation. In the engine domain, blockchain framework management supports open source and proprietary blockchain frameworks such as Hyperledger Fabric, Ethereum, and Corda; consensus management enables consensus mechanisms such as DPoS, Kafka, and SOLO; and smart contract execution executes chain codes and handles exceptions. In the membership domain, consortium management and user management register, authorize, and govern organizations and users, respectively. The actuation domain is essential to public blockchain — encouraging participation via rewards in the offer and execute stages — but is optional for permissioned blockchain.
- **Application streamlines blockchain application delivery.** This layer has two domains: enablement and anchoring. The enablement domain contains repositories of horizontal and vertical templates for smart contracts and business solutions; the container image registry contains images of blockchain applications for fast provisioning; development includes IDEs, APIs, and SDKs for blockchain developers; and testing offers integrated benchmarking and testing tools.[8] In the anchoring domain, off-chain integration integrates digital assets not on the blockchain with records on it; cross-chain integration — like Hyperledger Quilt in the incubate stage — allows blockchain networks to interoperate; and physical integration bridges the gap between the digital and physical worlds.[9]
- **Operations simplifies platform operations and value co-creation.** This layer has three key components. Monitoring provides visual dashboards, logging, and alerts to give platform operators from each participating organization unified visibility into the platform. Smart contract management provides predictive analysis of contract usage and automates contract deployment and upgrading. Ecosystem management facilitates co-innovation through marketplaces in public or permissioned environments.
- **Security ensures end-to-end security for blockchain adoption.** In addition to the data security mechanism, backup and recovery ensures effective data protection and disaster recovery, and the anti-DDoS, firewall, and node hardening components enhance the safety and reliability of the infrastructure layer.[10] Certificate and key management are critical to platform security and data privacy. Image signature scanning, auditing, and contract verification are essential components for application and operational safety.

FIGURE 3 The Functional Architecture Of Enterprise Blockchain Platforms



Choosing Consensus Mechanisms Requires A Business-Led Approach

Blockchain transactions must be written to the shared ledger in a consistent order. Consensus mechanisms play a key role in application performance in terms of transaction consistency, workload throughput, and network scalability. Different blockchains use different methods to reach consensus. Bitcoin uses proof of work (PoW) to determine the order by solving nonce calculations; Hyperledger Fabric provides pluggable options for organizations to choose the ordering mechanism that best suits the network; and Samsung SDS Nexledger not only has its own consensus mechanism, but it also supports Ethereum and Hyperledger Fabric.[11] To make the right architectural decision, EA pros must know detailed business requirements such as the number of transactions per second and number of network participants (see Figure 4 and see Figure 5).[12] To select the appropriate consensus mechanism:

- **Focus on throughput and fault tolerance for enterprise scenarios.** Business applications for enterprises normally have few participants but high demand for transaction throughput or business consistency. Consensus algorithms like Kafka and RAFT with higher throughput will be more suitable for transaction-intensive business scenarios. Hyperledger Fabric and R3 Corda are representative blockchain/distributed ledger technology (DLT) implementations, respectively. For applications that require further Byzantine fault tolerance in the distributed network, consensus mechanisms like Hedera's ABFT and MultiChain's PBFT will help.[13]
- **Prioritize decentralized applications over public blockchain.** "Degree of decentralization" refers to the percentage of the nodes in the network that will participate in the consensus process. Decentralized applications (DApps) like Augur and Counterparty running on public blockchain aim to maximize permissionless participation using incentives like cryptotokens.[14] In this case, consensus algorithms with a higher degree of decentralization are more suitable; Ethereum covers PoW and Samsung SDS Nexledger covers proof of authority (PoA).

FIGURE 4 The Performance And Implementation Of Consensus Mechanisms Vary

Consensus/ordering mechanism*	Throughput	Degree of decentralization	Example blockchain/DLT implementations
Asynchronous Byzantine fault tolerance (ABFT)	Medium	Medium	Hedera (Hashgraph)
Delegated proof of stake (DPoS)	High	Medium	Bitshares, EOS, Steemit
Kafka	High	Low	Hyperledger Fabric
Nexledger consensus algorithm (NCA)	High	Medium	Samsung SDS (Nexledger Platform)
Paxos/RAFT	High	Medium	Quorum, R3 (Corda)
Practical Byzantine fault tolerance (PBFT)	High	Medium	Bubi, MultiChain, Tendermint, Zilliqa
Proof of elapsed time (PoET)	Medium	High	Hyperledger Sawtooth
Proof of authority (PoA)	Medium	High	Inspur, Kovan, Samsung SDS (Nexledger Platform)
Proof of stake (PoS)	Medium	High	Ethereum, Factom, Nxt
Proof of work (PoW)	Low	High	Bitcoin, Ethereum, IOTA (Tangle)
Ripple protocol consensus agreement (RPCA)	High	Medium	Ripple
Simple Byzantine fault tolerance (SBFT)	High	Medium	Hyperledger Fabric

*This is a nonexhaustive list of consensus mechanisms and their variations.

