Primechain Technologies

Blockchain Security Controls

Primechain-BSC

Version 1.2 dated 26th February, 2021

Primechain-BSC prescribes security controls for blockchain implementations. Many of the security controls are based on *NIST Special Publication 800-53 Revision 4* and apply to blockchain as well as distributed ledger systems.

Primechain-BSC is maintained by Primechain Technologies Private Limited.

Primechain Technologies Pvt. Ltd.
410, Supreme Headquarters,
Mumbai-Bangalore Highway,
Near Audi Showroom,
Baner,
Pune - 411045 (INDIA)

Email: info@primechain.in
Web: http://www.primechaintech.com

Document history

26th February 2021: Version 1.2 of PT-BSC released. Changes include – addition to list of consensus mechanisms.

4th August 2018: Version 1.1 of PT-BSC released. Changes include – changes to the document layout, fonts and design, addition of a glossary and addition of a section about Primechain Technologies.

29th November 2017: Version 1.0 of PT-BSC released

Note: Blockchains inherently involve multiple parties and organizations. In this document, the term *organization* includes, unless repugnant to the context, all participating organizations that have agreed on a common security framework, framework revision procedures, and security compliance monitoring processes.

Table of Contents

A. Introduction to blockchain technology

Blockchain technology was announced through the paper titled "*Bitcoin: A Peer-to-Peer Electronic Cash System*" by Satoshi Nakamoto in 2008. Interestingly, this paper does not specifically use the word "blockchain". This paper talks about a "purely peer-to-peer version of electronic cash" where "the network timestamps transactions by hashing them into an ongoing chain of hash-based proof-of-work, forming a record that cannot be changed without redoing the proof-of-work".

Blockchain technology is an innovative mix of public key cryptography (invented in the 1970s), cryptographic hash functions (born in the 1970s) and proof-of-work (invented in the 1990s).

Over the last few years, many derivate and blockchain-inspired projects have been created. Most of them are not technically blockchains, but rather distributed ledger systems. For simplicity, we have used the terms blockchain and distributed ledger system interchangeably in this article.

Blockchain solutions can be **permissioned** (e.g. a Government run land registry) or **permission-less** (e.g. Bitcoin, where anyone can become a miner). Blockchain solutions can be **private** (e.g. a contract management system implemented in a pharmaceutical company), **public** (e.g. an asset backed cryptocurrency) or **hybrid** (e.g. a group of banks running a shared KYC platform).

There are 2 things that blockchains can do very well: data authentication & verification (immutable storage, digital signatures and encryption) and smart asset management (issuance, payment, exchange, escrow and retirement).

The original blockchain, which powers the bitcoin crypto-currency, used proof of work as a **consensus** mechanism. But today there are multiple distributed ledger systems that offer a host of consensus mechanisms such as Proof of stake, Byzantine fault tolerant, Deposit based consensus, Federated Byzantine Agreement, Proof of Elapsed Time, Derived PBFT, Redundant Byzantine Fault Tolerance, Simplified Byzantine Fault Tolerance, Federated consensus, Round Robin and Delegated Proof of Stake.

Some of the popular blockchain platforms / **frameworks** include: Hyperledger (Burrow, Fabric, Indy, Iroha & Sawtooth), Multichain & Ethereum, Quorum, Stellar.

Primechain-BSC prescribes security controls for blockchain implementations. Many of the security controls are based on *NIST Special Publication 800-53 Revision 4* and apply to blockchain as well as distributed ledger systems.

B. Components of a blockchain

There are several components of a blockchain:

#	Component	Example / description
1	blockchain platform	Used interchangeably with the term distributed ledger system; examples - bitcoin, ethereum, multichain, sawtooth, fabric;
2	blockchain instance	a running implementation of multichain including the block data and block headers;
3	blockchain nodes	the systems on which a *blockchain instance* is installed; nodes replicate, access, write to and maintain a single series of linked blocks of transactions; nodes for a single blockchain may be spread across several geographies and organizations.
4	blockchain connectors	a *Macintosh* laptop used to connect to the *blockchain nodes* through ssh;
5	external interface	a *nodejs* based blockchain explorer;
6	blockchain development ecosystem	the technological ecosystem of the entities where the design, development, upgrade and maintenance of the blockchain takes place;
7	blockchain user ecosystem	the technological ecosystem of the end-users of the blockchain.

C. Security controls for blockchain instances

C.1 Primary considerations

(a) Blockchain permissions

The organization has systems in place to determine:

1. restrictions applied to connecting to the network
2. restrictions applied to signing transaction inputs
3. restrictions applied to appearing in transaction outputs
4. restrictions applied to creating new assets
5. restrictions applied to confirming transactions
6. restrictions applied to changing permissions of other users

(b) Consensus mechanisms

The organization has systems in place to determine the appropriate consensus mechanism:

Consensus algorithms are the heart of blockchains. They enable network participants to agree on the contents of a blockchain in a distributed and trust-less manner. The world's first consensus algorithm was Bitcoin's Proof of Work (PoW). Today there are 75 algorithms divided into 10 categories:

1. Chain-based Proof of Work
2. Chain-based Proof of Stake
3. Chain-based Proof of Capacity/Space
4. Chain-based Hybrid models
5. Chain-based Proof of Burn
6. Chain-based Trusted computing algorithms
7. Chain-based PBFT and BFT-based Proof of Stake
8. Chain-based others
9. Chain-based DAG
10. Magi's proof-of-work (mPoW)

(c) Considerations for proof-of-work based blockchain instances

The organization has systems in place to determine the:

1. target average time between blocks
2. maximum size of each block
3. length of initial setup phase
4. mining diversity
5. minimum / initial proof-of-work difficulty
6. frequency of recalculating proof-of-work difficulty level
7. maximum size of a standard transaction,
8. maximum size of data elements in standard transactions.

(d) Considerations for native blockchain currency (optional)

The organization has systems in place to determine the:

1. initial block reward
2. first block reward,

3. reward halving interval,
4. reward spendable delay,
5. minimum quantity of native currency in every transaction output
6. maximum quantity of native currency in every transaction output
7. minimum relay fee
8. units per display unit of the native currency

(e) Blockchain Security Program Plan

1. The organization develops and disseminates an organization-wide blockchain security program plan that:
    a. Provides an overview of the requirements for the security program and a description of the security program management controls and common controls in place or planned for meeting those requirements;
    b. Includes the identification and assignment of roles, responsibilities, management commitment, coordination among organizational entities, and compliance;
    c. Reflects coordination among organizational entities responsible for the different aspects of information security (i.e., technical, physical, personnel, cyber-physical); and
    d. Is approved by a senior official with responsibility and accountability for the risk being incurred to organizational operations (including mission, functions, image, and reputation), organizational assets, individuals, and other organizations.

