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**CONTRIBUTION**

**Source:** China Unicom, NTRA Egypt, ZTE Corporation, CART MIIT, ISA CETC, Alibaba Group

**Title:** Proposed a new work item on "Framework of blockchain of things as decentralized service platform"

**Purpose:** Proposal

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**Keywords:** Blockchain, IoT, trust, security

**Abstract:** This contribution proposes the establishment by Question 4/20 of a new work item on “Framework of blockchain of things as decentralized service platform”, to study how the blockchain-related technologies to improve the IoT applications and services (also including IoT devices, processes, data), and to study relevant concept, characteristics, high-level requirements, framework, capabilities and use cases.

## 1. Background

Blockchain-related technologies present opportunities for disruptive innovations, which enable global businesses to transact with less frictions and more trusts and efficiencies. Blockchains use shared, immutable ledgers to record the history of transactions. Blockchain fosters a new generation of transactional applications that establish trust, accountability, transparency and efficiency.

Some of the blockchains are reliant on the exchange of cryptocurrencies with anonymous users on a public network (e.g. Bitcoin, Ethereum); others are for business and working on permissioned network (e.g. Hyperledger), with known identities and without the need for cryptocurrencies.

Blockchains show great promises across a wide range of business applications in many fields, such as finance, banking, healthcare, government, manufacturing, insurance, retail, legal, media and entertainment, supply chain and logistics, finance and accounting, etc.

Blockchain-related technologies can be widely utilized in the fields of IoT and SC&C. In followed discussion, this contribution will brief why IoT and SC&C need blockchain, and list some representative activities related to blockchains from several organizations, and provide some gap analysis for using blockchains to facilitate IoT and SC&C from the standardization perspective.

Based on the discussion, this contribution proposes to establish a new work item to study how the blockchain-related technologies to improve the IoT applications and services (including IoT devices, processes and data), and to study relevant concept, characteristics, high-level requirements, framework, capabilities and use cases.

## 2. Discussion

### 2.1 Why IoT needs blockchain?

### 2.1.1 What is blockchain?

Blockchain is usually seen as a peer to peer distributed ledger based on a group of technologies for a new generation of transactional applications, which maintains a continuously growing list of cryptographically secured data records as hardened against tampering and revision. Blockchain can help establish **trust, accountability, transparency and efficiency** while streamlining business processes.

The big advantage of blockchain is that it's **public**. Everyone participating can see the chain blocks and the transactions stored in them. This doesn't mean everyone can see the actual content of the transaction, however; that's protected by the private key.

A blockchain is **decentralized**, so there is no single authority that can approve the transactions or set specific rules to have transactions accepted. That means there's a huge amount of trust involved since all the participants in the network have to reach a consensus to accept transactions.

Most importantly, it's secure and makes **trust**. The data in the blockchain can only be extended and previous records cannot be changed.

It's worthy to **point out that**: Blockchain is not bitcoin; there will not be only one blockchain or a chain-of-all-chains, and there will be many public/private/consortium blockchains potentially each with different mechanisms (such as for consensus, contract, permissions etc.). Blockchains are continuously evolving, though they appear some problems of one kind or another, such as, limited throughput, slow transaction confirmations, designed for cryptocurrency, poor Governance, no privacy, anonymous processors, and no settlement finality etc.

### 2.1.2 The challenges of IoT/SC&C

There have been many visible successes in many fields for IoT/SC&C, especially for high-value applications, such as smart meters, e-health, etc. However, there are some key challenges that IoT/SC&C must be faced, for example:

- High cost of connectivity and low scalability, if using current centralized connection solutions, to connect the huge amount of things (physical things and virtual things);

- Unease to building trust on the un-trust Internet for the diverse IoT devices, many of the IoT devices are too vulnerable to be trusted ;
- Lack of solutions to meet the needs to maintain long life-cycle IoT devices;
- Unease to create meaningful value based on current broken business models.

### 2.1.3 Key benefits to making blockchain and IoT/SC&C together

Businesses don't exist in isolation, which are connected to customers, suppliers and partners. There are many benefits to making blockchain and IoT/SC&C together, and the key benefits are from **building trust**, **reducing costs** and **accelerating transactions**.

Blockchain offers new ways for IoT/SC&C data to **automate business processes** among partners without setting up a complex and expensive centralized IT infrastructure. Data protection of blockchain fosters stronger working relationship with partners and greater efficiency as partners take advantage of the information provided.

Making IoT/SC&C and blockchain together **enables IoT devices to participate in blockchain transactions**. Specifically, IoT devices can send data to public/consortium/private blockchain ledgers for inclusion in shared transactions with distributed records, maintained by consensus, and cryptographically hashed. The distributed replication in blockchain allows business partners to access and supply IoT/SC&C data without the need for central control and management.

Additionally, the distributed ledger in a blockchain **makes it easier to create cost-efficient business networks** where virtually anything of value can be tracked and traded, without requiring a central point of control.

Blockchain with IoT/SC&C together becomes a potential game changer by **opening the door** to invent new styles of digital interactions, enabling IoT devices to participate in blockchain transactions, as well as creating opportunities to reduce the cost and complexity of operating and sustaining business.

In the proposed content of the new work item, **appendix II** lists several **use cases** to illustrate what the benefits of making blockchain and IoT/SC&C together.

## 2.2 Gap analysis for blockchain-related standards

Due to applicability of blockchain-related technologies and standards, many organizations (such as SDOs, alliances, companies) are involved in the activities of those fields. They focus on standardization or application practices respectively; the followed table lists some main activities involved in blockchain from some organizations and provides some brief gap analysis.

Table 1 – Groups involved in blockchain-related activities and relevant gap analysis

| Organizations | Standards / Platforms | Description and applicability | Gap Analysis |
|---|---|---|---|
| ISO<br>ISO/TC 307 | None (temporary) | ISO/TC 307, "Blockchain and electronic distributed ledger technologies", was initialized just at the end of 2016, which first meeting (scheduled) is at Sydney in April 2017.<br>The pre-intended study scope of ISO/TC 307 is below:<br>***Standardization of blockchains and distributed ledger technologies to support interoperability and data interchange among users, applications and systems.***<br>Currently, the chairpersons of the ISO/TC 307 are vacant, and its detailed study scopes and structures are expected to be caught at its first meeting in 2017. | ITU-T SG20 is responsible for studies relating to IoT/SC&C and relevant applications / services / identifications, and it is the lead study group in those study fields in ITU-T.<br>This proposed new work item is about blockchain aspects of IoT and SC&C, and its proposed scopes won't be overlapping with that of ISO/TC 307, though the latter's study scope is not detailed currently.<br>ITU-T SG20 will collaborate with ISO/TC 307 in the future. |

