embodiments, the bridge device 504 continuously updates the local height value by retrieving blockchain blocks from the blockchain network node 506. In some embodiments, the bridge device 504 verifies the blockchain blocks and updates the check height value. In some embodiments, the three cursor values satisfy the following relationship: check height value ⩽ local height value ⩽ remote height value.

[0101] In some embodiments, the updating of the remote height value is related to the notification that the bridge device 504 receives from the blockchain network node 506. In some embodiments, the notification includes a new block notification indicating a new block has been added to a blockchain stored on the blockchain network node 506. The updating of the remote height value and the operation of the blockchain network node 506 are kept in sync such that the remote height value is continuously incremented at the bridge device 504 based on the new block notification. In some embodiments, the bridge device 504 synchronizes the blockchain blocks with the blockchain network node 506 by retrieving blockchain blocks from the blockchain network node based on a comparison between the local height value and the remote height value. In some embodiments, the blockchain blocks that have been synchronized by the bridge device 504 and stored on the bridge device 504 are indicated by the local height value. In some embodiments, the blockchain transaction data in the blockchain blocks obtained by the bridge device 504 during the block synchronization process triggers a verification process of the bridge device 504. After the bridge device 504 verifies the blockchain transaction data in the blockchain blocks, the blockchain blocks can be considered trusted blocks. The blockchain blocks that have been verified by the bridge device 504 are indicated by the check height value.

[0102] In some embodiments, the check height value continuously increments (e.g., increases by 1 every time), which ensures that the blockchain transactions in the blockchain blocks less than (or below) the check height value have been completely processed by the bridge device 504. In some embodiments, a recovery process of the bridge device 504 can start from the check height value when a system fault or failure occurs. In some embodiments, even if the block data in the bridge device 504 is lost or compromised, the lost or compromised block data can be recovered by resetting the local height value to the check height value and monitoring the block notification from the blockchain network node 506 to update the remote height value.

that are stored on the bridge device and updating the check height value until the check height value equals the local height value.

[0120] At 622, in response to determining that the check height value is not less than the local height value, the bridge device refrains from verifying blockchain blocks that are stored on the bridge device. For example, if the check height value equals the local height value, the bridge device 504 can refrain from verifying the blockchain blocks stored on the bridge device 504.

[0121] At 624, a system fault is detected. In some embodiments, the system fault can include software bugs and errors, hard disk failures, input or output device failures, or other temporary or permanent failures. In some embodiments, the system fault can cause a communications connection to be lost between the bridge device and the blockchain network node. In some examples, the blockchain blocks that are stored on the bridge device can be compromised or lost due to the system fault.

[0122] At 626, the bridge device performs a recovery process in response to detecting the system fault. In some embodiments, the bridge device can set the local height value to the check height value. In response to determining that the local height value is less than the remote height value, the bridge device can obtain at least one blockchain block subsequent to the latest blockchain block in the number of blockchain blocks that have been verified by the bridge device and that are indicated by the check height value.

[0123] In some embodiments, during and/or after the recovery process, the bridge device can go back to 608 for maintaining the three cursor values and continue the process 650. In some embodiments, as described with respect to FIGS. 4-5, the process 650 can be performed by one or more independent threads of the bridge device, which can improve the processing speed and flexibility of the bridge device, and increase throughput of communications between the client device and the blockchain network node while providing fault tolerance and maintaining an ordered executions of block-related processing to enhance data security and trustworthy stored by the bridge device and communicated between the client device and the blockchain network node.

[0124] FIG. 7 is a diagram of an example of modules of an apparatus 700 in accordance with embodiments of this specification. The apparatus 700 can be an example of an embodiment of a bridge device (e.g., bridge device 304a of FIG. 3, or bridge device 504 of

CLAIMS

1. A computer-implemented method, comprising:

retrieving, by a bridge device communicatively linked to a blockchain network node of a blockchain network, a first set of blockchain blocks from the blockchain network node using a first set of threads of the bridge device, wherein the first set of blockchain blocks are generated by the blockchain network node after a first consensus process performed by consensus nodes of the blockchain network, wherein the bridge device is separate from the consensus nodes of the blockchain network and the bridge device is communicatively linked to a client device;

storing, by the bridge device, the first set of blockchain blocks in the bridge device;

retrieving, by the bridge device, a second set of blockchain blocks from the blockchain network node using a second set of threads of the bridge device, wherein the second set of blockchain blocks are generated by the blockchain network node after a second consensus process performed by the consensus nodes of the blockchain network; and

verifying, by the bridge device, the first set of blockchain blocks that have been stored in the bridge device using a third set of threads of the bridge device; and

wherein retrieving the second set of blockchain blocks and verifying the first set of blockchain blocks are performed asynchronously using the second set of threads and the third set of threads.