2. The organization reviews the organization-wide blockchain security program plan every month.

3. The organization updates the plan to address organizational changes and problems identified during plan implementation or security control assessments.

4. The organization protects the blockchain security program plan from unauthorized disclosure and modification.

Note: Blockchain security program plans can be represented in single documents or compilations of documents at the discretion of organizations.

(f) Senior blockchain security officer

The organization appoints a senior blockchain security officer with the mission and resources to coordinate, develop, implement, and maintain an organization-wide blockchain security program.

(g) Blockchain security resources

1. The organization ensures that all capital planning and investment requests include the resources needed to implement the blockchain security program and documents all exceptions to this requirement.

2. The organization ensures that blockchain security resources are available for expenditure as planned.

(h) Plan of action and milestones process

1. The organization implements a process for ensuring that plans of action and milestones for the blockchain program and associated organizational information systems are developed and maintained.

2. The organization documents the remedial blockchain security actions to adequately respond to risk to organizational operations and assets, individuals, and other organizations.

3. The organization reviews plans of action and milestones for consistency with the organizational risk management strategy and organization-wide priorities for risk response actions.

(i) Information system inventory

The organization develops and maintains an inventory of its blockchain systems.

(j) Information security measures of performance

The organization develops, monitors, and reports on the results of blockchain security measures of performance.

(k) Enterprise architecture

The organization develops an enterprise architecture with consideration for blockchain security and the resulting risk to organizational operations, organizational assets, individuals, and other organizations.

(l) Critical infrastructure plan

The organization addresses blockchain security issues in the development, documentation, and updating of a critical infrastructure and key resources protection plan.

(m) Risk management strategy

1. The organization develops a comprehensive strategy to manage risk to organizational operations and assets, individuals, and other organizations associated with the operation and use of blockchain systems.

2. The organization implements the risk management strategy consistently across the organization.

3. The organization reviews and updates the risk management strategy regularly to address organizational changes. An organization-wide risk management strategy includes, for example, an unambiguous expression of the risk tolerance for the organization, acceptable risk assessment methodologies, risk mitigation strategies, a process for consistently evaluating risk across the organization with respect to the organization's risk tolerance, and approaches for monitoring risk over time.

(n) Security authorization process

1. The organization manages (i.e., documents, tracks, and reports) the security state of organizational blockchain systems and the environments in which those systems operate through security authorization processes;

2. The organization designates individuals to fulfil specific roles and responsibilities within the organizational risk management process.
3. The organization fully integrates the security authorization processes into an organization-wide risk management program.

(o) Mission/business process definition

1. The organization defines mission/business processes with consideration for blockchain security and the resulting risk to organizational operations, organizational assets, individuals, and other organizations.

2. The organization determines blockchain protection needs arising from the defined mission/business processes and revises the processes as necessary, until achievable protection needs are obtained.

(p) Insider threat program
The organization implements an insider threat program that includes a cross-discipline insider threat incident handling team.

(q) Blockchain security workforce
The organization establishes a blockchain security workforce development and improvement program.

(r) Testing, training, and monitoring

1. The organization implements a process for ensuring that organizational plans for conducting blockchain security testing, training, and monitoring activities associated with organizational information systems are developed and maintained and continue to be executed in a timely manner.

2. The organization reviews testing, training, and monitoring plans for consistency with the organizational risk management strategy and organization-wide priorities for risk response actions.

(s) Contacts with security groups and associations
The organization establishes and institutionalizes contact with selected groups and associations within the security community to facilitate ongoing security education and training for organizational personnel; to maintain currency with recommended security practices, techniques, and technologies; and to share current security-related information including threats, vulnerabilities, and incidents.

(t) Threat awareness program

The organization implements a threat awareness program that includes a cross-organization information-sharing capability.

C.2 Blockchain Access Control

(a) Blockchain Access Control Policy and Procedures

1. The organization develops, documents, and disseminates, to relevant personnel, a blockchain access control policy that addresses purpose, scope, roles, responsibilities, management commitment, coordination among organizational entities, and compliance.

2. The organization develops, documents, and disseminates, to relevant personnel, procedures to facilitate the implementation of the blockchain access control policy and associated access controls.

3. The organization reviews and updates the current Blockchain Access Control Policy and Blockchain Access Control Procedures every month.

(b) Blockchain Account Management

1. The organization identifies and selects the following types of blockchain accounts to support organizational missions / business functions: (a) blockchain administrator (b) blockchain manager (c) blockchain processor.

2. The organization assigns account managers for blockchain accounts.

3. The organization establishes conditions for group and role membership.

4. The organization specifies authorized users of the blockchain, group and role membership, and access authorizations (i.e., privileges) and other attributes (as required) for each account.

5. The organization requires approvals by the blockchain administrator for requests to create blockchain accounts;

6. The organization creates, enables, modifies, disables, and removes blockchain accounts in accordance with the Blockchain Access Control Policy and Procedures.

7. The organization monitors the use of blockchain accounts.

8. The organization notifies the blockchain administrator (a) when accounts are no longer required; (b) when users are terminated or transferred; and (c) when individual information system usage or need-to-know changes;

9. The organization authorizes access to the blockchain based on: (a) valid access authorization; (b) intended system usage; and (c) other attributes as required by the organization or associated missions/business functions;

10. The organization reviews accounts for compliance with blockchain account management requirements every 24 hours.

11. The organization establishes a process for reissuing shared / group account credentials (if deployed) when individuals are removed from the group.

12. The organization employs automated mechanisms to support the management of blockchain accounts.

13. The organization only permits the use of shared / group accounts that meet organization-defined conditions for establishing shared / group accounts.

14. The organization disables accounts of users posing a significant risk immediately on discovery of the risk.

(c) Blockchain Access Enforcement

1. The organization enforces approved authorizations for logical access to the blockchain in accordance with applicable blockchain access control policies.

2. The organization enforces dual authorization for all actions.

3. The blockchain prevents access to blockchain parameters and specified cryptographic keys except during secure, non-operable system states.

4. The blockchain does not release information outside of the established system boundary.

(d) Information Flow Enforcement

1. The organization enforces approved authorizations for controlling the flow of information within the blockchain and between interconnected systems based on organization-defined information flow control policies.

2. The blockchain prevents encrypted information from bypassing content-checking mechanisms by decrypting the information, blocking the flow of the encrypted information and / or by terminating communications sessions attempting to pass encrypted information.

3. The blockchain enforces organization-defined limitations on embedding data types within other data types.

4. The blockchain enforces information flow control based on organization-defined metadata.

5. The blockchain uniquely identifies and authenticates source and destination points by organization, system, application and / or individual] for information transfer.