| | | | |
|---|---|---|---|
| W3C<br>Blockchain Community Group<br>(W3C BCG) | None (temporary) | W3C Blockchain Community Group (W3C BCG) initialized in 2016 is a new **community group** of W3C.<br>The W3C BCG will study message format standards of blockchains, and generate guidelines for usages of blockchains (including peer-to-peer networks, public/private/consortium blockchains, side-chains, inter-chains, etc.), and analyze use cases related to blockchains (such as interbank communications).<br>Currently, the W3C BCG is at the beginning of its study work, and there is not any substantial outcomes related to blockchain. | This proposed new work item is about blockchain aspects of IoT and SC&C, and its proposed scopes won't be overlapping with that of W3C BCG.<br>ITU-T SG20 will collaborate with W3C BCG in the future. |
| Chain of things<br>(Alliance CoT) | -- | Chain of things is an alliance (Alliance CoT) and was formed by a group of technologists at the nexus of IoT hardware manufacturing and alternative blockchain applications.<br>Alliance CoT is developing integrated blockchain and IoT hardware solutions to solve IoT's issues with identity, security and interoperability, and evaluate existing technologies, explore practical applications within various verticals, and look at the development of open-standards for industry to use.<br>Alliance CoT is focusing on technologies and practices on the fields of IoT and blockchains, not for forwarding industrial standards. | This proposed new work item will be one of the basic standards about IoT and blockchains of ITU-T, which is not (won't be) overlapping with the deliverables of Alliance CoT.<br>The outcomes and deliverables of Alliance CoT will be good inputs for this proposed new work item.<br>ITU-T SG20 will collaborate with Alliance CoT in the future. |
| Bitcoin | Open-source platform | Bitcoin is an innovative **payment network** and a **new kind of money**. Bitcoin also refers an open-source platform.<br>Bitcoin uses peer-to-peer technology to operate with no central authority or banks; managing transactions and the issuing of bitcoins is carried out collectively by the network. Bitcoin is public; nobody owns or controls Bitcoin and everyone can take part. Bitcoin is continuously evolving.<br>Through many of its unique properties (such as Fast peer-to-peer transactions, worldwide payments and low processing fees), Bitcoin allows exciting uses that could not be covered by any previous payment system. | The thinking of Bitcoin – blockchain – and parts of its infrastructural technologies (decentered ledger, crypo, consensus etc.), are ones of important basses of blockchains of things.<br>Bitcoin is work in the financial fields, and is applicable to some cases of IoT. But there are yet some disadvantages (lack of effectives, privacies and scopes, etc.) for IoT and SC&C. |
| Ethereum | Open-source platform | Ethereum is an open-source, public, blockchain-based distributed computing platform featuring smart contract functionality.<br>Ethereum is continuously evolving. Due to supporting smart contract, Ethereum is applicable to many fields, including some fields of IoT and SC&C. | The outcomes and deliverables of Ethereum will be good inputs for this proposed new work item. |
| R3 | -- | R3 is a **financial innovation firm** that leads a consortium partnership with over dozens of the world's leading financial institutions. R3 and its partners work together to design and deliver advanced distributed ledger technologies to the **global financial markets.** R3 participates to Hyperledger from 2016. | R3 is only work in the financial fields. There is not any overlap with this proposed new work item. |
| Hyperledger<br>(Linux Foundation) | Open-source platform | The Hyperledger is an open source collaborative effort created to advance cross-industry blockchain technologies. It is a global collaboration including leaders in finance, banking, IoT, supply chains, manufacturing and Technology. The Linux Foundation hosts Hyperledger as a Collaborative Project under the foundation. Hyperledger is continuously evolving. | The outcomes and deliverables of Hyperledger will be good inputs for this proposed new work item. |
| ITU-T<br>SG16&SG17 | None (temporary) | The ITU-T SG16&SG17 are intended to open study works, from 2017, in the fields of blockchain from the perspectives of **security** and **multimedia services** respectively. | This proposal will focus on the aspects of IoT and SC&C and won't make overlap with other study groups.<br>ITU-T SG20 will collaborate with SG16, SG17 and other study groups in the future. |

## 2.3 What can ITU-T do for blockchain?

To be sure, at present and in the future, blockchain-related standards and technologies will play **important roles** in the fields of IoT and SC&C. However, there is not any common recognized blockchain-related standard as applicable to IoT and SC&C; that makes adverse impacts on the

IoT/SC&C markets. Considering those urgent needs and the roles of ITU-T SG20 as the lead group of IoT and SC&C in ITU-T, ITU-T SG20 has responsibility to fill in the blanks.

The new work item proposed in this contribution is expected to provide one of the bases to study blockchain-related standards as applicable to IoT and SC&C.

## 3. Proposals

**Proposal 1** - Based on the reasons foresaid in the discussion part, it is proposed that Q4/20 starts a new work item on “Framework of blockchain of things as decentralized service platform” with the followed scope, but not limited to:

– concept, common characteristics and high-level requirements of the BoT as decentralized service platform,

– general framework of BoT as decentralized service platform and relevant common capabilities.

**Proposal 2** - And it is proposed to use the following text as the baseline document for the proposed new work item:

**CONTENTS**

**Page**

## List of Tables



## List of Figures

# Draft new Y.IoT-BoT-fw

## Framework of blockchain of things as decentralized service platform

### AAP Summary

*[To be provided before Consent]*

### Summary

*[Mandatory part]*

### Keyword

Blockchain, BoT, Internet of Things, Trust

## 1 Scope

This Recommendation introduces concept of blockchain of things (BoT), analyses its common characteristics and high-level requirements when it is as a decentralized service platform for IoT, and then brings a general framework of BoT and relevant common capabilities as mapping to IoT reference model specified in ITU-T Y.4000.

The scope of this Recommendation includes:

– concept, common characteristics and high-level requirements of the BoT as decentralized service platform,

– general framework of BoT as decentralized service platform and relevant common capabilities.

## 2 References

The following ITU-T recommendations and other references contain provisions, which, through reference in this text, constitute provisions of this recommendation. At the time of publication, the editions indicated were valid. All recommendations and other references are subject to revision; all users of this recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the recommendations and other references listed below.

[ITU-T Y.4000] Recommendation ITU-T Y.4000/Y.2060 (2012), *Overview of Internet of Things*

[ITU-T Y.2091] Recommendation ITU-T Y.2091 (2011), *Terms and definitions for next generation networks*.

*[TBD]*

## 3 Definitions

### 3.1 Terms defined elsewhere

This document uses the following terms defined elsewhere:

**3.1.1 address** [ITU-T Y.2091]: An address is the identifier for a specific termination point and is used for routing to this termination point.

