

Recommendation
ITU-T F.751.13 (09/2023)

SERIES F: Non-telephone telecommunication services

Multimedia services

**Framework and requirements for distributed
ledger technology-based distributed power
trading systems**



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Recommendation ITU-T F.751.13

Framework and requirements for distributed ledger technology-based distributed power trading systems

Summary

Recommendation ITU-T F.751.13 specifies the framework and requirements for the distributed power trading (DPT) system based on distributed ledger technology (DLT). The framework includes the infrastructure layer, the interface layer and the application layer.

History *

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Distributed ledger technology, distributed power trading, framework, requirement.

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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 F.751.13

Framework and requirements for distributed ledger technology-based distributed power trading systems

1 Scope

This Recommendation specifies the framework and requirements for the development and design of the distributed power trading (DPT) system based on distributed ledger technology (DLT), including:

- Framework;
- Participating entities for the DPT system;
- Requirements for the infrastructure layer;
- Requirements for the interface layer; and
- Requirements for the application layer.

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.751.2] Recommendation ITU-T F.751.2 (2020), *Distributed ledger technology reference architecture – Architecture*.

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.

3.1.2 blockchain [b-ITU-T F.751.0]: A type of distributed ledger that is composed of digitally recorded data arranged as a successively growing chain of blocks with each block cryptographically linked and hardened against tampering and revision.

3.1.3 distributed ledger [b-ITU-T X.1400]: A type of ledger that is shared, replicated, and synchronized in a distributed and decentralized manner.

3.1.4 distributed ledger technology (DLT) [b-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.

3.1.5 settlement [b-ITU-T Q.1743]: Payment of amounts resulting from the accounting process.

3.1.6 smart contract [b-ITU-T X.1400]: A program written on a distributed ledger system which encodes the rules for specific types of distributed ledger system transactions in a way that can be validated, and triggered by specific conditions.

3.1.7 transaction [b-ITU-T X.1400]: Whole of the exchange of information between nodes. A transaction is uniquely identified by a transaction identifier.

3.2 Terms defined in this Recommendation

This Recommendation defines the following term:

3.2.1 quotation: The process of providing a specific price or rate for the supply or purchase of electricity. It provides potential buyers or sellers with the pricing information necessary to evaluate and make informed decisions regarding electricity transactions.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

API	Application Program Interface
DLT	Distributed Ledger Technology
DPT	Distributed Power Trading
RPC	Remote Procedure Call
SDK	Software Development Kit

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.
- The keywords "**may optionally**" indicate an optional requirement which is permissible, without implying any sense of being recommended. This term is not intended to imply that the vendor's implementation must provide the option and the feature can be optionally enabled by the network operator/service provider. Rather, it means the vendor may optionally provide the feature and still claim conformance with the specification.

6 Framework

As shown in Figure 1, this Recommendation specifies a framework for the DLT-based DPT system.

