WIRELESS DEVICE, COMMUNICATION DEVICE, WIRELESS CONTROL METHOD, COMMUNICATION CONTROL METHOD, AND PROGRAM

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of Japanese Priority Patent Application JP 2016-172716 filed September 5, 2016, the entire contents of which are incorporated herein by reference.

Technical Field

[0002] The present invention relates to a wireless device, a communication device, a wireless control method, a communication control method, and a program.

Background Art

[0003] In recent years, standardization of a new wireless LAN has been under review by IEEE 802.11 working groups and the like. For example, a method in which a plurality of wireless devices simultaneously perform data transmission with one access point device using multi-user spatial multiplex communication is under review. Patent Literature 1 discloses a communication control method in a wireless device that performs both multi-user spatial multiplex communication and single user communication.

Citation List

Patent Literature

[0004] PTL 1: JP 5437307B

Summary

Technical Problem

[0005] However, in the wireless LAN system, implementation of the single user communication is delayed due to influence of implementation of the multi-user spatial multiplex communication. For example, when an operation mode is switched from the multi-user spatial multiplex communication to the single user communication, an initial value of a waiting time for the single user communication is reset. For this reason, even when data with high priority is transmitted, a wireless device is on standby until the reset waiting time elapses and performs data transmission using the single user communication after the waiting time elapses.

[0006] Embodiments of the present invention provide a wireless device, a communication device, a wireless control method, a communication control method, and a program, which are novel and improved and capable of preventing the implementation of the single user communication from being delayed due to the influence of the implementation of the multi-user spatial multiplex communication in the wireless device that performs both the multi-user spatial multiplex communication and the single user communication.

Solution to Problem

[0007] According to a first aspect of the present invention, there is provided a wireless device, including: circuitry configured to perform multi-user spatial multiplex communication and single user communication with a communication device operating as an access point; set a first waiting time for the single user communication; count the first waiting time in a period in which a second waiting time for the multi-user spatial multiplex communication is counted; receive, from the communication device, a trigger frame causing transmission of data using the multi-user spatial multiplex communication; suspend counting the first waiting time in response to receiving the trigger frame; set a transmission prohibition period, during which the wireless device is unable to transmit a signal, as a network allocation vector, NAV, in a case where the wireless device is not included as a permission target of the multi-user spatial multiplex communication designated by the trigger frame; transmit the data using the multi-

user spatial multiplex communication in a case where the wireless device is included as a permission target of the multi-user spatial multiplex communication designated by the trigger frame; restart to count the suspended first waiting time without resetting the first waiting time, based on a lapse of a time for reception of a response frame from the communication device, wherein the response frame is responded to transmission of the data using the multi-user spatial multiplex communication caused by the trigger frame; or based on a lapse of the transmission prohibition period; and transmit the data to the communication device by the single user spatial multiplex communication after the first waiting time expired.

[0008] According to a second aspect of the present invention, there is provided a method performed by a wireless device, the method including: performing multi-user spatial multiplex communication and single user communication with a communication device operating as an access point; setting a first waiting time for the single user communication; counting the first waiting time in a period in which a second waiting time for the multi-user spatial multiplex communication is counted; receiving, from the communication device, a trigger frame causing transmission of data using the multi-user spatial multiplex communication; suspending counting the first waiting time in response to receiving the trigger frame; setting a transmission prohibition period, during which the wireless device is unable to transmit a signal, as a network allocation vector, NAV, in a case where the wireless device is not included as a permission target of the multi-user spatial multiplex communication designated by the trigger frame; transmitting the data using the multi-user spatial multiplex communication in a case where the wireless device is included as a permission target of the multi-user spatial multiplex communication designated by the trigger frame; restarting to count the suspended first waiting time without resetting the first waiting time, based on a lapse of a time for reception of a response frame from the communication device, wherein the response frame is responded to transmission of the data using the multi-user spatial multiplex communication caused by the trigger frame, or based on a lapse of the transmission prohibition period; and transmitting the data to the communication device by the single user spatial multiplex communication after the first waiting time expired.

