CLAIMS

1. A computer-implemented method for processing blockchain-based transactions, the computer-implemented method comprising:

receiving, by a first member node device in a blockchain, a target transaction initiated by a second member node device in the blockchain, wherein the target transaction comprises a unique identifier of the target transaction and a block height of a candidate block on the blockchain defining a creation time stamp of a logical clock;

determining that the target transaction is valid by determining that the target transaction is authorized to be performed within a transaction validity period based on the unique identifier of the target transaction, wherein the transaction validity period enables differentiation of overdue transactions from valid transactions and is characterized by a difference between the block height of the candidate block and a threshold;

determining that the candidate block is a legitimate block by verifying that the creation time stamp of the target transaction is monotonically increasing in comparison to other creation timestamps of blocks in the blockchain;

in response to determining that the target transaction is valid and that the candidate block is a legitimate block, querying, by the first member node device in the blockchain, a transaction idempotent table on the blockchain to determine missing transaction idempotent records from the transaction idempotent table based on the unique identifier of the target transaction, the transaction idempotent table being jointly maintained by a plurality of member node devices in the blockchain by using a consensus mechanism established between the plurality of member node devices in the blockchain and being configured to store one or more combined transaction identifiers and one or more individual transaction identifiers, each of the one or more combined transaction identifiers comprising a plurality of recorded monotonically increasing transaction identifiers combined to minimize storage of records of transactions;

in response to determining that the transaction idempotent table has not stored the transaction idempotent record corresponding to the unique identifier of the target transaction, recording, by the first member node device in the blockchain, the target transaction in the candidate block on the blockchain; and

inserting the transaction idempotent record corresponding to the unique identifier of the target transaction into the transaction idempotent table on the blockchain.

2. The computer-implemented method of claim 1, further comprising:

determining that the transaction idempotent table comprises a plurality of monotonically increasing transaction identifiers with consecutive values after the unique identifier of the target transaction is inserted into the transaction idempotent table;

in response to determining that the transaction idempotent table comprises the plurality of monotonically increasing transaction identifiers with consecutive values after the unique identifier of the target transaction is inserted into the transaction idempotent table, recording the plurality of monotonically increasing transaction identifiers with consecutive values in the transaction idempotent table based on an interval; and

in response to determining that the transaction idempotent table does not comprise the plurality of monotonically increasing transaction identifiers with consecutive values after the unique identifier of the target transaction is inserted into the transaction idempotent table, recording a transaction identifier of the target transaction in the transaction idempotent table based on a discrete value.

3. The computer-implemented method of claim 1, wherein the target transaction further comprises a reference time parameter based on a time stamp to assist determining that the target transaction is a valid transaction within a transaction validity period.

4. The computer-implemented method of claim 3, further comprising:

prior to determining that the transaction idempotent table stores the transaction idempotent record corresponding to the unique identifier of the target transaction, determining that the target transaction is the valid transaction within the transaction validity period based on the reference time parameter; and

in response to determining that the target transaction is the valid transaction within the transaction validity period, determining that the transaction idempotent table stores the transaction idempotent record corresponding to the unique identifier of the target transaction.

5. The computer-implemented method of claim 4, wherein determining that the target transaction is the valid transaction within the transaction validity period comprises:

determining that the target transaction occurs within a time window of the time stamp from the reference time parameter, wherein the time window is characterized by at least one of: a duration time for a blockchain transaction on the blockchain and a clock offset time for devices on the blockchain.

6. A non-transitory, computer-readable medium storing one or more instructions executable by a computer system to perform operations comprising:

receiving, by a first member node device in a blockchain, a target transaction initiated by a second member node device in the blockchain, wherein the target transaction comprises a unique identifier of the target transaction and a block height of a candidate block on the blockchain defining a creation time stamp of a logical clock;

determining that the target transaction is valid by determining that the target transaction is authorized to be performed within a transaction validity period based on the unique identifier of the target transaction, wherein the transaction validity period enables differentiation of overdue transactions from valid transactions and is characterized by a difference between the block height of the candidate block and a threshold;

determining that the candidate block is a legitimate block by verifying that the creation time stamp of the target transaction is monotonically increasing in comparison to other creation timestamps of blocks in the blockchain;

in response to determining that the target transaction is valid and that the candidate block is a legitimate block, querying, by the first member node device in the blockchain, a transaction idempotent table on the blockchain to determine missing transaction idempotent records from the transaction idempotent table based on the unique identifier of the target transaction, the transaction idempotent table being jointly maintained by a plurality of member node devices in the blockchain by using a consensus mechanism established between the plurality of member node devices in the blockchain and being configured to store one or more combined transaction identifiers and one or more individual transaction identifiers, each of the one or more combined transaction identifiers comprising a plurality of recorded monotonically increasing transaction identifiers combined to minimize storage of records of transactions;

in response to determining that the transaction idempotent table has not stored the transaction idempotent record corresponding to the unique identifier of the target transaction, recording, by the first member node device in the blockchain, the target transaction in the candidate block on the blockchain; and

inserting the transaction idempotent record corresponding to the unique identifier of the target transaction into the transaction idempotent table on the blockchain.

