CLAIMS

[Claim 1] (Amended)

A communication device connected to a network, comprising:

a bandwidth control unit that manages a bandwidth regarding a packet which is transmitted from the communication device to an another communication device via the network, for each interval time, and controls a bandwidth for sending a packet to the network depending on a change in a discarding rate of a packet on the basis of the managed bandwidth during a current interval time and the managed bandwidth during an interval time in the past; and

a transmission unit that sends a packet to the network according to the controlled bandwidth.

[Claim 2] (Amended)

The communication device according to claim 1, wherein

the current interval time is a first time from a reference time point which is updated for each interval time to a current time point, and the interval time in the past is a second time from a time point which is an interval time before the reference time point to the reference time point, and

the bandwidth control unit controls the bandwidth for sending a packet to the network on the basis of a bandwidth during the first time and a bandwidth during the second time.

[Claim 3] (Amended)

The communication device according to claim 1, wherein the bandwidth during the current interval time is a retransmission bandwidth or a discarding bandwidth, and the bandwidth during the interval time in the past is a control

bandwidth or a transmission bandwidth.

[Claim 4] (Amended)

The communication device according to claim 1, wherein the bandwidth control unit reduces a control bandwidth for sending a packet so as to be smaller than a control bandwidth during the interval time in the past when an increasing rate of a discarding rate of packets exceeds a predetermined value.

[Claim 5] (Amended)

The communication device according to claim 4, wherein the bandwidth control unit obtains a discarding rate of packets during the current interval time by using a ratio of a transmission bandwidth or a control bandwidth during the interval time in the past and a retransmission bandwidth or a discarding bandwidth during the current interval time.

[Claim 6] (Amended)

The communication device according to claim 1, wherein a retransmission ratio of packets is used instead of the discarding rate of packets.

[Claim 7] (Amended)

A communication device connected to a network, comprising:

a bandwidth control unit that manages a predefined interval time and a reference time point updated for each interval time, and adds the interval time to the reference time point so as to update the reference time point when a difference between the current time point and the reference time point exceeds the interval time; and

a storage unit that records therein a retransmission bandwidth or a discarding bandwidth, a transmission bandwidth, and a control bandwidth for limiting a sum total of the

retransmission bandwidth or a discarding bandwidth and the transmission bandwidth according to the time that is divided into a first time from a reference time point to a current time point and a second time from the reference time point to an old reference time point which is an interval time before the reference time point,

wherein the bandwidth control unit varies a control bandwidth after the reference time point on the basis of a retransmission bandwidth or a discarding bandwidth during the first time and a control bandwidth or a transmission bandwidth during the second time, depending on a change in a discarding rate of a packet.

[Claim 8] (Amended)

The communication device according to claim 7, wherein the bandwidth control unit

obtains a first discarding rate which is a ratio of a transmission bandwidth or a control bandwidth during the second time and a retransmission bandwidth or a discarding bandwidth during the first time, and a second discarding rate which is a ratio of a transmission bandwidth or a control bandwidth during a third time from the old reference time point until before a further interval time and a retransmission bandwidth or a discarding bandwidth during the second time, and

reduces the control bandwidth after the reference time point so as to be smaller than the control bandwidth during the second time on the basis of the retransmission bandwidth or the discarding bandwidth after the reference time point, when the first discarding rate is larger than the second discarding rate.

[Claim 9] (Amended)

A communication system comprising:

a first communication device; and

a second communication device connected to the first communication device via a network,

wherein the first communication device includes

a bandwidth control unit that manages a bandwidth regarding a packet which is transmitted from the first communication device to the second communication device via the network, for each interval time, and controls a bandwidth for sending a packet to the second communication device via the network depending on a change in a discarding rate of a packet on the basis of the managed bandwidth during a current interval time and a bandwidth during an interval time in the past; and

a transmission unit that sends a packet to the network according to the controlled bandwidth.

[Claim 10] (Amended)

The communication system according to claim 9, wherein

the current interval time is a first time from a reference time point which is updated for each interval time to a current time point, and the interval time in the past is a second time from a time point which is an interval time before the reference time point to the reference time point, and

the bandwidth control unit controls the bandwidth for sending a packet to the second communication device via the network on the basis of a bandwidth during the first time and a bandwidth during the second time.