[0009] According to a third aspect of the present invention, there is provided a non-transitory computer-readable medium including computer-program instructions, which when executed by a wireless device, cause the wireless device to: perform multi-user spatial multiplex communication and single user communication with a communication device operating as an access point; set a first waiting time for the single user communication; count the first waiting time in a period in which a second waiting time for the multi-user spatial multiplex communication is counted; receive, from the communication device, a trigger frame causing transmission of data using the multi-user spatial multiplex communication; suspend counting the first waiting time in response to receiving the trigger frame; set a transmission prohibition period, during which the wireless device is unable to transmit a signal, as a network allocation vector, NAV, in a case where the wireless device is not included as a permission target of the multi-user spatial multiplex communication designated by the trigger frame; transmit the data using the multi-user spatial multiplex communication in a case where the wireless device is included as a permission target of the multi-user spatial multiplex communication designated by the trigger frame; restart to count the suspended first waiting time without resetting the first waiting time, based on a lapse of a time for reception of a response frame from the communication device, wherein the response frame is responded to transmission of the data using the multi-user spatial multiplex communication caused by the trigger frame, or based on a lapse of the transmission prohibition period; and transmit the data to the communication device by the single user spatial multiplex communication after the first waiting time expired.

[0010] According to a fourth aspect of the present invention, there is provided a communication device, including: circuitry configured to perform multi-user spatial multiplex communication and single user communication with a wireless device operating as an access point; set a second waiting time for the multi-user spatial multiplex communication; count the second waiting time in a period in which a first waiting time for the single user communication is counted; transmit a trigger frame including permission information for

the multi-user spatial multiplex communication to the wireless device after the second waiting time expires; receive data from the wireless device through the multi-user spatial multiplex communication in response to the trigger frame; generate a response frame for the multi-user spatial multiplex communication based on reception of the data through the multi-user spatial multiplex communication; transmit the response frame for the multi-user spatial multiplex communication to the wireless device; receive data from the wireless device through the single user communication; generate a response frame for the single user communication based on reception of the data through the single user communication; transmit the response frame for the single user communication to the wireless device; suspend counting the second waiting time based on the reception of the data through the single user communication; and start counting the second waiting time based on transmission of the response frame for the single user communication.

[0011] According to a fifth aspect of the present invention, there is provided a method performed by a communication device, the method including: performing multi-user spatial multiplex communication and single user communication with a wireless device operating as an access point; setting a second waiting time for the multi-user spatial multiplex communication; counting the second waiting time in a period in which a first waiting time for the single user communication is counted; transmitting a trigger frame including permission information for the multi-user spatial multiplex communication to the wireless device after the second waiting time expires; receiving data from the wireless device through the multi-user spatial multiplex communication in response to the trigger frame; generating a response frame for the multi-user spatial multiplex communication based on reception of the data through the multi-user spatial multiplex communication; transmitting the response frame for the multi-user spatial multiplex communication to the wireless device; receiving data from the wireless device through the single user communication; generating a response frame for the single user communication based on reception of the data through the single user communication; transmitting the response frame for the single user communication to the wireless device; suspending counting the second waiting time based on the reception of the data through the single user communication; and starting counting the second waiting time based on transmission of the response frame for the single user communication.

[0012] According to a sixth aspect of the present invention, there is provided a non-transitory computer-readable medium including computer-program instructions, which when executed by a wireless device, cause the wireless device to: perform multi-user spatial multiplex communication and single user communication with a wireless device operating as an access point; set a second waiting time for the multi-user spatial multiplex communication; count the second waiting time in a period in which a first waiting time for the single user communication is counted; and transmit a trigger frame including permission information for the multi-user spatial multiplex communication to the wireless device after the second waiting time expires; receive data from the wireless device through the multi-user spatial multiplex communication in response to the trigger frame; generate a response frame for the multi-user spatial multiplex communication based on reception of the data through the multi-user spatial multiplex communication; transmit the response frame for the multi-user spatial multiplex communication to the wireless device; receive data from the wireless device through the single user communication; generate a response frame for the single user communication based on reception of the data through the single user communication; transmit the response frame for the single user communication to the wireless device; suspend counting the second waiting time based on the reception of the data through the single user communication; and start counting the second waiting time based on transmission of the response frame for the single user communication.

