

Recommendation

ITU-T F.751.11 (09/2023)

SERIES F: Non-telephone telecommunication services

Multimedia services

**Performance test suite for distributed ledger
technology systems**



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Recommendation ITU-T F.751.11

Performance test suite for distributed ledger technology systems

Summary

Recommendation ITU-T F.751.11 provides a performance test suite for distributed ledger technology (DLT) system based on assessment criteria proposed in Recommendations ITU-T F.751.1 and ITU-T F.751.6. This Recommendation specifies the basic principles and main dimensions of the performance testing for a DLT system and provides a suite of test cases that can help users quantitatively and objectively analyse the performance of the DLT system in different test environments comprehensively and find the most suitable path to improve performance.

History *

Edition	Recommendation	Approval	Study Group	Unique ID
1.0	ITU-T F.751.11	2023-09-13	16	11.1002/1000/15625

Keywords

Blockchain, distributed ledger technology, DLT, performance, test suit.

* To access the Recommendation, type the URL <https://handle.itu.int/> in the address field of your web browser, followed by the Recommendation's unique ID.

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Recommendation ITU-T F.751.11

Performance test suite for distributed ledger technology systems

1 Scope

This Recommendation specifies a performance test suite for a distributed ledger technology system (DLT) system, which includes the basic principles and main dimensions of performance testing for a DLT system. This Recommendation is based on [ITU-T F.751.1] and [ITU-T F.751.6], and can be used as a guideline for DLT system performance testing and development.

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; 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. A list of the currently valid ITU-T Recommendations is regularly published. The reference to a document within this Recommendation does not give it, as a stand-alone document, the status of a Recommendation.

- [ITU-T F.751.0] Recommendation ITU-T F.751.0 (2020), *Requirements for distributed ledger system*.
- [ITU-T F.751.1] Recommendation ITU-T F.751.1 (2020), *Assessment criteria for distributed ledger technology (DLT) platforms*.
- [ITU-T F.751.6] Recommendation ITU-T F.751.6 (2022), *Performance assessment methods for distributed ledger technology platforms*.

3 Definitions

3.1 Terms defined elsewhere

This Recommendation uses the following terms defined elsewhere:

3.1.1 consensus [ITU-T F.751.0]: Agreement that a set of transactions is valid.

3.1.2 distributed ledger technology (DLT) [ITU-T F.751.1]: Technology enabling large groups of nodes in distributed ledger networks to reach agreement and record information without the need for a central authority.

NOTE – Adapted from [b-ITU-T TS FG DLT D1.1].

3.1.3 smart contract [ITU-T F.751.0]: Program written on the distributed ledger system that encodes the rules for specific types of distributed ledger system transactions in a way that can be validated, and triggered by specific conditions.

NOTE – Adapted from [b-ITU-T TS FG DLT D1.1].

3.1.4 transaction [ITU-T F.751.0]: An incident or an operation that leads to a change in the status of a ledger, such as adding a record or equivalent exchange based on currency.

3.1.5 large-scale network [b-ITU-T Y.3113]: A network or a set of networks, whose longest end-to-end path includes 16 or more relay nodes.

3.2 Terms defined in this Recommendation

None.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

DLT Distributed Ledger Technology

5 Conventions

None.

6 Basic principles

The design of the test suite should follow the following basic principles:

- Reproducibility. Test cases should be able to run successfully in different experimental environments and not be limited to specific test environments. In environments with the same hardware configuration, the test results should be similar. Additional uncontrollable variables, which may prevent the reproducibility of test results, should not be introduced.
- Predictability. Through the design of the test suite, it is possible to infer the trend of DLT system performance changes in different scenarios, such as changes in DLT performance with changes in the number of nodes, the size of the transaction body or the amount of data on the chain.

7 Main dimensions

The design of the test suite should follow the following dimensions:

- Type of transactions: the differences between different transaction types mainly include transaction logic and transaction payload. There are three main types of transaction, account fund transfer transactions, data storage transactions and query transactions.
- Network scale of the DLT system: the number of nodes participating in the consensus of the DLT system. The DLT system needs to be designed with different node scales according to a certain gradient.
- Duration of pressure: The duration of continuous pressure applied to the DLT system.

