for determining whether or not the terminal transmits a packet and setting a transmission parameter such as transmission power and a transmission time on the basis of the information regarding the received signal.

[0004]

Furthermore, regarding an In-Band Full Duplex terminal (terminal that can simultaneously perform transmission and reception in same frequency, referred to as “FD terminal” below) that is studied to be practically used in the future, an effect for doubling communication resources by receiving a packet transmitted from the other terminal even when transmitting a packet is expected. At this time, by acquiring information regarding the packet transmitted from the FD terminal, the other terminal can determine whether or not the packet can be transmitted to the FD terminal.

CITATION LIST

PATENT DOCUMENT

[0005]

Patent Document 1: Japanese Patent Application Laid-Open No. 2003-249908

SUMMARY OF THE INVENTION

PROBLEMS TO BE SOLVED BY THE INVENTION

[0006]

Embodiments of the present invention provide a communication device and a communication method that transmit and receive wireless packets.

SOLUTIONS TO PROBLEMS

[0007]

According to a first aspect of the present invention, there is provided a communication device including: a control circuitry configured to: upon determining that a received packet is from a basic service set (BSS) not associated with the communication device, determine to perform a spatial reuse (SR) operation in a multi-carrier signal, wherein the SR operation includes: setting a plurality of subcarriers of the

multi-carrier signal to be null tones; and embedding information from the BSS not associated with the communication device in the null tones; and a transmission circuitry configured to: generate and wirelessly transmit the multi-carrier signal, the multi-carrier signal including: the information embedded in the null tones, and other information for a BSS that is associated with the communication device in tones of the multi-carrier signal not set to be null tones.

[0008]

The control unit determines the positions and the number of subcarriers to be the null tones in a range of a null tone candidate position that is determined in the multi-carrier signal in advance. Alternatively, the control unit fixes the number of subcarriers to be null tones and determines the position of the subcarrier to be the null tone corresponding to the information. Furthermore, the control unit changes a subcarrier to be a null tone according to temporal variation of the information. Then, the control unit determines a subcarrier to be a null tone according to the information including at least one of a BSS identifier, transmission time information, transmission power information, a flag that identifies uplink communication or downlink communication, or a flag indicating whether or not a packet can be received.

[0009]

According to a second aspect of the present invention, there is provided a communication method performed by a communication device that includes a processor and a transmitter, the method including: receiving a packet, upon determining that the received packet is from a basic service set (BSS) not associated with the communication device, determining to perform a spatial reuse (SR) operation in a multi-carrier signal, wherein the SR operation includes: setting a plurality of subcarriers of the multi-carrier signal to be null tones; and embedding information from the BSS not associated with the communication device in the null tones; and generating and wirelessly transmitting the multi-carrier signal, the multi-carrier signal including: the information embedded in the null tones, and other information for a BSS

that is associated with the communication device in tones of the multi-carrier signal not set to be null tones.

[0010]

According to a third aspect of the present invention, there is provided a communication device including: a receiver configured to receive, from a relay device, a spatial reuse (SR) multi-carrier signal, the SR multi-carrier signal including: information from a first basic service set (BSS) that is embedded in null tones of the SR multi-carrier signal, and other information from a second BSS located in tones of the SR multi-carrier signal not set to be null tones; and control circuitry configured to: detect via power detection the information from the first BSS that is embedded in the null tones; and detect via preamble detection, the other information from the second BSS that is in the tones of the multi-carrier signal not set to be null tones.

[0011]

The control unit acquires the information on a basis of a position of a subcarrier and the number of subcarriers determined to be a null tone by the determination unit. Alternatively, the control unit acquires the information on a basis of a position of a subcarrier determined to be a null tone by the determination unit. Then, it is possible that, in a case where the number of subcarriers to be null tones by the determination unit is other than an expected number, the control unit determines that determination is wrong. Furthermore, it is possible that the control unit determines whether or not the information is successfully acquired on a basis of a code for detecting or correcting an error included in the acquired information.

[0012]

The control unit further performs packet transmission control on a basis of the acquired information. For example, the control unit determines whether or not a packet transmission by spatial reuse can be performed or adjusts a transmission parameter of the packet on a basis of the acquired information. Alternatively, the control unit can determine whether or not a packet can be transmitted to a Full

Duplex terminal or adjust a transmission parameter of the packet on a basis of the null tone determination result by the determination unit on a multi-carrier signal received from the Full Duplex terminal.

[0013]

According to a fourth aspect of the present invention, there is provided a communication method performed by a communication device that includes a processor and a receiver, the method including: receiving, from a relay device, a spatial reuse (SR) multi-carrier signal, the SR multi-carrier signal including: information from a first basic service set (BSS) that is embedded in null tones of the SR multi-carrier signal to be null tones, and other information from a second BSS located in tones of the SR multi-carrier signal not set to be null tones; and detecting, via power detection, the information from the first BSS that is embedded in the null tones; and detecting, via preamble detection, the other information from the second BSS that is in the tones of the multi-carrier signal not set to be null tones.

EFFECTS OF THE INVENTION

[0014]

According to embodiments of the invention disclosed herein, a communication device and a communication method that transmit and receive wireless packets can be provided.

[0015]

Note that the effects described in the present specification are only exemplary, and the effect of the present invention is not limited to those. Furthermore, there is a case where the present invention has a further additional effect other than the effects described above.

