However, when the radio backhaul link and the access link are operated in the time division scheme in a small-cell base station, the latency for relaying traffic will be increased, which leads to reduction in the use efficiency of radio resources. In addition, the memory size necessary for a small-cell base station to buffer the traffic will be increased. To solve this, an idea of full-duplex radio communications is introduced to the small-cell base station to allow the radio backhaul link and the access link to be operated simultaneously on the same channel as disclosed in Non-Patent Literature 3, thereby utilizing efficiently radio resources. In the small-cell base station, the self-interference due to sneak of transmission signals can be removed by applying the self-interference cancellation (SIC) technique as disclosed in Non-Patent Literature 3. However, when the ratio of power of an interference signal to power of a desired signal is not small, the self-interference is not sufficiently removed by the SIC technique, and thus the full-duplex radio communication does not function well.

[0008]

Embodiments of the present invention disclose a mechanism to address at least one of the above-mentioned problems and to utilize radio resources more efficiently in the environment where a small cell is operated.

Solution to Problem

[0009]

According to a first aspect of the present invention, there is provided a communication control apparatus including: a communication unit configured to communicate with a radio communication apparatus being connected to a base station via a radio backhaul link and being connected to one or more terminals via an access link; and a control unit configured to, when a reception on the radio backhaul link and a transmission on the access link, or a reception on the access link and a transmission on the radio backhaul link are executed on an identical channel simultaneously in the radio communication apparatus, adjust a power ratio between a reception signal and a transmission signal in order to support the radio communication apparatus in removing self-interference due to a sneak of the transmission signal from the reception signal, wherein the control unit is further configured to decide whether the transmission signal is to be executed in a full duplex mode based on at least one selected from the group consisting of remaining battery level, configuration of an antenna and self-interference cancellation functionality of the radio communication apparatus.

[0010]

According to a second aspect of the present invention, there is provided a communication control method including: adjusting a power ratio between a reception signal and a transmission signal in a processor of a communication control apparatus communicating with a radio communication apparatus in order to support the radio communication apparatus in removing self-interference due to a sneak of the transmission signal from the reception signal when a reception on a radio backhaul link and a transmission on an access link, or a reception on the access link and a transmission on the radio backhaul link are executed on an identical channel simultaneously in the radio communication apparatus being connected to a base station via the radio backhaul link and being connected to one or more terminals via the access link, wherein the step of adjusting the power ratio further comprises a step of deciding whether the transmission signal is to be executed in a full duplex mode based on at least one selected from the group consisting of remaining battery level, configuration of an antenna and self-interference cancellation functionality of the radio communication apparatus.

[0011]

According to a third aspect of the preset invention, there is provided a communication control apparatus including: a radio communication unit configured to communicate with a base station via a radio backhaul link and to communicate with one or more terminals via an access link; a self-interference processing unit configured to, when a reception on the radio backhaul link and a transmission on the access link, or a reception on the access link and a transmission on the radio backhaul link are executed on an identical channel simultaneously in the radio communication unit, remove self-interference due to a sneak of a transmission signal from a reception signal; and a control unit configured to allow the radio communication unit to use a power ratio between the reception signal and the transmission signal, the power ratio being adjusted in order to support removal of the self-interference, wherein the control unit is further configured to decide whether the transmission signal is to be executed in a full duplex mode based on at least one selected from the group consisting of remaining battery level, configuration of an antenna and self-interference cancellation functionality of the radio communication apparatus.

[0012]

According to a fourth aspect of the present invention, there is provided a communication control method including: executing a reception on a radio backhaul link and a transmission on an access link, or a reception on the access link and a transmission on the radio backhaul link on an identical channel simultaneously in a radio communication

apparatus being configured to communicate with a base station via the radio backhaul link and to communicate with one or more terminals via the access link; and removing self-interference due to a sneak of a transmission signal from a reception signal, wherein a power ratio between the reception signal and the transmission signal is adjusted in such a way that the self-interference is removable from the reception signal, wherein the step of adjusting the power ratio further comprises a step of deciding whether the transmission signal is to be executed in a full duplex mode based on at least one selected from the group consisting of remaining battery level, configuration of an antenna and self-interference cancellation functionality of the radio communication apparatus.