6. The blockchain binds security attributes to information using organization-defined binding techniques to facilitate information flow policy enforcement.

7. The blockchain provides access from a single device to computing platforms, applications, or data residing on multiple different security domains, while preventing any information flow between the different security domains.

(e) Least Privilege

1. The organization employs the principle of least privilege, allowing only authorized accesses for users (or processes acting on behalf of users), which are necessary to accomplish assigned tasks in accordance with organizational missions and business functions.

2. The organization explicitly authorizes access to blockchain parameters, cryptographic keys.

3. The organization prohibits privileged access to the blockchain by non-organizational users.

4. The organization reviews daily the privileges assigned to blockchain administrators, managers and processors to validate the need for such privileges; and reassigns or removes privileges, if necessary, to correctly reflect organizational mission/business needs.

(f) Permitted actions without identification or authentication

1. The organization identifies actions that can be performed on the blockchain without identification or authentication consistent with organizational missions / business functions.

2. The organization documents and provides supporting rationale in the security plan for the blockchain, user actions not requiring identification or authentication.

(g) Remote Access

1. The organization establishes and documents usage restrictions, configuration / connection requirements, and implementation guidance for each type of remote access allowed.

2. The organization authorizes remote access to the information system prior to allowing such connections.

3. The blockchain implements cryptographic mechanisms to protect the confidentiality and integrity of remote access sessions.

4. The organization ensures that users protect information about remote access mechanisms from unauthorized use and disclosure.

(g) Wireless Access

1. The organization establishes usage restrictions, configuration / connection requirements, and implementation guidance for wireless access.

2. The organization authorizes wireless access to the information system prior to allowing such connections.

3. The blockchain protects wireless access to the system using encryption and authentication of users & devices.

(h) Access control for mobile devices

1. The organization establishes usage restrictions, configuration requirements, connection requirements, and implementation guidance for organization-controlled mobile devices.

2. The organization authorizes the connection of mobile devices to organizational information systems.

3. The organization prohibits the use of unclassified mobile devices unless specifically permitted by the authorizing official.

4. The organization employs container encryption to protect the confidentiality and integrity of information on organization-defined mobile devices.

(i) Use of external information systems

1. The organization establishes terms and conditions, consistent with any trust relationships established with other organizations owning, operating, and/or maintaining external information systems, allowing authorized individuals to access the blockchain from external information systems.

2. The organization permits authorized individuals to use an external information system to access the blockchain only when the organization verifies the implementation of required security controls on the external system as specified in the organization's information security policy and security plan.

3. The organization restricts / prohibits the use of portable storage devices by authorized individuals on external information systems.

C.3 Awareness & Training

(a) Security awareness and training policy and procedures

1. The organization develops, documents, and disseminates, to relevant personnel, a security awareness and training policy that addresses purpose, scope, roles, responsibilities, management commitment, coordination among organizational entities, and compliance.

2. The organization develops, documents, and disseminates, to relevant personnel, procedures to facilitate the implementation of the security awareness and training policy and associated security awareness and training controls.

3. The organization develops, documents, and disseminates, to relevant personnel, reviews and updates the current security awareness and training policy and security awareness and training procedures every 3 months.

(b) Security awareness training

1. The organization provides basic security awareness training to blockchain users (a) as part of initial training for new users (b) when required by information system changes and (c) every 3 months thereafter.

2. The organization includes practical exercises in security awareness training that simulate actual cyber attacks.

3. The organization includes security awareness training on recognizing and reporting potential indicators of insider threat.

(c) Role-based security training

The organization provides role-based security training to personnel with assigned security roles and responsibilities (a) before authorizing access to the blockchain or performing assigned duties (b) when required by information system changes and (c) every 3 months thereafter.

C.4 Audit and Accountability

(a) Audit and accountability policy and procedures

1. The organization develops, documents, and disseminates to relevant personnel, an audit and accountability policy that addresses purpose, scope, roles, responsibilities, management commitment, coordination among organizational entities, and compliance.

2. The organization develops, documents, and disseminates to relevant personnel, procedures to facilitate the implementation of the audit and accountability policy and associated audit and accountability controls.

3. The organization reviews and updates the current audit and accountability policy and audit and accountability procedures every 6 months.

(b) Content of audit records

The blockchain generates audit records containing information that establishes what type of event occurred, when the event occurred, where the event occurred, the source of the event, the outcome of the event, and the identity of any individuals or subjects associated with the event.

(c) Audit review, analysis, and reporting

The organization reviews and analyzes information system audit records in real time for indications of inappropriate or unusual activity and reports findings to the relevant personnel.

(d) Time stamps

The blockchain uses internal system clocks to generate time stamps for audit records and records time stamps for audit records that can be mapped to Greenwich Mean Time (GMT).

(e) Protection of audit information

The blockchain protects audit information and audit tools from unauthorized access, modification, and deletion.

C.5 Security assessment and authorization

(a) Security assessment and authorization policy and procedures

1. The organization develops, documents, and disseminates to relevant personnel, a security assessment and authorization policy that addresses purpose, scope, roles, responsibilities, management commitment, coordination among organizational entities, and compliance.

2. The organization develops, documents, and disseminates to relevant personnel, procedures to facilitate the implementation of the security assessment and authorization policy and associated security assessment and authorization controls.

3. The organization reviews and updates the current security assessment and authorization policy and security assessment and authorization procedures every 6 months.

(b) Security assessments

1. The organization develops a security assessment plan that describes the scope of the assessment including (a) Security controls and control enhancements under assessment; (b) Assessment procedures to be used to determine security control effectiveness; and (c) Assessment environment, assessment team, and assessment roles and responsibilities.

2. The organization assesses the security controls in the information system and its environment of operation every month to determine the extent to which the controls are implemented correctly, operating as intended, and producing the desired outcome with respect to meeting established security requirements;

3. The organization produces a security assessment report that documents the results of the assessment and provides the results of the security control assessment to relevant personnel.

(c) System interconnections

1. The organization authorizes connections from the information system to other information systems through the use of Interconnection Security Agreements.

2. The organization documents, for each interconnection, the interface characteristics, security requirements, and the nature of the information communicated.

3. The organization reviews and updates Interconnection Security Agreements every 6 months.

4. The organization prohibits the direct connection of a blockchain to an external network without the use of an approved boundary protection device.

5. The organization employs allow-all / deny-by-exception / deny-all / permit-by-exception policy for allowing a blockchain to connect to external information systems.

(d) Continuous monitoring

The organization develops a continuous monitoring strategy and implements a continuous monitoring program.

