network). More particularly, implementations of the present specification are directed to performing a change of primary node in a blockchain network that includes a plurality of network nodes, wherein the plurality of network nodes include the primary node and one or more backup nodes.

[0006] In some implementations, actions include: determining by a backup node of a blockchain network that an epoch change needs to be performed, wherein the epoch change causes a change from a current epoch with a current primary node to a new epoch with a new primary node, wherein the current epoch includes a consensus process for obtaining agreement among a number of network nodes using the primary node, and wherein the consensus process includes three phases; determining, by the backup node, a respective weight of the backup node associated with each of the three phases of the consensus process in the current epoch, wherein the weight is a metric of a qualification of the backup node to be the new primary node; determining a weight sum for the backup node by the backup node based on the respective weight of the backup node associated with each of the three phases in the current epoch; sending an EPOCH_CHANGE message by the backup node to the number of network nodes other than the network node in response to determining that the weight sum reaches a first predetermined threshold, wherein the EPOCH_CHANGE message indicates a request for a change from the current epoch with the current primary node to the new epoch with the backup node being the new primary node, and the EPOCH-CHANGE includes the weight sum of the backup node; receiving at least one NEW_EPOCH message by the backup node from at least one of the number of network nodes other than the backup node, wherein the NEW_EPOCH message indicates an acknowledgement of the backup node to be the new primary node; verifying by the backup node whether the at least one NEW_EPOCH message is valid; determining by the backup node whether a number of valid NEW_EPOCH messages out of the at least one NEW_EPOCH message exceeds a second predetermined threshold; and determining the backup node to be the new primary node in the new epoch by the backup node in response to determining that the number of valid NEW_EPOCH messages exceeds the second predetermined threshold. Determining a respective weight of the backup node associated with each of the three phases of the consensus process in the current epoch includes: in response to determining a failure of a

quorum verification in a third phase of the consensus process in the current epoch, determining a weight of the backup node for the third phase of the consensus process to be a third value, and in response to determining a success of a quorum verification in the third phase of the consensus process in the current epoch, determining the weight of the backup node for the third phase of the consensus process to be a fourth value, wherein the third value is smaller than the fourth value.

[0007] Other implementations include corresponding systems, apparatus, and computer programs, configured to perform the actions of the methods, encoded on computer storage devices or stored on non-transitory, computer-readable mediums.

[0008] These and other implementations may each optionally include one or more of the following features:

WHAT IS CLAIMED IS:

1. A computer-implemented method of performing a change of a primary node in a blockchain network that comprises a plurality of network nodes, wherein the plurality of network nodes comprises the primary node and one or more backup nodes, the method comprising:

determining, by a backup node, that an epoch change needs to be performed, wherein the epoch change causes a change from a current epoch with a current primary node to a new epoch with a new primary node, wherein the current epoch comprises a consensus process for obtaining agreement among the plurality of network nodes using the primary node, the consensus process comprising three phases;

determining, by the backup node, a respective weight of the backup node associated with each of the three phases of the consensus process in the current epoch, wherein the weight is a metric of a qualification of the backup node to be the new primary node;

determining, by the backup node, a weight sum for the backup node based on the respective weight of the backup node associated with each of the three phases in the current epoch;

in response to determining that the weight sum reaches a first predetermined threshold, sending, by the backup node, an EPOCH_CHANGE message to the plurality of network nodes other than the network node, wherein the EPOCH_CHANGE message indicates a request for a change from the current epoch with the current primary node to the new epoch with the backup node being the new primary node, and the EPOCH_CHANGE message comprises the weight sum of the backup node;

receiving, by the backup node, at least one NEW_EPOCH message from at least one of the plurality of network nodes other than the backup node, wherein the NEW_EPOCH message indicates an acknowledgement of the backup node to be the new primary node;

verifying, by the backup node, whether the at least one NEW_EPOCH message is valid;

