Chainstack

Whitepaper v7

Contents

EXECUTIVE SUMMARY

While blockchain technology is viewed as a disruptive force for the existing infrastructure and may fundamentally change the way multiple industry verticals operate day-to-day business, the challenges of enterprise adoption and integration need to be addressed.

There are dozens of blockchain platforms today. In the near future, there will be many blockchain platforms and thousands of services running on top of them, solving unique business challenges and use cases within various industries: finance, healthcare, manufacturing, logistics, public sector, cybersecurity.

Enterprises, governments and mid-size businesses will need to work with multiple blockchain networks and will require a platform with a set of essential services providing advanced management capabilities and facilitating leveraging of multiple blockchains platforms.

Chainstack seeks to create a complete platform for building, deploying, and managing blockchain-powered applications. The platform will bring the enterprises the tools and services they need today and will allow businesses to leverage blockchain networks and ecosystem in the long term.

Chainstack enables profitable integration of blockchain into existing enterprise business functions. Working closely with partners, global consulting companies, system integrators and service providers, Chainstack offers a comprehensive blockchain Platform as a Service. Unique capabilities such as Management & Orchestration, Universal API and Services Hub allow Chainstack to complement and enhance blockchain platforms and protocols, enabling customers to build bleeding edge blockchain-powered applications atop the platform.

Next generation blockchain platforms will be more efficient, secure, trusted and cheaper than any of the available alternatives for the enterprises today. Chainstack primary focus is to serve the enterprise blockchain market for cost saving, performance, security and regulatory reasons. However, Chainstack also handles specific public blockchain network use cases to facilitate interoperability between various networks.

To summarize, *"Many blockchain developers liken the maturity of the blockchain tools and frameworks to those of the web during early days of the Internet. […] "There is extremely low-hanging fruit in making the field more accessible, and a lot of technical infrastructure needs to be built up to bring blockchain from 1994, in internet terms, to 2017."* [1]

THE CHAINSTACK PLATFORM

Today's decentralized applications are built by a tiny group of blockchain-savvy early adopters, rather than mainstream developers. Steep learning curve and effort involved in the process has delayed wide adoption, which is blocking the major wave of blockchain applications. To attract large numbers of developers, building a blockchain-enabled application should be as simple as creating a modern web service.

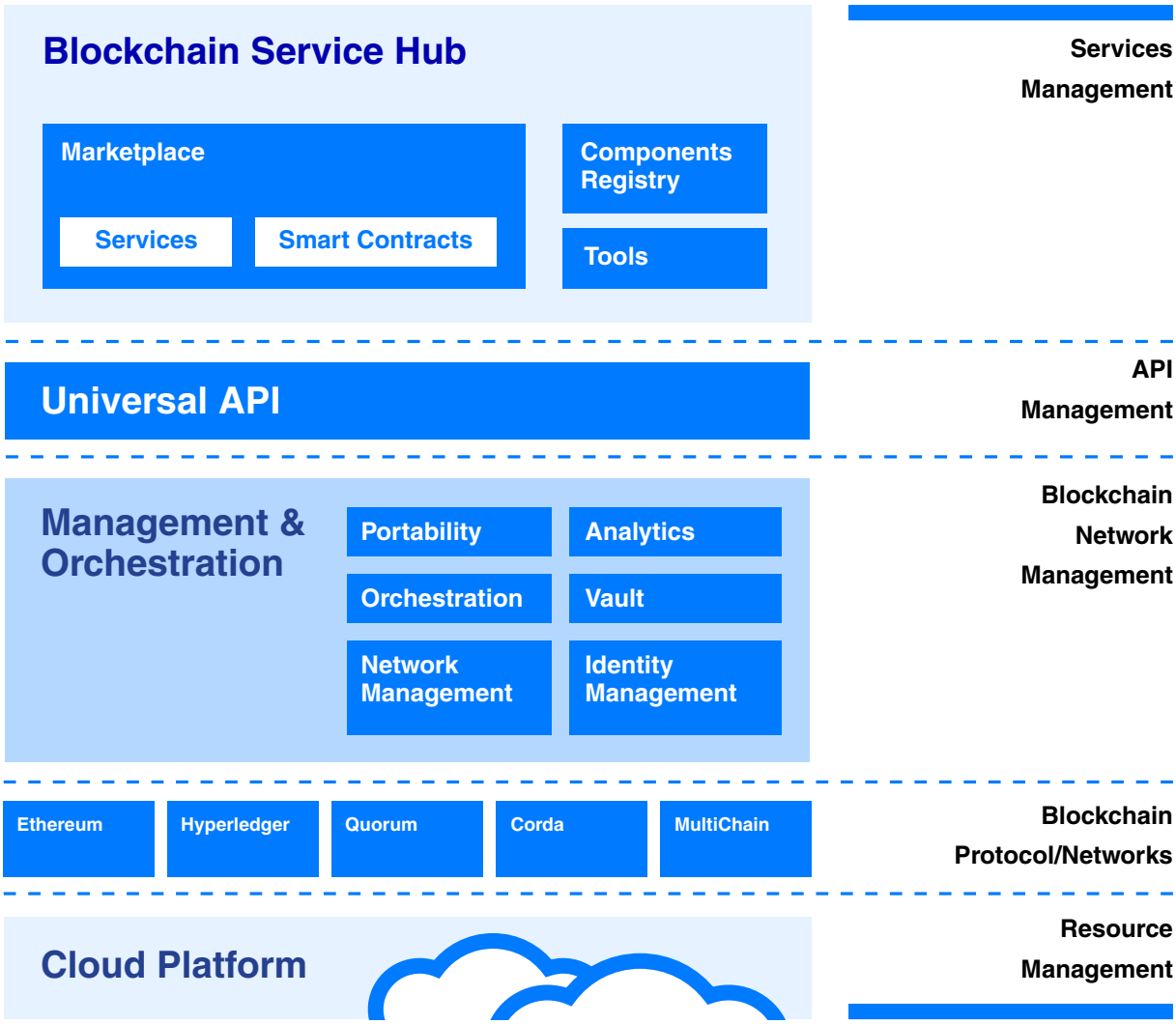
Chainstack is a cloud- and blockchain-agnostic platform with the following key features

