Summary of Invention

Technical Problem

[0005]

However, the new introduction of an arrangement for sensing the communication state requires correspondingly high cost. If the adverse interference can be prevented by using an existing arrangement at low cost instead of the above sensing, the secondary use of a frequency channel can be promoted, resulting in an increase in network efficiency.

[0006]

Embodiments of the present invention prevent the adverse interference by using an existing arrangement when a frequency channel is secondarily used.

Solution to Problem

[0007]

According to a first aspect of the present invention, there is provided a communication control device including: an obtaining unit configured to, in a radio communication system including a primary base station to which a primary terminal is connected, and a secondary base station to which a secondary terminal is connected by secondarily using a frequency channel for the primary base station, obtain at least one of a quality report containing a communication quality indicator measured by the primary terminal and a quality report containing a communication quality indicator measured by the secondary terminal; and an interference control unit configured to instruct the secondary base station to reduce transmission power, when it is determined that adverse interference is present in the radio communication system, based on the communication quality indicator contained in the quality report obtained by the obtaining unit, wherein the primary terminal and the primary base station operate according to a frequency division duplex scheme, wherein the secondary terminal and the secondary base station secondarily use an uplink channel of the primary base station, wherein, when interference power in the secondary base station caused by transmission power of the primary terminal does not satisfy allowable interference power on an assumption that the primary terminal is located at a cell edge of the secondary base station, the interference control unit determines that the adverse interference is present, and wherein, when interference power in the primary base station caused by transmission power of the secondary terminal does not satisfy allowable interference power on an assumption that the secondary terminal is located at a cell edge of the secondary base station, the interference control unit determines that the adverse interference is present.

[0008]

According to a second aspect of the present invention, there is provided a communication control method executed by a communication control device in a radio communication system including a primary base station to which a primary terminal is connected, and a secondary base station to which a secondary terminal is connected by secondarily using a frequency channel for the primary base station, the communication control method including: obtaining at least one of a quality report containing a

communication quality indicator measured by the primary terminal and a quality report containing a communication quality indicator measured by the secondary terminal; determining whether or not adverse interference is present in the radio communication system, based on the communication quality indicator contained in the obtained quality report;wherein the primary terminal and the primary base station operate according to a frequency division duplex scheme, wherein the secondary terminal and the secondary base station secondarily use an uplink channel of the primary base station, wherein, when interference power in the secondary base station caused by transmission power of the primary terminal does not satisfy allowable interference power on an assumption that the primary terminal is located at a cell edge of the secondary base station, the determing step determines that the adverse interference is present, and wherein, when interference power in the primary base station caused by transmission power of the secondary terminal does not satisfy allowable interference power on an assumption that the secondary terminal is located at a cell edge of the secondary base station, the determing step determines that the adverse interference is present.

[0009]

According to a third aspect of the present invention, there is provided a radio communication system including: a primary base station to which a primary terminal is connected; a secondary base station to which a secondary terminal is connected by secondarily using a frequency channel for the primary base station; and a cooperation manager configured to instruct the secondary base station to reduce transmission power, if it is determined that adverse interference is present in the system, based on a communication quality indicator contained in at least one of a quality report containing the communication quality indicator measured by the primary terminal and a quality report containing the communication quality indicator measured by the secondary terminal, wherein the primary terminal and the primary base station operate according to a frequency division duplex scheme, wherein the secondary terminal and the secondary base station secondarily use an uplink channel of the primary base station, wherein, when interference power in the secondary base station caused by transmission power of the primary terminal does not satisfy allowable interference power on an assumption that the primary terminal is located at a cell edge of the secondary base station, the cooperation manager determines that the adverse interference is present, and wherein, when interference power in the primary base station caused by transmission power of the secondary terminal does not satisfy allowable interference power on an assumption that the secondary terminal is located at a cell edge of the secondary base station, cooperation manager determines that the adverse interference is present.