Advantageous Effects of Invention

[0013]

According to embodiments of the present invention, it is possible to utilize radio resources more efficiently in the environment where a small cell is operated.

Note that the effects described above are not necessarily limited, and along with or instead of the effects, any effect that is desired to be introduced in the present specification or other effects that can be expected from the present specification may be exhibited.

Brief Description of Drawings

[0014]

[FIG.1] FIG. 1 is an explanatory diagram illustrated to describe an overview of a communication control system according to one embodiment.

[FIG. 2A] FIG. 2A is an explanatory diagram illustrated to describe the self-interference in the FD mode of a downlink.

[FIG. 2B] FIG. 2B is an explanatory diagram illustrated to describe the self-interference in the FD mode of an uplink.

[FIG. 3] FIG. 3 is a block diagram illustrating an example of the logical configuration of a communication control apparatus according to one embodiment.

[FIG. 4] FIG. 4 is an explanatory diagram illustrated to describe a first example of the distribution of radio resources to a backhaul link and an access link.

[FIG. 5] FIG. 5 is an explanatory diagram illustrated to describe a second example of the distribution of radio resources to the backhaul link and the access link.

[FIG. 6] FIG. 6 is an explanatory diagram illustrated to describe an example of the

CLAIMS

1. A communication control apparatus comprising:

a communication unit configured to communicate with a radio communication apparatus being connected to a base station via a radio backhaul link and being connected to one or more terminals via an access link; and

a control unit configured to, when a reception on the radio backhaul link and a transmission on the access link, or a reception on the access link and a transmission on the radio backhaul link are executed on an identical channel simultaneously in the radio communication apparatus, adjust a power ratio between a reception signal and a transmission signal in order to support the radio communication apparatus in removing self-interference due to a sneak of the transmission signal from the reception signal,

wherein the control unit is further configured to decide whether the transmission signal is to be executed in a full duplex mode based on at least one selected from the group consisting of remaining battery level, configuration of an antenna and self-interference cancellation functionality of the radio communication apparatus.

2. The communication control apparatus according to claim 1,

wherein the control unit adjusts the power ratio in such a way that a ratio of power of the transmission signal to power of the reception signal does not exceed a threshold.

3. The communication control apparatus according to claim 2,

wherein the control unit adjusts the power ratio between the power of the reception signal from the one or more terminals via the access link and the power of the transmission signal to the base station via the radio backhaul link.

4. The communication control apparatus according to claim 3,

wherein the control unit, when the power ratio exceeds the threshold, reduces the power of the transmission signal by lowering a modulation order applied to the transmission signal.

5. The communication control apparatus according to claim 4,

wherein the control unit compensates for a reduction in throughput caused by lowering

the modulation order by increasing a resource allocated to the transmission signal.

6. The communication control apparatus according to claim 3,

wherein the control unit, when the power ratio exceeds the threshold, increases the power of the reception signal by raising transmission power of the one or more terminals.

7. The communication control apparatus according to claim 6,

wherein the control unit raises the transmission power of the one or more terminals within a range that does not cause harmful interference to a neighboring system.

8. The communication control apparatus according to claim 6,

wherein the control unit, when a resource allocated to the transmission signal is difficult to be increased, raises the transmission power of the one or more terminals.

9. The communication control apparatus according to claim 1,

wherein the control unit, when capacity of the radio communication apparatus is determined to be necessary to be increased based on at least one of an amount of traffic to be processed by the radio communication apparatus and the number of the terminals, allows the radio communication apparatus to execute the reception and the transmission on an identical channel simultaneously.