- Blockchain network management in public/private/hybrid environment
- Universal API to manage the services in the platform and simplify integration with existing applications
- Marketplace for variety of services such as decentralized storage/ computation and smart contracts
- Component registry for code components contributed by community developers
- Analytics centered on the blockchain network aspects such as cost and performance
- Migration of operations and business-level interoperability between blockchains
- Developer tools to facilitate easy and robust production, testing and deployment of blockchain applications

Blockchain technology should become completely transparent to the creators. We believe that developers should be spending more time building their applications than creating blockchain network or implementing an integration with a decentralized service. We want to build a platform to make it easier to approach the blockchain ecosystem.

Currently, the benefits of decentralized networks are often outweighed by high, unpredictable cost and complex deployment. Existing solutions from major cloud service providers like IBM and Microsoft are not built to facilitate the diversity of blockchains or decentralization in general, but to maximize the service cost.

Moreover, there is no convenient way to put a blockchain-based solution into production once an organization builds a PoC and proves the value of applying blockchain in particular use case. Who can assemble, harden and support the blockchain network components and all required infrastructure? Who is going to provide monitoring, troubleshooting and day-to-day administration like upgrading the blockchain software to new versions with backward compatibility? With a blockchain solution in production, operations and supportability become critical, including ability to comply to service-level agreements, support migration of data between different blockchains and identify transaction anomalies.



Basic Architecture of the Chainstack Platform

Management & Orchestration

Chainstack Platform provides comprehensive management and orchestration capabilities. Since our target is to fit in the familiar development environment, both web and command-line interfaces are available.

Dashboard

Dashboard provides an overview of provisioned services in the Chainstack Platform:

- Blockchain network configuration, status, topology, health and latest transactions;
- Blockchain services status, consumption and cost;
- Notifications regarding performance, security issues or anomalies.

Network Management

Chainstack provides a convenient and interactive web interface to go through key steps to set up and provision the network and manage the blockchain network through its entire lifecycle:

Configuration
Define network topology, governance model and consensus mechanism

Deployment
Choose between public, private or hybrid cloud

Governance
Invite and remove members, issue and revoke credentials

Operation
Monitor health and activity, orchestrate deployments, install patches and updates and tear down nodes

Recovery
Automatically recover and re-deploy nodes when they go down

Network Management layer is cloud-agnostic, capable of working across all major cloud providers, including Google Cloud, Amazon Web Services and Microsoft Azure. Being blockchain-agnostic as well, Chainstack intends to support a variety of blockchain networks and protocols that might be useful for enterprise scenarios, such as Ethereum, Hyperledger Fabric and Burrow, Corda, MultiChain, Quorum, Chain Core and Exonum. We plan to add support for new networks and protocols as soon as they are available and reach a certain level of maturity.

Vault

Chainstack provides a secure and versatile vault for the users of the blockchain networks deployed on the platform. The vault can store identities, currencies or tokens for all blockchain networks available in the platform. Our vault supports both Multisignature *(Multisig)* and Hierarchical Deterministic *(HD)* blockchain wallets:

Multisignature wallet: multiple private keys are required to used the funds in the wallet. In a typical 2-of-2 keys scenario, the platform creates and stores one part of the private key and the user creates another part and stores it separately. Both keys will have to be united to make transactions;
Hierarchical Deterministic (HD) wallet: system of wallets wherein a random seed value is used to derive the keys for the user. The seed is then presented to the user as strings for storage.

Thus users can choose to be partially responsible for the safety of their account credentials or let Chainstack handle the security on their behalf. All sensitive materials including cryptographic keys are housed in secure storage solutions provided by the Cloud Service Providers: for example, CloudHSM [2] or Key Management Service (KMS) [3] on Amazon Web Services and Key Vaults on Microsoft Azure [4].

Vault service also facilitates the storage of customer funds. Chainstack primarily accepts CSK tokens as a form of payment for the platform services. We intend to support conventional payments for entry into the platform — this will make it easier for enterprises to adopt the platform initially. Once onboarded, customers will need to convert their fiat money deposit to CSK tokens to access the services.

In order to support cross-currency conversion between fiat, CSK tokens and other cryptocurrencies/tokens that can be used to pay for various decentralized services from the Marketplace, Chainstack is going to integrate with well-known exchanges like Binance, Bittrex, ShapeShift and Changelly. In the future, we plan to support protocols such as Interledger and Cosmos to switch between multiple currencies/tokens.

Identity Management

The Chainstack Platform provides identity management capabilities for both permissioned and permissionless blockchains. This allows for secure management of organizational identities and their hierarchy. Chainstack supports multiple formats and protocols and can be easily integrated with existing identity management solutions.

