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SERIES Y: GLOBAL INFORMATION  
INFRASTRUCTURE, INTERNET PROTOCOL ASPECTS,  
NEXT-GENERATION NETWORKS, INTERNET OF  
THINGS AND SMART CITIES

Internet of things and smart cities and communities –  
Services, applications, computation and data processing

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### **Blockchain-based data management for supporting Internet of things and smart cities and communities**

Recommendation ITU-T Y.4561



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# Recommendation ITU-T Y.4561

## Blockchain-based data management for supporting Internet of things and smart cities and communities

### Summary

Along with the development of the Internet of things (IoT) and smart cities and communities (SC&C), various applications have different kinds of requirements for data management, and there are many challenges, especially in data representing, data processing, data service provisioning, and other aspects in a secure and effective manner. Meanwhile, blockchain as an emerging technology possesses the characteristics of trust, transparency, traceability and accountability. It has the potential capabilities to solve the existing issues in data management.

Recommendation ITU-T Y.4561 specifies the requirements, generic reference model, common capabilities, and procedures of blockchain-based data management.

### History

| Edition | Recommendation | Approval   | Study Group | Unique ID*                                                                |
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### Keywords

Blockchain, capability, data management, reference model, requirement.

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\* To access the Recommendation, type the URL <http://handle.itu.int/> in the address field of your web browser, followed by the Recommendation's unique ID. For example, <http://handle.itu.int/11.1002/1000/11830-en>.

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The approval of ITU-T Recommendations is covered by the procedure laid down in WTSA Resolution 1.

In some areas of information technology which fall within ITU-T's purview, the necessary standards are prepared on a collaborative basis with ISO and IEC.

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# Recommendation ITU-T Y.4561

## Blockchain-based data management for supporting Internet of things and smart cities and communities

### 1 Scope

This Recommendation provides technical descriptions and specifications of the blockchain-based data management in Internet of things (IoT) and smart cities and communities (SC&C) application domains.

The scope of this Recommendation includes:

- Requirements of blockchain-based data management,
- Generic reference model of blockchain-based data management,
- Common capabilities and procedures of blockchain-based data management.

In addition, this Recommendation provides two data management approaches based on blockchain in Appendix I.

### 2 References

None.

### 3 Definitions

#### 3.1 Terms defined elsewhere

This Recommendation uses the following terms defined elsewhere:

**3.1.1 application** [b-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.

**3.1.2 blockchain** [b-FG-DPM TR D3.5]: A peer to peer distributed ledger based on a group of technologies for a new generation of transactional applications which may maintain a continuously growing list of cryptographically secured data records hardened against tampering and revision.

NOTE 1 – Blockchains can help establish trust, accountability and transparency while streamlining business processes.

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

NOTE 3 – Definition compatible with [b-ISO 22739].

**3.1.3 data management** [b-ISO/IEC TR 10032]: The activities of defining, creating, storing, maintaining and providing access to data and associated processes in one or more information systems.

**3.1.4 Internet of things (IoT)** [b-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 – From a broader perspective, the IoT can be perceived as a vision with technological and societal implications.

**3.1.5 service** [b-ITU-T Y.2091]: A set of functions and facilities offered to a user by a provider.

**3.1.6 smart sustainable city** [b-ITU-T Y.4900]: A smart sustainable city (SSC) is an innovative city that uses information and communication technologies (ICTs) and other means to improve quality of life, efficiency of urban operation and services, and competitiveness, while ensuring that it meets the needs of present and future generations with respect to economic, social, environmental as well as cultural aspects.

NOTE – City competitiveness refers to policies, institutions, strategies and processes that determine the city's sustainable productivity.

## **3.2 Terms defined in this Recommendation**

None.

## **4 Abbreviations and acronyms**

This Recommendation uses the following abbreviations and acronyms:

|      |                                          |
|------|------------------------------------------|
| API  | Application Programming Interface        |
| ETL  | Extract Transform Load                   |
| FTP  | File Transfer Protocol                   |
| HTTP | Hyper Text Transfer Protocol             |
| IoT  | Internet of Things                       |
| ICT  | Information and Communication Technology |
| REST | Representational State Transfer          |
| SC&C | Smart Cities and Communities             |
| SDK  | Software Development Kit                 |
| SSC  | Smart Sustainable City                   |

## **5 Conventions**

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.

## **6 Overview of blockchain-based data management**

In the context of the IoT and SC&C, the requirements of data management based on blockchain need to be specified. Subsequently, generic reference model, functional entities, and their capabilities and interactions are specified according to the requirements.

### **6.1 Introduction**

#### **6.1.1 Data management from an applications perspective**

Based on the definition of data management, in the context of IoT and SC&C, data management needs to cover the management aspects in the whole data life cycle, at least including the activities of data collecting, aggregating, transferring, storing and integrating, and the associated processes. It controls all the input-output operations within data processing. The data management in the data life cycle is briefly depicted in Figure 1.

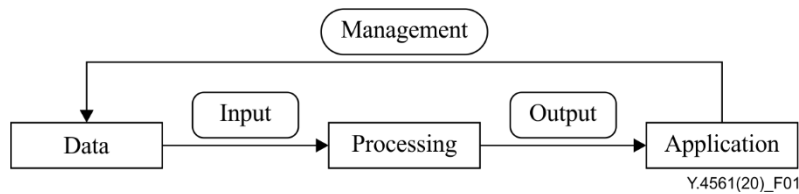


**Figure 1 – Introduction of data management in the data life cycle**

Figure 1 shows that data can either be raw data collected by the IoT device or processed data from the IoT application, and it needs to be collected and integrated in advance to create the appropriate input. The processing procedure entails the management and converting of data from the input state through to the required output requested by different kinds of applications. During the whole data life cycle, the following stages need to be monitored:

- Data collecting and transferring before data input,
- Data aggregating and storing upon input or after processing,
- Data transferring and data integrating upon processing.

### 6.1.2 Characteristics of blockchains from a data management perspective

A blockchain is distinguished by the following characteristics:

- Decentralized,
- Distributed storage,
- Asymmetric cryptography,
- Digital fingerprint,
- Tamper-proof.

Each characteristic can be adopted to improve particular aspects of data management as follows:

- Decentralized mechanism can be adopted to reduce the need for intermediaries among multiple parties to establish trust data transaction,
- Each blockchain node usually stores a copy of the entire verified blocks of data, the distributed storage can be adopted to the benefit of data recovery and data sharing,
- Asymmetric cryptography can be adopted to enhance data confidentiality and communication security, and facilitate non-repudiation by using the private key as digital signature,
- Digital fingerprint can be adopted to enhance data integrity,
- Immutable blocks of data are recorded by each node of blockchain.

## 6.2 Requirements of data management based on a blockchain

### 6.2.1 Security requirement

It is required to enhance the secure control of IoT data when it is being transferred through all the data processes. Secure control includes managing to keep data confidentiality, data integrity, and non-repudiation.

### 6.2.2 Authenticity requirement

It is required to record the data in a pre-defined format as per application requirement in the blockchain after consensus, to guarantee data authenticity and immutability.

### 6.2.3 Data acquisition requirements

It is required to collect data from data source and related metadata for authenticity verification.