FIGURE 5 Implementations Of Consensus Mechanisms

Mechanism	Characteristics
ABFT	A system that allows for the possibility that some messages between honest members will be delayed for an arbitrarily long time or not make it to their intended recipients at all. This is the strongest form of BFT. Hedera uses DAG for ABFT.*
DPoS	Witnesses or delegates are authorities elected by network participants that are allowed to produce and broadcast blocks. EOS uses DAG for DPoS; Steemit uses Graphene, which is also based on DAG.
Kafka	A voting-based approach to consensus that provides crash fault tolerance (CFT) and finality. Not BFT.
NCA	This is a proprietary algorithm of Samsung SDS.
Paxos/RAFT	The nodes elect one node to be the leader, responsible for validating transactions. Raft is more understandable by design. R3 Corda implements RAFT and BFT-Smart algorithms.†
PBFT	An optimized solution to achieve BFT using a round-robin style.
PoET	Randomly selected individual peers execute requests at a given target rate using a lottery-based approach. Based on Intel's SGX. Proprietary.
PoA	An optimized PoS model that leverages identity as the form of stake rather than actually staking tokens.
PoS	Determines who gets to create the next block to link to the blockchain based on their stake in the network. Factom consensus has PoS elements with improvements.‡ Ethereum uses PoW for major workloads but PoS for checkpoint validation.
PoW	As one part of the Nakamoto consensus for BFT, PoW determines whether the blocks mined are the same ones present on the majority of nodes across the network. Compute-intensive. IOTA combines PoW with DAG.
RPCA	A federated consensus: Each node chooses which other nodes to trust, which becomes a system-level quorum of consensus.
SBFT	An optimized solution to achieve Byzantine fault tolerance; still on the road map of Hyperledger Fabric.

*A directed acyclic graph (DAG) is a finite directed graph with no directed cycles. For blockchain, it means that a user sending a transaction also acts as a validator, validating previous transactions.
†Corda's Notary services are separate from the P2P network of transacting nodes, which can cover both centralized and decentralized scenarios.
‡PoS has "stake grinding" and "nothing at stake" problems, which Factom has addressed.

Use Anchoring Mechanisms To Ensure Full Asset Integrity On And Off The Chain

The native blockchain technologies that Bitcoin and Ethereum use can only ensure tamperproof authenticity of data stored on the blockchain itself. It's not realistic to put all data from your digital assets on the blockchain network, as much of your application data will remain in legacy systems. These legacy off-chain elements mean that you can't prove the integrity of the data off the chain — so blockchain cannot unilaterally guarantee the ownership and immutability of physical assets in the real world. To have end-to-end nonrepudiation across digital and physical environments, keep a close watch on anchoring mechanisms and fit decisions to business needs. Forrester separates anchoring mechanisms into three categories:

- **Digital identifiers.** Digital assets contain not only the original data, but also native attributes like header metadata and timestamp that uniquely identify it. Examples include digital media and electronic contracts and standalone digital information on physical assets, such as RFID, QR codes, or other unique product data in application databases. Blockchain vendors take diverse approaches to generating unique digital identifiers from this data for asset anchoring. R3 Corda allows users to store not only arbitrary object graphs containing user-defined fields on the blockchain, but also attachments for transactions.[15] Factom Harmony Connect allows anchoring between private and public Factom protocol networks. Cryptowerk Seal makes it easy to write apps that verify data integrity at massive scale by anchoring the data in blockchains. All vendors can generate hashes of the original data for on-chain storage.
- **Native fingerprints.** These are unique, immutable patterns in raw data that can identify physical or digital objects in a tamperproof way, such as a molecular watermark in a diamond, the optical structure or DNA sequence of an object, or the acoustic fingerprint of a digital song or movie. IBM is working on molecular watermarks to verify physical products; it also formed the TrustChain alliance with Helzberg and other companies involved with mining and refining to track gems and precious metals.[16]
- **Embedded watermarks.** These are artificial data and metadata identifiers embedded in digital or physical assets to provide unclonable identification. These identifiers can survive digital transformations such as cropping, downsampling, and format conversion. Digimarc protects digital audio files by inserting identifiers into them and combining that with a blockchain network.[17] For physical assets, vendors like Alibaba Cloud, Huawei Cloud, IBM, PeerSafe, and Tencent Cloud are proactively embracing IoT and biometric technologies to bridge the gap. IBM is developing cryptoanchors that can be embedded in the product and consist of cryptographic mechanisms in forms like magnetic ink.[18]