PERMISSIONED NETWORKS

In a permissioned model, blockchain network members are known entities and must be enrolled though membership services, which issue enrollment certificates. These cryptographically signed certificates securely link member identity and authorization attributes with the cryptographic key that enables authentication of their digitally signed messages. There are two types of permissioned blockchains currently used in the enterprise model [5]:

Private: usually managed by a single organization. Typically, the network participants are internal business units or divisions;
Consortium: in this case, the blockchain network is managed by multiple trusted organizations. New participants require a consensus of several participants.

Most private blockchains have provisions for Certificate Authorities *(CAs)* within their blockchain networks. For instance, Hyperledger Fabric has a "fabric-ca" *(as a root CA)* using X.509 certificates [6]; Corda has a similar CA hierarchy defined with four levels of CAs [7]. The platform provides the flexibility to spin-up, configure and use the relevant CA depending on the type of blockchain deployed. The blockchain network can implement its certificate hierarchy, with the root CA at its highest level of trust.

PERMISSIONLESS NETWORKS

In a permissionless model, anyone can be a node in a blockchain network. Each node is usually identified with a wallet and one or many private keys and the nodes function anonymously or with a pseudonymous identity. Permissionless blockchain networks deployed on the platform can make use of the Vault service hosted by the platform.

Cost Management

The Chainstack Platform will provide a unified cost management interface to project metrics for usage metering, planning, forecasting and reconciliation of the underlying blockchain networks and services.

Analytics

Data analysis on blockchains tend to focus on two categories of data:

Data at rest: refers to data that already exists in a blockchain's immutable data store. Chainstack provides advanced blockchain exploration capabilities to browse the history of mined blocks, transactions included within them and will include more advanced features like fishing out individual transaction parameters and tracing the trail of certain transactions;
Data in movement: this moves the collection point of data in event form to the processes of a blockchain network. Adding event generation at various points in the client, miner/consensus and protocol processes of a blockchain, it is possible to provide stream-based, real-time analytics of any blockchain activity or blockchain content. The analytics produced using this method are operational in nature and include network information *(ledger status, active members, number of peers and blocks, latest transactions, transactions rate, block updates per second and total transaction times from creation to block update)* [8], performance data, nodes status and deployed smart contracts. The Chainstack Platform exposes event-driven API which make it possible to obtain real-time analytics from the deployed blockchain.

The Analytics module also supports an auditing service which can deliver comprehensive information to aid compliance audits.

Portability

The platform enables easy migration of data and operations from one blockchain to another. This can be desired for a few reasons:

- Optimize blockchain operations by offloading excessive data content to sidechains;
- Abandon a blockchain network and move to another one, if the current one is not trusted anymore.

The platform is able to issue automated suggestions for migration to optimize operations. Such migration is feasible as long as both blockchain networks provide total ordering of events.

Universal API

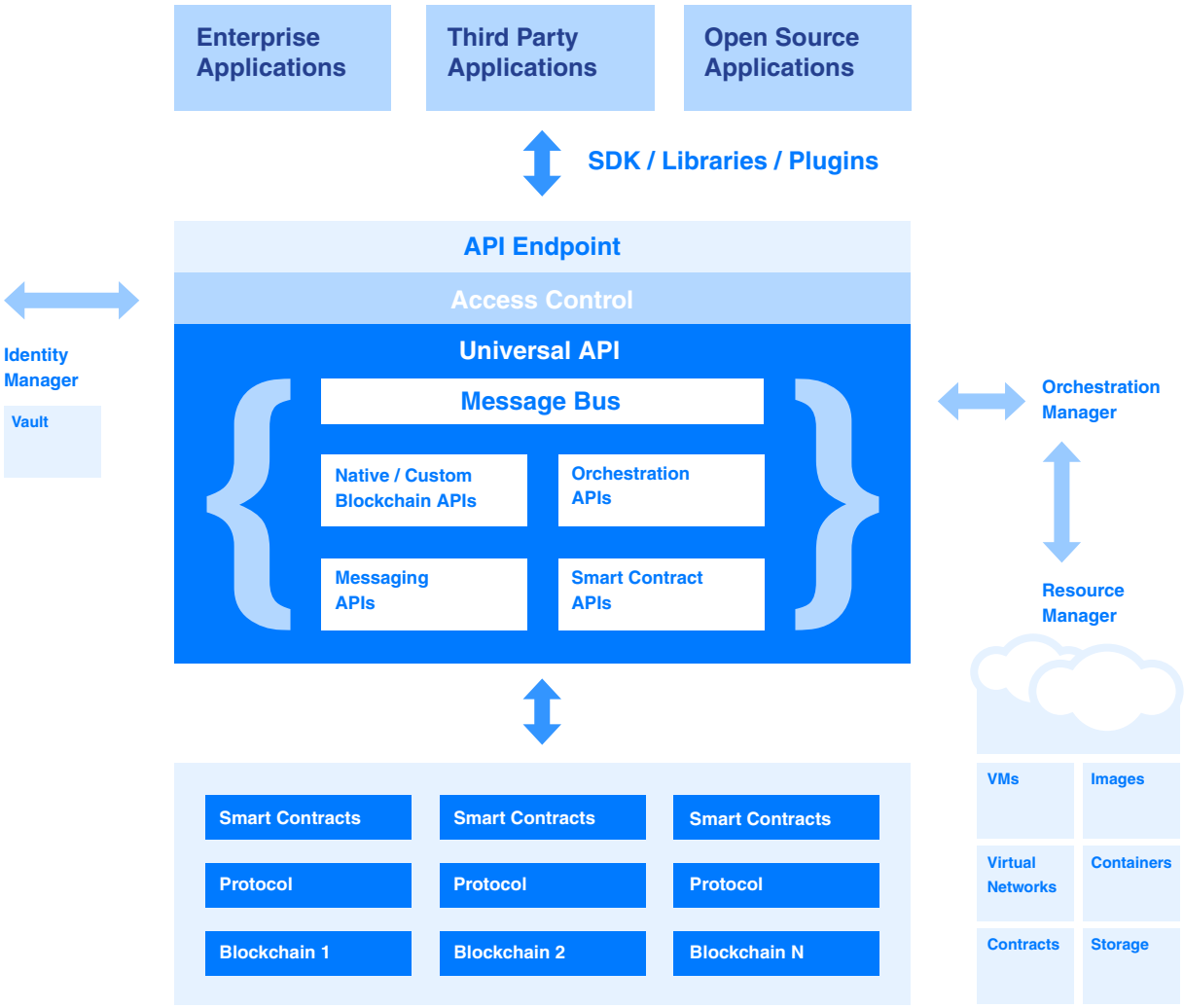
Blockchain is envisioned not to replace, but rather extend current enterprise systems of record keeping such as supply chain management, enterprise resource planning and human capital management. Building and managing such integration from scratch is a complex, costly and error prone endeavor that few businesses are currently willing to undertake.

