(see, for example, NPL 6). At the time of frequency hopping, carrier frequency retuning time is required. It is thought that time corresponding to up to about two symbols is required as the retuning time (see, for example, NPL 7).

[0015] In a downlink, since a Rel-13 MTC terminal does not receive an existing LTE downlink control channel (PDCCH: Physical Downlink Control Channel), the first two OFDM symbols of a subframe which is an existing LTE PDCCH region can be used for the retuning time.

[0016] On the other hand, in an uplink, the Rel-13 MTC terminal can transmit a PUSCH or a PUCCH using all SC-FDMA symbols in a subframe, similarly to an existing LTE terminal. Therefore, in order to apply frequency hopping to the MTC terminal, it is necessary to, at the time of retuning, stop transmission of a part of the PUSCH or the PUCCH to secure retuning time corresponding to about two SC-FDMA symbols. It is necessary to suppress deterioration of transmission characteristics while securing the retuning time for an uplink signal (PUSCH or PUCCH).

[0017] According to a first aspect of the present disclosure, there is provided a communication terminal including: a controller, which, in operation, punctures two symbols and set the two symbols as a retuning time when a first narrowband to be used for a first subframe to transmit a first channel is different from a second narrowband to be used for a second subframe to transmit a second channel, the second subframe following the first subframe; and a transmitter, which, in operation, transmits the first channel and the second channel, wherein: when the first channel and the second channel are a PUSCH (Physical Uplink Shared Channel), the controller punctures a last symbol of the first subframe and a first symbol of the second subframe, and when the first channel is the PUSCH and the second channel is a PUCCH (Physical Uplink Control Channel), the controller punctures last two symbols of the first subframe.

[0017a] According to a second aspect of the present disclosure, there is provided a transmission method including: when a first narrowband to be used for a first subframe to transmit a first channel is different from a second narrowband to be used for a second subframe to transmit a second channel, the second subframe following the first subframe, puncturing two symbols and setting the two symbols as returning time; transmitting the first channel and the second channel; when the first channel and the second channel are a PUSCH (Physical Uplink Shared Channel), puncturing a last symbol of the first subframe and a first symbol of the second subframe; and when the first channel is the PUSCH and the second channel is a PUCCH (Physical Uplink Control Channel), puncturing last two symbols of the first subframe.

[0017b] According to a third aspect of the present disclosure, there is provided an integrated circuit that controls: a process of puncturing two symbols and setting the two symbols as a retuning time when a first narrowband to be used for a first subframe to transmit a first

channel is different from a second narrowband to be used for a second subframe to transmit a second channel, the second subframe following the first subframe; and a process of transmitting the first channel and the second channel, wherein: when the first channel and the second channel are a PUSCH (Physical Uplink Shared Channel), the integrated circuit punctures a last symbol of the first subframe and a first symbol of the second subframe, and when the first channel is the PUSCH and the second channel is a PUCCH (Physical Uplink Control Channel), the integrated circuit punctures last two symbols of the first subframe.

[0018] Comprehensive or specific aspects of the above may be realized by a system, a method, an integrated circuit, a computer program or a recording medium or may be realized by an arbitrary combination of a system, an apparatus, a method, an integrated circuit, a computer program and a recording medium.

[0019] According to embodiments of the present disclosure, it is possible to secure retuning time while suppressing deterioration of transmission characteristics of an uplink signal (PUSCH or PUCCH).

[0020] Further advantages and effects of the aspects of the present disclosure will be made clear from the specification and accompanying drawings. Such advantages and/or effects are provided by some embodiments and features shown in the specification and the accompanying drawings. It is not necessarily required that all of them are provided to obtain one or more same features.

Brief Description of Drawings

[0021]

FIG. 1 illustrates an example of a configuration of a PUSCH subframe;

FIG. 2 illustrates an example of a response signal generation process in a PUCCH;

FIG. 3 illustrates an example of a configuration of a PUCCH format 1a/1b subframe;

FIG. 4 illustrates an example of setting retuning time (Method 1);

FIG. 5 illustrates an example of setting retuning time (Method 2);

FIG. 6 illustrates an example of setting retuning time (Method 3);

FIG. 7 illustrates an example of setting retuning time (Method 4);

FIG. 8 is a block diagram showing a configuration of a main part of a terminal according to Embodiment 1;

FIG. 9 is a block diagram showing a configuration of a base station according to Embodiment 1;

FIG. 10 is a block diagram showing a configuration of the terminal according to Embodiment 1;

FIG. 11 illustrates an example of frequency hopping according to Embodiment 1;

FIG. 12 illustrates an example of frequency hopping according to Embodiment 2;

FIG. 13 illustrates an example of mapping of an ACK/NACK signal according to

CLAIMS

1. A communication terminal comprising:

a controller, which, in operation, punctures two symbols and set the two symbols as a retuning time when a first narrowband to be used for a first subframe to transmit a first channel is different from a second narrowband to be used for a second subframe to transmit a second channel, the second subframe following the first subframe; and

a transmitter, which, in operation, transmits the first channel and the second channel, wherein:

when the first channel and the second channel are a PUSCH (Physical Uplink Shared Channel), the controller punctures a last symbol of the first subframe and a first symbol of the second subframe, and

when the first channel is the PUSCH and the second channel is a PUCCH (Physical Uplink Control Channel), the controller punctures last two symbols of the first subframe.

