DESCRIPTION

Title of Invention: TRANSMISSION APPARATUS. TRANSMISSION METHOD, RECEPTION APPARATUS AND RECEPTION METHOD

Technical Field

[0001]

The present disclosure relates to a transmission apparatus, a transmission method, a reception apparatus and a reception method using a millimeter wave communication.

Background Art

[0002]

IEEE 802.11 is one of wireless LAN related standards, and includes IEEE802.11n standard (hereafter, referred to as "11n standard"), IEEE802.11ad standard (hereinafter, referred to as "11ad standard"), and the like (see, for example, NPL 1 and NPL 2).

[0003]

The 11n standard supports compatibility between 2.4 GHz and 5 GHz, and provides a high throughput higher than 100 Mbps in MAC layers. In the 11n standard, use of OFDM (Orthogonal Frequency Division Multiplexing) transmission as a secondary modulation scheme is stipulated.

[0004]

Furthermore, to enhance the peak throughput, the 11n standard supports channel bonding in which, in data transmission, a data field is allocated across two adjacent channels each having a bandwidth of 20 MHz, that is, the data field (payload) is allocated in a bandwidth of 40 MHz. In the 11n standard, a preamble (including L-STF, L-LTF, L-SIG, HT-SIG) is allocated in each channel such that reception is possible even for a terminal that does not support the channel bonding.

[0005]

According to the 11ad standard, a high-speed communication at a maximum of 7 Gbps is achieved using a plurality of channels of a millimeter wave in a 60 GHz band. In the 11ad standard, as secondary modulation schemes, single carrier transmission and OFDM transmission are stipulated. As a means of further enhancing a peak throughput compared with that achieved by the 11ad standard, in addition to the channel bonding, a communication standard using

carrier aggregation has been proposed.

Citation List

Non Patent Literature

[0006]

NPL 1: IEEE Std 802.11 TM-2012

NPL 2: IEEE Std 802.11ad TM-2012

Summary

[0007]

To perform carrier aggregation, it is necessary to use a high frequency (RF: Radio Frequency) circuit with a wideband corresponding to the number of channels used at the same time, and an analog front end circuit (for example, a D/A converter, an A/D converter). Furthermore, in carrier aggregation using OFDM transmission according to the 11ad standard, unlike the channel bonding, it is necessary to perform an up-sampling process and a filtering process for each channel, and thus it is difficult to achieve a reduction in apparatus size, a reduction in consumption power, and a reduction in cost (by using general-purpose semiconductor technology).

[0008]

Furthermore, in the OFDM transmission according to the 11ad standard, if the up-sampling process and the filtering process are performed for each channel as with the single carrier transmission, it is difficult to achieve a reduction in apparatus size, a reduction in consumption power, and a reduction in cost.

[0009]

In an embodiment, the present disclosure provides a communication apparatus and a communication method according to the 11ad standard.

[0010]

In a first aspect, the present disclosure provides a transmission apparatus comprising: single carrier signal circuitry which, in operation, generates a first single carrier signal and a second single carrier signal, each of the first and second single carrier signals including a legacy preamble signal, a legacy header signal and an extension header signal, the legacy preamble signal including a short training field (STF) and a channel estimation field (CEF); orthogonal frequency-division multiplexing (OFDM) signal circuitry which, in operation, sets a first center frequency of a first payload signal to a position that is 209 subcarriers

lower from a center of 1024 consecutive subcarriers; sets a second center frequency of a second payload signal to another position that is 210 subcarriers higher from the center of the 1024 consecutive subcarriers; performs inverse fast Fourier transform (IFFT) processing on the first payload signal and the second payload signal and generates one OFDM signal to be mapped on a bonding channel comprising a first channel and a second channel, wherein a fast Fourier transform (FFT) size is 1024; and shifts the generated OFDM signal by an offset amount that is a difference between a center-frequency of the first channel and one of the 1024 consecutives subcarriers; frame generation circuitry which, in operation, generates a frame by: mapping the first single carrier signal and the second single carrier signal respectively to the first channel and the second channel; and mapping the shifted OFDM signal to the bonding channel; and transmission circuitry which, in operation, transmits the generated frame over the bonding channel.