The many facets of such an endeavor, including provisioning and scaling of hardware resources, blockchain network management, development and deployment of smart contracts, access control and security present challenges which currently do not have an elegant solution.

A modern API-driven service is needed to address these challenges so that businesses can leverage blockchain services without having to worry about the underlying complexities. Chainstack provides a comprehensive set of programmatic interfaces, libraries and services to enable seamless integration of existing business applications with blockchain networks.

Chainstack Universal API simplifies automation, coordination and management of processes that span both existing business applications and blockchains, as well as reconciliation of data. Chainstack helps to deliver new applications that drive enterprise innovation and integrate with existing solutions like ERP, CRM, SCM and other systems that are key to information sharing with external organizations.

To facilitate easy integration with Chainstack Universal API, a set of client SDKs, plugins and DevOps tools will be made available in a number of programming languages.



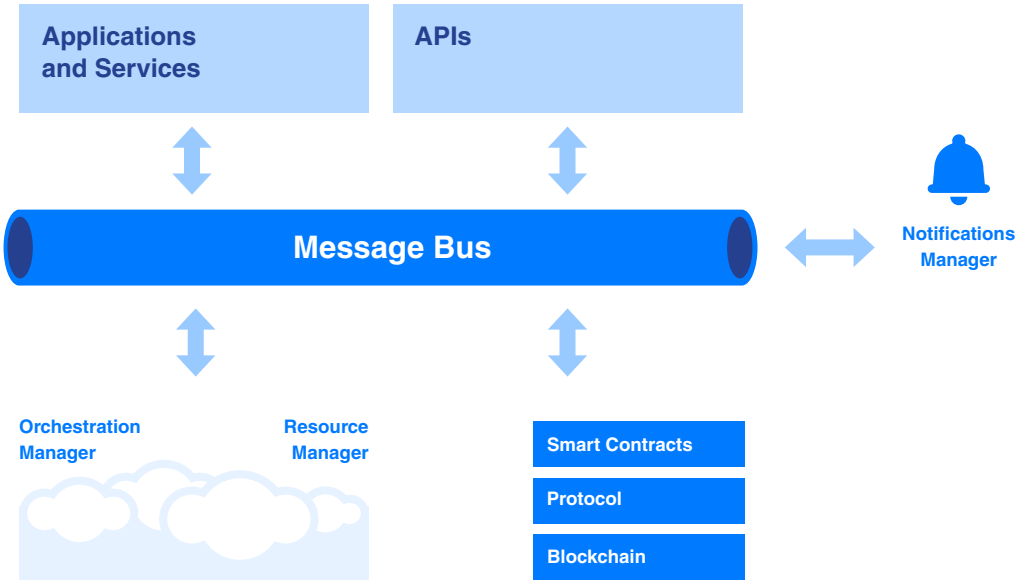
Universal API in the Chainstack Platform

Messaging

Messaging enables interoperability between the various platform services and existing business applications. Such event-driven design leads to loose coupling of the various components, thereby providing natural scalability and extensibility. This facilitates rapid development of new services and applications without having to rethink the architecture.

A variety of messaging patterns, including Publish-Subscribe, Queue and Push-Pull are supported. The system is driven by the message bus responsible for message reception, storage, routing and dispersion.

Developers can leverage these messaging capabilities of the platform via a set of APIs. Applications and services will be able to register for and respond to real-time and non-real-time events such as new transactions on the blockchain networks, smart contract related activities and infrastructure alerts. Events can also be generated via APIs to be consumed by other applications and/or third parties. Notifications can be received on a number of platforms including mobile devices.



Messaging in the Chainstack Platform

Orchestration API

Provision infrastructure resources such as nodes, storage and other artifacts required for successful operation of the blockchain network programmatically. Bring up, scale, manage and easily control the life cycle of such resources.