(e) Penetration testing

1. The organization conducts regular penetration testing on all blockchains.

2. The organization employs an independent penetration agent or penetration team to perform penetration testing on the blockchain.

3. The organization employs exercises to simulate attempts by adversaries to compromise blockchains.

(f) Internal system connections

The organization authorizes internal connections of information system components or classes of components to the blockchain and documents, for each internal connection, the interface characteristics, security requirements, and the nature of the information communicated.

C.6 Contingency planning

(a) Contingency planning policy and procedures

1. The organization develops, documents, and disseminates to relevant personnel, a contingency planning policy that addresses purpose, scope, roles, responsibilities, management commitment, coordination among organizational entities, and compliance.

2. The organization develops, documents, and disseminates to relevant personnel, procedures to facilitate the implementation of the contingency planning policy and associated contingency planning controls.

3. The organization reviews and updates the current contingency planning policy and contingency planning procedures every 6 months.

(b) Contingency plan

1. The organization develops a contingency plan for the information system that:
    a. Identifies essential missions and business functions and associated contingency requirements;
    b. Provides recovery objectives, restoration priorities, and metrics;
    c. Addresses contingency roles, responsibilities, assigned individuals with contact information;
    d. Addresses maintaining essential missions and business functions despite an information system disruption, compromise, or failure;
    e. Addresses eventual, full information system restoration without deterioration of the security safeguards originally planned and implemented; and
    f. Is reviewed and approved by [Assignment: organization-defined personnel or roles].

2. The organization distributes copies of the contingency plan to relevant personnel.

3. The organization coordinates contingency planning activities with incident handling activities.

4. The organization reviews the contingency plan for the information system every month.

5. The organization updates the contingency plan to address changes to the organization, blockchain, or environment of operation and problems encountered during contingency plan implementation, execution, or testing.

6. The organization communicates contingency plan changes to relevant personnel.

7. The organization protects the contingency plan from unauthorized disclosure and modification.

8. The organization coordinates contingency plan development (Business Continuity Plans, Disaster Recovery Plans, Continuity of Operations Plans, Crisis Communications Plans, Critical Infrastructure Plans, Cyber Incident Response Plans, Insider Threat Implementation Plan, and Occupant Emergency Plans) with organizational elements responsible for related plans.

9. The organization conducts capacity planning so that necessary capacity for information processing, telecommunications, and environmental support exists during contingency operations.

10. The organization plans for the resumption of essential missions and business functions within 1 hour of contingency plan activation.

11. The organization plans for the resumption of all missions and business functions within 1 hour of contingency plan activation.

12. The organization plans for the continuance of essential missions and business functions with little or no loss of operational continuity and sustains that continuity until full information system restoration at primary processing and/or storage sites.

13. The organization plans for the transfer of essential missions and business functions to alternate processing and/or storage sites with little or no loss of operational continuity and sustains that continuity through information system restoration to primary processing and/or storage sites.

14. The organization coordinates its contingency plan with the contingency plans of external service providers to ensure that contingency requirements can be satisfied.

15. The organization identifies critical information system assets supporting essential missions and business functions.

(c) Contingency training

The organization provides contingency training to information system users consistent with assigned roles and responsibilities (a) within 1 day of assuming a contingency role or responsibility; (b) when required by information system changes and (c) every month thereafter.

(d) Contingency plan testing

1. The organization tests the contingency plan for the information system weekly to determine the effectiveness of the plan and the organizational readiness to execute the plan.

2. The organization reviews the contingency plan test results and initiates corrective actions, if needed.

(e) Alternate storage site

1. The organization establishes an alternate storage site including necessary agreements to permit the storage and retrieval of information system backup information.

2. The organization ensures that the alternate storage site provides information security safeguards equivalent to that of the primary site.

3. The organization identifies an alternate storage site that is separated from the primary storage site to reduce susceptibility to the same threats.

4. The organization configures the alternate storage site to facilitate recovery operations in accordance with recovery time and recovery point objectives.

5. The organization identifies potential accessibility problems to the alternate storage site in the event of an area-wide disruption or disaster (e.g., hurricane, regional power outage) and outlines explicit mitigation actions (for example: (i) duplicating backup information at other alternate storage sites if access problems occur at originally designated alternate sites; or (ii) planning for physical access to retrieve backup information if electronic accessibility to the alternate site is disrupted).

(f) Alternate processing site

1. The organization establishes an alternate processing site including necessary agreements to permit the transfer and resumption of operations for essential missions/business functions within the organization's specified and agreed recovery time objective.

2. The organization ensures that equipment and supplies required to transfer and resume operations are available at the alternate processing site or contracts are in place to support delivery to the site within the organization-defined time period for transfer/resumption.

3. The organization ensures that the alternate processing site provides information security safeguards equivalent to those of the primary site.

(g) Telecommunications services

The organization establishes alternate telecommunications services including necessary agreements to permit the resumption of operations for essential missions and business functions within the organization's specified and agreed recovery time objective.

(h) Information system recovery and reconstitution

The organization provides for the recovery and reconstitution of the information system to a known state after a disruption, compromise, or failure.

C.7 Incident response

(a) Incident response policy and procedures

1. The organization develops, documents, and disseminates to relevant personnel, an incident response policy that addresses purpose, scope, roles, responsibilities, management commitment, coordination among organizational entities, and compliance.

2. The organization develops, documents, and disseminates to relevant personnel, procedures to facilitate the implementation of the incident response policy and associated incident response controls.

3. The organization reviews and updates the current Incident response policy and Incident response procedures every 6 months.

(b) Incident response training

1. The organization provides incident response training to information system users consistent with assigned roles and responsibilities (a) Within 1 day of assuming an incident response role or responsibility (b) When required by information system changes and every 3 months thereafter.

2. The organization incorporates simulated events into incident response training to facilitate effective response by personnel in crisis situations.

3. The organization employs automated mechanisms to provide a more thorough and realistic incident response training environment.

(c) Incident response testing

1. The organization tests the incident response capability for the blockchain every week using defined tests to determine the incident response effectiveness and documents the results.

2. The organization employs automated mechanisms to more thoroughly and effectively test the incident response capability.

3. The organization coordinates incident response testing with organizational elements responsible for related plans such as Business Continuity Plans, Contingency Plans, Disaster Recovery Plans, Continuity of Operations Plans, Crisis Communications Plans, Critical Infrastructure Plans, and Occupant Emergency Plans.

(d) Incident handling

1. The organization implements an incident handling capability for security incidents that includes preparation, detection and analysis, containment, eradication, and recovery.

2. The organization coordinates incident handling activities with contingency planning activities.
3. The organization incorporates lessons learned from ongoing incident handling activities into incident response procedures, training, and testing, and implements the resulting changes accordingly.