2. The communication terminal according to claim 1, wherein when the first channel is the PUCCH and the second channel is the PUSCH, the controller punctures first two symbols of the second subframe.

3. The communication terminal according to claim 1, wherein when the first channel and the second channel are the PUCCH and an ACK/NACK signal is transmitted through the PUCCH, in the first subframe, a sequence with a sequence length of 4 is used in a first half slot and a sequence with a sequence length of 3 is used in a second half slot, and in the second subframe, a sequence with a sequence length of 3 is used in a first half slot, and a sequence with a sequence length of 4 is used in a second half slot.

4. The communication terminal according to claim 1, wherein when the first channel and the second channel are the PUCCH and a CSI (Channel State Information) is transmitted through the PUCCH, the controller punctures the last symbol of the first frame and the first symbol of the second subframe.

5. The communication terminal according to any one of claims 1 to 4, wherein the controller switches from the first narrowband to the second narrowband using frequency hopping.

6. The communication terminal according to any one of claims 1 to 5, wherein the first narrowband and the second narrowband are set for MTC (Machine Type Communication) terminals.

7. The communication terminal according to claim 1, wherein when the first channel and the second channel are the PUCCH and PUCCH Format 2 is used in the PUCCH, the controller punctures the last symbol of the first subframe and the first symbol of the second subframe.

8. A transmission method comprising:

when a first narrowband to be used for a first subframe to transmit a first channel is different from a second narrowband to be used for a second subframe to transmit a second channel, the second subframe following the first subframe, puncturing two symbols and setting the two symbols as returning time;

transmitting the first channel and the second channel;

when the first channel and the second channel are a PUSCH (Physical Uplink Shared Channel), puncturing a last symbol of the first subframe and a first symbol of the second subframe; and

when the first channel is the PUSCH and the second channel is a PUCCH (Physical Uplink Control Channel), puncturing last two symbols of the first subframe.

9. The transmission method according to claim 8, wherein when the first channel is the PUCCH and the second channel is the PUSCH, first two symbols of the second subframe are punctured.

10. The transmission method according to claim 8, wherein when the first channel and the second channel are the PUCCH and an ACK/NACK signal is transmitted through the PUCCH, in the first subframe, a sequence with a sequence length of 4 is used in a first half slot and a sequence with a sequence length of 3 is used in a second half slot, and in the second subframe, a sequence with a sequence length of 3 is used in a first half slot, and a sequence with a sequence length of 4 is used in a second half slot.

11. The transmission method according to claim 8, wherein when the first channel and the second channel are the PUCCH and a CSI (Channel State Information) is transmitted through the PUCCH, the last symbol of the first frame and the first symbol of the second subframe are punctured.

12. The transmission method according to any one of claims 8 to 11, wherein switching from the first narrowband to the second narrowband is performed using frequency hopping.

13. The transmission method according to any one of claims 8 to 12, wherein the first narrowband and the second narrowband are set for MTC (Machine Type Communication) terminals.

14. The transmission method according to claim 8, wherein when the first channel and the second channel are the PUCCH and PUCCH Format 2 is used in the PUCCH, the last symbol of the first subframe and the first symbol of the second subframe are punctured.

15. An integrated circuit that controls:

a process of puncturing two symbols and setting the two symbols as a retuning time when a first narrowband to be used for a first subframe to transmit a first channel is different from a second narrowband to be used for a second subframe to transmit a second channel, the second subframe following the first subframe; and

a process of transmitting the first channel and the second channel, wherein:

when the first channel and the second channel are a PUSCH (Physical Uplink Shared Channel), the integrated circuit punctures a last symbol of the first subframe and a first symbol of the second subframe, and

when the first channel is the PUSCH and the second channel is a PUCCH (Physical Uplink Control Channel), the integrated circuit punctures last two symbols of the first subframe.

16. The integrated circuit according to claim 15, wherein when the first channel is the PUCCH and the second channel is the PUSCH, the integrated circuit punctures first two symbols of the second subframe.

17. The integrated circuit according to claim 15, wherein when the first channel and the second channel are the PUCCH and an ACK/NACK signal is transmitted through the PUCCH, in the first subframe, a sequence with a sequence length of 4 is used in a first half slot and a sequence with a sequence length of 3 is used in a second half slot, and in the second subframe, a sequence with a sequence length of 3 is used in a first half slot, and a sequence with a sequence length of 4 is used in a second half slot.

18. The integrated circuit according to claim 15, wherein when the first channel and the second channel are the PUCCH and a CSI (Channel State Information) is transmitted through the PUCCH, the integrated circuit punctures the last symbol of the first frame and the first symbol of the second subframe.

19. The integrated circuit according to any one of claims 15 to 18, wherein the integrated circuit switches from the first narrowband to the second narrowband using frequency hopping.

20. The integrated circuit according to any one of claims 15 to 19, wherein the first narrowband and the second narrowband are set for MTC (Machine Type Communication) terminals.

21. The integrated circuit according to claim 15, wherein when the first channel and the second channel are the PUCCH and PUCCH Format 2 is used in the PUCCH, the integrated circuit punctures the last symbol of the first subframe and the first symbol of the second subframe.