[Claim 11] (Amended)

The communication system according to claim 9, wherein the bandwidth during the current interval time is a

retransmission bandwidth or a discarding bandwidth, and the bandwidth during the interval time in the past is a control bandwidth or a transmission bandwidth.

[Claim 12] (Amended)

The communication system according to claim 9, wherein the bandwidth control unit reduces a control bandwidth for sending a packet so as to be smaller than a control bandwidth during the interval time in the past when an increasing rate of a discarding rate of packets exceeds a predetermined value.

[Claim 13] (Amended)

The communication system according to claim 12, wherein the bandwidth control unit obtains a discarding rate of packets during the current interval time by using a ratio of a transmission bandwidth or a control bandwidth during the interval time in the past and a retransmission bandwidth or a discarding bandwidth during the current interval time.

[Claim 14] (Amended)

The communication system according to claim 9, wherein a retransmission ratio of packets is used instead of the discarding rate of packets.

[Claim 15] (Amended)

A bandwidth control method for controlling a bandwidth to send a packet to a network, comprising:

managing a bandwidth regarding a packet which is sent to the network, for each interval time;

controlling a bandwidth for sending a packet to the network depending on a change in a discarding rate of a packet on the basis of the managed bandwidth during a current interval time and the managed bandwidth during an interval time in the past; and

sending a packet to the network according to the controlled bandwidth.

[Claim 16] (Amended)

The bandwidth control method according to claim 15, wherein

the current interval time is a first time from a reference time point which is updated for each interval time to a current time point, and the interval time in the past is a second time from a time point which is an interval time before the reference time point to the reference time point, and the bandwidth control method comprising:

controling the bandwidth for sending a packet to the network on the basis of a bandwidth during the first time and a bandwidth during the second time.

[Claim 17] (Amended)

The bandwidth control method according to claim 15, wherein the bandwidth during the current interval time is a retransmission bandwidth or a discarding bandwidth, and the bandwidth during the interval time in the past is a control bandwidth or a transmission bandwidth.

[Claim 18] (Added)

The bandwidth control method according to claim 15, comprising:

reducing a control bandwidth for sending a packet so as to be smaller than a control bandwidth during the interval time in the past when an increasing rate of a discarding rate of packets exceeds a predetermined value.

[Claim 19] (Added)

The bandwidth control method according to claim 18, comprising:

obtaining a discarding rate of packets during the current interval time by using a ratio of a transmission bandwidth or a control bandwidth during the interval time in the past and a retransmission bandwidth or a discarding bandwidth during the current interval time.

[Claim 20] (Added)

The bandwidth control method according to claim 15, wherein a retransmission ratio of packets is used instead of the discarding rate of packets.

CLAIMS

[Claim 1]

A communication system comprising:

a first communication device and a second communication device that are located between two terminals and relay TCP communication between the terminals,

wherein

the second communication device notifies the first communication device of an acknowledgement packet including identification information of an unreceived location in a feedback manner when a data location which cannot be received during communication is detected,

the first communication device transmits a retransmitted packet including data of the unreceived location which is included in the acknowledgement packet, the notification of which is sent in a feedback manner, and

the second communication device periodically notifies the first communication device of an acknowledgement packet including the identification information of the unreceived location in a feedback manner until the retransmitted packet including the data of the unreceived location is received.

[Claim 2]

The communication system according to claim 1, wherein

the first communication device manages a predefined interval time and a reference time point updated for each interval time, and adds the interval time to the reference time point so as to update the reference time point when a difference between a current time point and the reference time point exceeds the interval time,

the first communication device

includes a table in which a retransmission/discarding bandwidth, a transmission bandwidth, and a control bandwidth for limiting a sum total of the retransmission/discarding bandwidth and the transmission bandwidth are recorded according to the time that is divided into a first time from a reference time point to a current time point, a second time from the reference time point to an old reference time point which is an interval time before the reference time point, and a third time from the old reference time point until before a further interval time; and

varies a control bandwidth after the reference time point on the basis of a retransmission/discarding bandwidth during the first time after the reference time point and a control bandwidth or a transmission bandwidth during the second time before the reference time point.