[0010a]

In a second aspect, the present disclosure provides a reception apparatus comprising: reception circuitry which, in operation, receives a signal mapped to a bonding channel; and processing circuitry which, in operation, generates a first payload signal and a second payload signal by performing fast Fourier transform (FFT) processing on the received signal; wherein: the received signal is generated in a transmission apparatus and includes a first single carrier signal mapped to a first channel, a second single carrier signal mapped to a second channel and an orthogonal frequency-division multiplexing (OFDM) signal mapped to the bonding channel, each of the first and second single carrier signals includes a legacy preamble signal, a legacy header signal and an extension header signal, the legacy preamble signal including a short training field (STF) and a channel estimation field (CEF), a first center frequency of the first payload signal is set to a position that is 209 subcarriers lower from a center of 1024 consecutive subcarriers, a second center frequency of the second payload signal is set to another position that is 210 subcarriers higher from the center of the 1024 consecutive subcarriers, the one OFDM signal is generated by performing inverse fast Fourier transform (IFFT) processing on the first payload signal and the second payload signal and generating one OFDM signal to be mapped on the bonding channel comprising the first channel and the second channel, an FFT size is 1024,

and the generated OFDM signal is shifted by an offset amount that is a difference between a center-frequency of the first channel and one of the 1024 consecutives subcarriers.

[0010b]

In a third aspect, the present disclosure provides a transmission method comprising: generating a first single carrier signal and a second single carrier signal, each of the first and second single carrier signals including a legacy preamble signal, a legacy header signal and an extension header signal, the legacy preamble signal including a short training field (STF) and a channel estimation field (CEF); setting a first center frequency of a first payload signal to a position that is 209 subcarriers lower from a center of 1024 consecutive subcarriers; setting a second center frequency of a second payload signal to another position that is 210 subcarriers higher from the center of the 1024 consecutive subcarriers; performing inverse fast Fourier transform (IFFT) processing on the first payload signal and the second payload signal and generating one orthogonal frequency-division multiplexing (OFDM) signal to be mapped on a bonding channel comprising a first channel and a second channel, wherein a fast Fourier transform (FFT) size is 1024; shifting the generated OFDM signal by an offset amount that is a difference between a center-frequency of the first channel and one of the 1024 consecutives subcarriers; generating a frame by: mapping the first single carrier signal and the second single carrier signal respectively to the first channel and the second channel; and mapping the shifted OFDM signal to the bonding channel; and transmitting the generated frame over the bonding channel.

[0010c]

In a fourth aspect, the present disclosure provides a reception method comprising: receiving a signal mapped to a bonding channel; and generating a first payload signal and a second payload signal by performing fast Fourier transform (FFT) processing on the received signal; wherein: the received signal is generated in a transmission apparatus and includes a first single carrier signal mapped to a first channel, a second single carrier signal mapped to a second channel and an orthogonal frequency-division multiplexing (OFDM) signal mapped to the bonding channel, each of the first and second single carrier signals including a legacy preamble signal, a legacy header signal and an extension header signal, the

legacy preamble signal including a short training field (STF) and a channel estimation field (CEF), a first center frequency of the first payload signal is set to a position that is 209 subcarriers lower from a center of 1024 consecutive subcarriers, a second center frequency of the second payload signal is set to another position that is 210 subcarriers higher from the center of the 1024 consecutive subcarriers, the one OFDM signal is generated by performing inverse fast Fourier transform (IFFT) processing on the first payload signal and the second payload signal and generating one OFDM signal to be mapped on the bonding channel comprising the first channel and the second channel, an FFT size is 1024, and the generated OFDM signal is shifted by an offset amount that is a difference between a center-frequency of the first channel and one of the 1024 consecutives subcarriers.

[0010d]

In an embodiment of the present disclosure, a transmission apparatus includes a signal carrier signal generator that generates two single carrier signals including on a legacy preamble signal, a legacy header signal and an extension header signal respectively, OFDM signal generator that generates one OFDM signal by performing an IFFT processing on payload signals, and transmission circuitry that transmits the two single carrier signals by allocating to a bonding channel which is formed by bonding two adjacent channels used in a bonding transmission scheme

and the one OFDM signals by allocating to the bonding channel which is frequency-shifted.

[0011]

In an embodiment, a transmission method includes generating two single carrier signals including a legacy preamble signal and a legacy header signal and an extension header signal respectively, generating one OFDM signal by, performing an IFFT processing on one or more payload signals, and transmitting the two single carrier signals by allocating to a bonding channel which is formed by bonding two adjacent channels used in a bonding transmission scheme and the one OFDM signals by allocating to the bonding channel which is frequency-shifted.

[0012]

General or specific embodiments may be implemented as a system, an apparatus, a method, an integrated circuit, a computer program, or a storage medium or any combination of a system, an apparatus, a method, an integrated circuit, a computer program, and a storage.

Advantageous Effects

[0013]

According to the embodiment of the present disclosure, in aggregation transmission using a communication apparatus or according to a communication method using a millimeter wave communication, it becomes unnecessary to perform the up-sampling process and the filtering process, and thus it becomes possible to achieve a reduction in apparatus size, a reduction in consumption power, and a reduction in cost.