**3.1.2 application**[ITU-T Y.2091]: A structured set of capabilities, which provide value-added functionality supported by one or more services, which may be supported by an API interface.

**3.1.3 capability** [b-ITU-T M.1224-1]: The ability of an item to meet a service demand of given quantitative characteristics under given internal conditions.

**3.1.4 device** [ITU-T Y.4000]: With regard to the Internet of things, this is a piece of equipment with the mandatory capabilities of communication and the optional capabilities of sensing, actuation, data capture, data storage and data processing.

**3.1.5 Internet of Things** [ITU-T Y.4000]: A global infrastructure for the information society, enabling advanced services by interconnecting (physical and virtual) things based on, existing and evolving, interoperable information and communication technologies

NOTE 1 – Through the exploitation of identification, data capture, processing and communication capabilities, the IoT makes full use of things to offer services to all kinds of applications, whilst ensuring that security and privacy requirements are fulfilled.

NOTE 2 – In a broad perspective, the IoT can be perceived as a vision with technological and societal implications.

**3.1.6 thing** [ITU-T Y.4000]: In the Internet of Things, object of the physical world (physical things) or of the information world (virtual things), which is capable of being identified and integrated into the communication networks.

*[TBD]*

### 3.2 Terms defined in this Recommendation

*Editor’s Note: Contributions are invited to refine the new terms defined in this sub-clause.*

This document defines the following terms:

***3.2.1 Blockchain****: A peer to peer distributed ledger technology for a new generation of transactional applications which maintains a continuously growing list of cryptographically secured data records hardened against tampering and revision.*

*NOTE 1 - Blockchain can help establish trust, accountability and transparency while streamlining business processes.*

*NOTE 2 - Blockchains can be classified three types (i.e. public, consortium and private) based on the relationship of the participants and the way to provide services.*

***3.2.2 Blockchain of things (BoT)****: A decentralized service platform, based on blockchain-related technologies, enabling the (physical and virtual) things to participate in and make transactions.*

***3.2.3 BoT application****: An IoT application which supports BoT-related functionalities.*

***3.2.4 BoT contract****: Embedded logic that encodes the rules for specific types of BoT transactions. A BoT contract can be stored in a BoT ledger, and can be invoked by specific BoT applications.*

***3.4.5 BoT consensus****: A broader term overarching the entire flow for a BoT transaction, in which the entities involved in a BoT to generate agreements and to confirm the correctness of the BoT transaction.*

***3.2.6 BoT ledger****: A distributed append-only transaction log managed by the BoT peers. The BoT ledger stores whole or part of information for the BoT transactions.*

***3.2.6 BoT peer****: A functional entity which supports BoT-related functionalities (e.g., executing and maintaining the BoT ledgers), such as IoT device, IoT gateway and IoT system, etc.*

***3.2.7 BoT transaction****: An operation (e.g. deploying, invoking and querying) in a BoT in which an authorized end user performs operations (e.g. reading/writing BoT ledgers, invoking a BoT contract).*

*[TBD]*

## 4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

BoT Blockchain of Things

DDoS Distributed Denial of service

IoT Internet of Things

ITS Intelligent Transportation System

*[TBD]*

## 5 Conventions

The following conventions are used in this Recommendation:

– The keywords "is required to" indicate a requirement which must be strictly followed and from which no deviation is permitted, if conformance to this Recommendation is to be claimed.

– The keywords "is recommended" indicate a requirement which is recommended but which is not absolutely required. Thus, this requirement need not be present to claim conformance.

All figures in the normative sections follow the conventions depicted in Figure 5-1.

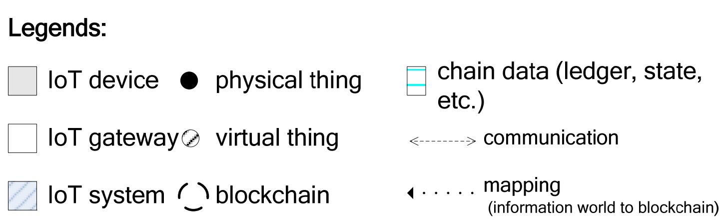


**Figure 5-1 - Conventions for figures in the normative sections**

NOTE – The legend 'physical thing' in Figure 5-1 refers to physical thing [see ITU-T Y.4000] which doesn't participate into a blockchain by itself, but by a BoT peer.

## 6 Introduction of BoT

### 6.1 Concept of the BoT

*Editor's Note: Contributions are invited to refine this clause.*

Blockchain is usually seen as a peer to peer distributed ledger based on a group of technologies for a new generation of transactional applications, which maintains a continuously growing list of cryptographically secured data records hardened against tampering and revision. Blockchain can help establish trust, accountability, transparency and efficiency while streamlining business processes.

Considering the inherent properties of blockchain and IoT, there are many benefits to making blockchain and IoT together, called blockchain of things (BoT), especially for building trust, reducing costs, accelerating transactions, and connecting large scale IoT devices. A BoT can be seen as a decentralized service platform which works on the IoT.

The BoT offers new ways for IoT data to automate business processes among partners without setting up a complex and expensive centralized IT infrastructure. Data protection in BoT fosters stronger working relationship with partners and greater efficiency as partners take advantage of the information provided.

The BoT enables BoT peers to participate in blockchain, and also allow physical things and virtual things to be mapped into blockchain (see Figure 6-1). The BoT peers can send IoT data to BoT ledgers for inclusion in shared transactions with distributed records, maintained by consensus, and cryptographically hashed. The distributed replication in BoT allows business partners to access and supply IoT data without the need for central control and management.

Additionally, the distributed ledger in a BoT makes it easier to create cost-efficient business networks where virtually anything of value can be tracked and traded, without requiring a central point of control.

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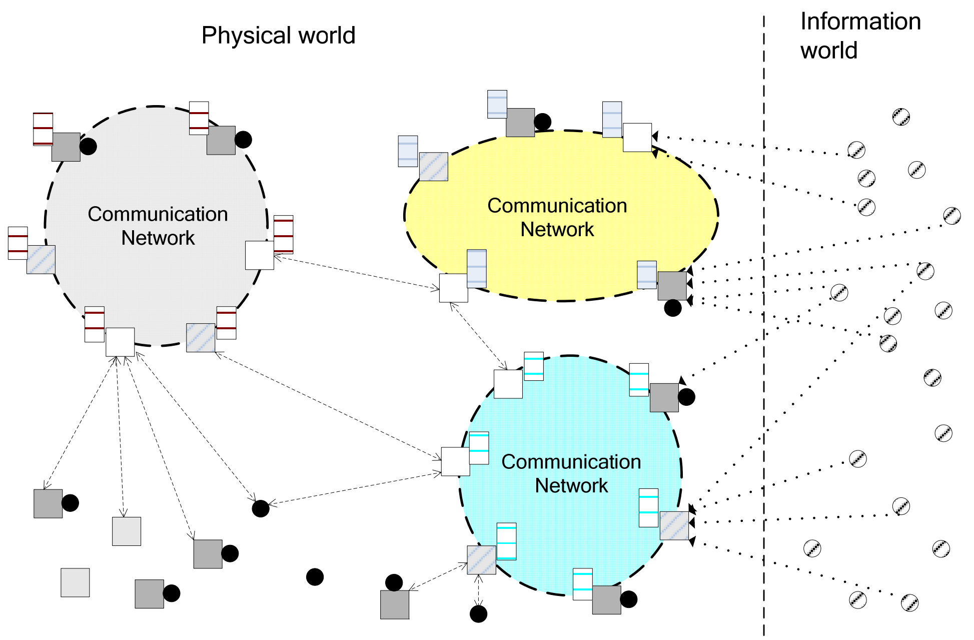