Table 1 – Test case dimensions and conditions

Case No.	Transaction type	Network scale of DLT system
Case 01	Payment-related transaction	Small
Case 02		Large
Case 03	Evidence-based transaction	Small
Case 04		Large
Case 05	Query transaction	Small

8 Test cases

8.1 Payment-related transaction under a small-scale network of a DLT system

See Table 2.

Table 2 – Payment-related transaction under a small-scale network of a DLT system

Test Case 01	Payment-related transaction under a small-scale network of a DLT system
Test reference	Clause 7 of [ITU-T F.751.6]
Test purpose	Test the performance of the system for payment-related transactions by sending continuous pressure to a small-scale network of a DLT system.
Test workflow	<p>Step 1. Build a small-scale network of a DLT system where the number of participating consensus nodes can tolerate at least one malicious node.</p> <p>Step 2. Generate a certain number of accounts on the DLT system, and deposit a certain amount of balance.</p> <p>Step 3. Prepare sufficient payment-related transactions; the transfer amount of each transaction should be greater than zero, and the outgoing and incoming accounts should be different.</p> <p>Step 4. Send transactions to the DLT system at a sufficiently fast speed, and after a certain duration, examine the performance test results. Multiple rounds of testing need to be conducted based on the actual circumstances to observe the overall performance changes in the system.</p>
Expected results	<ol style="list-style-type: none"> 1. The DLT system is running normally, and there are no abnormalities in the status of each node. 2. There are a certain number of accounts on the chain, each account owns a certain amount of balance. 3. The number of transactions is large enough and ensures the DLT system can be successfully executed. 4. There was no abnormality in the system during the test, and the results included in clause 7 of [ITU-T F.751.6] could be calculated.

8.2 Payment-related transaction under a large-scale network of a DLT system

See table 3.

Table 3 – Payment-related transaction under a large-scale network of a DLT system

Test Case 02	Payment-related transactions under a large-scale network of a DLT system
Test reference	Clause 7 of [ITU-T F.751.6]
Test purpose	Test the performance of the system for payment-related transactions by sending continuous pressure to a large-scale network of a DLT system.
Test workflow	<p>Step 1. Build a large-scale network of a DLT system with hundreds or thousands of participating consensus nodes.</p> <p>Step 2. Generate a certain number of accounts on the DLT system, and deposit a certain amount of balance.</p> <p>Step3. Prepare sufficient payment-related transactions; the transfer amount of each transaction should be greater than zero, and the outgoing and incoming accounts should be different.</p> <p>Step 4. Send transactions to the DLT system at a sufficiently fast speed, and after a certain duration, examine the performance test results. Multiple rounds of testing need to be conducted based on the actual circumstances to observe the overall performance changes in the system.</p>
Expected results	<ol style="list-style-type: none"> 1. The DLT system is running normally, and there are no abnormalities in the status of each node.

Table 3 – Payment-related transaction under a large-scale network of a DLT system

Test Case 02	Payment-related transactions under a large-scale network of a DLT system
Test reference	Clause 7 of [ITU-T F.751.6]
	<p>2. There are a certain number of accounts on the chain; each account owns a certain amount of balance.</p> <p>3. The number of transactions is large enough and ensures the DLT system can be successfully executed.</p> <p>4. There was no abnormality in the system during the test, and the results included in clause 7 of [ITU-T F.751.6] could be calculated.</p>

8.3 Evidence-based transaction under a small-scale network of a DLT system

See Table 4.