[0010]

According to a fourth aspect of the present invention, there is provided a terminal device operable in a radio communication system including a primary base station to which a primary terminal is connected, and a secondary base station to which a secondary terminal is connected by secondarily using a frequency channel for the primary base station, the terminal

device including: a control unit configured to generate a quality report containing a communication quality indicator used by a control node configured to determine whether or not adverse interference is present in the radio communication system, the communication quality indicator being used for the determination; and a radio communication unit configured to transmit the quality report generated by the control unit to a base station to which the terminal device is connected,wherein the primary terminal and the primary base station operate according to a frequency division duplex scheme, wherein the secondary terminal and the secondary base station secondarily use an uplink channel of the primary base station, wherein, when interference power in the secondary base station caused by transmission power of the primary terminal does not satisfy allowable interference power on an assumption that the primary terminal is located at a cell edge of the secondary base station, the control unit determines that the adverse interference is present, and wherein, when interference power in the primary base station caused by transmission power of the secondary terminal does not satisfy allowable interference power on an assumption that the secondary terminal is located at a cell edge of the secondary base station, the control unit determines that the adverse interference is present.

Advantageous Effects of Invention

[0011]

Embodiments of the present invention provide an arrangement that can prevent the adverse interference when a frequency channel is secondarily used, at low cost.

Brief Description of Drawings

[0012]

[FIG. 1] FIG. 1 is an explanatory diagram for explaining an overview of a radio communication system according to an embodiment.

[FIG. 2A] FIG. 2A is an explanatory diagram for explaining first example secondary use of a frequency channel.

[FIG. 2B] FIG. 2B is an explanatory diagram for explaining second example secondary use of a frequency channel.

[FIG. 2C] FIG. 2C is an explanatory diagram for explaining third example secondary use of a frequency channel.

[FIG. 2D] FIG. 2D is an explanatory diagram for explaining fourth example secondary use of a frequency channel.

[FIG. 3A] FIG. 3A is a first explanatory diagram for explaining a duty ratio in the TDD scheme.

[FIG. 3B] FIG. 3B is a second explanatory diagram for explaining a duty ratio in the TDD scheme.

CLAIMS

1. A communication control device comprising:

an obtaining unit configured to, in a radio communication system including a primary base station to which a primary terminal is connected, and a secondary base station to which a secondary terminal is connected by secondarily using a frequency channel for the primary base station, obtain at least one of a quality report containing a communication quality indicator measured by the primary terminal and a quality report containing a communication quality indicator measured by the secondary terminal; and

an interference control unit configured to instruct the secondary base station to reduce transmission power, when it is determined that adverse interference is present in the radio communication system, based on the communication quality indicator contained in the quality report obtained by the obtaining unit,

wherein the primary terminal and the primary base station operate according to a frequency division duplex scheme,

wherein the secondary terminal and the secondary base station secondarily use an uplink channel of the primary base station,

wherein, when interference power in the secondary base station caused by transmission power of the primary terminal does not satisfy allowable interference power on an assumption that the primary terminal is located at a cell edge of the secondary base station, the interference control unit determines that the adverse interference is present, and

wherein, when interference power in the primary base station caused by transmission power of the secondary terminal does not satisfy allowable interference power on an assumption that the secondary terminal is located at a cell edge of the secondary base station, the interference control unit determines that the adverse interference is present.

2. The communication control device according to claim 1,

wherein the quality report is a measurement report or a channel quality indicator (CQI) report.

3. The communication control device according to claim 1,

wherein the quality report contains a received power indicator for a reference signal,

wherein the interference control unit estimates a distance between a first terminal and

a first base station to which the first terminal is connected, from the received power indicator, and determines that the adverse interference is present, if the communication quality indicator does not satisfy allowable quality depending on the estimated distance.

4. The communication control device according to claim 3,
wherein the first terminal is the primary terminal, and
wherein the first base station is the primary base station.

5. The communication control device according to claim 4,
wherein the interference control unit assumes that an interference component of the communication quality indicator contained in the quality report of the primary terminal is caused by the transmission power of the secondary base station, and calculates a control target value of the transmission power of the secondary base station.

6. The communication control device according to claim 5,
wherein the secondary terminal and the secondary base station operate according to a time division duplex scheme, and
wherein the interference control unit changes the control target value, depending on a ratio of uplink slots and downlink slots of the secondary base station.