**Figure 6-1 – Overview and concept of the BoT**

## 6.2 Technical overview of the BoT

*Editor's Note: This sub-clause provides technical descriptions about BoT, including public BoT, private BoT and consortium BoT. Those descriptions will be refined according to the study scopes after the new work item is established.*

*According to the freedom of participants and the way to provide services, BoTs can be divided into three types, public BoTs, consortium BoTs and private BoTs.*

### 6.2.1 Public BoT

*In a public BoT, every participant can use his/her BoT peers can equally participate in, and read/write data in the BoT. Some public BoTs can limit the access to just reading or writing.*

*Usually, in a public BoT, the participants can be divided into two types, common participants and BoT manager. Common participants equally participate in the BoT, and the BoT manager (e.g., organizers, experts, and monitors) maintain the BoT. Figure 6-2 illustrates an example of public BoT.*

*……*

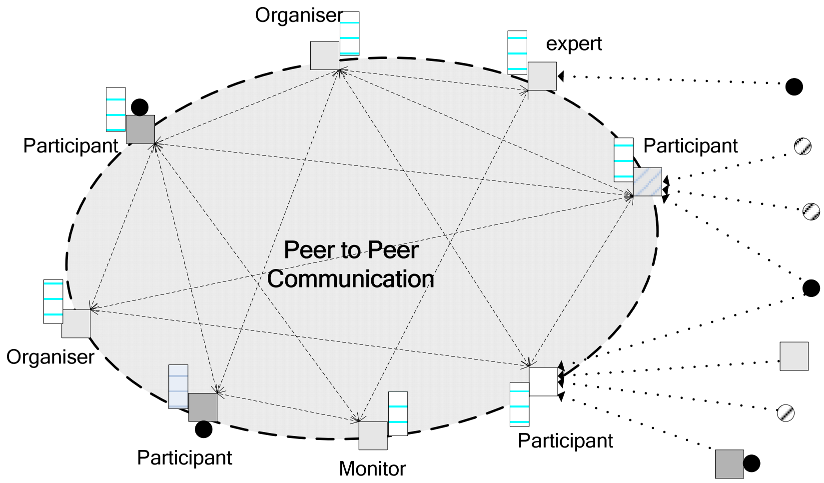


**Figure 6-2 – Technical overview of the public BoT**

### 6.2.2 Consortium BoT

*In a consortium BoT, parts of the participants are known and trusted with which they provide services for their consumers.*

*Usually, in a consortium BoT, there are membership management and permission policy. The members include consortium members and common participants; the common participants are usual the consumers of the consortium members. The consortium members make the BoT policies and manage the BoT.*

*Figure 6-3 shows an example of consortium BoT. Members A, B, C and D make a consortium BoT. The IoT systems of the consortium members make consensus for transactions and maintain the BoT data, and the common participants use their BoT peers to connect to the BoT.*

*……*

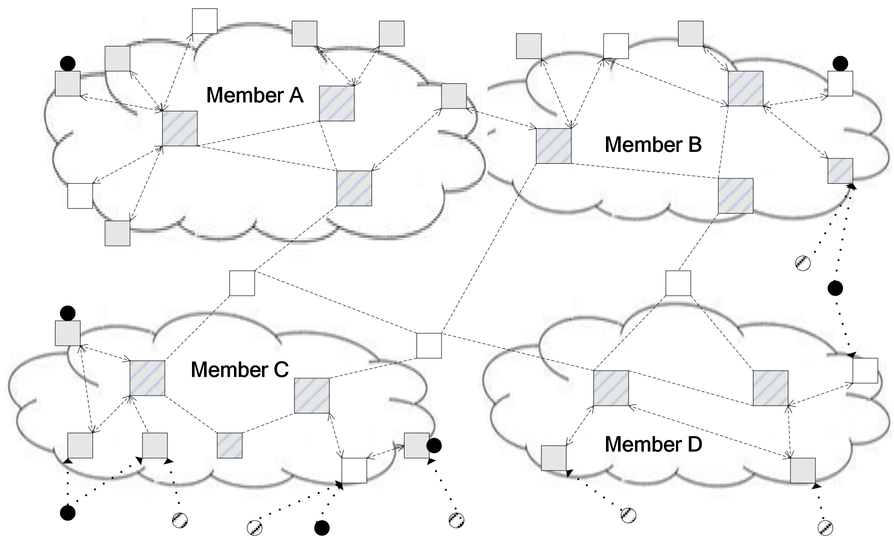


**Figure 6-3 – Technical overview of the consortium BoT**

### 6.2.3 Private BoT

*In a private BoT, all the participants are known and trusted. This is useful when the BoT is used between companies that belong to the same legal mother entity.*

*……*

## 7 Common characteristics and high-level requirements of the BoT

### 7.1 Common characteristics

*Editor's Note: ITU-T Y.4000 provides descriptions about a group of fundamental characteristics of IoT, related to interconnectivity, services, heterogeneity, dynamic changes and scales. This sub-clause provides common characteristics of BoT related to decentralization, crowding-consensus, smart contract, etc.*

*Recognized currently, the BoT has the followed common characteristics, but not limited:*

- *Distributed and sustainable:*
- *Secure and indelible:*
- *Transparent and auditable:*
- *Consensus-based and transactional:*
- *Flexible, manageable and operational:*
- *Pluggable:*
- *……*

### 7.2 high-level requirements

*Editor's Note: ITU-T Y.4000 provides descriptions about a group of high-level requirements for IoT, including identification, interoperability, autonomic networking and service provisioning, location, security, privacy, plug and play etc. This sub-clause provides high-level requirements for BoT as decentralized services platform, which involved in device, application, platform, data process etc.*