7. The non-transitory, computer-readable medium of claim 6, wherein the operations further comprise:

determining that the transaction idempotent table comprises a plurality of monotonically increasing transaction identifiers with consecutive values after the unique identifier of the target transaction is inserted into the transaction idempotent table;

in response to determining that the transaction idempotent table comprises the plurality of monotonically increasing transaction identifiers with consecutive values after the unique identifier of the target transaction is inserted into the transaction idempotent table, recording the plurality of monotonically increasing transaction identifiers with consecutive values in the transaction idempotent table based on an interval; and

in response to determining that the transaction idempotent table does not comprise the plurality of monotonically increasing transaction identifiers with consecutive values after the unique identifier of the target transaction is inserted into the transaction idempotent table, recording a transaction identifier of the target transaction in the transaction idempotent table based on a discrete value.

8. The non-transitory, computer-readable medium of claim 6, wherein the target transaction further comprises a reference time parameter based on a time stamp to assist determining that the target transaction is a valid transaction within a transaction validity period.

9. The non-transitory, computer-readable medium of claim 8, wherein the operations further comprise:

prior to querying determining that the transaction idempotent table stores the transaction idempotent record corresponding to the unique identifier of the target transaction, determining that

the target transaction is the valid transaction within the transaction validity period based on the reference time parameter; and

in response to determining that the target transaction is the valid transaction within the transaction validity period, determining that the transaction idempotent table stores the transaction idempotent record corresponding to the unique identifier of the target transaction.

10. The non-transitory, computer-readable medium of claim 9, wherein determining that the target transaction is the valid transaction within the transaction validity period comprises:

determining that the target transaction occurs within a time window of the time stamp from the reference time parameter, wherein the time window is characterized by at least one of: a duration time for a blockchain transaction on the blockchain and a clock offset time for devices on the blockchain.

11. A computer-implemented system, comprising:

one or more computers; and

one or more computer memory devices interoperably coupled with the one or more computers and having tangible, non-transitory, machine-readable media storing one or more instructions that, when executed by the one or more computers, perform one or more operations comprising:

receiving, by a first member node device in a blockchain, a target transaction initiated by a second member node device in the blockchain, wherein the target transaction comprises a unique identifier of the target transaction and a block height of a candidate block on the blockchain defining a creation time stamp of a logical clock;

determining that the target transaction valid by determining that the target transaction is authorized to be performed within a transaction validity period based on the unique identifier of the target transaction, wherein the transaction validity period enables differentiation of overdue transactions from valid transactions and is characterized by a difference between the block height of the candidate block and a threshold;

determining that the candidate block is a legitimate block by verifying that the creation time stamp of the target transaction is monotonically increasing in comparison to other creation timestamps of blocks in the blockchain;

in response to determining that the target transaction is valid and that the candidate block is a legitimate block, querying, by the first member node device in the blockchain, a transaction idempotent table on the blockchain to determine missing transaction idempotent records from the transaction idempotent table based on the unique identifier of the target transaction, the transaction idempotent table being jointly maintained by a plurality of member node devices in the blockchain by using a consensus mechanism established between the plurality of member node devices in the blockchain and being configured to store one or more combined transaction identifiers and one or more individual transaction identifiers, each of the one or more combined transaction identifiers comprising a plurality of recorded monotonically increasing transaction identifiers combined to minimize storage of records of transactions;

in response to determining that the transaction idempotent table has not stored the transaction idempotent record corresponding to the unique identifier of the target transaction, recording, by the first member node device in the blockchain, the target transaction in the candidate block on the blockchain; and

inserting the transaction idempotent record corresponding to the unique identifier of the target transaction into the transaction idempotent table on the blockchain.

12. The computer-implemented system of claim 11, wherein the operations further comprise:

determining that the transaction idempotent table comprises a plurality of monotonically increasing transaction identifiers with consecutive values after the unique identifier of the target transaction is inserted into the transaction idempotent table;

in response to determining that the transaction idempotent table comprises the plurality of monotonically increasing transaction identifiers with consecutive values after the unique identifier of the target transaction is inserted into the transaction idempotent table, recording the plurality of monotonically increasing transaction identifiers with consecutive values in the transaction idempotent table based on an interval; and

in response to determining that the transaction idempotent table does not comprise the plurality of monotonically increasing transaction identifiers with consecutive values after the unique identifier of the target transaction is inserted into the transaction idempotent table, recording a transaction identifier of the target transaction in the transaction idempotent table based

on a discrete value.

13. The computer-implemented system of claim 11, wherein the target transaction further comprises a reference time parameter based on a time stamp to assist determining that the target transaction is a valid transaction within a transaction validity period.

14. The computer-implemented system of claim 13, wherein the operations further comprise:

prior to determining that the transaction idempotent table stores the transaction idempotent record corresponding to the unique identifier of the target transaction, determining that the target transaction is the valid transaction within the transaction validity period based on the reference time parameter; and

in response to determining that the target transaction is the valid transaction within the transaction validity period, determining that the transaction idempotent table stores the transaction idempotent record corresponding to the unique identifier of the target transaction.

15. The computer-implemented system of claim 14, wherein determining that the target transaction is the valid transaction within the transaction validity period comprises:

determining that the target transaction occurs within a time window of the time stamp from the reference time parameter, wherein the time window is characterized by at least one of: a duration time for a blockchain transaction on the blockchain and a clock offset time for devices on the blockchain.