determining, by the backup node, whether a number of valid NEW_EPOCH messages out of the at least one NEW_EPOCH message exceeds a second predetermined threshold; and

in response to determining that the number of valid NEW_EPOCH messages exceeds the second predetermined threshold, determining, by the backup node, the backup node to be the new primary node in the new epoch,

wherein determining a respective weight of the backup node associated with each of the three phases of the consensus process in the current epoch comprises:

in response to determining a failure of a quorum verification in a third phase of the consensus process in the current epoch, determining a weight of the backup node for the third phase of the consensus process to be a third value, and

in response to determining a success of a quorum verification in the third phase of the consensus process in the current epoch, determining the weight of the backup node for the third phase of the consensus process to be a fourth value, wherein the third value is smaller than the fourth value.

2. The computer-implemented method of claim 1, wherein determining a respective weight of the backup node associated with each of the three phases of the consensus process in the current epoch comprises determining a weight of the backup node for a first phase of the consensus process to be a first value.

3. The computer-implemented method of claim 1, wherein determining a respective weight of the backup node associated with each of the three phases of the consensus process in the current epoch comprises:

in response to determining a failure of a quorum verification in a second phase of the consensus process in the current epoch, determining a weight of the backup node for the second phase of the consensus process to be a first value; and

in response to determining a success of a quorum verification in the second phase of the consensus process in the current epoch, determining the weight of the backup node for the second phase of the consensus process to be a second value, wherein the first value is smaller than the second value.

4. The computer-implemented method of claim 3, wherein the quorum verification in the second phase for the network node comprises receiving a predetermined number of ECHO messages from other network nodes.

5. The computer-implemented method of claim 1, wherein the quorum verification in the third phase for the network node comprises receiving a pre-determined number of accept messages from other network nodes, wherein each of the accept messages from other network nodes indicates each of the other network nodes has accepted a predetermined number of ECHO messages.

6. The computer-implemented method of claim 1, wherein the EPOCH_CHANGE message further comprises a set of signatures associated with a set of network nodes out of the plurality of network nodes, and wherein the NEW_EPOCH message comprises a digest of the EPOCH_CHANGE message.

7. The computer-implemented method of claim 6, wherein verifying whether the at least one valid NEW_EPOCH message is valid comprises verifying whether the digest of the EPOCH_CHANGE message in the at least one NEW_EPOCH message is valid, and wherein verifying whether the digest of the EPOCH_CHANGE message in the at least one NEW_EPOCH message is valid comprises verifying whether the set of signatures in the EPOCH_CHANGE message are valid.

8. The computer-implemented method of claim 1, wherein determining that an epoch change needs to be performed comprises determining that an epoch change needs to be performed in response to determining that the consensus has not been achieved in an old epoch within a predetermined time period.

9. The computer-implemented method of claim 1, further comprising operating in the new epoch with the new primary node, wherein the new epoch comprises a consensus

process for achieving consensus among the plurality of network nodes using the new primary node.

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

determining, by a backup node of a blockchain network comprising a plurality of network nodes, that an epoch change needs to be performed, wherein the plurality of network nodes comprise a primary node and one or more backup nodes comprising the backup node, wherein the epoch change causes a change from a current epoch with a current primary node to a new epoch with a new primary node, wherein the current epoch comprises a consensus process for obtaining agreement among the plurality of network nodes using the primary node, the consensus process comprising three phases;

determining, by the backup node, a respective weight of the backup node associated with each of the three phases of the consensus process in the current epoch, wherein the weight is a metric of a qualification of the backup node to be the new primary node;

determining, by the backup node, a weight sum for the backup node based on the respective weight of the backup node associated with each of the three phases in the current epoch;

in response to determining that the weight sum reaches a first predetermined threshold, sending, by the backup node, an EPOCH_CHANGE message to the plurality of network nodes other than the network node, wherein the EPOCH_CHANGE message indicates a request for a change from the current epoch with the current primary node to the new epoch with the backup node being the new primary node, and the EPOCH_CHANGE message comprises the weight sum of the backup node;

