In the Inter-eNB CA, for example, a cell of the macro base station (Macro eNB (MeNB)) and a cell of a low-power base station (Low-Power Node (LPN)) are used simultaneously as a PCell and a SCell, respectively. In this case, bearers are separately configured in the PCell and the SCell. The UE communicates with the MeNB through a bearer in the PCell and communicates with the LPN through the bearer in the SCell.

[0012]

The inventors of this application has conducted various studies on the continuity of communication services when a radio terminal (UE) that is executing Inter-eNB CA moves between cells and has found several problems. For example, a case in which a UE that is executing Inter-eNB CA using a cell of a MeNB as a PCell and using a cell of a first LPN as a SCell changes the SCell to a cell of another second LPN will be considered. When a SCell change procedure (Fig. 17) in normal CA (i.e., Intra-eNB CA) is applied to this change of the SCell, the UE has to release all information regarding the cell of the first LPN and to newly configure information regarding the cell of the second LPN. Thus, a problem occurs in that communication services in the cell of the first LPN cannot be continued in the cell of the second LPN after the SCell is changed.

[0013]

Accordingly, embodiments of the present invention provide a radio communication system, a radio station, a radio terminal, a communication control method, and a program which contribute to enabling a communication service in a secondary cell to be continued after the secondary cell is changed when a radio terminal which is simultaneously using a plurality of cells served by different radio stations changes the secondary cell from a cell of one radio station to a cell of another radio station.

Solution to Problem

[0013a]

According to a first aspect of the present invention, there is provided a first radio station configured to operate a first cell, the first radio station comprising: means for communicating with a radio terminal performing Dual Connectivity which is configured with the first cell as a Primary Cell (PCell) and either a second cell operated by a second radio station or a third cell operated by a third radio station as a Secondary Cell (SCell); means for sending to the second radio station, within a procedure for changing a radio station operating the SCell of the radio terminal from the second radio station to the third radio station, a request to abort providing user data to the radio terminal in the second cell; and means for instructing, by transmitting an Radio Resource Control (RRC) connection reconfiguration message, the radio terminal to change the secondary cell after sending the request to the second radio station.

[0013b]

According to a second aspect of the present invention, there is provided a second radio station configured to operate a second cell, the second radio station comprising: means for communicating with a radio terminal performing Dual Connectivity which is configured with a first cell operated by a first radio station as a Primary Cell (PCell) and either the second cell or a third cell operated by a third radio station as a Secondary Cell (SCell); means for receiving from the first radio station, within a procedure for changing a radio station operating the SCell of the radio terminal from the second radio station to the third radio station, a request to abort providing user data to the radio terminal in the second cell; and means for aborting providing the user data upon reception of the request, wherein the means for receiving is configured to receive the request before the first radio station instructs, by transmitting an RRC connection reconfiguration message, the radio terminal to change the secondary cell.

[0013c]

According to a third aspect of the present invention, there is provided a communication control method in a first radio station configured to operate a first cell, the method comprising: communicating with a radio terminal performing Dual Connectivity which is configured with the first cell as a Primary Cell (PCell) and either a second cell operated by a second radio station or a third cell operated by a third radio station as a Secondary Cell (SCell); sending to the second radio station, within a procedure for changing a radio station operating the SCell of the radio terminal from the second radio station to the third radio station, a request to abort providing user data to the radio terminal in the second cell; and instructing, by transmitting an Radio Resource Control (RRC) connection reconfiguration message, the radio terminal to change the secondary cell after sending the request to the second radio station.

[0013d]

According to a fourth aspect of the present invention, there is provided a communication control method in a second radio station configured to operate a second cell, the method comprising: communicating with a radio terminal performing Dual Connectivity which is configured with a first cell operated by a first radio station as a Primary Cell (PCell) and either the second cell or a third cell operated by a third radio station as a Secondary Cell (SCell); and within a procedure for changing a radio station operating the SCell of the radio terminal from the second radio station to the third radio station, receiving, from the first radio station, a request to abort providing user data to the radio terminal in the second cell, and aborting providing the user data upon reception of the request, wherein the receiving comprises receiving the request before the first radio station instructs, by transmitting an RRC connection reconfiguration message, the radio terminal to change the secondary cell.

