Description

Title of Invention

COMMUNICATION APPARATUS AND COMMUNICATION METHOD

Technical Field

[0001]

The present disclosure relates to communication apparatuses and communication methods.

Background Art

[0002]

Wireless local area networks (LANs), typified by IEEE (Institute of Electrical and Electronics Engineers) 802.11, have in recent years been widespread, leading to an increase in the information amount of transmitted contents and the number of wireless LAN-capable products. Therefore, to improve the efficiency of communication over an entire network, the standard IEEE 802.11 is still being enhanced.

[0003]

In the 802.11ac standard, which is an example enhanced version of the standard IEEE 802.11, multi-user multi-input multi-output (MU-MIMO) is employed for a downlink (DL). MU-MIMO is a technique for allowing transmission of a plurality of signals during the same period of time through space-division multiplexing. The technique can improve the efficiency of use of frequencies, for example.

[0004]

However, different communication apparatuses may transmit frames during different transmission time periods. In this case, the number of multiplexed frames fluctuates during a period of time when the frames are received. Therefore, the reception power of a communication apparatus that receives multiplexed frames fluctuates during the reception time period. The fluctuation of the reception power may have an influence on the performance of reception. To address this problem, a technique of transmitting frames during equal transmission time periods has been proposed.

[0005]

For example, Patent Literature 1 describes a communication apparatus that appropriately adds a padding to a plurality of frames having different transmission time periods and thereby transmits the plurality of frames during equal transmission time periods.

[0006]

In addition, Patent Literature 2 describes a communication method in which a

communication apparatus serving as an access point (AP) transmits uplink (UL) permission information designating a transmission time period of a UL frame and a communication apparatus receiving the UL permission information transmits a UL frame over the designated transmission time period.

Citation List

Patent Literature

[0007]

Patent Literature 1:	JP 2010-263490A
Patent Literature 2:	JP 2010-263493A

Disclosure of Invention

Technical Problem

[0008]

However, according to the inventions disclosed in Patent Literatures 1 and 2, there are cases in which it is difficult to efficiently use wireless communication resources. For example, according to the invention disclosed in Patent Literature 1, wireless communication resources are consumed by a padding that is not relevant as data. In addition, according to the invention disclosed in Patent Literature 2, an AP does not know a transmission time period desired by each of communication apparatuses that transmit UL frames at a point in time at which a transmission time period of the UL frames is designated, and thus may designate a transmission time period longer than the desired transmission time period. For this reason, there is a probability that all of communication apparatuses which transmit UL frames will transmit paddings.

[0009]

Therefore, embodiments of the present invention propose a new and improved communication apparatus and communication method that can reconcile efficient use of wireless communication resources with stabilization of reception performance in wireless multiplex communication.

Solution to Problem

[0010]

According to a first aspect of the present invention, there is provided a first communication apparatus, wherein the first communication apparatus is configured to wirelessly communicate with a plurality of second communication apparatuses based on IEEE802.11 standard, and wherein the first communication apparatus includes: processing circuitry configured to receive a first frame from the plurality of the second communication apparatuses, wherein the first frame includes resource information related to resources for

transmissions by the plurality of second communication apparatuses; and transmit a plurality of trigger frames to the plurality of second communication apparatuses, wherein each trigger frame of the plurality of trigger frames includes: transmission time period information to indicate a first transmission time period for the plurality of second communication apparatuses to perform an uplink multiplexing operation, and transmission power information to indicate a transmission power for the plurality of second communication apparatuses to perform the uplink multiplexing operation.

[0010a]

According to a second aspect of the present invention, there is provided a second communication apparatus, wherein the second communication apparatus is configured to wirelessly communicate with a first communication apparatus based on IEEE802.11 standard, and wherein the second communication apparatus includes: processing circuitry configured to: transmit a first frame to the first communication apparatus, wherein the first frame includes resource information related to resources for transmissions by the second communication apparatus; and receive a trigger frame from the first communication apparatus, wherein the trigger frame includes: transmission time period information to indicate a first transmission time period for the second communication apparatuses to perform the uplink multiplexing operation, and transmission power information to indicate a transmission power for the second communication apparatus to perform the uplink multiplexing.

[0011]

According to a third aspect of the present invention, there is provided a communication method of a first communication apparatus, including: wirelessly communicating with a plurality of second communication apparatuses based on IEEE802.11 standard; receiving a first frame from the plurality of second communication apparatuses, wherein the first frame includes resource information related to resources for transmissions by the plurality of second communication apparatuses; and transmitting a plurality of trigger frames to the plurality of second communication apparatuses, wherein each trigger frame of the plurality of trigger frames includes: transmission time period information indicating a transmission time period for the plurality of second communication apparatuses to perform an uplink multiplexing, and transmission power information indicating a transmission power for the plurality of second communication apparatuses to perform the uplink multiplexing.

Advantageous Effects of Invention

[0012]

As described above, according to embodiments of the present invention, a communication apparatus and a communication method that can reconcile efficient use of wireless

CLAIMS

1. A first communication apparatus, wherein the first communication apparatus is configured to

wirelessly communicate with a plurality of second communication apparatuses based on IEEE802.11 standard, and

wherein the first communication apparatus comprises:

processing circuitry configured to:

receive a first frame from the plurality of the second communication apparatuses,

wherein the first frame includes resource information related to resources for transmissions by the plurality of second communication apparatuses; and

transmit a plurality of trigger frames to the plurality of second communication apparatuses, wherein each trigger frame of the plurality of trigger frames includes:

transmission time period information to indicate a first transmission time period for the plurality of second communication apparatuses to perform an uplink multiplexing operation, and

transmission power information to indicate a transmission power for the plurality of second communication apparatuses to perform the uplink multiplexing operation.