receiving, by the backup node, at least one NEW_EPOCH message from at least one of the plurality of network nodes other than the backup node, wherein the NEW_EPOCH message indicates an acknowledgement of the backup node to be the new primary node;

verifying, by the backup node, whether the at least one NEW_EPOCH message is valid;

determining, by the backup node, whether a number of valid NEW_EPOCH messages out of the at least one NEW_EPOCH message exceeds a second predetermined threshold; and

in response to determining that the number of valid NEW_EPOCH messages exceeds the second predetermined threshold, determining, by the backup node, the backup node to be the new primary node in the new epoch,

wherein determining a respective weight of the backup node associated with each of the three phases of the consensus process in the current epoch comprises:

in response to determining a failure of a quorum verification in a third phase of the consensus process in the current epoch, determining a weight of the backup node for the third phase of the consensus process to be a third value, and

in response to determining a success of a quorum verification in the third phase of the consensus process in the current epoch, determining the weight of the backup node for the third phase of the consensus process to be a fourth value, wherein the third value is smaller than the fourth value.

11. The non-transitory, computer-readable medium of claim 10, wherein determining a respective weight of the backup node associated with each of the three phases of the consensus process in the current epoch comprises determining a weight of the backup node for a first phase of the consensus process to be a first value.

12. The non-transitory, computer-readable medium of claim 10, wherein determining a respective weight of the backup node associated with each of the three phases of the consensus process in the current epoch comprises:

in response to determining a failure of a quorum verification in a second phase of the consensus process in the current epoch, determining a weight of the backup node for the second phase of the consensus process to be a first value; and

in response to determining a success of a quorum verification in the second phase of the consensus process in the current epoch, determining the weight of the backup node for the second phase of the consensus process to be a second value, wherein the first value is smaller than the second value.

13. The non-transitory, computer-readable medium of claim 12, wherein the quorum verification in the second phase for the network node comprises receiving a predetermined number of ECHO messages from other network nodes.

14. The non-transitory, computer-readable medium of claim 10, wherein the quorum verification in the third phase for the network node comprises receiving a predetermined number of accept messages from other network nodes, wherein each of the accept messages from other network nodes indicates each of the other network nodes has accepted a predetermined number of ECHO messages.

15. The non-transitory, computer-readable medium of claim 10, wherein the EPOCH_CHANGE message further comprises a set of signatures associated with a set of network nodes out of the plurality of network nodes, and wherein the NEW_EPOCH message comprises a digest of the EPOCH_CHANGE message.

16. The non-transitory, computer-readable medium of claim 15, wherein verifying whether the at least one valid NEW_EPOCH message is valid comprises verifying whether the digest of the EPOCH_CHANGE message in the at least one NEW_EPOCH message is valid, and wherein verifying whether the digest of the EPOCH_CHANGE message in the at least one NEW_EPOCH message is valid comprises verifying whether the set of signatures in the EPOCH_CHANGE message are valid.

17. The non-transitory, computer-readable medium of claim 10, wherein determining that an epoch change needs to be performed comprises determining that an epoch change needs to be performed in response to determining that the consensus has not been achieved in an old epoch within a predetermined time period.

18. The non-transitory, computer-readable medium of claim 10, wherein the operations further comprise:

operating in the new epoch with the new primary node, wherein the new epoch comprises a consensus process for achieving consensus among the plurality of network nodes using the new primary node.