*Recognized currently, but not limited, the high-level requirements include:*

- *Adaptation to communication networks:*
- *Distributed ledgers:*
- *Identification:*
- *Interoperability:*
- *Scalability (for number of participants, transaction throughput):*
- *Pluggable capability (for data store, consensus mechanism, member management, permission, etc.):*
- *Supporting trust and confidentiality:*
- *……*

## 8 General framework of BoT as decentralized service platform

*Editor's Note: This clause provides a general framework of BoT as decentralized service platform.*

## 9 BoT-related capabilities on the IoT reference model

*The IoT reference model defined [ITU-T Y.4000] is applicable to the BoT. Considering the decentralization characteristics and trust mechanism of BoT, there are some special BoT-related capability requirements on the IoT reference model (see Figure 9-1).*

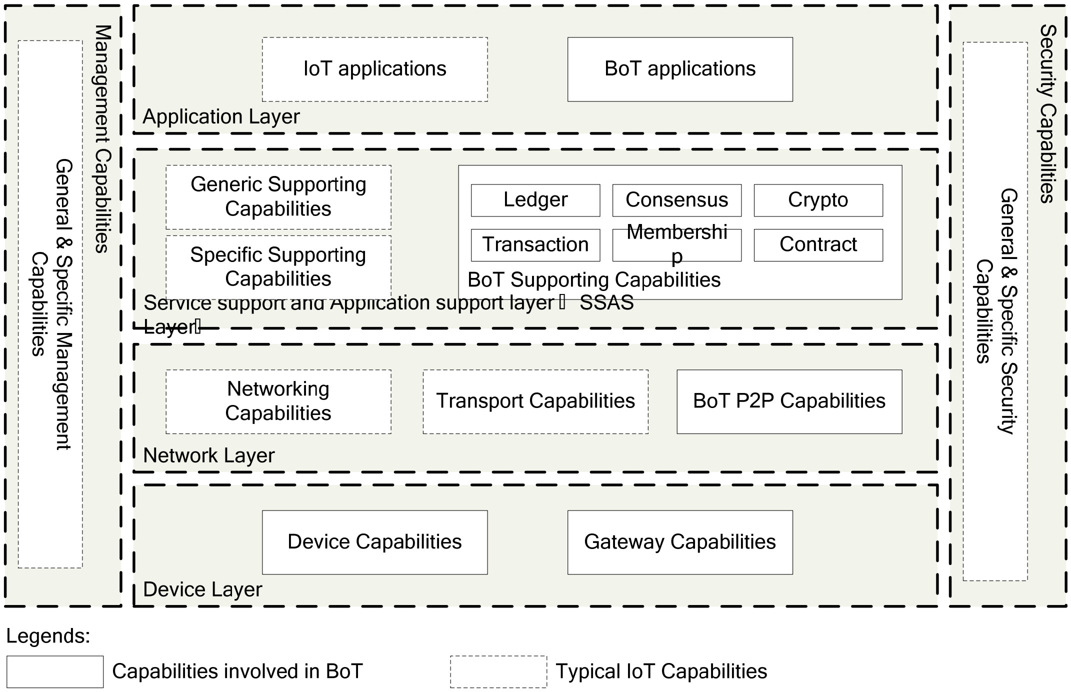


**Figure 9-1 – BoT-related capabilities on the IoT reference model**

*Editor's Note: Contributions are invited to refine this clause.*

*This clause describes BoT-related capabilities on the IoT reference model. Those new capabilities are enhancements to the capabilities as described in clause 8 of [ITU-T Y.4000].*

## 9.1 Application layer

*Editor's Note: The application layer contains BoT applications. A BoT application is an IoT application which supports BoT-related functionalities. The BoT applications can be deployed in IoT devices, IoT gateways and IoT sink nodes, or on the clouds. BoT applications store and maintain the BoT ledgers and make trust consensuses in the un-trust environments (e.g., P2P networks and semi-anonymous). This sub-clause describes BoT-related capabilities for the BoT applications in the application layer.*

## 9.2 Service support and application support layer

*Editor's Note: ITU-T Y.4000 provides briefs of two capability groups, generic support capabilities and specific supporting capabilities in this layer. As for parts of the public BoTs (e.g. Bitcoin-based), they are decentralized and see this layer as transparent, and need little support requirements from the entities on this layer. As for other parts of the public BoTs (e.g. Ethereum-based), and the consortium BoTs (e.g. Hyperledger-based) and private BoTs, they need special supports from the entities on this layer. This sub-clause describes BoT supporting capabilities for the entities (involved in BoT as decentralized service platform) on this layer.*

## 9.3 Network layer

*Editor's Note: ITU-T Y.4000 provides briefs of two capability groups, networking capabilities and transportation capabilities in this layer. BoTs are established on peer to peer networks (dynamical sub-networks overlaying on communication networks) and can be see usually network-independent.*

*However, in some fields as thirsty for high robustness, high reliability and high efficiency, especially industry and finance, it is a natural need for the typical networks to be involved in. This sub-clause describes BoT-related capabilities for the entities (involved in BoT as decentralized service platform) on this layer.*

### 9.4 Device layer

*Editor's Note: The entities in device layer (e.g. device, gateway, sink node) involved in the BoTs as decentralized service platforms are building trust transactions on current un-trust environments. This sub-clause describes BoT-related capabilities for the entities in the device layer.*

### 9.5 Management capabilities

*Editor's Note: BoTs are established on peer to peer networks and can be see usually network-independent. However, as similar as the relationship with the Network layer, fully utilizations and enhancements for the typical network management capabilities can make benefits for the BoTs. This sub-clause describes the management capabilities to support the BoT as decentralized service platform.*

### 9.6 Security capabilities

*Editor's Note: It's a natural need that the BoTs can fully utilized the security capabilities of the typical networks (e.g. 3A systems –authentication, authorization and accounting), in order to enhance their security capabilities, especially in private and consortium BoTs. This sub-clause describes the security capabilities to support BoT as decentralized service platforms.*

## Appendix I

## Representative blockchain-related platforms

(Note: This appendix does not form an integral part of this Recommendation.)