Blockchain Network API

Chainstack provides a set of APIs to communicate with deployed blockchain networks, including obtaining information about accounts, addresses, blocks and transactions. It enables blockchain unaware applications to seamlessly interact with blockchain networks by abstracting away the underlying nuance and bring about new functionalities to suit a variety of enterprise use cases.

IAM API

Identities on the Chainstack platform are managed via Identity and Access Management (IAM) APIs. Users, groups, roles and permissions can be created, managed and destroyed programmatically. Fine grained access control and authorization policies are free to be developed for a variety of business needs. Different components of the Chainstack Platform could be made selectively available to different users of an organization.

The APIs provide secure and revocable methods for services and applications on the Chainstack Platform to communicate with one another. Identity federation will also be supported so that existing enterprise IAM setup such as Active Directory and LDAP can seamlessly work with Chainstack.

Smart Contract API

Facilitates operations related to smart contracts, including automated customization, deployment from templates library, execution, querying and destruction.

Interoperability

PRIVATE BLOCKCHAINS

Universal API will facilitate cross-chain communication between multiple private blockchains deployed within the platform. This interaction will be securely governed by the message bus and restricted by appropriate identity and access control measures.

It is to be noted that this cross-chain interaction for data sharing is done via secure APIs at a business level and not at the blockchain protocol level. When protocol-level cross-chain interconnecting networks like Aion and Cosmos extend their platforms to support private blockchains, we will evaluate and support them in the Chainstack Platform.

The ability to interact across chains opens up a wide array of interesting applications for enterprises in the fields of healthcare, insurance and finance. For instance, enterprises in the insurance and healthcare domains can use interacting blockchains to share sensitive precision medical information between themselves securely, by harnessing the immutable and transparent nature of private blockchains.

PUBLIC BLOCKCHAINS

The Chainstack Platform facilitates interactions between private blockchains managed by itself and other public blockchains, if and when required. Typical use cases for this could be to establish sidechains or perform data anchoring.

Sidechains

A sidechain is a blockchain that runs in parallel to the main blockchain, extending the functionality of the main chain and allowing a decentralized way of transferring/synchronizing value between the two chains. In other words, value can usually be propagated to the sidechain and then back into the main chain. Sidechains can offer useful enhancements in terms of security and performance.

Sidechains add flexibility and allow developers to experiment with beta releases of software updates before pushing them on to the main chain. Traditional banking functions like issuing and tracking ownership of shares can be tested on sidechains before moving them onto main chains. If the security mechanisms for sidechains can be bolstered, sidechain technology holds promise for massive blockchain scalability [9].

Anchoring

Anchoring to public blockchains can be undertaken to uplift the level of security of a private chain to that of a public chain. Currently, these are the widely adopted approaches:

Data anchoring: publishing hashes and metadata from the private chain to the public chain at periodic intervals, thereby creating timestamped proofs of existence of data [10];

Signature anchoring: similar to data anchoring, but creating timestamped proofs of existence of signatures of data. The data is signed with the identities of the nodes creating them, thereby attesting the data and its source [11].

Unmindful of the type of interaction with public blockchains, transaction handling is maintained at the business level and not at the protocol level. So any data contained within the transaction is not moved across the network without the explicit authorization of a node.

Services Hub

Marketplace

DECENTRALIZED SERVICES

A key component of the Chainstack Platform is the Decentralized Services Marketplace which hosts and provides easy access to a variety of decentralized services.

The list includes but is not limited to services for storage and sharing *(IPFS, Sia, Storj, Filecoin*), computation *(iExec, SONM, Golem, Enigma)*, trusted timestamping *(OpenTimestamps)*, data exchange *(GXS, dock.io)*, domain name service *(Namecoin)*, scalable databases *(BigchainDB, IPDB)*, dispute resolution *(Kleros)* and IP management *(COALA IP)*.

The platform manages all the aspects of running such a marketplace:

Service Identification
The platform facilitates this stage by recording details of service identifiers and descriptions to map the service provider so as to distinguish and distribute functionally equivalent services

Integration
All available services are integrated and categorized into relevant sections and listed under one unified marketplace portal

Service Lookup
The platform provides capabilities to lookup a specific service using service-specific queries. Users can provide as much information as possible to locate functionally equivalent services in a targeted category

Selection
Users can select to use any one or more services under different categories

Purchase
Users can use CSK tokens to purchase and pay for the selected services

Management
Users can configure, provision and orchestrate the chosen services. After the service is provisioned, users can manage configuration parameters, secret credentials and billing details. Event-driven APIs are available to manage the services programmatically and integrate them with existing business applications, as outlined under the Universal API section

Availability
The platform maintains P2P registries of functionally equivalent nodes; thereby improving availability in the case of failure of specific service providers

Security
The underlying APIs are secure and provide access controls to ensure reliability of the accessed services

Maintenance
The platform takes care of pruning and maintaining the marketplace as new services enter and existing services are deprecated

If required, the user and service provider may enter into smart contract. In this scenario, users may choose to reuse smart contracts from the Smart Contract Marketplace hosted by the platform.

SMART CONTRACTS

The Chainstack Platform will host a marketplace for smart contracts, categorized based on their application. Developers can list and sell their smart contracts in the marketplace, submit their code for audit using tools/services available in the Services Hub and earn higher ranking or recommendations from the community. The platform will attempt to enforce best practices for building smart contracts in a standardized manner [12].

The users of the platform can choose to customize the purchased smart contracts or deploy them as is. The marketplace will provide ratings for smart contracts and assign them grades based on a number of factors like security level, complexity and applicability. This will serve to guide the users in making an informed choice when selecting smart contracts for deployment and execution.