19. A system, including:

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:

determining, by a backup node of a blockchain network comprising a plurality of network nodes, that an epoch change needs to be performed, wherein the plurality of network nodes comprise a primary node and one or more backup nodes comprising the backup node, wherein the epoch change causes a change from a current epoch with a current primary node to a new epoch with a new primary node, wherein the current epoch comprises a consensus process for obtaining agreement among the plurality of network nodes using the primary node, the consensus process comprising three phases;

determining, by the backup node, a respective weight of the backup node associated with each of the three phases of the consensus process in the current epoch, wherein the weight is a metric of a qualification of the backup node to be the new primary node;

determining, by the backup node, a weight sum for the backup node based on the respective weight of the backup node associated with each of the three phases in the current epoch;

in response to determining that the weight sum reaches a first predetermined threshold, send, by the backup node, an EPOCH_CHANGE message to the plurality of network nodes other than the network node, wherein the EPOCH_CHANGE message indicates a request for a change from the current epoch with the current primary node to the new epoch with the backup node being the new primary node, and the EPOCH_CHANGE message comprises the weight sum of the backup node;

receiving, by the backup node, at least one NEW_EPOCH message from at least one of the plurality of network nodes other than the backup node, wherein the NEW_EPOCH message indicates an acknowledgement of the backup node to be the new primary node;

verifying, by the backup node, whether the at least one NEW_EPOCH message is valid;

determining, by the backup node, whether a number of valid NEW_EPOCH messages out of the at least one NEW_EPOCH message exceeds a second predetermined threshold; and

in response to determining that the number of valid NEW_EPOCH messages exceeds the second predetermined threshold, determining, by the backup node, the backup node to be the new primary node in the new epoch,

wherein determining a respective weight of the backup node associated with each of the three phases of the consensus process in the current epoch comprises:

in response to determining a failure of a quorum verification in a third phase of the consensus process in the current epoch, determining a weight of the backup node for the third phase of the consensus process to be a third value, and

in response to determining a success of a quorum verification in the third phase of the consensus process in the current epoch, determining the weight of the backup node for the third phase of the consensus process to be a fourth value, wherein the third value is smaller than the fourth value.

20. The system of claim 19, wherein determining a respective weight of the backup node associated with each of the three phases of the consensus process in the current epoch comprises determining a weight of the backup node for a first phase of the consensus process to be a first value.

21. The system of claim 19, wherein determining a respective weight of the backup node associated with each of the three phases of the consensus process in the current epoch comprises:

in response to determining a failure of a quorum verification in a second phase of the consensus process in the current epoch, determining a weight of the backup node for the second phase of the consensus process to be a first value; and

in response to determining a success of a quorum verification in the second phase of the consensus process in the current epoch, determining the weight of the backup node for the second phase of the consensus process to be a second value, wherein the first value is smaller than the second value.

22. The system of claim 21, wherein the quorum verification in the second phase for the network node comprises receiving a predetermined number of ECHO messages from other network nodes.

23. The system of claim 19, wherein the quorum verification in the third phase for the network node comprises receiving a pre-determined number of accept messages from other network nodes, wherein each of the accept messages from other network nodes indicates each of the other network nodes has accepted a predetermined number of ECHO messages.

24. The system of claim 19, wherein the EPOCH_CHANGE message further comprises a set of signatures associated with a set of network nodes out of the plurality of network nodes, and wherein the NEW_EPOCH message comprises a digest of the EPOCH_CHANGE message.

25. The system of claim 24, wherein verifying whether the at least one valid NEW_EPOCH message is valid comprises verifying whether the digest of the EPOCH_CHANGE message in the at least one NEW_EPOCH message is valid, and wherein verifying whether the digest of the EPOCH_CHANGE message in the at least one NEW_EPOCH message is valid comprises verifying whether the set of signatures in the EPOCH_CHANGE message are valid.

26. The system of claim 19, wherein determining that an epoch change needs to be performed comprises determining that an epoch change needs to be performed in response to determining that the consensus has not been achieved in an old epoch within a predetermined time period.

27. The system of claim 19, wherein the operations further comprise:

operating in the new epoch with the new primary node, wherein the new epoch comprises a consensus process for achieving consensus among the plurality of network nodes using the new primary node.