*This appendix takes briefs for current representative blockchain-related platforms (e.g., Bitcoin, Ethereum and Hyperledger) and relevant applicability analysis for IoT.*

*Editor's Note: Contributions are invited to refine this appendix.*

### I.1 Bitcoin and Ethereum

*Bitcoin and Ethereum are two representatives of public blockchain platforms. Both are open source and based on public blockchain-based distributed computing.*

#### I.1.1 Bitcoin

*Editor's Note: This sub-clause provides an overview of Bitcoin and applicability to IoT.*

*Bitcoin is an innovative payment network and a new kind of money, which uses peer-to-peer technology to operate with no central authority or banks.*

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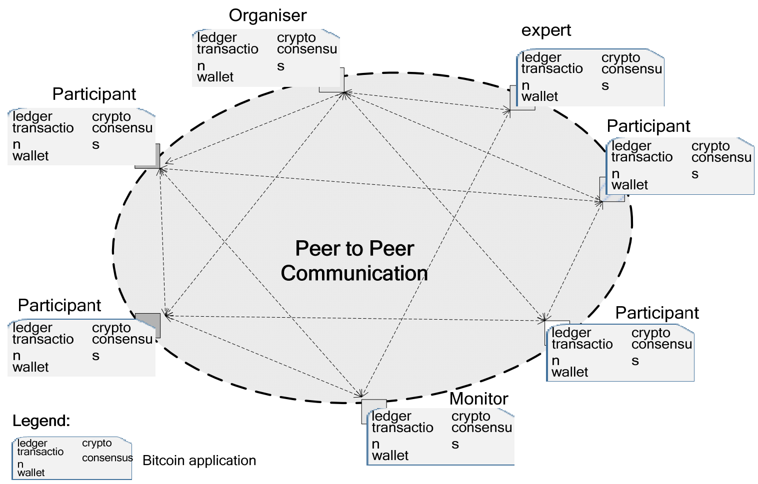


**Figure I-1 – Overview of the Bitcoin**

### I.1.2 Ethereum

*Editor's Note: This sub-clause provides an overview of Ethereum and applicability to IoT.*

*Ethereum is an open source public blockchain-based distributed computing platform, featuring smart contract functionality. It provides a decentralized virtual machine (Ethereum Virtual Machine, EVM) which can execute peer-to-peer contracts using token called ether.*

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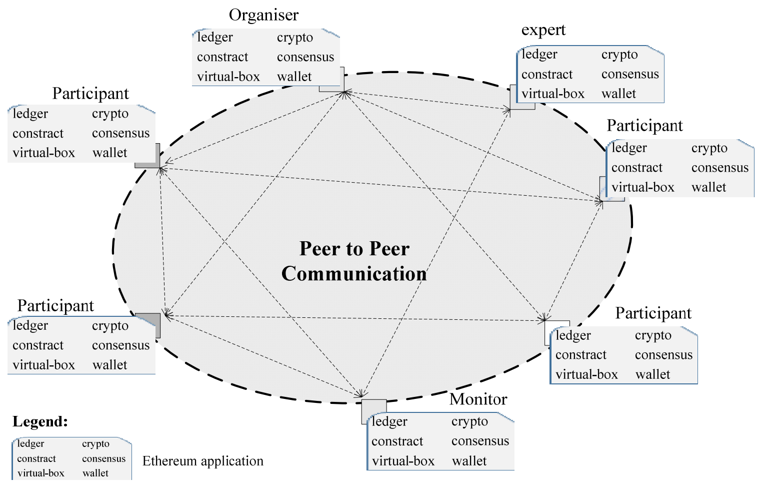


**Figure I-2 – Overview of the Ethereum**

## I.2 Hyperledger

*Editor's Note: This sub-clause provides an overview of Hyperledger and applicability to IoT.*

*Hyperledger is one of the consortium blockchain platforms, which supports blockchain-based distributed ledgers. Hyperledger is focused on ledgers designed to support global business transactions, including finance, banking, IoT, supply chains, manufacturing, etc. Hyperledger has a modular structure, make it easy to support various models such as consensus, storage, identity, access control and contracts.*

……

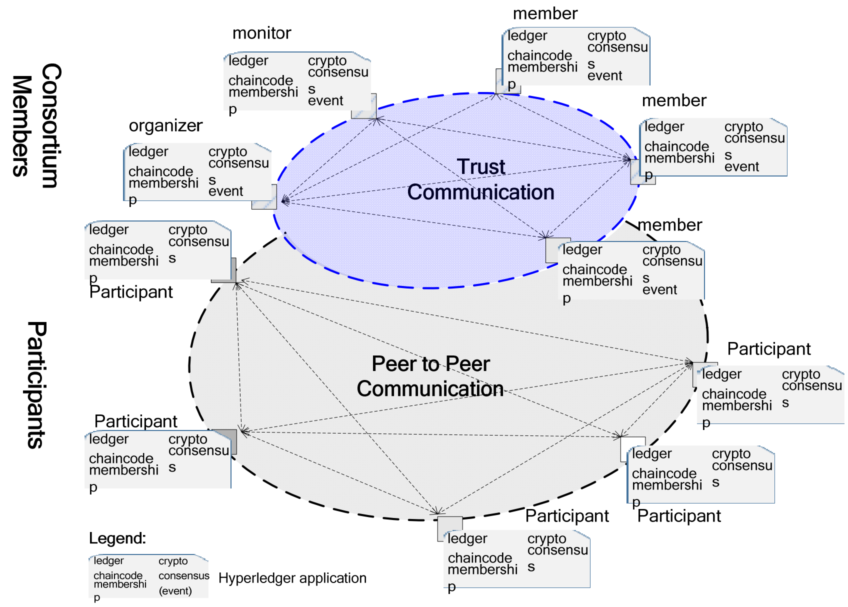


**Figure I-3 – Overview of Hyperledger**

# Appendix II

# Use cases for BoT

(Note: This appendix does not form an integral part of this Recommendation.)

This appendix provides some use cases to illustrate the concept of the BoT.

*Editor's Note: Contributions are invited to refine this appendix.*

## II.1 Use case: Using BoT to enhance supply chains for trust productions

*Editor's Note: This sub-appendix provides a use case about using BoT to enhance supply chains.*

The supply chains represent all the links involved in producing and distributing goods, from raw materials to the finished products that go into the possessions of the consumers. Figure II-1 shows supply chains for bikes, which include links to *Raw Materials Suppliers*, *Semi-manufactures*, *Bike Manufactures*, *Business Channels*, *Retailers* and *Consumers*, etc.

Currently, typical supply chains usually span many separate stages and geographical locations, which make it very hard to trace part/whole of the production processes. Under the typical supply chains, the productions processes are lack of transparency, traceability, security, and trust.

The BoT has the potential to revolutionize the typical supply chains and improve the trust to the ways for producing, marketing, purchasing, and consuming goods. The BoT-related supply chains can make transparency, traceability and security, and can go a long way toward making our economies safer and much more reliable by promoting trust and honesty, and preventing the implementation of questionable practices.

With the production of bikes as an example, showed in Figure II-1, relevant typical supply chains can be upgraded by employing BoT-related technologies. Those supply chains connect each other. Any of the bodies in the supply chains – in certain authorized circumstances and agreements – can trace the production processes of the bikes. That makes transparency, traceability and security and trust.