Brief Description of Drawings

[0014]

[Fig. 1] Fig. 1 is a diagram illustrating an example of a spectrum in an aggregation transmission of a millimeter wave communication.

[Fig. 2] Fig. 2 is a diagram illustrating an example of a configuration of a

communication apparatus configured to perform an OFDM transmission.

[Fig. 3] Fig. 3 is a diagram illustrating an example of a configuration of a communication apparatus configured to perform an OFDM transmission.

[Fig. 4] Fig. 4 is a diagram illustrating an example of a process on a payload signal S1.

[Fig. 5] Fig. 5 is a diagram illustrating an example of a process on a payload

payload signals of the respective channels. The amounts of phase shifts are set in advance in the phase shift setting unit 301.

[0116]

For example, as illustrated in Fig. 22A, for the payload signal S1, a first symbol block (a 336-symbol block) is shifted in phase by φ rad, a second symbol block is shifted in phase by 2φ rad, and an n*th* symbol block is shifted in phase by $n\varphi$ rad. That is, the amount of the phase shift increases with the symbol block number (n is an integer equal to or greater than 1).

[0117]

On the other hand, in the payload signal S2, as illustrated in Fig. 22B, the phase shift is applied by a sign opposite to that for the payload signal S1. A process of inverting the sign of the amount of phase shift is performed by the sign inverter 302.

[0118]

Here, φ is determined by a deviation Δ (GHz) of the center frequency, the carrier frequency f, and (OFDM symbol length + CP length) L according to a formula described below.

[0119]

$\varphi = (\Delta / f) * L * 2\pi$ [rad]

Example of calculation

Δ = 1080 MHz - (5280 MHz/1024*209) = 2.34375 MHz

f = 60 GHz

L = 512 + 128 = 640

$\varphi = 0.05\pi$

As a result, a phase shift to be applied to a sample (for example, a 320*th* sample) located at the center of a time-domain signal with a total of 640 samples including the OFDM symbols and CP is equally applied to all 640 samples. Thus, although a spectrum identical to that shown in Fig. 14 is not obtained, a reduction in reception signal error in the OFDM receiver and an increase in signal quality are achieved. Unlike the conventional technique in which a phase shift is applied to a time-domain signal, it is possible to achieve approximate frequency shift independently for the channels ch1 and ch2.

[0120]

CLAIMS

1. A transmission apparatus comprising:

single carrier signal circuitry which, in operation, generates a first single carrier signal and a second single carrier signal, each of the first and second single carrier signals including a legacy preamble signal, a legacy header signal and an extension header signal, the legacy preamble signal including a short training field (STF) and a channel estimation field (CEF);

orthogonal frequency-division multiplexing (OFDM) signal circuitry which, in operation,

sets a first center frequency of a first payload signal to a position that is 209 subcarriers lower from a center of 1024 consecutive subcarriers;

sets a second center frequency of a second payload signal to another position that is 210 subcarriers higher from the center of the 1024 consecutive subcarriers;

performs inverse fast Fourier transform (IFFT) processing on the first payload signal and the second payload signal and generates one OFDM signal to be mapped on a bonding channel comprising a first channel and a second channel, wherein a fast Fourier transform (FFT) size is 1024; and

shifts the generated OFDM signal by an offset amount that is a difference between a center-frequency of the first channel and one of the 1024 consecutives subcarriers;

frame generation circuitry which, in operation, generates a frame by:

mapping the first single carrier signal and the second single carrier signal respectively to the first channel and the second channel; and

mapping the shifted OFDM signal to the bonding channel; and

transmission circuitry which, in operation, transmits the generated frame over the bonding channel.

2. The transmission apparatus according to claim 1, wherein

an interval between the first channel and the second channel is 2.16 GHz,

a sampling rate in the IFFT processing is 5.28 GHz, and

a center frequency of the bonding channel corresponds to a frequency separated by 209 subcarriers from a center frequency of the first channel.