Component Registry

Chainstack understands and acknowledges the immense contributions of open source projects and allied developers to the blockchain ecosystem. We intend to setup a registry for developers to submit code components. By allowing developers to contribute code, Chainstack can incorporate innovative use cases, functions and features, which might be ignored otherwise.

Developers who contribute high-quality components, will be rewarded for their work with CSK tokens. All contributions in the Component Registry are licensed under an open source license and can be used even outside of the Chainstack Platform, which will significantly boost the overall blockchain adoption.

ENTERPRISE APPLICATION ADAPTERS

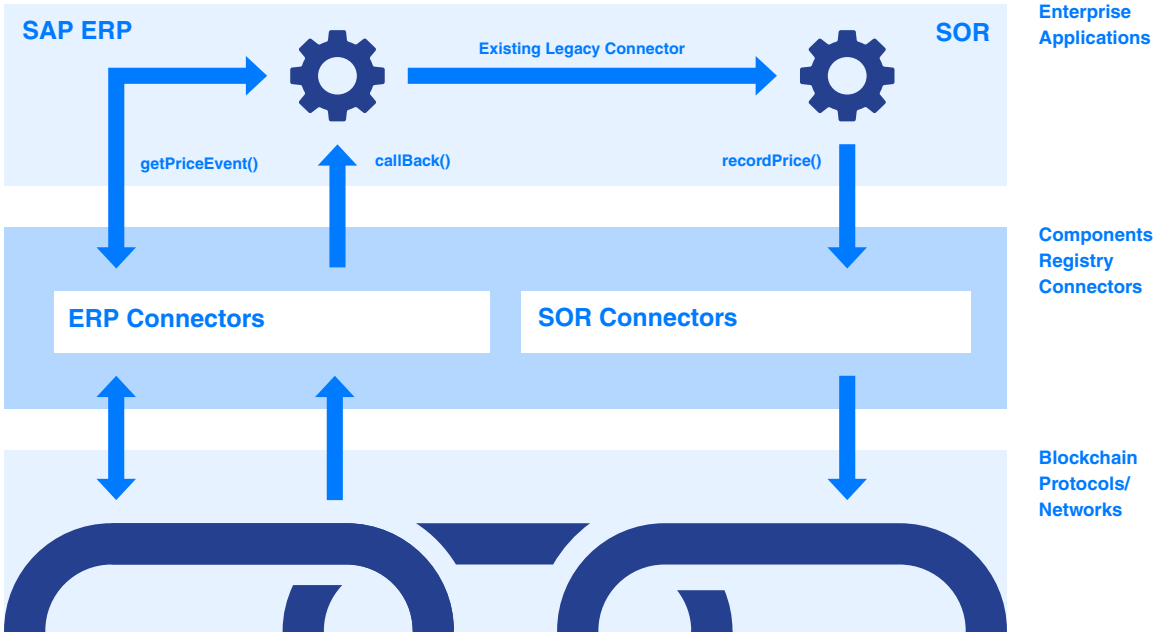
Enterprises rely on a variety of applications to conduct their day-to-day operations, such as ERP, CRM, Systems of Records *(SOR)*, SAP PI, Active Directory and many others, including legacy applications. We envision blockchain and associated protocols not to replace such applications but rather work together with and add value on the top.

To this end, it is important that a robust set of adapters are made available such that interaction between these enterprise applications and blockchain networks and services can be effected in a seamless manner. The Component Registry will house many such adapters for all major enterprise applications including ones from major vendors such as SAP, Oracle, SalesForce and Microsoft.

Taken together, these provide the necessary building blocks to successfully integrate blockchain networks and services with enterprise applications and legacy systems. Such tight integration exposes the full capabilities of the Chainstack Platform to the enterprise domain and enables businesses to reap full benefit of the Chainstack Platform without any significant modifications to their existing setup or architecture.

A few examples of such integration include:

- UI elements such that blockchain related interactions can be initiated from within the existing enterprise application;
- Dashboard integration to manage and monitor blockchain network state;
- SDKs and libraries for access and event processing;
- Helper modules such as data transformers, reconcilers, validators and business context processors;
- Monitoring, exception management and alerting.



Example ERP workflow integration for quotation management

Chainstack will work closely with leading vendors as well as the open source community to develop a rich set of components as well as standards and guidelines for integration of enterprise applications with blockchain networks and services. Components can also be combined together to form an integration recipe, usually for well-defined, predictable and recurring use cases that are common to many different verticals.

BLOCKCHAIN NETWORK ADAPTERS

With blockchain network adapters, enterprise applications can connect to any blockchain supported on the Chainstack Platform. The integration process is greatly simplified and can be made equivalent to connecting to any standard data sources. Functionality brought about by these adapters include configuration, interaction and analysis. The adapters could also provide any necessary data transformation to suit business needs as well as movement of information back and forth between multiple blockchain networks.

Adapters could also be developed for existing tools such as Puppeth [13] to bring about compatibility with Chainstack Platform.

DECENTRALIZED SERVICE ADAPTERS

Services running on the Chainstack Platform, as listed under the Decentralized Services section, can be easily accessed and integrated with the help of service adapters. These adapters bring about functionality including service discovery, configuration, interaction and lifecycle management, and can enable applications or legacy systems to fully leverage a variety of decentralized services on the Chainstack Platform. Service adapters can also be used by enterprises to rapidly test or prototype various services and use cases, and pick ones that best solve their business needs. Service switching can be done in a transparent manner by replacing the appropriate service adapter.