[0016]

Other purpose, characteristics, and advantages of the technology disclosed herein would be obvious by the detailed description based on the embodiment described later and the attached drawings.

CLAIMS

1. A communication device comprising:

a control circuitry configured to:

upon determining that a received packet is from a basic service set (BSS) not associated with the communication device, determine to perform a spatial reuse (SR) operation in a multi-carrier signal,

wherein the SR operation comprises:

setting a plurality of subcarriers of the multi-carrier signal to be null tones; and

embedding information from the BSS not associated with the communication device in the null tones; and

a transmission circuitry configured to:

generate and wirelessly transmit the multi-carrier signal, the multi-carrier signal including:

the information embedded in the null tones, and

other information for a BSS that is associated with the communication device in tones of the multi-carrier signal not set to be null tones.

2. The communication device according to claim 1, wherein the control circuitry determines positions of the plurality of subcarriers of the multi-carrier signal to be null tones and a number of subcarriers to be null tones in correspondence with information of the received packet.

3. The communication device according to claim 1, wherein a power level of transmission of the information embedded in the null tones is less than a power level of transmission of the other information in the tones of the multi-carrier signal not set to be null tones.

4. The communication device according to claim 1, wherein the control circuitry changes a subcarrier to be a null tone according to temporal variation of information to be embedded in the null tone.

5. The communication device according to claim 1, wherein transmission of the information embedded in the null tones also includes reference tones having a power level determined to compensate for frequency selective fading.

6. The communication device according to claim 1, wherein the transmission circuitry sets a same subcarrier as a null tone in each stream when transmitting a plurality of streams.

7. The communication device according to claim 1, wherein the embedded information includes, within a predetermined null tone pattern, each of a BSS identifier, transmission time information, transmission power information, a flag that identifies uplink communication

or downlink communication, and a flag indicating whether or not a packet can be received.

8. The communication device according to claim 7, wherein the predetermined null tone pattern further includes a null tone location used for a code for detecting or correcting an error in the embedded information.

9. The communication device according to claim 1, wherein the control circuitry determines to perform the SR operation after the other information is determined to be transmitted.

10. The communication device according to claim 1, wherein the other information is transmitted with a predetermined preamble configured to enable preamble detection, while the information embedded in the null tones is transmitted without any predetermined preamble configured to enable preamble detection, the transmission circuitry replacing a subcarrier determined to be a null tone with a null tone after data is applied to each subcarrier.

11. A communication method performed by a communication device that includes a processor and a transmitter, the method comprising:

receiving a packet,

upon determining that the received packet is from a basic service set (BSS) not associated with the communication device, determining to perform a spatial reuse (SR) operation in a multi-carrier signal,

wherein the SR operation comprises:

setting a plurality of subcarriers of the multi-carrier signal to be null tones; and

embedding information from the BSS not associated with the communication device in the null tones; and

generating and wirelessly transmitting the multi-carrier signal, the multi-carrier signal including:

the information embedded in the null tones, and

other information for a BSS that is associated with the communication device in tones of the multi-carrier signal not set to be null tones.

12. A communication device comprising:

a receiver configured to receive, from a relay device, a spatial reuse (SR) multi-carrier signal, the SR multi-carrier signal including:

information from a first basic service set (BSS) that is embedded in null tones of the SR multi-carrier signal, and

other information from a second BSS located in tones of the SR multi-carrier signal not set to be null tones; and

control circuitry configured to:

detect via power detection the information from the first BSS that is embedded in the null tones; and

detect via preamble detection, the other information from the second BSS that is in the tones of the multi-carrier signal not set to be null tones.

13. The communication device according to claim 12, wherein the control circuitry is configured to:

further detect the information from the first BSS that is embedded in the null tones based on a corresponding null tone power level analysis; and

further detect the other information from the second BSS that is in the tones of the multi-carrier signal not set to be null tones based on a corresponding reception power level analysis.

14. The communication device according to claim 12, wherein the embedded information includes, within a predetermined null tone pattern, each of a BSS identifier, transmission time information, transmission power information, a flag that identifies uplink communication or downlink communication, and a flag indicating whether or not a packet can be received.

15. The communication device according to claim 14, wherein the predetermined null tone pattern further

includes a null tone location for a code for detecting or correcting an error in the embedded information.

16. The communication device according to claim 13, wherein the null tone power level analysis includes determining a subcarrier having a reception power that is higher than a first threshold and is lower than a reception power of an adjacent reference tone by a second threshold or more as a null tone.

17. A communication method performed by a communication device that includes a processor and a receiver, the method comprising:

receiving, from a relay device, a spatial reuse (SR) multi-carrier signal, the SR multi-carrier signal including:

information from a first basic service set (BSS) that is embedded in null tones of the SR multi-carrier signal to be null tones, and

other information from a second BSS located in tones of the SR multi-carrier signal not set to be null tones; and

detecting, via power detection, the information from the first BSS that is embedded in the null tones; and

detecting, via preamble detection, the other information from the second BSS that is in the tones of

the multi-carrier signal not set to be null tones.

18. The method of claim 17, further comprising:

further detecting the information from the first BSS that is embedded in the null tones based on a corresponding null tone power level analysis; and

further detecting the other information from the second BSS that is in the tones of the multi-carrier signal not set to be null tones based on a corresponding reception power level analysis.