4. The organization employs automated mechanisms to support the incident handling process.

5. The organization includes dynamic reconfiguration of [Assignment: organization-defined information system components] as part of the incident response capability.

6. The organization identifies classes of incidents and actions to take in response to classes of incidents to ensure continuation of organizational missions and business functions.

7. The organization correlates incident information and individual incident responses to achieve an organization-wide perspective on incident awareness and response.

8. The organization implements incident handling capability for insider threats.

9. The organization coordinates incident handling capability for insider threats across defined components or elements of the organization.

10. The organization coordinates with relevant external organizations to correlate and share incident information to achieve a cross-organization perspective on incident awareness and more effective incident responses.

11. The organization employs dynamic response capabilities] to effectively respond to security incidents.

12. The organization coordinates incident handling activities involving supply chain security events (e.g. compromises / breaches involving information system components, information technology products, development processes or personnel, and distribution processes or warehousing facilities.) with other organizations involved in the supply chain (e.g. system/product developers, integrators, manufacturers, packagers, assemblers, distributors, vendors, and resellers).

(e) Incident Monitoring

1. The organization tracks and documents information system security incidents. Documenting information system security incidents includes, for example, maintaining records about each incident, the status of the incident, and other pertinent information necessary for forensics, evaluating incident details, trends, and handling. Incident information can be obtained from a variety of sources including, for example, incident reports, incident response teams, audit monitoring, network monitoring, physical access monitoring, and user/administrator reports.

2. The organization employs automated mechanisms to assist in the tracking of security incidents and in the collection and analysis of incident information.

(f) Incident reporting

1. The organization requires personnel to report suspected security incidents (e.g. the receipt of suspicious email communications that can potentially contain malicious code.) to the organizational incident response capability in real time.

2. The organization reports security incident information to the blockchain administrator.

3. The organization employs automated mechanisms to assist in the reporting of security incidents.

4. The organization reports information system vulnerabilities associated with reported security incidents to the blockchain administrator.

5. The organization provides security incident information to other organizations involved in the supply chain (e.g. system / product developers, integrators, manufacturers, packagers, assemblers, distributors, vendors, and resellers) for information systems or information system components related to the incident.

(g) Incident response assistance

1. The organization provides an incident response support resource (e.g. help desks, assistance groups, and access to forensics services,), integral to the organizational incident response capability that offers advice and assistance to users of the blockchain for the handling and reporting of security incidents.

2. The organization employs automated mechanisms to increase the availability of incident response-related information and support.

3. The organization establishes a direct, cooperative relationship between its incident response capability and external providers of information system protection capability.

4. The organization identifies organizational incident response team members to the external providers.

(h) Incident response plan

1. The organization develops an incident response plan that:
    a. Provides the organization with a roadmap for implementing its incident response capability;
    b. Describes the structure and organization of the incident response capability;
    c. Provides a high-level approach for how the incident response capability fits into the overall organization;
    d. Meets the unique requirements of the organization, which relate to mission, size, structure, and functions;
    e. Defines reportable incidents;
    f. Provides metrics for measuring the incident response capability within the organization;
    g. Defines the resources and management support needed to effectively maintain and mature an incident response capability; and
    h. Is reviewed and approved by specified personnel.

2. The organization distributes copies of the incident response plan to incident response personnel.

3. The organization reviews the incident response plan every month.

4. The organization updates the incident response plan to address system/organizational changes or problems encountered during plan implementation, execution, or testing.

5. The organization communicates incident response plan changes to incident response personnel.

6. The organization protects the incident response plan from unauthorized disclosure and modification.

(i) Information spillage response

1. The organization responds to information spills by:
    a. Identifying the specific information involved in the information system contamination;
    b. Alerting relevant personnel the information spill using a method of communication not associated with the spill;
    c. Isolating the contaminated information system or system component;
    d. Eradicating the information from the contaminated information system or component;
    e. Identifying other information systems or system components that may have been subsequently contaminated.

2. The organization assigns relevant personnel with responsibility for responding to information spills.

3. The organization provides information spillage response training regularly.

4. The organization implements procedures to ensure that organizational personnel impacted by information spills can continue to carry out assigned tasks while contaminated systems are undergoing corrective actions.

(j) Integrated information security analysis team

The organization establishes an integrated team of forensic/malicious code analysts, tool developers, and real-time operations personnel.

C.8 Maintenance

(a) System maintenance policy and procedures

1. The organization develops, documents, and disseminates to relevant personnel, a system maintenance policy that addresses purpose, scope, roles, responsibilities, management commitment, coordination among organizational entities, and compliance.

2. The organization develops, documents, and disseminates to relevant personnel, procedures to facilitate the implementation of the system maintenance policy and associated system maintenance controls; and

3. The organization reviews and updates the current System maintenance policy and System maintenance procedures every 6 months.

C.9 Physical and environmental protection

(a) Physical and environmental protection policy and procedures

1. The organization develops, documents, and disseminates to relevant personnel, a physical and environmental protection policy that addresses purpose, scope, roles, responsibilities, management commitment, coordination among organizational entities, and compliance.

2. The organization develops, documents, and disseminates to relevant personnel, procedures to facilitate the implementation of the physical and environmental protection policy and associated physical and environmental protection controls.

3. The organization reviews and updates the current Physical and environmental protection policy and Physical and environmental protection procedures every 6 months.

(b) Physical access authorizations

1. The organization develops, approves, and maintains a list of individuals with authorized access to the facility where the blockchain resides.

2. The organization issues authorization credentials (e.g. forge-proof badges, smart cards, or identification cards) for blockchain facility access.

3. The organization reviews the access list detailing authorized blockchain facility access by individuals every week.

4. The organization removes individuals from the facility blockchain access list when access is no longer required.

5. The organization authorizes physical access to the facility where the blockchain resides based on position or role.

6. The organization requires two forms of identification (e.g. passports, Personal Identity Verification cards, drivers' licenses, key cards, PINs, biometrics) for visitor access to the facility where the blockchain resides.

7. The organization restricts unescorted access to the facility where the blockchain resides to personnel with (a) security clearances for all information contained within the blockchain; (b) formal access authorizations for all information contained within the blockchain; (c) need for access to all information contained within the blockchain.

8. The organization ensures that individuals lacking sufficient security clearances, access approvals, or need to know, are escorted by individuals with appropriate credentials.

(c) Physical access control

1. The organization enforces physical access authorizations at entry/exit points to the facility where the blockchain resides by verifying individual access authorizations before granting access to the facility; and controlling ingress/egress to the facility using physical access control systems / devices and guards.