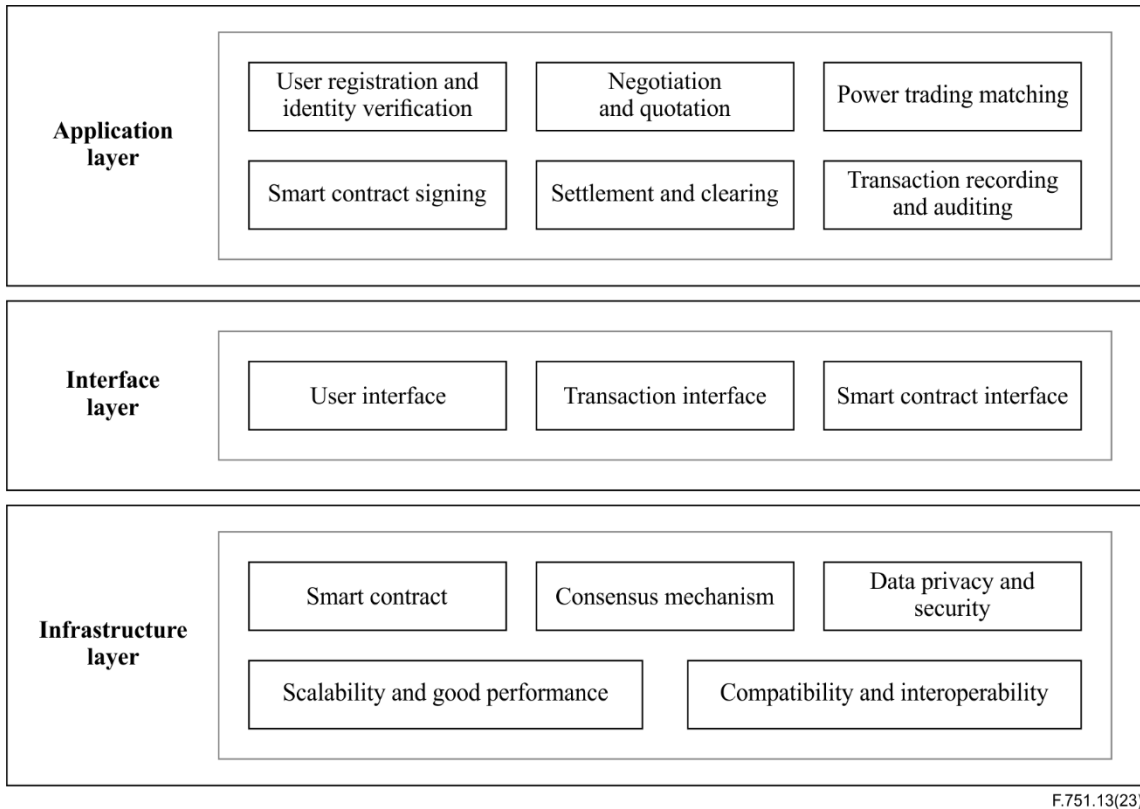


Figure 1 – Framework for the DLT-based distributed power trading system

The framework for the DLT-based DPT system includes the infrastructure layer, interface layer and application layer.

- The infrastructure layer provides the DLT platform, ensuring a secure and trustworthy execution of power trading through smart contracts, consensus mechanisms, privacy protection and other capabilities.
- The interface layer interacts with the application layer and the infrastructure layer. It includes the user interfaces, transaction interfaces and contract interfaces.
- The application layer provides power trading management, including user identity management and the full lifecycle management of power trading.

7 Participating entities for the DPT system

The participating entities for the DPT system include power users, power generation companies and technical service providers.

- **Power users:** They are consumers in the DPT system, including households, businesses and public institutions. They can purchase electricity through the power trading platform and choose the energy supply that suits their needs.
- **Power generation companies:** They are those who produce electricity and can be a traditional power generation facility, renewable energy power plant or distributed energy system. Power generation companies provide electricity resources according to market demand and trading rules. They need to access the blockchain network and execute electricity transactions through smart contracts.

- **Technical service providers:** They provide the development, deployment and maintenance of blockchain technology platforms to ensure the performance, security and reliability of the power trading platform. Technology service providers are also responsible for the development and implementation of smart contracts, ensuring automated execution of transactions and enforcement of rules.

8 Requirements for infrastructure layer

The infrastructure layer provides the DLT platform. The requirements for the DLT platform can refer to [ITU-T F.751.2], Reference framework for distributed ledger technologies.

- **Smart contracts:** It is required to handle the business logic about the power trading through smart contracts, including negotiation and quotation, power trading matching, settlement and clearing.
- **Consensus mechanism:** It is required to verify and validate the validity of transactions through the consensus mechanism.
- **Data privacy and security:** It is required to provide effective authentication and access control mechanisms to prevent unauthorized access and malicious behaviours. In addition, the system should have a flexible data sharing mechanism to ensure that participants can control the use and scope of sharing their data.
- **Scalability and good performance:** It is required to be able to handle a large number of transactions and maintain fast confirmation and settlement of transactions.
- **Compatibility and interoperability:** It is required to allow seamless integration with existing energy systems and standard interfaces. The system should be able to interoperate with other DLT platforms to facilitate cross-platform transactions and collaboration.

9 Requirements for interface layer

The interface layer is required to observe the following rules:

- **Multiple types of interfaces:** It is recommended to provide multiple types of interfaces, including but not limited to the RPC, API and SDK.
- **Permission management:** It is required to control the access permissions of interfaces for different users.
- **Classification of interface functions:** It is required to provide user interfaces, smart contract interfaces and transaction interfaces in the interface management.

10 Requirements for application layer

10.1 Trading flow

The complete process for DLT-based DPT is recommended to include the stages shown in Figure 2.