3. A reception apparatus comprising:

reception circuitry which, in operation, receives a signal mapped to a bonding channel; and

processing circuitry which, in operation, generates a first payload signal and a second payload signal by performing fast Fourier transform (FFT) processing on the received signal; wherein:

the received signal is generated in a transmission apparatus and includes a first single carrier signal mapped to a first channel, a second single carrier signal mapped to a second channel and an orthogonal frequency-division multiplexing (OFDM) signal mapped to the bonding channel,

each of the first and second single carrier signals includes a legacy preamble signal, a legacy header signal and an extension header signal, the legacy preamble signal including a short training field (STF) and a channel estimation field (CEF),

a first center frequency of the first payload signal is set to a position that is 209 subcarriers lower from a center of 1024 consecutive subcarriers, a second center frequency of the second payload signal is set to another position that is 210 subcarriers higher from the center of the 1024 consecutive subcarriers,

the one OFDM signal is generated by performing inverse fast Fourier transform (IFFT) processing on the first payload signal and the second payload signal and generating one OFDM signal to be mapped on the bonding channel comprising the first channel and the second channel,

an FFT size is 1024, and

the generated OFDM signal is shifted by an offset amount that is a difference between a center-frequency of the first channel and one of the 1024 consecutives subcarriers.

4. The reception apparatus according to claim 3, wherein

an interval between the first and second channels is 2.16 GHz,

a sampling rate in the IFFT processing is 5.28 GHz, and

a center frequency of the bonding channel corresponds to a frequency separated by 209 subcarriers from a center frequency of the first channel.

5. A transmission method comprising:

generating a first single carrier signal and a second single carrier signal, each of the first and second single carrier signals including a legacy preamble signal, a legacy header signal and an extension header signal, the legacy preamble signal including a short training field (STF) and a channel estimation field (CEF);

setting a first center frequency of a first payload signal to a position that is 209 subcarriers lower from a center of 1024 consecutive subcarriers;

setting a second center frequency of a second payload signal to another position that is 210 subcarriers higher from the center of the 1024 consecutive subcarriers;

performing inverse fast Fourier transform (IFFT) processing on the first payload signal and the second payload signal and generating one orthogonal frequency-division multiplexing (OFDM) signal to be mapped on a bonding channel comprising a first channel and a second channel, wherein a fast Fourier transform (FFT) size is 1024;

shifting the generated OFDM signal by an offset amount that is a difference between a center-frequency of the first channel and one of the 1024 consecutives subcarriers;

generating a frame by:

mapping the first single carrier signal and the second single carrier signal respectively to the first channel and the second channel; and

mapping the shifted OFDM signal to the bonding channel; and

transmitting the generated frame over the bonding channel.

6. The transmission method according to claim 5, wherein

an interval between the first channel and the second channel is 2.16 GHz,

a sampling rate in the IFFT processing is 5.28 GHz, and

a shifted center frequency of the bonding channel corresponds to a frequency separated by 209 subcarriers from a center frequency of the first channel.

7. A reception method comprising:

receiving a signal mapped to a bonding channel; and

generating a first payload signal and a second payload signal by performing

fast Fourier transform (FFT) processing on the received signal; wherein:

the received signal is generated in a transmission apparatus and includes a first single carrier signal mapped to a first channel, a second single carrier signal mapped to a second channel and an orthogonal frequency-division multiplexing (OFDM) signal mapped to the bonding channel,

each of the first and second single carrier signals including a legacy preamble signal, a legacy header signal and an extension header signal, the legacy preamble signal including a short training field (STF) and a channel estimation field (CEF),

a first center frequency of the first payload signal is set to a position that is 209 subcarriers lower from a center of 1024 consecutive subcarriers, a second center frequency of the second payload signal is set to another position that is 210 subcarriers higher from the center of the 1024 consecutive subcarriers,

the one OFDM signal is generated by performing inverse fast Fourier transform (IFFT) processing on the first payload signal and the second payload signal and generating one OFDM signal to be mapped on the bonding channel comprising the first channel and the second channel,

an FFT size is 1024, and

the generated OFDM signal is shifted by an offset amount that is a difference between a center-frequency of the first channel and one of the 1024 consecutives subcarriers.

8. The reception method according to claim 7, wherein

an interval between the first channel and the second channel is 2.16 GHz,

a sampling rate in the IFFT processing is 5.28 GHz, and

a shifted center frequency of the bonding channel corresponds to a frequency separated by 209 subcarriers from a center frequency of the first channel.

9. The transmission apparatus according to claim 1, wherein a gap between a shifted center frequency of the bonding channel and the center frequency of the one of the first and second channels is an integer multiple of a subcarrier spacing.

10. The reception apparatus according to claim 3, wherein a gap between a shifted center frequency of the bonding channel and the center frequency of the one of the first and second channels is an integer multiple of a subcarrier spacing.

11. The transmission method according to claim 5, wherein a gap between a shifted center frequency of the bonding channel and the center frequency of the one of the first and second channels is an integer multiple of a subcarrier spacing.

12. The reception method according to claim 7, wherein a gap between a shifted center frequency of the bonding channel and the center frequency of the one of the first and second channels is an integer multiple of a subcarrier spacing.