2. The organization maintains physical access audit logs for entry / exit points.

3. The organization provides security safeguards to control access to areas within the facility officially designated as publicly accessible.

4. The organization ensures that visitors are escorted and visitor activity is monitored.
5. The organization ensures that keys, combinations, and other physical access devices are secured.

6. The organization ensures that combinations and keys are changed when keys are lost, combinations are compromised, or individuals are transferred or terminated.

7. The organization enforces physical access authorizations to the blockchain in addition to the physical access controls for the facility.

8. The organization performs daily security checks at the physical boundary of the facility or blockchain for unauthorized exfiltration of information or removal of information system components.

9. The organization employs guards and/or alarms to monitor every physical access point to the facility where the blockchain resides 24 hours per day, 7 days per week.

10. The organization uses lockable physical casings to protect the blockchain from unauthorized physical access.

11. The organization employs security safeguards to detect and prevent physical tampering or alteration of the blockchain.

12. The organization employs a penetration testing process that includes daily, unannounced attempts to bypass or circumvent security controls associated with physical access points to the facility.

C.10 Risk assessment

(a) Risk assessment policy and procedures

1. The organization develops, documents, and disseminates to relevant personnel, a risk assessment policy that addresses purpose, scope, roles, responsibilities, management commitment, coordination among organizational entities, and compliance.

2. The organization develops, documents, and disseminates to relevant personnel, procedures to facilitate the implementation of the risk assessment policy and associated risk assessment controls.

3. The organization reviews and updates the current Risk assessment policy and Risk assessment procedures every 6 months.

(b) Risk assessment

1. The organization conducts an assessment of risk, including the likelihood and magnitude of harm, from the unauthorized access, use, disclosure, disruption, modification, or destruction of the blockchain and the information it processes, stores, or transmits.

2. The organization documents risk assessment results.

3. The organization reviews risk assessment results regularly.

4. The organization disseminates risk assessment results to relevant personnel.

5. The organization updates the risk assessment every 1 month or whenever there are significant changes to the blockchain or environment of operation (including the identification of new threats and vulnerabilities), or other conditions that may impact the security state of the blockchain.

(c) Vulnerability scanning

1. The organization scans for vulnerabilities in the blockchain e.g. (i) scanning for patch levels; (ii) scanning for functions, ports, protocols, and services that should not be accessible to users or devices; and (iii) scanning for improperly configured or incorrectly operating information flow control mechanisms.

2. The organization ensures that when new vulnerabilities potentially affecting the blockchain are identified and reported, it:
    a. Employs vulnerability scanning tools and techniques that facilitate interoperability among tools and automate parts of the vulnerability management process by using standards for (i) Enumerating platforms,

software flaws, and improper configurations; (2) Formatting checklists and test procedures; and (3) Measuring vulnerability impact.

b. Analyzes vulnerability scan reports and results from security control assessments;
c. Remediates legitimate vulnerabilities in accordance with an organizational assessment of risk; and
d. Shares information obtained from the vulnerability scanning process and security control assessments with relevant personnel to help eliminate similar vulnerabilities in other information systems (i.e., systemic weaknesses or deficiencies).

3. The organization employs vulnerability scanning tools that include the capability to readily update the vulnerabilities to be scanned.

4. The organization updates the vulnerabilities scanned prior to a new scan and when new vulnerabilities are identified and reported.

5. The organization employs vulnerability scanning procedures that can identify the breadth and depth of coverage (i.e., information system components scanned and vulnerabilities checked).

6. The organization determines what information about the blockchain is discoverable by adversaries and subsequently takes corrective actions.

7. The organization employs automated mechanisms to compare the results of vulnerability scans over time to determine trends in information system vulnerabilities.

8. The organization reviews historic audit logs to determine if a vulnerability identified in the blockchain has been previously exploited.

9. The organization correlates the output from vulnerability scanning tools to determine the presence of multi-vulnerability/multi-hop attack vectors.

(d) Insider threat program

The organization implements an insider threat program that includes a cross-discipline insider threat incident handling team.

(e) Contacts with security groups and associations

The organization establishes and institutionalizes contact with selected groups and associations within the security community: (a) to facilitate ongoing security education and training for organizational personnel; (b) To maintain currency with recommended security practices, techniques, and technologies; and (c) To share current security-related information including threats, vulnerabilities, and incidents.

Ongoing contact with security groups and associations is of paramount importance in an environment of rapidly changing technologies and threats. Security groups and associations include, for example, special interest groups, forums, professional associations, news groups, and/or peer groups of security professionals in similar

organizations. Organizations select groups and associations based on organizational missions/business functions.

(f) Threat awareness program

The organization implements a threat awareness program that includes a cross-organization information-sharing capability. This can include, for example, sharing threat events (i.e., tactics, techniques, and procedures) that organizations have experienced, mitigations that organizations have found are effective against certain types of threats, threat intelligence (i.e., indications and warnings about threats that are likely to occur). Threat information sharing may be bilateral or multilateral.

C.11 Blockchain Integrity

(a) Blockchain integrity policy and procedures

1. The organization develops, documents, and disseminates, to relevant personnel, a blockchain integrity policy that addresses purpose, scope, roles, responsibilities, management commitment, coordination among organizational entities, and compliance.

2. The organization develops, documents, and disseminates, to relevant personnel, procedures to facilitate the implementation of the blockchain integrity policy and associated system and information integrity controls.

3. The organization reviews and updates the current blockchain integrity policy and blockchain integrity procedures every 3 months.

(b) Flaw remediation

1. The organization identifies, reports, and corrects blockchain system flaws including those discovered during security assessments, continuous monitoring, incident response activities, and system error handling.

2. The organization tests software and firmware updates related to flaw remediation for effectiveness and potential side effects before installation.

3. The organization installs security-relevant software (e.g. patches, service packs, hot fixes, and anti-virus signatures) and firmware updates as soon as updates are released.

4. The organization incorporates flaw remediation into the organizational configuration management process.

5. The organization centrally manages the planning, implementing, assessing, authorizing, and monitoring the organization-defined, flaw remediation security controls.

6. The organization employs automated mechanisms daily to determine the state of blockchain components with regard to flaw remediation.

7. The organization measures the time between flaw identification and flaw remediation and establishes benchmarks for taking corrective actions.

8. The organization installs relevant software and firmware updates automatically to blockchain components.

9. The organization removes previous versions of software and/or firmware components after updated versions have been installed.

(c) Malicious code protection

1. The organization employs malicious code protection mechanisms at blockchain entry and exit points (e.g. firewalls, electronic mail servers, web servers, proxy servers, remote-access servers, workstations, notebook computers, and mobile devices) to detect and eradicate malicious code (e.g. viruses, worms, Trojan horses, and spyware; malicious code encoded in various formats such as UUENCODE, Unicode), contained within compressed or hidden files, or hidden in files using steganography).