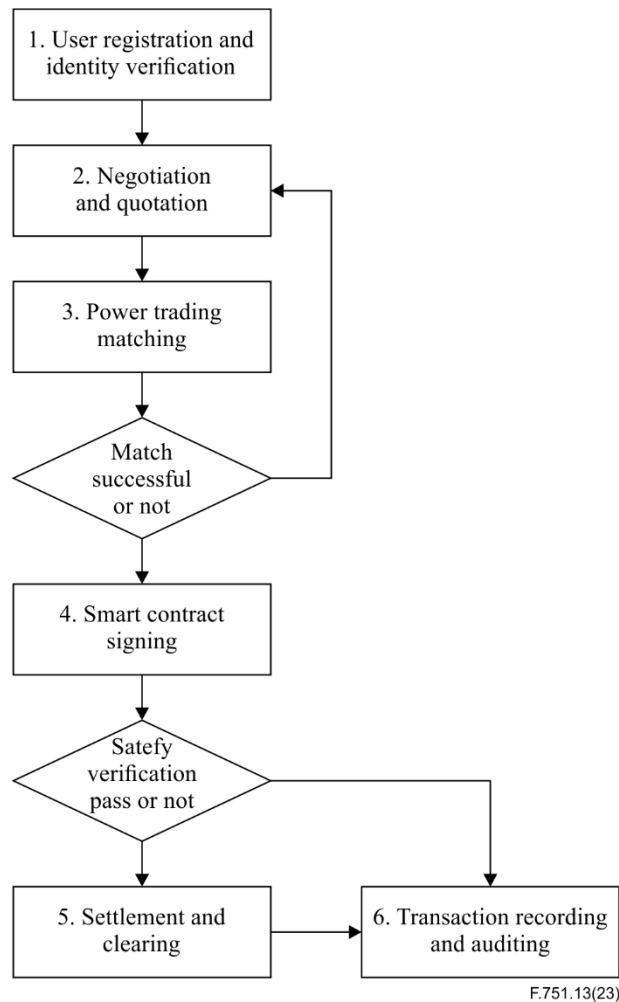


Figure 2 – Process for DLT-based distributed power trading

- **Stage 1:** User registration and identity verification. The power generation companies and users are required to register, and then they can trade on the platform after passing the registration review.
- **Stage 2:** Negotiation and quotation. Power generation companies and power users provide the electricity prices and electricity consumption during the trading cycle.
- **Stage 3:** Power trading matching. The DPT platform performs transaction matching according to the quotation generated in Stage 2.
- **Stage 4:** Smart contract signing. Both the power generation company and the power user shall sign the smart contract.
- **Stage 5:** Settlement and clearing. Automate the settlement and clearing process of transactions, ensuring secure settlement and clearing of transaction funds.
- **Stage 6:** Transaction recording and auditing. Record transaction data and auditing information to provide transaction traceability and auditability.

10.2 Key functions

10.2.1 User registration and identity verification

It is required to ensure that only authorized users can participate in power trading and protect the system from unauthorized access and malicious activities.

- **Identity verification:** It is recommended to implement decentralized user identity verification using blockchain technology, verifying identities through users' digital credentials and public key authentication.
- **Distributed identity management:** It is required to store user identity data on the DLT platform to ensure identity security and trustworthiness.
- **Privacy protection:** It may optionally provide anonymous transaction functions to protect user privacy.

10.2.2 Negotiation and quotation

The power generation companies or power users issue a request for power trading, and the request is signed by the customer and then broadcast in the power trading system.

- **Bilateral quotation:** It is required that power generation companies and users submit the electricity price and electricity for the next trading cycle to the trading platform.
- **Digital signature:** It is required that the transaction requests are digitally signed by the power users or power generation companies before transaction broadcasting.
- **Transaction broadcasting:** It is required to broadcast the transaction data in the DLT network, include but not limited to user ID, transaction time, transaction volume and transaction price.

10.2.3 Power trading matching

This stage is to achieve effective matching between power users and the generation companies, which can optimize power supply-demand balance and improve the utilization efficiency of energy.

- **Matching algorithm:** It is required to design and implement supply-demand matching algorithms based on smart contracts, considering the preferences, conditions and priorities of power suppliers and demand-side participants to ensure the best matching results.
- **Real-time data updates:** It is required to keep data updated in real-time, including electricity market prices, supply capacity and demand forecasts, to support accurate matching decisions.
- **Decentralized transaction matching:** It is required to utilize the decentralized nature of DLT to eliminate traditional intermediaries and enable direct transaction matching between supply and demand participants, reducing transaction costs and improving efficiency.

10.2.4 Smart contract signing

At this stage, the power users and the generation companies need to sign the contract with their private keys in DLT.

- **Security verification:** It is required to perform a security verification of the smart contract signed by the power generation company and the power user.
- **Contract content:** It is required to define the transaction period, transaction electricity, settlement method, settlement electricity price and liability for breach of smart contracts.
- **Automatic execution:** It is required to automatically execute smart contracts based on validated transaction requests, facilitating power exchange between suppliers and demand-side participants.

10.2.5 Settlement and clearing

At this stage, automatic settlement and clearing are realized through smart contracts.

- **Automatic settlement:** It is required to automate the transaction settlement process based on smart contracts, including determining payable amounts, initiating payments and fund transfers, reducing manual intervention and errors, and ensuring accurate and trustworthy transactions.

- **Automatic clearing:** It is required to establish an automatic clearing mechanism through smart contracts to periodically reconcile and clear transaction data and settlement results, ensuring transaction accuracy and completeness.
- **Settlement methods:** It is required to define the calculation and settlement methods for transaction fees and service charges, ensuring transparency and reasonableness of transaction costs. Determine appropriate settlement cycles to meet participants' settlement.
- **Cross-chain settlement support:** It is recommended to support cross-chain transaction, enabling fund transfers and settlements between different DLT platforms through cross-chain technologies, increasing transaction flexibility and interoperability.

10.2.6 Transaction recording and auditing

Store transaction records in the DLT, ensuring transaction traceability and transparency.

- **Transaction records:** It is required to record key information of transactions on the DLT, including transaction time, participating parties, transaction quantities and transaction results, ensuring accurate recording and storage of transactions.
- **Audit logs:** It is required to record key events and operations during transaction execution, including user access, transaction execution and system configuration changes, to support secure auditing and traceability.
- **Privacy protection:** It is required to implement appropriate data encryption and privacy protection measures to safeguard transaction data and participants' privacy information.

Bibliography

- [b-ITU-T F.751.0] Recommendation ITU-T F.751.0 (2020), *Requirements for distributed ledger systems.*
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