[0014]

Disclosed herein is a radio communication system including a radio terminal and a radio network including first to third radio stations. The first to third radio stations serve first to third cells, respectively. The radio terminal has a capability of, while using a cell of one radio station as a primary cell, using a cell of another radio station as a secondary cell. Furthermore, the radio network and the radio terminal are configured to, when the radio terminal is using the first cell as the primary cell and the second cell as the secondary cell, change the secondary cell from the second cell to the third cell while keeping communication status information regarding the radio terminal on the second cell.

[0015]

Disclosed herein is a first radio station including a radio communication unit that serves a first cell, and a communication control unit. The communication control unit is configured to, when changing a secondary cell to a third cell served by a third radio station while a radio terminal is using the first cell as a primary cell and using a second cell served by a second radio station as the secondary cell, perform at least one of: (a) sending a request to abort data communication with the radio terminal in the second cell; and (b) receiving or sending communication status information regarding the radio terminal on the second cell.

[0016]

Disclosed herein is a second radio station including a radio communication unit that serves a second cell, and a communication control unit. The communication control unit is configured to, when changing a secondary cell to a third cell served by a third radio station while a radio terminal is using a first cell served by a first radio station as a primary cell and using the second cell as the secondary cell, receive at least one of: (a) a request to abort data communication with the radio terminal in the second cell; and (b) a request to send communication status information regarding the radio terminal on the second cell, and perform at least one of aborting the data communication and sending the communication status information.

[0017]

Disclosed herein is a third radio station including a radio communication unit that serves a third cell, and a communication control unit. The communication control unit is configured to, when changing a secondary cell to the third cell while a radio terminal is using a first cell served by a first radio station as a primary cell and a second cell served by a second radio station as the secondary cell, receive, from the first radio station or the second radio station, communication status information regarding the radio terminal on the second cell.

[0018]

Disclosed herein is a radio terminal including radio communication unit configured to communicate with first to third

radio stations, and a communication control unit. The communication control unit is configured to perform control of, while using a first cell of the first radio station as a primary cell, using a second cell served by the second radio station as a secondary cell. The communication control unit is further configured to, when the first cell is being used as the primary cell and the second cell is being used as the secondary cell, change the secondary cell from the second cell to a third cell served by the third radio station while keeping communication status information on the second cell.

[0019]

Disclosed herein is a communication control method, in a first radio station that serves a first cell, including when changing a secondary cell to a third cell served by a third radio station while a radio terminal is using the first cell as a primary cell and using a second cell served by a second radio station as the secondary cell, performing at least one of: (a) sending a request to abort data communication with the radio terminal in the second cell; and (b) receiving or sending communication status information regarding the radio terminal on the second cell.

[0020]

Disclosed herein is a communication control method, in a second radio station that serves a second cell, including when changing a secondary cell to a third cell served by a third radio station while a radio terminal is using a first cell served by a first radio station as a primary cell and using the second cell as the secondary cell, receiving at least one of (a) a request to abort data communication with the radio terminal in the second cell and (b) a request to send communication status information regarding the radio terminal on the second cell; and performing at least one of aborting the data communication and sending the communication status information.

[0021]

Disclosed herein is a communication control method, in a third radio station that serves a third cell, including when changing a secondary cell to the third cell while a radio terminal is using a first cell served by a first radio station as a primary cell and a second cell served by a second radio station as the secondary cell, receiving, from the first radio station or the second radio station, communication status information regarding the radio terminal on the second cell.

