TECHNICAL REPORT

ISO/TR 23455

First edition
2019-09

Blockchain and distributed ledger technologies — Overview of and interactions between smart contracts in blockchain and distributed ledger technology systems

ISO/TR 23455:2019 - Preview only Copy via ILNAS e-Shop

Reference number
ISO/TR 23455:2019(E)

© ISO 2019

ISO/TR 23455:2019 - Preview only Copy via ILNAS e-Shop

COPYRIGHT PROTECTED DOCUMENT

© ISO 2019

All rights reserved. Unless otherwise specified, or required in the context of its implementation, no part of this publication may be reproduced or utilized otherwise in any form or by any means, electronic or mechanical, including photocopying, or posting on the internet or an intranet, without prior written permission. Permission can be requested from either ISO at the address below or ISO's member body in the country of the requester.

ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Fax: +41 22 749 09 47
Email: copyright@iso.org
Website: www.iso.org

Published in Switzerland

© ISO 2019 – All rights reserved

Contents

Page

Foreword ... **iv**
Introduction ... **v**
1 Scope ... **1**
2 Normative references ... **1**
3 Terms and definitions ... **1**
4 Symbols and abbreviated terms ... **2**
5 Overview of smart contracts ... **2**
5.1 History of smart contracts ... 2
5.2 Different ways of understanding smart contracts ... 3
6 Operation of smart contracts ... **4**
6.1 The concept of a smart contract ... 4
6.2 Benefits and challenges of smart contracts ... 6
6.3 Difference between on-chain and off-chain smart contracts regarding deployment and execution ... 7
6.4 Access of real-world-information for smart contracts ... 8
6.4.1 General considerations about real-world-interaction ... 8
6.4.2 One-way event delivery from a smart contract to an event consumer ... 9
6.4.3 Transfer of control from a smart contract to an external process ... 11
6.5 Life cycle of smart contracts: creation, operation, termination ... 11
6.5.1 Overview ... 11
6.5.2 Modifying smart contracts in a public BC/DLT system ... 11
6.5.3 Update and roll-back mechanisms supported by the underlying ledger ... 12
6.5.4 Migration mechanisms defined by smart contracts ... 12
6.6 Security ... 12
7 Binding and enforceable smart contracts ... **14**
7.1 General ... 14
7.2 Legal enforceability of smart contracts ... 14
8 Smart contracts for information transfer between blockchains (cross-chain and sidechain transactions) ... **15**
8.1 Introduction ... 15
8.2 Implementations of cross-chain and sidechain transactions ... 16
8.3 Importance of semantics, syntax, inputs and languages for the interoperability of smart contracts ... 20
Annex A (informative) **Examples of smart contract implementations** ... **21**
Annex B (informative) **Role of domain specific languages and methods** ... **24**
Annex C (informative) **Applications and smart contract use cases** ... **26**
Bibliography ... **40**

ISO/TR 23455:2019 - Preview only Copy via ILNAS e-Shop

© ISO 2019 – All rights reserved

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 307, *Blockchain and distributed ledger technologies*.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

ISO/TR 23455:2019 - Preview only Copy via ILNAS e-Shop

 © ISO 2019 – All rights reserved

Introduction

Smart contracts, a synonym for automated applications on blockchain and distributed ledger technology-based (BC/DLT) systems, are an important development step from early stage, purely transaction oriented blockchains to more interactive technologies where the transactions on the blockchain or distributed ledger technology system are conditional on the terms of that application. According to the current working-definition of ISO/TC 307, WG1, Terminology, a smart contract is a

"computer program stored in a distributed ledger system wherein the outcome of any execution of the program is recorded on the distributed ledger".

In specific implementations of BC/DLT systems, such a program can vary from program code interpreted on single peers to (pre-)compiled programs recorded on the ledger to be executed on arbitrary virtual machines within the system (such as miners). It should be understood that the "effects" to be recorded on the distributed ledger will usually be the transaction that is the deterministic, predefined coded outcome from the smart contract code.

As the term smart contract in its original intention as created by Nick Szabo in 1994 had a different, mainly legally oriented (precise and legitimate) meaning, this has often caused confusion regarding "legally binding intentions": As this document discusses and describes smart contracts as a technology for BC/DLT automation in general, it is also important to understand that smart contracts may have a legal binding intention. Because of this, the legal binding application and structure of smart contracts also requires understanding of legal background, context and definitions.

This document mainly describes the aspects of automated software in a BC/DLT-system.

ISO/TR 23455:2019 - Preview only Copy via ILNAS e-Shop

© ISO 2019 – All rights reserved

ISO/TR 23455:2019 - Preview only Copy via ILNAS e-Shop

Blockchain and distributed ledger technologies — Overview of and interactions between smart contracts in blockchain and distributed ledger technology systems

1 Scope

This document provides an overview of smart contracts in BC/DLT systems; describing what smart contracts are and how they work. It also discusses methods of interaction between multiple smart contracts. This document focuses on technical aspects of smart contracts. Smart contracts for legally binding use and applications will only be briefly mentioned in this document.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.1
asset
anything that has value to a stakeholder

[SOURCE: ISO/TS 19299:2015, 3.3, modified — Note 1 to entry has been removed.]

3.2
ledger
information store that keeps records of *transactions* (3.10) that are intended to be final, definitive and immutable

3.3
miner
DLT node which engages in *mining* (3.4)

3.4
mining
block-building activity in some consensus mechanisms

Note 1 to entry: Participation in mining is often incentivized by block rewards and *transaction* (3.10) fees.

3.5
off-chain
related to a blockchain system, but located, performed or run outside a blockchain system

3.6
on-chain
located, performed or run inside a blockchain system

ISO/TR 23455:2019 - Preview only Copy via ILNAS e-Shop

© ISO 2019 – All rights reserved