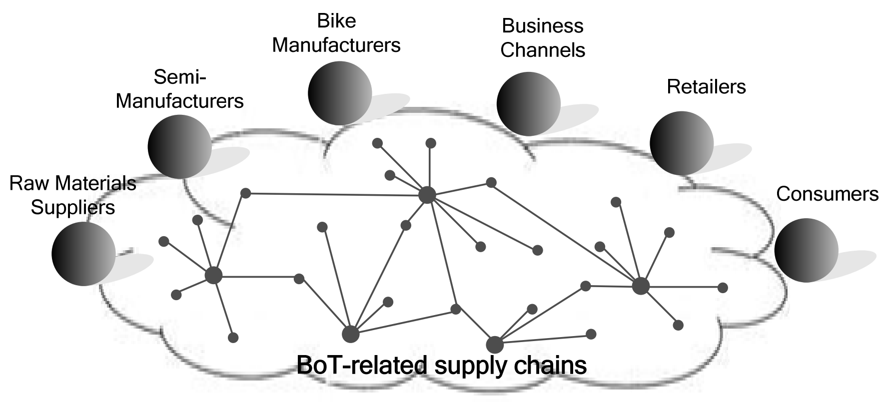


**Figure II-1 – Using BoT to enhance supply chains for trust productions**

## II.2 Use case: Using BoT to mitigate DDoS attacks from hijacked unsecure IoT devices

*Editor's Note: This sub-appendix provides a use case about using BoT to mitigate DDoS attacks from hijacked unsecure IoT devices.*

It is a big problem that many unsecure IoT devices (e.g. home cameras, smart lights, road monitors) are easy to be hijacked silently and become zombies. Those hijacked IoT devices are controlled by malwares to do DDoS attacks on specific servers. To remedy this problem the obvious answer is to prohibit the hijacked IoT devices from connecting to the communication network, and to cut the connections before they access to the target servers.

Most of the unsecure IoT devices are connected to the communication networks through IoT gateways. The IoT gateways can be upgraded to coordinate each other to perform those types of prohibitions.

As showed in Figure II-2, the IoT devices and IoT services connect to communication networks through their IoT gateways (gateway A, B, C and D) respectively. Those IoT gateways connect each other through communication networks and establish a BoT, and deploy smart contracts to validate, record and cancel DDoS attacks related information.

The home smart devices can connect to communication network through IoT gateway C showed in Figure II-2. If one of the home smart devices (e.g. the smart light) is hijacked and is controlled to perform DDoS attacks to the IoT service A. When the IoT service A validates the attacks, it notifies the IoT gateway A. The IoT gateway A then can connect the IoT gateway C to make a transaction according to a deployed smart contract. If the attacks are validated, relevant information could be written into the BoT ledger. After that, all of the IoT gateways in the BoT can drop the connection requests from the hijacked smart light. When the hijacked smart light is updated and works correctly, the IoT gateway C can make a new transaction to cancel the prohibition, and all of the IoT gateways can acknowledge the cancellation.

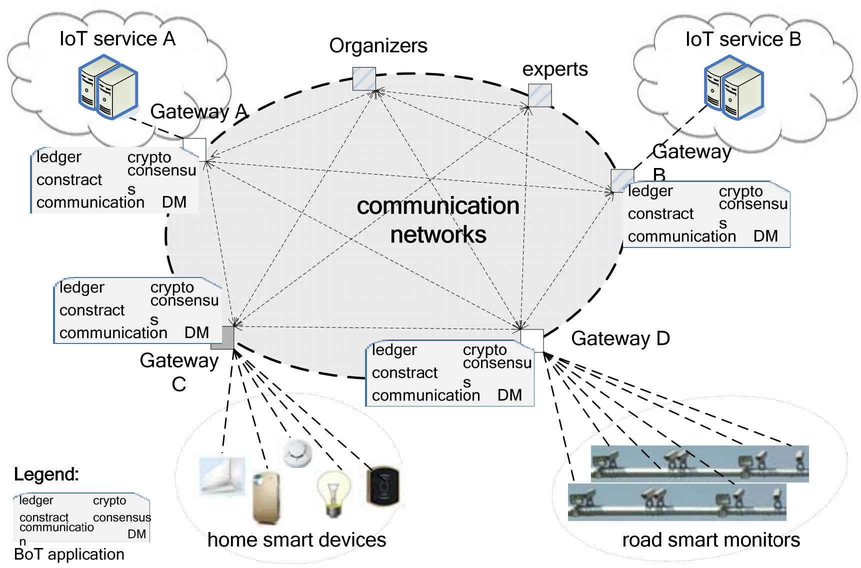


**Figure II-2 – Using BoT to mitigate DDoS attacks from hijacked unsecure IoT devices**

## II.3 Use case: Using BoT to improve ITS for trust data exchanges

*Editor's Note: This sub-appendix provides a use case about using BoT to enhance ITS.*

Through typical ITSs, the cars on the road can exchange information of themselves and their environments (e.g., speed, congestion degree, road humidity) to enhance their navigational abilities. However, there are some issues to be resolved, such as,

1) how to increase service coverage,
2) how to ensure the response speed and efficiencies,
3) how to motivate car users to join the activity to exchange information,
4) how to ensure the authenticity and effectiveness of the shared data, and
5) how to make the users trust the shared data.

Those issues can be solved or mitigated when the ITSs employ the BoT-related technologies. Figure II-3 provides an illustrative example about how to use BoT to enhance the ITSs. ITS provider A, B and others make an ITS alliance and establish an ITS BoT. Through the ITS BoT, the ITS providers coordinate each other to provide ITS services to the cars. The cars, as common participants, can produce and consume transportation information through the ITS BoT.

Firstly, the ITS BoT help the ITS providers solve issues 1) and 2) when they provide ITS services individually. Secondly, the cars become producers and/or consumers of the transportation information, the owners of the cars can get benefits from producing transportation information. Under correct strategies, the ITS BoT can motivate car users to join the activity of ITS (issue 3). Due to the inherent properties of BoT-related technologies, issues 4) and 5) can be easy to be solved.