Leverage Public Cloud Platforms To Accelerate Digital Innovation

In addition to blockchain software solutions for on-premises deployment, leading public cloud service providers worldwide have started to provide their own blockchain offerings, each with different technical and geographic coverage (see Figure 6). While blockchain architecture doesn't necessarily require a cloud infrastructure, public cloud platforms that provide blockchain as a service can help organizations shorten the life cycle from ideation to value delivery or fail fast, because they can:

- **Mask the complexity of blockchain infrastructure deployment.** Building blockchain infrastructure is not easy. It requires tedious preparation work to set up underlying hardware infrastructure and software environments like operating system and language runtime and requires hands-on experience in various technology areas. Deploying Hyperledger Fabric requires technical expertise in Docker containers and the Go language as well as knowledge of certificates and distributed network operations. Well-designed blockchain services on public cloud platforms can streamline provisioning, reducing the total cost of ownership. This is especially valuable in the very early stages to prove concepts for business ideation.
- **Accelerate blockchain application development and operations.** Beyond traditional design and development building blocks, public cloud service providers have other value-added services to speed up application development and operations. Alibaba Cloud and Tencent Cloud support consortium management; Baidu Cloud provides a smart contract library with DApps templates and an IDE; Huawei Cloud and JD Cloud have GUIs for chain-code deployment and instantiation; and IBM offers comprehensive tools, extensions, governance, and solutions for blockchain applications. All megacloud providers offer IoT services to serve as the foundation for physical asset anchoring.
- **Drive cross-industry and cross-border ecosystem expansion.** Public cloud service providers not only have worldwide geographical coverage; they also offer tech services on the development and platform layers such as containers, analytics, AI, and security and increase interoperability with software-as-a-service platforms and legacy on-premises applications. Public cloud platforms enable enterprises in the blockchain market to co-create value with partners. Partnering with the China Society of Inspection and Quarantine, Inspur built Qualink, a public cloud blockchain platform to improve quality. More than 1,000 firms, including Gree, Midea, and Tsingtao Beer, have participated in the blockchain network.

FIGURE 6 Public Cloud Service Providers Cover Diverse Areas Of Blockchain

Public cloud vendor	Service name	Blockchain/DLT framework support	Geographic availability*	Representative customers
Alibaba Cloud	Blockchain as a Service	Hyperledger Fabric, Ant Blockchain, Quorum	NA, EMEA, mainland China, Hong Kong, Singapore	Easy-visible, Muheda
Amazon Web Services	Amazon Managed Blockchain†; Amazon Quantum Ledger Database (QLDB)†; AWS Blockchain Templates	Ethereum, Hyperledger Fabric	NA	Depository Trust & Clearing Corporation, Guardian Life Insurance, Healthdirect Australia
Baidu Cloud	Baidu Blockchain Engine	Ethereum, Hyperledger Fabric Baidu Xchain	China	N/A
Huawei Cloud	Blockchain Service	Hyperledger Fabric	Mainland China, Hong Kong	cnfol.com
IBM Cloud	IBM Blockchain Platform	Hyperledger Fabric	NA	SecureKey, Walmart, we.trade
JD Cloud	JD Blockchain Open Platform	Ethereum, Hyperledger Fabric Stellar, JD CHAIN	China	China Pacific Insurance, Suqian Administration for Industry and Commerce
Microsoft Azure	Blockchain Workbench	Ethereum	NA	3M, Bank Hapoalim, Nestlé
Oracle Cloud	Blockchain	Hyperledger Fabric	NA	N/A
SAP Cloud Platform	Blockchain	Hyperledger Fabric, MultiChain	NA	South Tyrol region (Italy), Boehringer Ingelheim
Tencent Cloud	TBaaS	Hyperledger Fabric, BCOS	China	Aixin Life, Donghua Software, Huajin Online, Leju Holdings