Advantageous Effects of Invention

[0013] As described above, according to embodiments of the present invention, it is

CLAIMS

1. A wireless device, comprising:

circuitry configured to

perform multi-user spatial multiplex communication and single user communication with a communication device operating as an access point;

set a first waiting time for the single user communication;

count the first waiting time in a period in which a second waiting time for the multi-user spatial multiplex communication is counted;

receive, from the communication device, a trigger frame causing transmission of data using the multi-user spatial multiplex communication;

suspend counting the first waiting time in response to receiving the trigger frame;

set a transmission prohibition period, during which the wireless device is unable to transmit a signal, as a network allocation vector, NAV, in a case where the wireless device is not included as a permission target of the multi-user spatial multiplex communication designated by the trigger frame;

transmit the data using the multi-user spatial multiplex communication in a case where the wireless device is included as a permission target of the multi-user spatial multiplex communication designated by the trigger frame;

restart to count the suspended first waiting time without resetting the first waiting time, based on a lapse of a time for reception of a response frame from the communication device, wherein the response frame is responded to transmission of the data using the multi-user spatial multiplex communication caused by the trigger frame, or based on a lapse of the transmission prohibition period; and

transmit the data to the communication device by the single user communication after the first waiting time expired.

2. The wireless device according to claim 1, wherein

the circuitry is configured to set the second waiting time based on a priority of the data.

3. The wireless device according to claim 1, wherein

the circuitry is configured to set the second waiting time to a time longer than the first waiting time.

4. The wireless device according to claim 1, wherein

the wireless device is a station configured to communicate with the access point,

the first waiting time and the second waiting time are backoff times that are set based on a contention window, and

the priority of the data is set in accordance with an access category.

5. The wireless device according to claim 1, wherein

the multi-user spatial multiplex communication and the single user communication are uplink communications from the wireless device to the communication device.

6. A method performed by a wireless device, the method comprising:

performing multi-user spatial multiplex communication and single user communication with a communication device operating as an access point;

setting a first waiting time for the single user communication;

counting the first waiting time in a period in which a second waiting time for the multi-user spatial multiplex communication is counted;

receiving, from the communication device, a trigger frame causing transmission of data using the multi-user spatial multiplex communication;

suspending counting the first waiting time in response to receiving the trigger frame;

setting a transmission prohibition period, during which the wireless device is unable to transmit a signal, as a network allocation vector, NAV, in a case where the wireless device is not included as a permission target of the multi-user spatial multiplex communication designated by the trigger frame;

transmitting the data using the multi-user spatial multiplex communication in a case where the wireless device is included as a permission target of the multi-user spatial multiplex communication designated by the trigger frame;

restarting to count the suspended first waiting time without resetting the first waiting time, based on a lapse of a time for reception of a response frame from the communication device, wherein the response frame is responded to transmission of the data using the multi-user spatial multiplex communication caused by the trigger frame, or based on a lapse of the transmission prohibition period; and

transmitting the data to the communication device by the single user communication after the first waiting time expired.