[Claim 3]

The communication system according to claim 2, wherein, when a first retransmission ratio obtained by a ratio of a transmission bandwidth or a control bandwidth during the second time from the reference time point to the old reference time point and a retransmission/discarding bandwidth during the first time from the reference time point to the current time point is larger than a second retransmission ratio obtained by a ratio of a transmission bandwidth or a control bandwidth during the third time from the old reference time point until before a further interval time and a retransmission/discarding bandwidth during the second time from the reference time point to the old reference time point, the control bandwidth after the reference time point decreases so as to be smaller than

the control bandwidth during the second time from the reference time point to the old reference time point on the basis of the retransmission/discarding bandwidth after the reference time point.

[Claim 4]

The communication system according to claim 3, wherein, when a first retransmission ratio obtained by a ratio of a transmission bandwidth or a control bandwidth during the second time from the reference time point to the old reference time point and a retransmission/discarding bandwidth during the first time from the reference time point to the current time point is smaller than a second retransmission ratio obtained by a ratio of a transmission bandwidth or a control bandwidth during the third time from the old reference time point until before a further interval time and a retransmission/discarding bandwidth during the second time from the reference time point to the old reference time point, it is determined whether or not a predetermined period has elapsed from a time point when a control bandwidth decreases, and, if it is determined that the predetermined period has elapsed, a control bandwidth after the reference time point is controlled so as to increase by a first size, and, if it is determined that the predetermined period has not elapsed, the control bandwidth after the reference time point is controlled to increase by a second size smaller than the first size.

[Claim 5]

The communication system according to claim 1, wherein the first communication device controls a token size which defines a transmission amount per specific time so as to control a control bandwidth.

[Claim 6]

The communication system according to claim 1, wherein the first communication device and the second communication device are proxy devices.

[Claim 7]

The communication system according to claim 1, wherein

the first communication device performs first TCP communication with a data transmission terminal, the second communication device performs second TCP communication with a data reception terminal, third TCP communication is performed between the first communication device and the second communication device, and each TCP communication independently performs retransmission of transmitted data and arrangement of received data, and

the first communication device

returns an acknowledgement for a packet with data received at least one step before or an acknowledgement for data before final data, when a packet with data is received in the first TCP communication; and

returns an acknowledgement for final data received in the first TCP communication at a timing when an acknowledgement is received and thus there is no data which waits for an acknowledgement and transmission of which is in progress in the third TCP communication, in a state in which there is data which waits for an acknowledgement and transmission of which is in progress in the third TCP communication and there is no data which waits for arrangement and reception of which is in progress in the first TCP communication.

[Claim 8]

The communication system according to claim 7, wherein an acknowledgement for the packet with data received at least one step before or an acknowledgement for the data before the final data is returned when a packet with data is received in the first TCP communication in a state in which there is data which waits for an acknowledgement and transmission of which is in progress in the third TCP communication, or there is data which waits for arrangement and reception of which is in progress in the first TCP communication.

[Claim 9]

The communication system according to claim 8, wherein an acknowledgement is not returned when a packet with data is received in the first TCP communication in a state in which there is no data which waits for an acknowledgement and transmission of which is in progress in the third TCP communication, and there is no data which waits for arrangement and reception of which is in progress in the first TCP communication.

[Claim 10]

The communication system according to claim 7, wherein the first communication device includes:

a transmission buffer for the third TCP communication; and

a reception buffer for the first TCP communication,

data which waits for an acknowledgement and transmission of which is in progress is stored in the transmission buffer for the third TCP communication,

data which waits for arrangement and reception of which is in progress is stored in the reception buffer for the first

TCP communication, and

it is determined whether or not there is data which waits for an acknowledgement and transmission of which is in progress in the third TCP communication by referring to the transmission buffer, and it is determined whether or not there is data which waits for arrangement and reception of which is in progress by referring to the reception buffer in the first TCP communication.

[Claim 11]

A communication device which relays two data communications including a first data communication and a second data communication,

which returns an acknowledgement for a packet with data received at least one step before or an acknowledgement for data before final data, when a packet with data is received in the second data communication; and

returns an acknowledgement for final data received in the second data communication at a timing when an acknowledgement is received and thus there is no data which waits for an acknowledgement and transmission of which is in progress in the first data communication, in a state in which there is data which waits for an acknowledgement and transmission of which is in progress in the first data communication and there is no data which waits for arrangement and reception of which is in progress in the second data communication.