*Accessible as services in general availability or preview in data centers in the respective regions
†In the preview stage

Recommendations

Ensure Sufficient Governance For Your Blockchain Innovation

Blockchain technology enables new business and trust models and has transformational potential. However, it's still in the very early stages, and designing new business and trust models requires unprecedented levels of collaboration across organizational boundaries. Therefore, "pragmatic" is the keyword for blockchain adoption; EA pros must clearly understand the risks and threats, realizing that blockchain-based systems require a governance model.[19] EA pros must:

- **Prioritize business governance to build a dependable foundation.** Blockchain implementations are 80% business and 20% technology.[20] EA pros must work with business stakeholders, subject-matter experts, and even legal professionals to have a holistic view of regulatory requirements, customer preferences, and legal frameworks for various areas of blockchain, such as data privacy, asset sovereignty, and network reliability. For example, medical disclosure regulations in South Africa specify that all medical information must remain on servers in country and data privacy is critical. As a result, Factom implemented a private network for its portable medical wallet solution for the Gates Foundation.
- **Drive technology governance to streamline blockchain implementation.** In most cases, enterprise blockchain applications need to not only ensure the necessary integration with internal systems, but also guarantee interoperability with other ecosystem partners, focusing on consistent user experiences, platform scalability, and effective exception-handling. To ensure that data on the blockchain can anchor with real digital assets off the chain with legal validity, Bubi conducted a technical verification of its integration with financial certification organizations such as certificate authorities and evidence attestation institutions.
- **Work with reliable technology partners to speed up value delivery.** Blockchain technology is complex, and business collaboration is even harder. Organizations without a strong team of dedicated technical experts on blockchain should work with tech providers to accelerate digital innovation and ecosystem expansion. These providers fall into three categories: Infrastructure providers provide general-purpose blockchain platforms; application providers deliver direct business value to customers; and service providers engage customers with services on various levels.[21] Take a systematic approach to select the right partner for your blockchain journey.

Supplemental Material

Survey Methodology

The Forrester Analytics Global Business Technographics® Data And Analytics Survey, 2017, was fielded between February and April 2017. This online survey included 3,378 respondents in Australia, Brazil, Canada, China, France, Germany, India, New Zealand, the UK, and the US from companies with 100 or more employees.

Forrester's Business Technographics ensures that the final survey population contains only those with significant involvement in the planning, funding, and purchasing of business and technology products and services. Research Now fielded this survey on behalf of Forrester. Survey respondent incentives include points redeemable for gift certificates.

Please note that the brand questions included in this survey should not be used to measure market share. The purpose of Forrester's Business Technographics brand questions is to show usage of a brand by a specific target audience at one point in time.

Companies Interviewed For This Report

We would like to thank the individuals from the following companies who generously gave their time during the research for this report.

Alibaba Cloud
Baidu Cloud
Bubi
Cryptowerk
DataQin Tech
Huawei
IBM
Infosys
Inspur
JD Cloud
KPMG
NTT DATA
PeerSafe
R3
Samsung SDS
Tech Mahindra
Tencent Cloud

Endnotes

[1] Blockchain's creative combination of technologies facilitates innovation. See the Forrester report "Vendor Landscape: Blockchain Technology Providers In Asia Pacific."

[2] The blockchain hype machine has been running at full throttle for several years. Even transitioning an existing process to a distributed ledger may require revisiting legal and contractual agreements. See the Forrester report "Distributed Ledger Technology: How To Get Started Without Getting Your Fingers Burnt."

[3] HQLAX and TradeIX as independent vendors are building marketplace and trade finance networks on top of R3 Corda. They provide a range of services for global clients — such as the Marco Polo network which includes ING, Commerzbank, BNP Paribas, Anglo-Gulf Trade Bank, NatWest, Natixis, Bangkok Bank, and Standard Chartered Bank.

[4] Adaptive intelligence refers to real-time, multidirectional sharing of data in order to derive contextually appropriate, authoritative knowledge that helps maximize business value. See the Forrester report "Adaptive Intelligence: Assess Your Readiness."

[5] Sunshine Insurance transformed the points redemption system, allowing customers to reliably exchange points for other firms' digital currencies. See the Forrester report "Drive Digital Innovation With Blockchain."

[6] Customers can send insurance policies as gifts while not compromising the authenticity and provenance of policies. See the Forrester report "Drive Digital Innovation With Blockchain."

[7] "Trustworthy" based on confidence is one of the three dimensions of Forrester's B2B Tech CX Index. See the Forrester report "Introducing The B2B Tech Customer Experience Index."