2. The organization updates malicious code protection mechanisms whenever new releases are available in accordance with organizational configuration management policy and procedures.

3. The organization configures malicious code protection mechanisms to perform periodic and real-time scans of files from external sources as the files are downloaded, opened, or executed in accordance with organizational security policy.

4. The organization addresses the receipt of false positives during malicious code detection and eradication and the resulting potential impact on the availability of the blockchain.

5. The organization centrally manages malicious code protection mechanisms.

6. The organization tests malicious code protection mechanisms regularly by introducing a known benign, non-spreading test case into the blockchain and verifies that both detection of the test case and associated incident reporting occur.

7. The blockchain implements non signature-based malicious code detection mechanisms (e.g. the use of heuristics to detect, analyze, and describe the characteristics or behavior of malicious code and to provide safeguards against malicious code for which signatures do not yet exist or for which existing signatures may not be effective)[1].

8. The blockchain detects defined unauthorized operating system commands through the kernel application programming interface and (a) issues a warning; (b) audits the command execution; and (c) prevents the execution of the command.

9. The organization analyzes the characteristics and behaviour of malicious code; and incorporates the results from malicious code analysis into organizational incident response and flaw remediation processes.

(d) Blockchain monitoring

[1] This includes polymorphic malicious code (i.e., code that changes signatures when it replicates).

1. The organization monitors the blockchain to detect attacks and indicators of potential attacks in accordance and unauthorized local, network, and remote connections[2].

2. The organization identifies unauthorized use of the blockchain.

3. The organization deploys monitoring devices to collect organization-determined essential information and to track specific types of transactions of interest to the organization.

4. The organization protects information obtained from intrusion-monitoring tools from unauthorized access, modification, and deletion.

5. The organization heightens the level of blockchain monitoring activity whenever there is an indication of increased risk to organizational operations and assets.

6. The organization obtains legal opinion with regard to monitoring activities in accordance with applicable laws.

7. The organization provides monitoring information to relevant personnel as needed.

8. The organization connects and configures individual intrusion detection tools into an information system-wide intrusion detection system.

9. The organization employs automated tools (e.g. host-based, network-based, transport-based, or storage-based event monitoring tools or Security Information and Event Management (SIEM) technologies that provide real time analysis of alerts and/or notifications generated by blockchain) to support near real-time analysis of events.

10. The organization employs automated tools to integrate intrusion detection tools into access control and flow control mechanisms for rapid response to attacks by enabling reconfiguration of these mechanisms in support of attack isolation and elimination.

11. The blockchain monitors inbound and outbound communications traffic for unusual or unauthorized activities or conditions.

12. The organization tests intrusion-monitoring tools every day.

[2] Blockchain monitoring includes external and internal monitoring. External monitoring includes the observation of events occurring at the boundary (i.e., part of perimeter defence and boundary protection). Internal monitoring includes the observation of events occurring within the blockchain. Blockchain monitoring capability is achieved through a variety of tools and techniques e.g. intrusion detection systems, intrusion prevention systems, malicious code protection software, scanning tools, audit record monitoring software, network monitoring software.

13. The organization analyzes outbound communications traffic at the external boundary of the blockchain to discover anomalies (e.g. large file transfers, long-time persistent connections, unusual protocols and ports in use, and attempted communications with suspected malicious external addresses).

14. The organization employs automated mechanisms to alert security personnel of inappropriate or unusual activities with security implications.

15. The organization analyzes communications traffic/event patterns for the blockchain; develops profiles representing common traffic patterns and/or events; and uses the traffic/event profiles in tuning system-monitoring devices to reduce the number of false positives and the number of false negatives.

16. The organization employs a wireless intrusion detection system to identify rogue wireless devices and to detect attack attempts and potential compromises/breaches to the blockchain.

17. The organization employs an intrusion detection system to monitor wireless communications traffic as the traffic passes from wireless to wired networks.

18. The organization correlates information from monitoring tools (e.g., host monitoring, network monitoring, anti-virus software) employed throughout the components of the blockchain.

19. The organization correlates information from monitoring physical, cyber, and supply chain activities to achieve integrated, organization-wide situational awareness.

20. The organization analyzes outbound communications traffic at the external boundary of the blockchain to detect covert exfiltration of information.

21. The organization implements additional monitoring of individuals who have been identified by relevant sources (such as human resource records, intelligence agencies, law enforcement organizations, and/or other credible sources) as posing an increased level of risk.

22. The organization implements additional monitoring of privileged users and individuals during probationary period.

23. The organization implements host-based monitoring mechanisms at defined blockchain components.

24. The blockchain discovers, collects, distributes, and uses indicators of compromise[3].

[3] Indicators of compromise (IOC) are forensic artefacts from intrusions that are identified on organizational information systems (at the host or network level). IOCs for the discovery of

(e) Security alerts, advisories, and directives

1. The organization receives security alerts, advisories, and directives from relevant external organizations on an ongoing basis.

2. The organization generates internal security alerts, advisories, and directives as deemed necessary.

3. The organization disseminates security alerts, advisories, and directives to relevant personnel and external organizations.

4. The organization employs automated mechanisms to make security alert and advisory information available throughout the organization.

(f) Security function verification

1. The organization verifies the correct operations of defined security functions at blockchain transitional states (e.g. system startup, restart, shutdown, and abort) upon command by user with appropriate privilege.

2. The organization notifies relevant personnel of failed security verification tests.

3. The information system implements automated mechanisms to support the management of distributed security testing.

4. The organization reports the results of security function verification to relevant personnel.

(g) Software, firmware, and information integrity

1. The organization employs integrity verification tools to detect unauthorized changes to software, firmware, and information [4] using state-of-the-practice integrity-checking mechanisms (e.g., parity checks, cyclical redundancy checks, cryptographic hashes) and associated tools.

---

compromised hosts can include for example, the creation of registry key values. IOCs for network traffic include, for example, Universal Resource Locator (URL) or protocol elements that indicate malware command and control servers. The rapid distribution and adoption of IOCs can improve information security by reducing the time that information systems and organizations are vulnerable to the same exploit or attack.

[4] Software includes, for example, operating systems (with key internal components such as kernels, drivers), middleware, and applications. Firmware includes, for example, the Basic Input Output System (BIOS). Information includes metadata such as security attributes associated with information.

2. The organization employs automated tools that provide notification to relevant personnel upon discovering discrepancies during integrity verification.

3. The organization employs centrally managed integrity verification tools.

4. The blockchain implements cryptographic mechanisms (e.g. digital signatures and the computation and application of signed hashes using asymmetric cryptography, protecting the confidentiality of the key used to generate the hash, and using the public key to verify the hash information).