[Claim 12]

The communication device according to claim 11, wherein an acknowledgement for the packet with data received at least one step before or an acknowledgement for the data before the

final data is returned when a packet with data is received in the second data communication in a state in which there is data which waits for an acknowledgement and transmission of which is in progress in the first data communication, or there is data which waits for arrangement and reception of which is in progress in the second data communication.

[Claim 13]

The communication device according to claim 12, wherein an acknowledgement is not returned when a packet with data is received in the second data communication in a state in which there is no data which waits for an acknowledgement and transmission of which is in progress in the first data communication, and there is no data which waits for arrangement and reception of which is in progress in the second data communication.

[Claim 14]

The communication device according to claim 11, including:

a transmission buffer for the first data communication; and

a reception buffer for the second data communication,

data which waits for an acknowledgement and transmission of which is in progress is stored in the transmission buffer for the first data communication,

data which waits for arrangement and reception of which is in progress is stored in the reception buffer for the second data communication, and

it is determined whether or not there is data which waits for an acknowledgement and transmission of which is in progress

in the first data communication by referring to the transmission buffer, and it is determined whether or not there is data which waits for arrangement and reception of which is in progress by referring to the reception buffer in the second data communication.

[Claim 15]

The communication device according to claim 12, wherein, when a packet with data which is the same as a packet with data received at a previous time is received in the second data communication in a state in which there is data which waits for an acknowledgement and transmission of which is in progress in the first data communication, or there is data which waits for arrangement and reception of which is in progress in the second data communication, an acknowledgement for data after data for which an acknowledgement was returned at a previous time and before final data is returned.

[Claim 16]

The communication device according to claim 11, wherein

a predicted command is transmitted in the first data communication, and

when data received in the first data communication or data which is processed is transmitted in the second data communication, and then a packet with data for the predicted command is received in the second data communication, an acknowledgement for final data of the packet with data is returned in the second data communication.

[Claim 17]

The communication device according to claim 11, wherein an acknowledgement for a data packet located at the end among data packets received in the second data communication is

returned at a timing when a data packet with a PSH flag is received, and, then, an acknowledgement is received and thus there is no data which waits for an acknowledgement and transmission of which is in progress in the first data communication.

CLAIMS

1. A communication device connected to a network, comprising:

a bandwidth control unit configured to manage a bandwidth regarding a packet which is transmitted from the communication device to an another communication device via the network, for each interval time, and reduce a control bandwidth for sending the packet to the network to less than a control bandwidth of a past section when a rate of change in a discarding rate of the packet exceeds a predetermined value during a current section; and

a transmission unit configured to send the packet to the network according to the controlled bandwidth controlled by the bandwidth control unit.

2. The communication device according to claim 1, wherein

the current section is a first time from a current time point to a reference time point which is updated for each interval time, and the past section is a second time from a time point which is an interval time before the reference time point to the reference time point, and the bandwidth control unit is configured to control the bandwidth for sending the packet to the network on the basis of a retransmission bandwidth or a discarding bandwidth during the first time and the controlled control bandwidth during the second time.

3. The communication system according to claim 1, wherein the bandwidth control unit is configured to increase the control bandwidth for sending the packet to the network when the rate of change in the discarding rate of the packet does not exceed the predetermined value.

4. The communication device according to claim 1, wherein the rate of change in the discarding rate of the packet is a rate between the discarding rate of the packet during the current section and the discarding rate of the packet during the past section.

5. The communication system according to claim 1, wherein the bandwidth control unit is configured to obtain the discarding rate of packets during the current section by using a ratio of a transmission bandwidth during the past section and a retransmission bandwidth or a discarding bandwidth during the current section.

6. The communication device according to claim 1, wherein a retransmission ratio of packets is used instead of the discarding rate of packets.

7. A communication device connected to a network,

comprising:

a bandwidth control unit configured to manage a predefined interval time and a reference time point updated for each interval time, and adds the interval time to the reference time point so as to update the reference time point when a difference between the current time point and the reference time point exceeds the interval time; and

a storage unit configured to record therein a retransmission or a discarding bandwidth, a transmission bandwidth, and a control bandwidth for limiting a sum total of the retransmission bandwidth or the discarding bandwidth and the transmission bandwidth according to a first time from a reference time point to a current time point and a second time from the reference time point to an old reference time point which is an interval time before the reference time point,

wherein the bandwidth control unit is configured to reduce the control bandwidth after the reference time point on the basis of the retransmission bandwidth or the discarding bandwidth during the first time and the control bandwidth during the second time, when a rate of change in a discarding rate of a packet exceeds a predetermined value.