Development Tools

Services Hub will also host a set of developer tools to facilitate easy and robust production, testing and deployment of blockchain applications on to the Chainstack Platform. Developers can leverage these tools to quickly solve business problems without having to spend resources on setting up the necessary tooling.

Facilities provided by the toolset include but not limited to:

- Smart contract compilation, linking and deployment;
- Console access for smart contract interaction;
- Binary management;
- Testing and debugging;
- Application migration;
- Crypto faucet.

Examples of such tools include development frameworks like Truffle [14], Distributed Applications development tool like Embark [15] and collaborative tools like Hyperledger Composer [16]. Developers on the Chainstack Platform are free to select a particular tool set or framework best suited to solve their business problems.

Security

Blockchain security is complicated by a few issues [17]:

Immaturity and complexity of the technology: due to the different consensus algorithms available *(e.g. proof-of-work or proof-of-stake)*, blockchain types *(e.g. permissioned or permissionless)* and complex underlying cryptographic protocols, it is difficult for security practitioners to fully understand data flows and potential security weaknesses;
Lack of standards and regulations: as of today, blockchain technology is unregulated, resulting in legal uncertainties and grey areas;
Widespread belief that a blockchain is secure by design: blockchain technology is built upon public-key cryptography and primitives such as digital signatures and hash functions, which may give a false impression of security. The fact that all cryptographic protocols have their limits and that holistic security includes not only technology, but also people and processes, is often overlooked in the blockchain security analysis.

Due to these issues, some additional considerations are to be undertaken while defining the threat model and choosing security controls. This includes provisioning controls for attacks like Distributed Denial of Service *(DDoS)*, permissioned blockchain exploitation, smart contract exploitation and wallet hacking.

A number of traditional good security practices can be deployed to address these threats. These include robust key management, data encryption, access control and security monitoring. In addition, there are techniques specific to blockchain technology that can be set up, such as secure wallet management, permissioned chain management, and secure smart contract development and audit. These and other relevant controls will be built into the Chainstack Platform to minimize risk due to security breaches.

Smart Contracts Security

Level	Cause of vulnerability	Attacks
Solidity	Call to the unknown	The DAO Attack
	Gasless send	King of the Ether Throne
	Exception disorders	King of the Ether Throne, GovernMental
	Type casts	
	Reentrancy	The DAO Attack
	Keeping secrets	Multiplayer games
EVM	Immutable bugs	Rubixi, GovernMental
	Ether lost in transfer	
	Stack size limit	GovernMental
Blockchain	Unpredictable state	GovernMental, Dynamic libraries
	Generating randomness	
	Time constraints	GovernMental

A survey of attacks on the Ethereum blockchain

The table above shows a recent survey of attacks [18] perpetrated on the Ethereum blockchain, the bulk of which targeted vulnerabilities and coding bugs in smart contracts used during the respective transactions. This table readily shows the importance of constructing a trusted smart contract base where standard best practices are encouraged to be followed and recommended static smart contract analysis tools like Manticore, Mythril and SmartCheck [19] are available to readily vet the smart contracts.

The Chainstack Platform includes provisions to audit smart contracts in the allied Smart Contract Marketplace and custom ones created by the users. Based on the provided tooling, developers are able to build customized scanning routines and workflows.

Support

Chainstack is committed to support its users and intend to provide 24/7 assistance on any issues that arise on the Chainstack Platform.

BLOCKCHAIN IN ENTERPRISE

Blockchain and associated protocols can be leveraged to bring innovative solutions to many existing problems which otherwise may be cumbersome to solve with existing technologies or outright impossible. Blockchain empowered solutions are attractive to enterprises owing to increased transparency, trust, efficiency, reconciliation, along with reduced cost and better regulatory and compliance posture.

Potential Applications

Enterprise blockchain adoption is gaining traction in recent times as companies and industries realize the key features of blockchain and its capability to improve existing centralized processes. This is a brief overview of some of the areas of improvement across multiple sectors and industries, with the application of blockchain.

INSURANCE

The Insurance sector could possibly see faster, more transparent and efficient Property and Casualty Insurance Claims Processing owing to the truly autonomous nature of smart contracts on blockchain, which eliminate much of the redundant mediators inherent in such systems.

For example, IBM, AIG and Standard Chartered Bank announced they have successfully piloted the first multinational, smart contract based insurance policy using blockchain [20]. This system provides the ability to record and track events and associated payments in each country related to the insurance policy. No one party can modify, delete or even append any record without the consensus from others on the network. This level of transparency helps reduce fraud and errors, as well as the need for the parties to contact each other to view policy and payment data and the status of policies.

HEALTHCARE

Patient records and allied data management is a critical issue for the healthcare sector owing to privacy and regulatory concerns. It is also in the interest of the medical community to securely store and share this data for research and analysis purposes. Blockchain could vastly improve this process by allowing for secure storage using its inherent decentralized architecture and private sharing of sensitive data with the additional support for auditing and compliance as guaranteed by its Distributed Ledger Technology *(DLT)*.

LOGISTICS

Logistics is an area which has seen high proliferation of blockchain technology-based trials and deployments in real-world scenarios. The private blockchain key features of access control and immutability serve as drivers to efficient supply chain management to ensure the integrity of commodities and components on the supply chain. The De Beers blockchain initiative to protect the Diamond Value chain is a good example of this use case [21]. Supermarket giant Walmart has also launched a blockchain-based initiative to protect the integrity of food products starting from the producer of raw materials all the way to the consumer of the finished product [22].