5. The organization incorporates the detection of unauthorized security-relevant changes to the blockchain into the organizational incident response capability.

6. The blockchain verifies the integrity of the boot process of defined devices.

7. The organization implements defined security safeguards to protect the integrity of boot firmware in defined devices.

8. The organization requires that defined user-installed software execute in a confined physical or virtual machine environment with limited privileges.

9. The organization requires that the integrity of user-installed software be verified prior to execution.

10. The organization allows execution of binary or machine-executable code obtained from sources with limited or no warranty and without the provision of source code only in confined physical or virtual machine environments and with the explicit approval of relevant personnel.

11. The organization implements cryptographic mechanisms to authenticate software or firmware components prior to installation.

D. Security recommendations for other Blockchain components

Component	Issue	Recommended standards
Blockchain platform	System and software quality models	ISO/ IEC 25010:2011
	Evaluation process	ISO/ IEC 25040:2011
Blockchain nodes	Crypto Key Tamper Resistance	FIPS 140-2 Level 4
	Server Virtualization[5]	Common Criteria EAL 5 or higher
External interface	Configuration and Deployment Management Testing	OWASP Testing Guide
	Identity Management Testing	
	Authentication Testing	
	Authorization Testing	
	Session Management Testing	
	Input Validation Testing	
	Testing for Error Handling	
	Testing for weak Cryptography	
	Business Logic Testing	
	Client Side Testing	

[5] If sensitive blockchain solution components are not physically isolated.

E. Glossary

1. Blockchain

A blockchain is a peer-to-peer network which timestamps records by hashing them into an ongoing chain of hash-based proof-of-work, forming a record that cannot be changed without redoing the proof-of-work[6].

2. Distributed ledger system

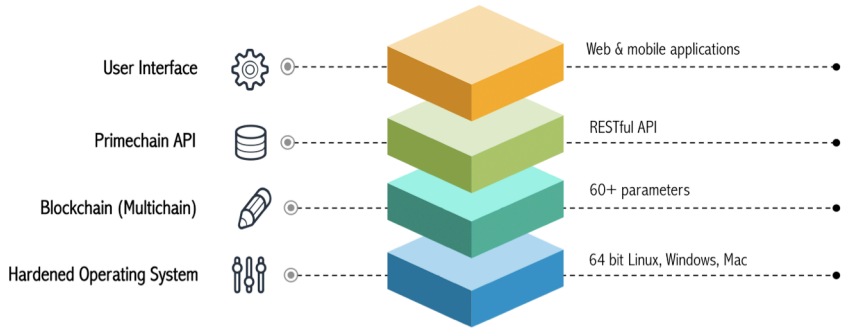
A distributed ledger is a peer-to-peer network, which uses a defined consensus mechanism to prevent modification of an ordered series of time-stamped records[7].

3. Hash function

A hash function is an algorithm mapping or translation of one sequence of bits into another, generally smaller, set known as hash-result such that an electronic record yields the same hash-result every time the algorithm is executed with the same electronic record as its input making it computationally infeasible to (i) to derive or reconstruct the original electronic record from the hash result produced by the algorithm; (ii) that two electronic records can produce the same hash result using the algorithm[8].

4. Node

A blockchain node can be on-premise or on-cloud. A typical Primechain node is illustrated below



5. Cryptocurrency

According to the FATF report on *Virtual Currencies - Key Definitions and Potential AML/CFT Risks*, Cryptocurrency refers to a math-based, decentralised convertible virtual currency that is protected by cryptography. - i.e., it incorporates principles of cryptography to implement a distributed, decentralised, secure information economy. Cryptocurrency relies on public and private keys to transfer value from one person (individual or entity) to another, and must be cryptographically signed each time it is transferred. The safety, integrity and balance of cryptocurrency ledgers is ensured by a network of mutually distrustful parties (in Bitcoin, referred to as miners) who protect the network in exchange for the opportunity to obtain a

[6] A blockchain can be permissioned, permission-less or hybrid.
[7] Consensus mechanisms include proof of stake and federated byzantine agreement.
[8] Adapted from section 3 of the Information Technology Act. Examples of hash functions include SHA-1 and SHA-2.

randomly distributed fee (in Bitcoin, a small number of newly created bitcoins, called the "block reward" and in some cases, also transaction fees paid by users as a incentive for miners to include their transactions in the next block).

6. Virtual currency

According to the FATF report on *Virtual Currencies - Key Definitions and Potential AML/CFT Risks*, virtual currency is a digital representation of value that can be digitally traded and functions as (1) a medium of exchange; and/or (2) a unit of account; and/or (3) a store of value, but does not have legal tender status (i.e., when tendered to a creditor, is a valid and legal offer of payment) in any jurisdiction. It is not issued nor guaranteed by any jurisdiction, and fulfils the above functions only by agreement within the community of users of the virtual currency[9].

[9] Virtual currency is distinguished from fiat currency (a.k.a. "real currency," "real money," or "national currency"), which is the coin and paper money of a country that is designated as its legal tender; circulates; and is customarily used and accepted as a medium of exchange in the issuing country. It is distinct from e-money, which is a digital representation of fiat currency used to electronically transfer value denominated in fiat currency. E-money is a digital transfer mechanism for fiat currency - i.e., it electronically transfers value that has legal tender status.

F. References & recommended resources

1. Bitcoin: A Peer-to-Peer Electronic Cash System by Satoshi Nakamoto.
   https://bitcoin.org/bitcoin.pdf

2. Latest version of the OWASP Web Security Testing Guide:
   https://owasp.org/www-project-web-security-testing-guide/

3. NIST Special Publication 800-53
   https://nvd.nist.gov/800-53

4. Blockchain Consensus?
   https://tokens-economy.gitbook.io/consensus/blockchain-consensus

G. About Primechain

Primechain™ Technologies is a blockchain company with the mission of building blockchains for a better world.

We are recognized as a startup by the Department of Industrial Policy and Promotion, Ministry of Commerce & Industry, Government of India vide certificate no. DIPP7127 dated 12th April, 2018.

Primechain Technologies Pvt. Ltd.
410, Supreme Headquarters,
Mumbai-Bangalore Highway,
Near Audi Showroom,
Baner,
Pune - 411045 (INDIA)

Email: info@primechain.in
Web: http://www.primechaintech.com

H. License

Primechain Technologies Pvt. Ltd.
410, Supreme Headquarters,
Mumbai-Bangalore Highway,
Near Audi Showroom,
Baner,
Pune - 411045 (INDIA)

Web: http://www.primechaintech.com
Email: info@primechain.in