CLAIMS

What is claimed is:

1. A method of controlling a size of a contention window in a node in a network, comprising:

under control of one or more processors configured with executable instructions:

maintaining a list of sizes of contention windows of parent nodes of the node;

setting a contention window for the node to be not shorter than a contention window of a parent node of the node and longer than contention windows used by upstream 1-hop upstream neighbors of the node, as indicated by the list; and

sending data to the parent node of the node, the sending beginning after a wait indicated by the contention window of the node.

2. The method of claim 1, wherein:

maintaining the list includes:

associating a plurality of parents on the list with a plurality of contention windows, respectively, and a plurality of timeout periods, respectively, each timeout period governing expiration of an associated contention window; and

setting the contention window includes:

monitoring the plurality of timeout periods for expiration; and

upon expiration of a timeout period, using a default contention window to replace a contention window associated with the expired timeout period.

3. The method of claim 1, wherein:

maintaining the list of sizes of contention windows comprises:

receiving a publication from a root node; and

setting the contention window comprises:

checking the publication for a longest contention window used by upstream 1-hop neighbors of the node; and

setting the contention window to be a longer of: a longest contention window used by upstream 1-hop neighbors of the node; and

a contention window based on a carrier sense multiple access with collision avoidance (CSMA/CA) algorithm.

4. The method of claim 1, wherein setting the contention window comprises:

calculating a contention window based on a carrier sense multiple access with collision avoidance (CSMA/CA) algorithm;

comparing the calculated contention window to a contention window in the list of sizes of contention windows; and

selecting a longer of the calculated contention window and the contention window in the list of sizes of contention windows.

5. The method of claim 1, wherein setting the contention window comprises:

expiring a contention window from the list according to its timeout period; and

setting the contention window of the node to not be shorter than parents of the node using non-expired portions of the list as input.

6. The method of claim 1, additionally comprising:

exchanging RTS and CTS packets with neighbors of the node; and

including a size of the contention window in the exchange.

7. The method of claim 1, additionally comprising:

receiving data from a child node of the node, wherein the data is received on a channel following a period of time after the channel became clear, the period of time being longer than the contention window of the node;

wherein sending data to the parent node of the node, includes sending on a second channel following a second period of time after the second channel became clear, the second period of time being longer than an announced contention window of the parent node.

8. The method of claim 1, additionally comprising:

announcing a size of the contention window of the node to 1-hop neighbors of the node; and

receiving data from a downstream 1-hop neighbor node on a channel, wherein the data was received following a period of time after the channel became clear, the period of time being longer than the announced contention window size.

9. A node in a network, comprising:

a processor; memory, in communication with the processor;

a list, defined in the memory and including indications of parents of the node, a size of a contention window associated with each parent, and a timeout associated with each contention window;

a timer to manage the timeouts in the list;

a contention window size calculation module, defined in the memory and configured to calculate a size of a contention window of the node, using as input:

a carrier sense multiple access with collision avoidance (CSMA/CA) algorithm; and

data from the list;

wherein the size of the contention window of the node is determined by comparing the input; and

a contention window manager defined in memory and configured to announce, in messages to neighbors, the size of the contention window of the node, as calculated by the contention window size calculation module.

10. The node of claim 9, wherein the contention window size calculation module is additionally configured to:

associate a plurality of parents on the list with a plurality of timeout periods, respectively, each timeout period governing expiration of an associated contention window;

monitor the plurality of timeout periods for expiration; and

upon expiration of a timeout period from among the plurality of timeout periods, use a default contention window to replace a contention window associated with the expired timeout period.

11. The node of claim 9, wherein the contention window size calculation module is additionally configured to:

calculate a contention window based on a CSMA/CA algorithm;

maintain the list using a publication from a root node;

compare the calculated contention window to a contention window in the list; and

select a longer of the calculated contention window and the contention window in the list.

12. The node of claim 9, wherein the contention window size calculation module is additionally configured to:

calculate the size of the contention window of the node based in part on an indication of a size of a contention window from a root of the network, if the root is located 1-hop upstream of the node, wherein the indication of the size of the contention window from the root is based in part on indications of sizes of contention windows sent to other 1-hop neighbors of the root.

13. The node of claim 9, wherein the contention window manager is additionally configured to:

announce the size of the contention window to 1-hop downstream neighbors of the node;

wherein data is received from a downstream 1-hop neighbor on a channel following a period of time after the channel became clear, the period of time being greater than the announced contention window size.

14. A method of controlling a size of a contention window in a node in a network, comprising:

under control of one or more processors configured with executable instructions:

exchanging RTS and CTS packets with neighbors of the node;

including a size of the contention window in the exchange;

maintaining a list of sizes of contention windows of parent nodes of the node, wherein the sizes of contention windows are obtained in part from the exchange;

setting a contention window for the node to be not shorter than a contention window of a parent node of the node, as indicated by the list; and

sending data to the parent node of the node, the sending beginning after a wait indicated by the contention window of the node.

15. The method of claim 14, wherein:

maintaining the list includes:

associating a plurality of parents on the list with a plurality of contention windows, respectively, and a plurality of timeout periods, respectively, each timeout period governing expiration of an associated contention window; and

setting the contention window includes:

monitoring the plurality of timeout periods for expiration; and

upon expiration of a timeout period, using a default contention window to replace a contention window associated with the expired timeout period.

16. The method of claim 14, wherein:

maintaining the list of sizes of contention windows comprises:

receiving a publication from a root node; and setting the contention window comprises:

checking the publication for a longest contention window used by upstream 1-hop neighbors of the node; and

setting the contention window to be a longer of: a longest contention window used by upstream 1-hop neighbors of the node; and

a contention window based on a carrier sense multiple access with collision avoidance (CSMA/CA) algorithm.