2. The first communication apparatus according to claim 1, wherein the processing circuitry is further configured to:

transmit a request frame to the plurality of second communication apparatuses, wherein the request frame is configured to request the plurality of second communication apparatuses to transmit the first frame; and

receive the first frame from the plurality of second communication apparatuses based on the transmitted request frame.

3. The first communication apparatus according to claim 1, wherein the processing circuitry is further configured to determine_ the first transmission time period based on a

second transmission time period longer than other transmission time periods among transmission time periods indicated by respective pieces of the resource information.

4. The first communication apparatus according to claim 1, wherein the processing circuitry is further configured to:

determine the first transmission time period based on a second transmission time period longer than other transmission time periods among transmission time periods indicated by respective pieces of the resource information; and

determine the first transmission time period to be a third transmission time period equal to or less than a threshold value based on the first transmission time period that is greater than the threshold value.

5. The first communication apparatus according to claim 4, wherein the threshold value is determined based on one of information indicating a spare time of a wireless channel or information indicating an amount of traffic relating to communication of the first communication apparatus.

6. The first communication apparatus according to claim 4, the processing circuitry is further configured to:

refrain transmission of the plurality of trigger frames to a second communication apparatus of the plurality of second communication apparatuses,

wherein the second communication apparatus is a transmission source of a second frame including the resource information indicating a fourth transmission time period greater than the threshold value.

7. The first communication apparatus according to claim 1, wherein the processing circuitry is further configured to:

determine whether the first frame including the resource information indicates that transmission of user data as a response to one of the plurality of trigger frames is undesired by one of the plurality of second communication apparatuses; and

insert information instructing transmission of an acknowledgement of the one of the plurality of trigger frames in an independent transmission time period in the plurality of trigger frames.

8. The first communication apparatus according to claim 1, wherein the processing circuitry is further configured to include the transmission power information in each trigger frame of the plurality of trigger frames.

9. The first communication apparatus according to claim 8, wherein the processing circuitry is further configured to designate the transmission power so that a difference in reception power between the first frame received from the plurality of second communication apparatuses is smaller than a determined value at the first communication apparatus.

10. The first communication apparatus according to claim 1, wherein the first frame further includes reference signals, and

wherein the processing circuitry is further configured to transmit, to the plurality of second communication apparatuses, frames indicating a request for transmission of the first frame including the resource information .

11. The first communication apparatus according to claim 10, wherein the first frame including the resource information is multiplexed by encoding the reference signals.

12. The first communication apparatus according to claim 10, wherein the processing circuitry is further configured to:

acquire antenna weights based on the reference signals;

space-division multiplex the plurality of trigger frames based on the acquired antenna weights; and

transmit the space-division multiplexed plurality of trigger frames to the plurality of second communication apparatuses.

13. The first communication apparatus according to claim 1, wherein the processing circuitry is further configured to:

frequency-division multiplex the plurality of trigger frames; and

transmit the frequency-division multiplexed plurality of trigger frames to the plurality of second communication apparatuses.

14. The first communication apparatus according to claim 1, wherein the processing circuitry is further configured to transmit the plurality of trigger frames to the plurality of second communication apparatuses based on a multicasting scheme.

15. A second communication apparatus, wherein the second communication apparatus is configured to

wirelessly communicate with a first communication apparatus based on IEEE802.11 standard, and

wherein the second communication apparatus comprises:

processing circuitry configured to:

transmit a first frame to the first communication apparatus,

wherein the first frame includes resource information related to resources for transmissions by the second communication apparatus; and

receive a trigger frame from the first communication apparatus, wherein the trigger frame includes:

transmission time period information to indicate a first transmission time period for the second communication apparatuses to perform the uplink multiplexing operation, and

transmission power information to indicate a transmission power for the second communication apparatus to perform the uplink multiplexing.

16. The second communication apparatus according to claim 15, wherein the processing circuitry is configured to generate the first frame so that a second transmission time period of the first frame becomes the first transmission time period.

17. The second communication apparatus according to claim 16, wherein the processing circuitry is configured to generate the first frame in which a second frame is connected to the user data, wherein the second frame is an acknowledgement of the trigger frame.

18. The second communication apparatus according to claim 16, wherein, in generation of the first frame, the processing circuitry is further configured to:

determine whether the second transmission time period of the first frame exceeds the

first transmission time period; and

divide the first frame based on the determination.

19. The second communication apparatus according to claim 16, wherein, in generation of the first frame, the processing circuitry is configured to pad the first frame based on the second transmission time period of the first frame that is shorter than the first transmission time period.

20. A communication method of a first communication apparatus, comprising:

wirelessly communicating with a plurality of second communication apparatuses based on IEEE802.11 standard;

receiving a first frame from the plurality of second communication apparatuses,

wherein the first frame includes resource information related to resources for transmissions by the plurality of second communication apparatuses; and

transmitting a plurality of trigger frames to the plurality of second communication apparatuses, wherein each trigger frame of the plurality of trigger frames includes:

transmission time period information indicating a transmission time period for the plurality of second communication apparatuses to perform an uplink multiplexing, and

transmission power information indicating a transmission power for the plurality of second communication apparatuses to perform the uplink multiplexing.

21. The first communication apparatus according to claim 1, wherein the resource information is generated based on an amount of data to be transmitted, and wherein the amount of data to be transmitted is calculated based on a transmission buffer of each second communication apparatus of the plurality of second communication apparatuses.

22. The second communication apparatus according to claim 15, wherein the processing circuitry is further configured to:

calculate an amount of data to be transmitted based on a transmission buffer of the second communication apparatus; and

generate the resource information based on the calculated amount of data.