10. The communication control apparatus according to claim 1,

wherein the control unit, when the radio communication apparatus is determined to have corresponding capability, allows the radio communication apparatus to execute the reception and the transmission on an identical channel simultaneously.

11. The communication control apparatus according to claim 1,

wherein the control unit, when the radio communication apparatus does not execute the reception and the transmission simultaneously, allows the radio communication apparatus to operate the radio backhaul link and the access link in a time division scheme.

12. The communication control apparatus according to claim 1,

wherein the control unit, when the radio communication apparatus does not execute

the reception and the transmission simultaneously, allows the radio communication apparatus to operate the radio backhaul link and the access link in a frequency division scheme.

13. The communication control apparatus according to claim 12,

wherein the radio communication apparatus is a master device being connected to the base station to provide a radio communication service for the one or more terminals, and

wherein a combination of a frequency resource allocated to the radio backhaul link and a frequency resource allocated to the access link is different for each master terminal being connected to an identical base station.

14. The communication control apparatus according to claim 13,

wherein the radio backhaul link is implemented using a beam forming technique.

15. A communication control method comprising:

adjusting a power ratio between a reception signal and a transmission signal in a processor of a communication control apparatus communicating with a radio communication apparatus in order to support the radio communication apparatus in removing self-interference due to a sneak of the transmission signal from the reception signal when a reception on a radio backhaul link and a transmission on an access link, or a reception on the access link and a transmission on the radio backhaul link are executed on an identical channel simultaneously in the radio communication apparatus being connected to a base station via the radio backhaul link and being connected to one or more terminals via the access link,

wherein the step of adjusting the power ratio further comprises a step of deciding whether the transmission signal is to be executed in a full duplex mode based on at least one selected from the group consisting of remaining battery level, configuration of an antenna and self-interference cancellation functionality of the radio communication apparatus.

16. A communication control apparatus comprising:

a radio communication unit configured to communicate with a base station via a radio backhaul link and to communicate with one or more terminals via an access link;

a self-interference processing unit configured to, when a reception on the radio backhaul link and a transmission on the access link, or a reception on the access link and a transmission on the radio backhaul link are executed on an identical channel simultaneously

in the radio communication unit, remove self-interference due to a sneak of a transmission signal from a reception signal; and

a control unit configured to allow the radio communication unit to use a power ratio between the reception signal and the transmission signal, the power ratio being adjusted in order to support removal of the self-interference,

wherein the control unit is further configured to decide whether the transmission signal is to be executed in a full duplex mode based on at least one selected from the group consisting of remaining battery level, configuration of an antenna and self-interference cancellation functionality of the radio communication apparatus.

17. The communication control apparatus according to claim 16,

wherein the power ratio is adjusted in such a way that a ratio of power of the transmission signal to power of the reception signal does not exceed a threshold,

18. The communication control apparatus according to claim 16,

wherein the radio communication unit includes one or more antennas intended for the radio backhaul link and includes one or more antennas intended for the access link.

19. The communication control apparatus according to claim 18,

wherein the radio communication unit includes at least a transmitting antenna and a receiving antenna intended for the radio backhaul link and includes at least a transmitting antenna and a receiving antenna intended for the access link.

20. A communication control method comprising:

executing a reception on a radio backhaul link and a transmission on an access link, or a reception on the access link and a transmission on the radio backhaul link on an identical channel simultaneously in a radio communication apparatus being configured to communicate with a base station via the radio backhaul link and to communicate with one or more terminals via the access link; and

removing self-interference due to a sneak of a transmission signal from a reception signal,

wherein a power ratio between the reception signal and the transmission signal is adjusted in such a way that the self-interference is removable from the reception signal,

wherein the step of adjusting the power ratio further comprises a step of deciding whether the transmission signal is to be executed in a full duplex mode based on at least one selected from the group consisting of remaining battery level, configuration of an antenna and self-interference cancellation functionality of the radio communication apparatus.