Table 4 – Evidence-based transaction under a small-scale network of a DLT system

Test Case 03	Evidence-based transaction under a small-scale network of a DLT system
Test reference	Clause 7 of [ITU-T F.751.6]
Test purpose	Test the performance of the system for evidence-based transactions by sending continuous pressure to a small-scale network of a DLT system.
Test workflow	<p>Step 1. Build a small-scale network of a DLT system where the number of participating consensus nodes can tolerate at least one malicious node.</p> <p>Step 2. Generate a certain number of accounts or addresses on the DLT system for storing data.</p> <p>Step 3. Prepare sufficient notarized transactions, with each transaction being stored in a different account or address; the amount of information to be stored in each transaction should reach hundreds or thousands of bytes.</p> <p>Step 4. Send transactions to the DLT system at a sufficiently fast speed, and after a certain duration, examine the performance test results. Multiple rounds of testing need to be conducted based on the actual circumstances to observe the overall performance changes in the system.</p>
Expected results	<p>1. The DLT system is running normally, and there are no abnormalities in the status of each node.</p> <p>2. There are a certain number of accounts on the chain, each account owns a certain amount of balance.</p> <p>3. The number of transactions is large enough and ensures the DLT system can be successfully executed.</p> <p>4. There was no abnormality in the system during the test, and calculate the results included in clause 7 of [ITU-T F.751.6].</p>

8.4 Evidence-based transaction under a large-scale network of a DLT system

See Table 5.

Table 5 – Evidence-based transaction under a large-scale network of a DLT system

Test Case 04	Evidence-based transaction under a large-scale network of a DLT system
Test reference	Clause 7 of [ITU-T F.751.6]
Test purpose	Test the performance of the system for evidence-based transactions by sending continuous pressure to a large-scale network of DLT system.

Table 5 – Evidence-based transaction under a large-scale network of a DLT system

Test Case 04	Evidence-based transaction under a large-scale network of a DLT system
Test workflow	<p>Step 1. Build a large-scale network of a DLT system with hundreds or thousands of participating consensus nodes.</p> <p>Step 2. Generate a certain number of accounts or addresses on the DLT system for storing data.</p> <p>Step 3. Prepare sufficient notarized transactions, with each transaction being stored in a different account or address; the amount of information to be stored in each transaction should reach hundreds or thousands of bytes.</p> <p>Step 4. Send transactions to the DLT system at a sufficiently fast speed, and after a certain duration, examine the performance test results. Multiple rounds of testing need to be conducted based on the actual circumstances to observe the overall performance changes in the system.</p>
Expected results	<ol style="list-style-type: none"> 1. The DLT system is running normally, and there are no abnormalities in the status of each node. 2. There are a certain number of accounts on the chain; each account owns a certain amount of balance. 3. The number of transactions is large enough and ensures the DLT system can be successfully executed. 4. There was no abnormality in the system during the test, and the results included in clause 7 of [ITU-T F.751.6] could be calculated.

8.5 Query transaction

See Table 6

Table 6 – Query transaction

Test Case 05	Query transaction
Test reference	Clause 7 of [ITU-T F.751.6]
Test purpose	Test the performance of a DLT system for query transactions
Test workflow	<p>Step 1. Build a small-scale network of a DLT system where the number of participating consensus nodes can tolerate at least one malicious node.</p> <p>Step 2. Generate a certain number of accounts on the DLT system, and deposit a certain amount of balance.</p> <p>Step 3. Prepare sufficient query requests and randomly query the balances or stored information in different accounts.</p> <p>Step 4. Send transactions to the DLT system at a sufficiently fast speed, and after a certain duration, examine the performance test results. Multiple rounds of testing need to be conducted based on the actual circumstances to observe the overall performance changes in the system.</p>
Expected results	<ol style="list-style-type: none"> 1. The DLT system is running normally, and there are no abnormalities in the status of each node. 2. There are a certain number of accounts on the chain; each account owns a certain amount of balance. 3. The number of transactions is large enough and ensures the DLT system can be successfully executed. 4. There was no abnormality in the system during the test, and the results included in clause 7 of [ITU-T F.751.6] could be calculated.

Bibliography

- [b-ITU-T Y.3113] Recommendation ITU-T Y.3113 (2021), *Requirements and framework for latency guarantee in large-scale networks including the IMT-2020 network*.

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