FINANCE

Banks and other financial organizations have already started launching successful blockchain pilot programs, owing to the success of cryptocurrencies relying on the security of the underlying blockchain. Some of the key areas where blockchains could further improve existing operations are Cross-border Payments & Transaction Processing, Online Identity Management and KYC processes, Rewards and Loyalty-Based Microtransactions and Inter and Intra-organizational records keeping [23].

We are already seeing pilot projects in this arena ranging from Project Ubin [24], a collaborative project between the Monetary Authority of Singapore and the banking industry, to explore the use of DLT for payment and securities clearing, to Singapore Airlines' first blockchain-based Airline Digital Wallet [25] for loyalty management.

GAMING & ENTERTAINMENT

Blockchain technology has already proven to be an excellent fit for the Online Gaming industry, what with the CryptoKitties craze on Ethereum and the concept of cryptocurrencies, which closely mirror virtual currencies in games, which allow gamers to purchase virtual objects in the gaming universe. Blockchain could potentially also usher in a more decentralized model of compensation and sponsorship for game developers.

Blockchain will greatly benefit the Entertainment industry by ensuring a fair payment model for Digital Content Distribution and Rights Management. For instance, DECENT, a Swiss tech startup, is already applying blockchain technology to build a secured and trusted content distribution platform for authors, artists, and creatives of all calibers [26].

As can be seen in this overview, blockchain offers numerous opportunities to revamp existing business platforms by functioning as immutable distributed ledgers, sensitive information sharing platforms, enabling autonomy via smart contracts and aiding with audit and compliance.

Key Value Proposition

Here, we explain the key value proposition that blockchain can offer businesses as opposed to the existing systems.

Problem	**Auditing and compliance** **Example:** Business systems generate vast amounts of log data which needs to be securely stored for audit, compliance and reconciliatory purposes. Integrity of the stored logs is paramount to maintain trust in such systems as well as for satisfying regulatory and reconciliation requirements.	**Storage and availability of sensitive data** **Example:** Critical IT systems such as FireWalls, Key servers etc. are configured via highly sensitive and confidential configuration files. Maintaining integrity, traceability and availability of these files is crucial to continued business operations.	**Information sharing across organizations** **Example:** Customer onboarding generates KYC data which is siloed and not easily accessible to units within a business as well as across businesses.
Current solution	Logs are stored in a centralized, and possibly mirrored, database. The system relies on trust worthy human administrators to maintain integrity of the stored logs.	Stored as text files or as entries in a traditional database, and possibly mirrored. The system relies on trust worthy human administrators to maintain integrity of the stored configurations. Version control is achieved via traditional mechanisms such as software versioning tools.	Businesses as well as units within a business duplicate the KYC process, leading to redundancy, inefficiency and lack of transparency in the on boarding process. Frustrated end users who have to complete KYC process multiple times.
Blockchain Solution	An immutable and distributed data store of cryptographic signatures, guaranteeing integrity, as well as being highly available in the face of multiple infrastructure failures. External parties such as auditors are provided with permissioned read access to the blockchain to facilitate efficient reconciliation.	An immutable, versioned and distributed data store for configuration data offering cryptographic storage as well as integrity guarantee, and being highly available in the face of multiple infrastructure failures.	A consortium driven, distributed data store that is shared securely among multiple pertinent business entities and/or among business units.
Value Proposition	Improved regulatory posture. Efficient data reconciliation. Remove trust on human administrators.	Remove trust on human administrators. Immutable data store. Distributed validation.	Increased transparency, streamlined workflow and de-duplication.
Blockchain deployment model	As a private, singly owned distributed ledger. Permissioned read/write access to intra business units, and permissioned read access to external units. Business units run one or more nodes of the blockchain network.	As a private, singly owned distributed ledger. Permissioned read/write access to intra business units. Business units run one or more nodes of the blockchain network.	As a multi entity, consortium owned distributed ledger. Permissioned read/write access to intra business units, and permissioned read access to external units which could include members of the public. Entities of the consortium and business units within such entities run one or more nodes of the blockchain network. The network operates without explicit consensus (as in a public blockchain consensus) but under strict apriori legal agreements among the consortium members. Members verify and validate new data on the blockchain, typically based on a Proof of Authority (PoA) model.

Conclusion

The evolution of blockchain applications is similar to the evolution of web technologies and cloud infrastructure.

As applications moved from enterprise-hosted bare metal servers to the cloud, platforms like AWS, Azure and Bluemix emerged. They were all infrastructure providers early in the paradigm shift, whereas now these services have transformed themselves into true Platforms as a Service. They provide a wide array of services at varying levels of abstraction: virtual and containerized execution environments, plethora storage solutions, identity management, security and business intelligence.

Similarly, blockchain networks are infrastructure and you need a platform to rapidly build relevant decentralized applications. Modular and extensible architecture of Chainstack Platform enables customers and partners to build decentralized applications to solve industry specific use cases.

The adoption of blockchain in the enterprise is not a matter of "if" but "when" it will happen. Different blockchain networks will provide the enterprises and governments the distributed ledger network they need. Chainstack Platform enables convenient, powerful and cost-effective way to access blockchain networks and services and integrate existing business applications with decentralized ecosystem.

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