2. The computer-implemented method of claim 1, wherein the second set of blockchain blocks comprise a first blockchain block and a second blockchain block, wherein the second set of threads comprise a first thread and a second thread, and wherein retrieving the second set of blockchain blocks from the blockchain network node using the second set of threads of the bridge device comprises:

retrieving the first blockchain block from the blockchain network node using the first thread of the bridge device in parallel with

retrieving the second blockchain block from the blockchain network node using the second thread of the bridge device.

3. The computer-implemented method of any preceding claim, wherein the first set of blockchain blocks comprise a third blockchain block and a fourth blockchain block, wherein the third set of threads comprise a third thread and a fourth thread, and wherein verifying the first set of blockchain blocks that are stored in the bridge device using the third set of threads of the bridge device comprises:

verifying the third blockchain block using the third thread of the bridge device in parallel with

verifying the fourth blockchain block using the fourth thread of the bridge device.

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

maintaining a remote height value and a local height value in a data store of the bridge device, wherein:

the remote height value indicates a number of blockchain blocks that are stored on the blockchain network node; and

the local height value indicates a number of blockchain blocks that are stored on the bridge device and that have been obtained from the blockchain network node,

wherein retrieving the second set of blockchain blocks from the blockchain network node using the second set of threads of the bridge device comprises:

determining whether the local height value is less than the remote height value by the bridge device; and

in response to determining that the local height value is less than the remote height value, obtaining at least one blockchain block that is not stored on the bridge device from the blockchain network node.

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

in response to storing the first set of blockchain blocks in the bridge device, updating the local height value by the bridge device to account for the first set of blockchain blocks;

storing the second set of blockchain blocks in the bridge device; and

in response to storing the second set of blockchain blocks in the bridge device, updating the local height value by the bridge device to account for the second set of blockchain blocks.

6. The computer-implemented method of claim 4 or 5, further comprising:

in response to determining that the local height value is not less than the remote height value, refraining from obtaining blockchain blocks from the blockchain network node.

7. The computer-implemented method of any one of the claims 4 to 6, further comprising:

receiving a notification from the blockchain network node by the bridge device, the notification indicating the remote height value;

receiving a transaction request from the client device by the bridge device, the transaction request requesting a transaction to be executed on the blockchain network;

sending the transaction request to the blockchain network node by the bridge device; and

receiving a second notification from the blockchain network node by the bridge device, the second notification indicating an updated remote height value, wherein the updated remote height value indicates an increase in the number of blockchain blocks that are stored on the blockchain network node based at least in part on the transaction.

8. The computer-implemented method of claim 7, wherein the notification comprises a new block notification indicating a new block has been added to a blockchain of the blockchain network, and the new block notification indicating the remote height value is increased.

9. The computer-implemented method of claim 7 or 8, wherein receiving the notification from the blockchain network node by the bridge device comprises at least one of the following:

receiving the notification that is pushed by the blockchain network node to the bridge device; or

pulling the notification from the blockchain network node by the bridge device.

10. The computer-implemented method of claim any one of claims 1-3, further comprising:

maintaining a local height value and a check height value in a data store of the bridge device, wherein:

the local height value indicates a number of blockchain blocks that are stored on the bridge device and that have been obtained from the blockchain network node; and

the check height value indicates a number of blockchain blocks that have been verified by the bridge device;

wherein verifying the first set of blockchain blocks that are stored in the bridge device using the third set of threads of the bridge device comprises:

determining whether the check height value is less than the local height value; and

in response to determining that the check height value is less than the local height value, verifying a blockchain block that is stored in the bridge device and that has not been verified by the bridge device.

11. The computer-implemented method of claim 10, wherein verifying the blockchain block that is stored in the bridge device and that has not been verified by the bridge device comprises determining a consistency between one or more blockchain transactions in the blockchain block and a transaction request.

12. The computer-implemented method of claim 10 or 11, further comprising:

in response to verifying the blockchain block that is stored on the bridge device and that has not been verified by the bridge device, determining that the blockchain block is trustworthy; and

updating the check height value by the bridge device.

13. The computer-implemented method of any one of the claims 10 to 12, further comprising:

in response to determining that the check height value is not less than the local height value, refraining from verifying blockchain blocks that are stored in the bridge device.

14. The computer-implemented method of any one of the claims 10 to 13, further comprising:

detecting a system fault in a system comprising the bridge device and the blockchain network node by the bridge device; and

in response to detecting the system fault, performing a recovery process based on the check height value, wherein performing the recovery process comprises:

setting the local height value equal to the check height value; and

in response to determining that the local height value is less than a remote height value that indicates a number of blockchain blocks that are stored on the blockchain network node, obtaining at least one blockchain block that is not stored on the bridge device from the blockchain network node.

15. An apparatus for implementing a blockchain-based fault-tolerant system, the apparatus comprising a plurality of modules for performing the computer-implemented method of any one of claims 1 to 14.

16. A blockchain-based fault-tolerant system, comprising:

one or more processors; and

one or more computer-readable memories coupled to the one or more processors and having instructions stored thereon that are executable by the one or more processors to perform the computer-implemented method of any one of claims 1 to 14.