7. The communication control device according to claim 5,
wherein, when the adverse interference is caused by an uplink signal transmitted to the secondary base station, the interference control unit hands over one or more secondary terminals from the secondary base station to the primary base station to reduce the adverse interference.

8. The communication control device according to claim 3,
wherein the first terminal is the secondary terminal, and
wherein the first base station is the secondary base station.

9. The communication control device according to claim 1,
wherein the obtaining unit further obtains location information of the primary base station and the secondary base station, and

wherein, when interference power calculated using transmission power of a reference signal of the secondary base station and a path loss estimated from the location information does not satisfy allowable interference power of the primary base station, the interference control unit determines that the adverse interference is present.

10. The communication control device according to claim 1,

wherein maximum transmission power of the secondary terminal is set to be greater as transmission power of a reference signal of the secondary base station increases.

11. A communication control method executed by a communication control device in a radio communication system including a primary base station to which a primary terminal is connected, and a secondary base station to which a secondary terminal is connected by secondarily using a frequency channel for the primary base station, the communication control method comprising:

obtaining at least one of a quality report containing a communication quality indicator measured by the primary terminal and a quality report containing a communication quality indicator measured by the secondary terminal;

determining whether or not adverse interference is present in the radio communication system, based on the communication quality indicator contained in the obtained quality report,

wherein the primary terminal and the primary base station operate according to a frequency division duplex scheme,

wherein the secondary terminal and the secondary base station secondarily use an uplink channel of the primary base station,

wherein, when interference power in the secondary base station caused by transmission power of the primary terminal does not satisfy allowable interference power on an assumption that the primary terminal is located at a cell edge of the secondary base station, the determing step determines that the adverse interference is present, and

wherein, when interference power in the primary base station caused by transmission power of the secondary terminal does not satisfy allowable interference power on an assumption that the secondary terminal is located at a cell edge of the secondary base station, the determing step determines that the adverse interference is present.

12. A radio communication system comprising:

a primary base station to which a primary terminal is connected;

a secondary base station to which a secondary terminal is connected by secondarily using a frequency channel for the primary base station; and

a cooperation manager configured to instruct the secondary base station to reduce transmission power, if it is determined that adverse interference is present in the system, based on a communication quality indicator contained in at least one of a quality report containing the communication quality indicator measured by the primary terminal and a quality report containing the communication quality indicator measured by the secondary terminal,

wherein the primary terminal and the primary base station operate according to a frequency division duplex scheme,

wherein the secondary terminal and the secondary base station secondarily use an uplink channel of the primary base station,

wherein, when interference power in the secondary base station caused by transmission power of the primary terminal does not satisfy allowable interference power on an assumption that the primary terminal is located at a cell edge of the secondary base station, the cooperation manager determines that the adverse interference is present, and

wherein, when interference power in the primary base station caused by transmission power of the secondary terminal does not satisfy allowable interference power on an assumption that the secondary terminal is located at a cell edge of the secondary base station, cooperation manager determines that the adverse interference is present.

13. A terminal device operable in a radio communication system including a primary base station to which a primary terminal is connected, and a secondary base station to which a secondary terminal is connected by secondarily using a frequency channel for the primary base station, the terminal device comprising:

a control unit configured to generate a quality report containing a communication quality indicator used by a control node configured to determine whether or not adverse interference is present in the radio communication system, the communication quality indicator being used for the determination; and

a radio communication unit configured to transmit the quality report generated by the control unit to a base station to which the terminal device is connected,

wherein the primary terminal and the primary base station operate according to a

frequency division duplex scheme,

wherein the secondary terminal and the secondary base station secondarily use an uplink channel of the primary base station,

wherein, when interference power in the secondary base station caused by transmission power of the primary terminal does not satisfy allowable interference power on an assumption that the primary terminal is located at a cell edge of the secondary base station, the control unit determines that the adverse interference is present, and

wherein, when interference power in the primary base station caused by transmission power of the secondary terminal does not satisfy allowable interference power on an assumption that the secondary terminal is located at a cell edge of the secondary base station, the control unit determines that the adverse interference is present.