7. A non-transitory computer-readable medium including computer-program instructions, which when executed by a wireless device, cause the wireless device to:

perform multi-user spatial multiplex communication and single user communication with a communication device operating as an access point;

set a first waiting time for the single user communication;

count the first waiting time in a period in which a second waiting time for the multi-user spatial multiplex communication is counted;

receive, from the communication device, a trigger frame causing transmission of data using the multi-user spatial multiplex communication;

suspend counting the first waiting time in response to receiving the trigger frame;

set a transmission prohibition period, during which the wireless device is unable to transmit a signal, as a network allocation vector, NAV, in a case where the wireless device is not included as a permission target of the multi-user spatial multiplex communication designated by the trigger frame;

transmit the data using the multi-user spatial multiplex communication in a case where the wireless device is included as a permission target of the multi-user spatial multiplex communication designated by the trigger frame;

restart to count the suspended first waiting time without resetting the first waiting time, based on a lapse of a time for reception of a response frame from the communication device, wherein the response frame is responded to transmission of the data using the multi-user spatial multiplex communication caused by the trigger frame, or based on a lapse of the transmission prohibition period; and

transmit the data to the communication device by the single user communication after the first waiting time expired.

8. A communication device, comprising:

circuitry configured to

perform multi-user spatial multiplex communication and single user communication with a wireless device operating as an access point;

set a second waiting time for the multi-user spatial multiplex communication;

count the second waiting time in a period in which a first waiting time for the single user communication is counted;

transmit a trigger frame including permission information for the multi-user spatial

multiplex communication to the wireless device after the second waiting time expires;

receive data from the wireless device through the multi-user spatial multiplex communication in response to the trigger frame;

generate a response frame for the multi-user spatial multiplex communication based on reception of the data through the multi-user spatial multiplex communication;

transmit the response frame for the multi-user spatial multiplex communication to the wireless device;

receive data from the wireless device through the single user communication;

generate a response frame for the single user communication based on reception of the data through the single user communication;

transmit the response frame for the single user communication to the wireless device;

suspend counting the second waiting time based on the reception of the data through the single user communication; and

start counting the second waiting time based on transmission of the response frame for the single user communication.

9. The communication device according to claim 8, wherein

the wireless device is a station device configured to communicate with the access point, and

the first waiting time and the second waiting time are backoff times that are set based on a contention window.

10. The communication device according to claim 8, wherein

the multi-user spatial multiplex communication and the single user communication are uplink communications from the wireless device to the communication device.

11. A method performed by a communication device, the method comprising:

performing multi-user spatial multiplex communication and single user communication with a wireless device operating as an access point;

setting a second waiting time for the multi-user spatial multiplex communication;

counting the second waiting time in a period in which a first waiting time for the single user communication is counted;

transmitting a trigger frame including permission information for the multi-user spatial

multiplex communication to the wireless device after the second waiting time expires;

receiving data from the wireless device through the multi-user spatial multiplex communication in response to the trigger frame;

generating a response frame for the multi-user spatial multiplex communication based on reception of the data through the multi-user spatial multiplex communication;

transmitting the response frame for the multi-user spatial multiplex communication to the wireless device;

receiving data from the wireless device through the single user communication;

generating a response frame for the single user communication based on reception of the data through the single user communication;

transmitting the response frame for the single user communication to the wireless device;

suspending counting the second waiting time based on the reception of the data through the single user communication; and

starting counting the second waiting time based on transmission of the response frame for the single user communication.

12. A non-transitory computer-readable medium including computer-program instructions, which when executed by a wireless device, cause the wireless device to:

perform multi-user spatial multiplex communication and single user communication with a wireless device operating as an access point;

set a second waiting time for the multi-user spatial multiplex communication;

count the second waiting time in a period in which a first waiting time for the single user communication is counted;

transmit a trigger frame including permission information for the multi-user spatial multiplex communication to the wireless device after the second waiting time expires;

receive data from the wireless device through the multi-user spatial multiplex communication in response to the trigger frame;

generate a response frame for the multi-user spatial multiplex communication based on reception of the data through the multi-user spatial multiplex communication;

transmit the response frame for the multi-user spatial multiplex communication to the wireless device;

receive data from the wireless device through the single user communication;

generate a response frame for the single user communication based on reception of the data through the single user communication;

transmit the response frame for the single user communication to the wireless device;

suspend counting the second waiting time based on the reception of the data through the single user communication; and

start counting the second waiting time based on transmission of the response frame for the single user communication.