[8] IDEs are independent development environments and SDKs are software development kits.

[9] Anchoring originally referred to linking the hash value of any data, file, or process to Bitcoin or other public blockchain for nonrepudiation in different ways, such as to create a timestamp proof. This term was initially coined in a November 2014 Factom white paper. Forrester broadens the definition to include approaches to ensuring the integrity of the data off the chain through on-chain/off-chain integration.

Hyperledger Quilt is a business blockchain tool and one of the Hyperledger projects hosted by The Linux Foundation. It offers interoperability between ledger systems by implementing the Interledger protocol (ILP), which is primarily a payments protocol and is designed to transfer value across distributed and nondistributed ledgers. Source: "Hyperlegder Quilt," Hyperledger (https://cn.hyperledger.org/projects/quilt).

[10] DDoS is distributed denial of service.

[11] The Fabric 1.0 architecture was designed to make the specific implementation of "ordering" (Solo, Kafka, BFT) a pluggable component. Source: Moses Sam Paul, "Hyperledger—Chapter 6 | Hyperledger Fabric Components—Technical Context," Medium, May 1, 2018 (https://medium.com/swlh/hyperledger-chapter-6-hyperledger-fabric-components-technical-context-767985f605dd).

[12] Blockchains are all about tradeoffs. See the Forrester report "Blockchain Technology: A CIO's Guide To The Six Most Common Myths."

[13] In the context of distributed systems, Byzantine fault tolerance is the ability of a distributed computer network to function as desired and correctly reach a sufficient consensus despite malicious components (nodes) of the system failing or propagating incorrect information to other peers. Source: Brian Curran, "What is Practical Byzantine Fault Tolerance? Complete Beginner's Guide," Blockonomi, May 11, 2018 (https://blockonomi.com/practical-byzantine-fault-tolerance/).

[14] Decentralized applications like Factom and Augur are a specific category of applications that run atop blockchain in a decentralized fashion. Augur is a decentralized oracle and prediction market protocol built on the Ethereum blockchain. Source: Augur (https://www.augur.net/).

Counterparty allows users to create and trade digital tokens, as well as to write specific digital agreements or smart contracts and execute them on the Bitcoin blockchain. Source: "The Counterparty Platform," Counterparty (https://counterparty.io/platform/).

[15] These graphs are called states and are the atomic units of data. States can have any number of user-defined fields, declare a relational mapping, and be queried using SQL. For integration with existing systems, the Corda network can support rapid bulk data imports from other database systems without placing a load on the network. Corda transactions can also have attachments — ZIP/JAR files containing arbitrary data — which are automatically requested from the node sending the transaction when needed and cached locally.

[16] IBM is working on placing molecular watermarks in products for verification. Source: Stephen Shankland, "IBM blockchain alliance tracks jewelry from the mine to the mall," CNET, April 26, 2018 (https://www.cnet.com/news/ibm-blockchain-alliance-tracks-jewelry-from-mine-to-mall/).

[17] Watermarks embedded in music files can facilitate licensing of stems or samples in remixes and mashups through blockchain transactions. Source: Bill Rosenblatt, "Watermarking Technology and Blockchains in the Music Industry," Digimarc (https://www.digimarc.com/docs/default-source/digimarc-resources/whitepaper-blockchain-in-music-industry.pdf?sfvrsn=8c9deb37_4).

[18] Cryptoanchors can take many forms, such as tiny computers or optical codes, when they are tied to a blockchain. For example, cryptoanchors can be embedded into an edible shade of magnetic ink, which can be used to dye a malaria pill. The code could become active and visible with a drop of water, letting a consumer know it's authentic and safe to consume. Source: "5 in 5: Five innovations that will help change our lives within five years," IBM (https://www.research.ibm.com/5-in-5/crypto-anchors-and-blockchain/).

[19] Blockchain is a multiparty play, and the governance model must come first and reflect end-to-end process. See the Forrester report "Distributed Ledger Technology: How To Get Started Without Getting Your Fingers Burnt."

[20] In the near term, candidates for blockchain business typically involve multiple organizations where lack of process visibility and reconciling data between parties are issues. See the Forrester report "Emerging Technology Spotlight: Distributed Ledger Technology."

[21] Blockchain technology providers are driving evolution and adoption of blockchain in various industries. See the Forrester report "Vendor Landscape: Blockchain Technology Providers In Asia Pacific."

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