8. The communication device according to claim 7,

wherein the bandwidth control unit is configured to:

obtain a first discarding rate which is a ratio of the transmission bandwidth during the second time and the retransmission bandwidth or the discarding bandwidth during the first time, and a second

discarding rate which is a ratio between the transmission bandwidth during a third time from the old reference time point until before the interval time and the retransmission bandwidth or the discarding bandwidth during the second time, and

reduce the control bandwidth after the reference time point to less than the control bandwidth during the second time on the basis of the retransmission bandwidth or the discarding bandwidth after the reference time point, when the first discarding rate is larger than the second discarding rate.

9. A communication system comprising:

a first communication device; and

a second communication device connected to the first communication device via a network,

wherein the first communication device includes

a bandwidth control unit configured to manage a bandwidth

regarding a packet which is transmitted from the first communication device to the second communication device via the network, for each interval time, and reduce a control bandwidth for sending the packet to the second communication device via the network to less than a control bandwidth of a past section when a rate of change in a discarding rate of a packet exceeds a predetermined value during a current section; and a transmission unit configured to send the packet to the network according to the control bandwidth controlled by the bandwidth control unit.

10. The communication system according to claim 9,

wherein

the current section is a first time from a current time point to a reference time point which is updated for each interval time, and the past section is a second time from a time point which is an interval time before the reference time point to the reference time point, and

the bandwidth control unit is configured to control the control bandwidth for sending the packet to the second communication device via the network on the basis of a retransmission bandwidth or a discarding bandwidth during the first time and the controlled control bandwidth during the second time.

11. The communication system according to claim 9, wherein the bandwidth control unit is configured to increase the control bandwidth for sending the packet to the network when the rate of change in the discarding rate of the packet does not exceed the predetermined value.

12. The communication system according to claim 9, wherein the rate of change in the discarding rate of the packet is a rate between the discarding rate of the packet during the current section and the discarding rate of the packet during the past section.

13. The communication system according to claim 9, wherein the bandwidth control unit is configured to obtain the discarding rate of packets during the current section by using a ratio of a transmission bandwidth during the past section and a retransmission bandwidth or a discarding bandwidth during the current section.

14. The communication system according to claim 9, wherein a retransmission ratio of packets is used instead of the discarding rate of packets.

15. A bandwidth control method for controlling a control bandwidth to send a packet to a network, comprising steps of:

managing a bandwidth regarding a packet which is sent to the network, for each interval time;

reducing the control bandwidth for sending the packet to the network to less than a control bandwidth of a past section when a rate of change in a discarding rate of the packet exceeds a predetermined value during a current section; and

sending the packet to the network according to the controlled control bandwidth.

16. The bandwidth control method according to claim 15, wherein
the current section is a first time from a current time point to a reference time point which is updated for each interval time, and the past section is a second time from a time point which is an interval time before the reference time point to the reference time point, and the bandwidth control method further comprises a step of controlling the control bandwidth for sending the packet to the network on the basis of a retransmission bandwidth or a discarding bandwidth during the first time and a controlled control bandwidth during the second time.

17. The bandwidth control method according to claim 15, wherein the bandwidth control unit is configured to increase the control bandwidth for sending the packet to the network when the rate of change in the discarding rate of the packet does not exceed the predetermined value.

18. The bandwidth control method according to claim 15,

wherein the rate of change in the discarding rate of the packet is a rate between the discarding rate of the packet during the current section and the discarding rate of the packet during the past section.

19. The bandwidth control method according to claim 18, further comprising a step of:

obtaining the discarding rate of packets during the current section by using a ratio of a transmission bandwidth during the past section and a retransmission bandwidth or a discarding bandwidth during the current section.

20. The bandwidth control method according to claim 15, wherein a retransmission ratio of packets is used instead of the discarding rate of packets.

21. The communication device according to claim 7, wherein the bandwidth control unit is configured to increase the control bandwidth for sending the packet to the network when the rate of change in the discarding rate of the packet does not exceed the predetermined value.