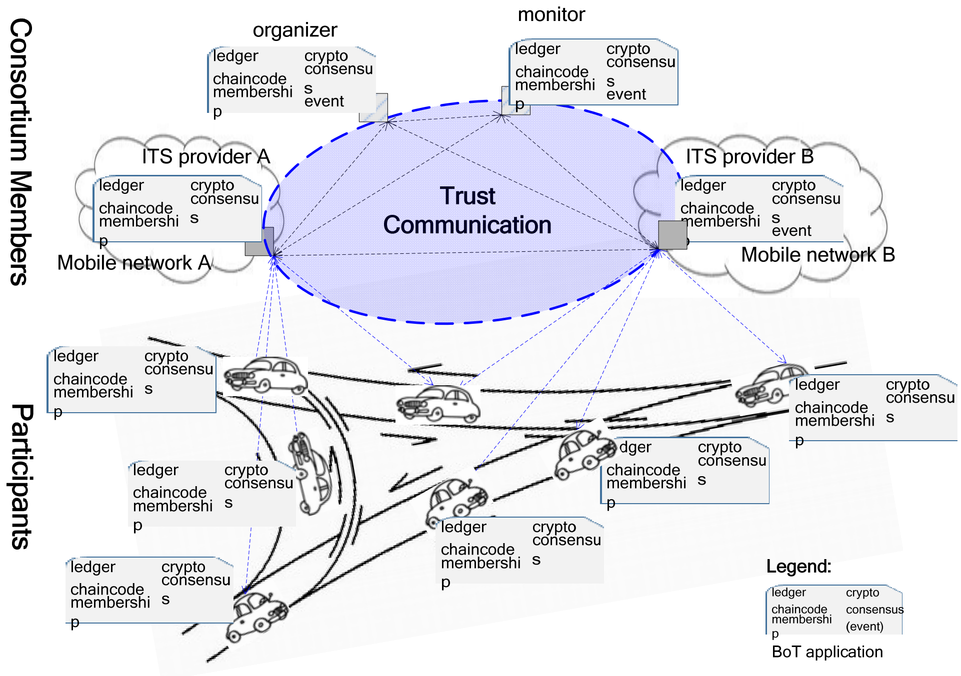


Figure II-3 – Using BoT to enhance ITS for trust data exchanges

## II.4 Use case: Using BoT to promote the device democracy

*Editor's Note: This sub-appendix provides a use case about using BoT to promote the device democracy.*

*Device democracy, or device-driven democracy, refers to a state in which the IoT devices are decentralized and they are autonomously interacting with each other at preset conditions.*

*……*

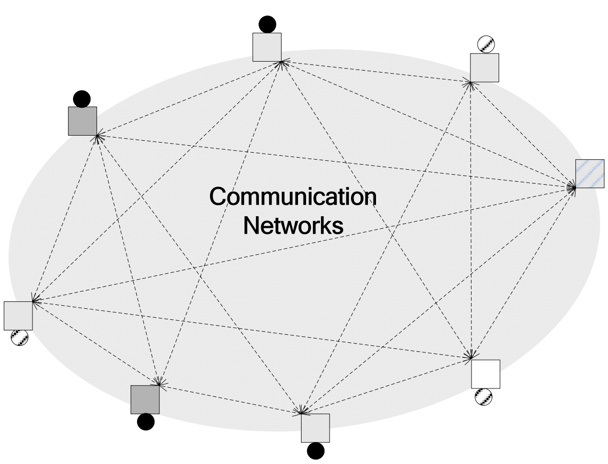


Figure II-4 – Using BoT to promote the device democracy

*NOTE: The concept of "device democracy" is from one of the IBM's executive reports, "Device democracy saving the future of the Internet of Things". It is not a political term, but to describe a state in which the IoT devices autonomously interact with each other at preset conditions.*

*……*

## Bibliography

[b-ITU-T M.1224-1] ITU-T Recommendation M.1224-1 (2012), *Vocabulary of terms for International Mobile Telecommunications (IMT)*.

*[TBD]*

# Annex XXX

## A.1 justification for proposed draft new Recommendation Y.IoT-BoT-fw

| | | | | |
|---|---|---|---|---|
| **Question:** | 4/20 | **Proposed new ITU-T Recommendation** | Dubai, 13-23 March 2017 | |
| **Reference and title:** | ITU-T Y.IoT-BoT-fw "Framework of blockchain of things as decentralized service platform" | | | |
| **Base text:** | COM20 C XXX | | **Timing:** | Q4 2018 |
| **Editor(s):** | Xiongwei Jia, China Unicom, jiaxw9@chinaunicom.cn;<br>Ramy Ahmed Fathy, NTRA Egypt, ramy.ahmed@ieee.org<br>Zheng Huang, ZTE Corporation, huang.zheng2@zte.com.cn<br>Song Luo, CATR MIIT, luosong@catr.cn<br>Jun Gong, ISA CETC, gongjunonly@gmail.com<br>Juntao Peng, Alibaba Group, juntao.pjt@alibaba-inc.com<br>...... | | **Approval process:** | AAP |

**Scope** (defines the intent or object of the Recommendation and the aspects covered, thereby indicating the limits of its applicability):

This Recommendation introduces concept of blockchain of things (BoT), analyses its common characteristics and high-level requirements when it is as a decentralized service platform for IoT, and then brings a general framework of BoT and relevant common capabilities as mapping to IoT reference model specified in ITU-T Y.4000.

The scope of this Recommendation includes:

– concept, common characteristics and high-level requirements of the BoT as decentralized service platform,

– general framework of BoT as decentralized service platform and relevant common capabilities.

**Summary** (provides a brief overview of the purpose and contents of the Recommendation, thus permitting readers to judge its usefulness for their work):

Blockchain-related technologies present opportunities for disruptive innovations, which enable global businesses to transact with less frictions and more trusts and efficiencies. Blockchains use shared, immutable ledgers to record the history of transactions. Blockchain fosters a new generation of transactional applications that establish trust, accountability, transparency and efficiency.

Some of the blockchains are reliant on the exchange of cryptocurrencies with anonymous users on a public network (e.g. Bitcoin, Ethereum); others are for business and working on permissioned network (e.g. Hyperledger), with known identities and without the need for cryptocurrencies. Blockchains show great promises across a wide range of business applications in many fields, including IoT and SC&C.

There are many benefits to making blockchain and IoT/SC&C together, and the key benefits are from building trust, reducing costs and accelerating transactions.

The proposed new work item will study how the blockchain-related technologies to improve the IoT applications and services (including IoT devices, processes and data), and to study relevant concept, characteristics, high-level requirements, framework, capabilities and use cases.

**Relations to ITU-T Recommendations or to other standards** (approved or under development):

To be sure, at present and in the future, blockchain-related standards and technologies will play important roles in the fields of IoT. However, there is not any common recognized blockchain-related standard as applicable to IoT. The proposed new work item is expected to provide one of the bases to study blockchain-related standards as applicable to IoT, and make bricks for filling in the blanks.

The outcomes and deliverables from other organizations (SDOs, alliances and companies, etc.) will be good inputs for this proposed new work item. And the SG20 will collaborate with them in the future.

**Liaisons with other study groups or with other standards bodies:**

ITU-T SG16&SG17, ISO/TC 307, W3C

**Supporting members that are committing to contributing actively to the work item:**

China Unicom, Egypt, ZTE Corporation, CATR MIIT, ISA CETC, Alibaba Group, Fiberhome, ……

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