17. The method of claim 14, wherein setting the contention window comprises:

calculating a contention window based on a carrier sense multiple access with collision avoidance (CSMA/CA) algorithm;

comparing the calculated contention window to a contention window in the list of sizes of contention windows; and

selecting a longer of the calculated contention window and the contention window in the list of sizes of contention windows.

18. The method of claim 14, wherein setting the contention window comprises:

setting the contention window to be longer than contention windows used by upstream 1-hop upstream neighbors of the node.

19. The method of claim 14, wherein setting the contention window comprises:

expiring a contention window from the list according to its timeout period; and

setting the contention window of the node to not be shorter than parents of the node using non-expired portions of the list as input.

20. The method of claim 14, additionally comprising:

receiving data from a child node of the node, wherein the data is received on a channel following a period of time after the channel became clear, the period of time being longer than the contention window of the node;

wherein sending data to the parent node of the node, includes sending on a second channel following a second period of time after the second channel became clear, the second period of time being longer than an announced contention window of the parent node.

CLAIMS

What is claimed is:

1. A method of controlling a size of a contention window in a node in a network, comprising:

under control of one or more processors configured with executable instructions:

maintaining a list of sizes of contention windows of parent nodes of the node;

setting a contention window for the node to be not shorter than a contention window of a parent node of the node, as indicated by the list; and

sending data to the parent node of the node, the sending beginning after a wait indicated by the contention window of the node.

2. The method of claim 1, wherein:

maintaining the list includes:

associating a plurality of parents on the list with a plurality of contention windows, respectively, and a plurality of timeout periods, respectively, each timeout period governing expiration of an associated contention window; and

setting the contention window includes:

monitoring the plurality of timeout periods for expiration; and

upon expiration of a timeout period, using a default contention window to replace a contention window associated with the expired timeout period.

3. The method of claim 1, wherein:

maintaining the list of sizes of contention windows comprises:

receiving a publication from a root node; and

setting the contention window comprises:

checking the publication for a longest contention window used by upstream 1-hop neighbors of the node; and

setting the contention window to be a longer of:

a longest contention window used by upstream 1-hop neighbors of the node; and

a contention window based on a carrier sense multiple access with collision avoidance (CSMA/CA) algorithm.

4. The method of claim 1, wherein setting the contention window comprises:

calculating a contention window based on a carrier sense multiple access with collision avoidance (CSMA/CA) algorithm;

comparing the calculated contention window to a contention window in the list of sizes of contention windows; and

selecting a longer of the calculated contention window and the contention window in the list of sizes of contention windows.

5. The method of claim 1, wherein setting the contention window comprises:

setting the contention window to be longer than contention windows used by upstream 1-hop upstream neighbors of the node.

6. The method of claim 1, wherein setting the contention window comprises:

expiring a contention window from the list according to its timeout period; and

setting the contention window of the node to not be shorter than parents of the node using non-expired portions of the list as input.

7. The method of claim 1, additionally comprising:

exchanging RTS and CTS packets with neighbors of the node; and

including a size of the contention window in the exchange.

8. The method of claim 1, additionally comprising:

receiving data from a child node of the node, wherein the data is received on a channel following a period of time after the channel became clear, the period of time being longer than the contention window of the node;

wherein sending data to the parent node of the node, includes sending on a second channel following a second period of time after the second channel became clear, the second period of time being longer than an announced contention window of the parent node.

9. The method of claim 1, additionally comprising:

announcing a size of the contention window of the node to 1-hop neighbors of the node; and

receiving data from a downstream 1-hop neighbor node on a channel, wherein the data was received following a period of time after the channel became clear, the period of time being longer than the announced contention window size.

10. The method of any of the preceding claims, implemented on a computer readable media.

11. A node in a network, comprising:

a processor;

memory, in communication with the processor;

a list, defined in the memory and including indications of parents of the node, a size of a contention window associated with each parent, and a timeout associated with each contention window;

a timer to manage the timeouts in the list;

a contention window size calculation module, defined in the memory and configured to calculate a size of a contention window of the node, using as input:

a carrier sense multiple access with collision avoidance (CSMA/CA) algorithm; and

data from the list;

wherein the size of the contention window of the node is determined by comparing the input; and

a contention window manager defined in memory and configured to announce, in messages to neighbors, the size of the contention window of the node, as calculated by the contention window size calculation module.

12. The node of claim 11, wherein the contention window size calculation module is additionally configured to:

associate a plurality of parents on the list with a plurality of timeout periods, respectively, each timeout period governing expiration of an associated contention window;

monitor the plurality of timeout periods for expiration; and

upon expiration of a timeout period from among the plurality of timeout periods, use a default contention window to replace a contention window associated with the expired timeout period.

13. The node of claim 11, wherein the contention window size calculation module is additionally configured to:

calculate a contention window based on a CSMA/CA algorithm;

maintain the list using a publication from a root node;

compare the calculated contention window to a contention window in the list; and

select a longer of the calculated contention window and the contention window in the list.

14. The node of claim 11, wherein the contention window size calculation module is additionally configured to:

calculate the size of the contention window of the node based in part on an indication of a size of a contention window from a root of the network, if the root is located 1-hop upstream of the node, wherein the indication of the size of the contention window from the root is based in part on indications of sizes of contention windows sent to other 1-hop neighbors of the root.

15. The node of claim 11, wherein the contention window manager is additionally configured to:

announce the size of the contention window to 1-hop downstream neighbors of the node;

wherein data is received from a downstream 1-hop neighbor on a channel following a period of time after the channel became clear, the period of time being greater than the announced contention window size.