[0022]

Disclosed herein is a communication control method, in a radio terminal, including (a) while using a first cell of a first radio station as a primary cell, using a second cell served by a second radio station as a secondary cell; and (b) when the first cell is being used as the primary cell and the second cell is being used as the secondary cell, changing the secondary cell from the second cell to a third cell served by a third radio station while

keeping communication status information on the second cell.

[0023]

Disclosed herein is a program including instructions for causing a computer to perform the communication control method according to the sixth aspect described above.

[0024]

Disclosed herein is a program including instructions for causing a computer to perform the communication control method according to the seventh aspect described above.

[0025]

Disclosed herein is a program including instructions for causing a computer to perform the communication control method according to the eighth aspect described above.

[0026]

Disclosed herein is a program including instructions for causing a computer to perform the communication control method according to the ninth aspect described above.

Advantageous Effects of Invention

[0027]

According to embodiments of the present invention, it is possible to provide a radio communication system, a radio station, a radio terminal, a communication control method, and a program capable of enabling a communication service in a secondary cell to be continued after the secondary cell is changed when a radio terminal which is simultaneously using a plurality of cells served by different radio stations changes the secondary cell from a cell of one radio station to a cell of another radio station.

Brief Description of Drawings

[0028]

Fig. 1 is a diagram illustrating a configuration example of a radio communication system according to a first embodiment.

Fig. 2 is a diagram illustrating a configuration example of a first radio station according to the first embodiment.

Fig. 3 is a diagram illustrating a configuration example of a second radio station according to the first embodiment.

Fig. 4 is a diagram illustrating a configuration example of a third radio station according to the first embodiment.

Fig. 5 is a diagram illustrating a configuration example of a radio terminal according to the first embodiment.

Fig. 6 is a flowchart illustrating an operation example of a radio terminal according to the first embodiment (Procedure Example 1).

Fig. 7 is a flowchart illustrating an operation example of a radio network according to the first embodiment (Procedure Example 1).

Fig. 8 is a sequence diagram illustrating an example of a communication control method in the radio communication system

CLAIMS

1. A first radio station configured to operate a first cell, the first radio station comprising:

means for communicating with a radio terminal performing Dual Connectivity which is configured with the first cell as a primary cell and either a second cell operated by a second radio station or a third cell operated by a third radio station as a secondary cell;

means for sending to the second radio station, within a procedure for changing a radio station operating the secondary cell of the radio terminal from the second radio station to the third radio station, a request to abort providing user data to the radio terminal in the second cell; and

means for instructing, by transmitting an Radio Resource Control (RRC) connection reconfiguration message, the radio terminal to change the secondary cell after sending the request to the second radio station.

2. The first radio station according to Claim 1, further comprising means for receiving, within the procedure for changing the radio station operating the secondary cell from the second radio station to the third radio station, a Sequence Number (SN) Status Transfer message associated with the radio terminal on the second cell,

wherein the Sequence Number (SN) Status Transfer message is used by the third radio station to provide, in the third cell, the user data which has been provided to the radio terminal in the second cell as the secondary cell.

3. The first radio station according to Claim 2, further comprising means for requesting the second radio station to report the Sequence Number (SN) Status Transfer message.

4. The first radio station according to Claim 1, further comprising means for receiving a Sequence Number (SN) Status Transfer message regarding the radio terminal on the second cell from the second radio station and sending a Sequence Number (SN) Status Transfer message to the third radio station within the procedure for changing the radio station operating the secondary cell from the second radio station to the third radio station.

5. The first radio station according to any one of Claims 1 to 4, further comprising means for requesting the radio terminal to change the secondary cell while keeping communication status indicated by the SN Status Transfer message in the radio terminal.

6. A second radio station configured to operate a second cell, the second radio station comprising:

means for communicating with a radio terminal performing Dual Connectivity which is configured with a first cell operated by a first radio station as a primary cell and either the second cell or a third cell operated by a third radio station as a secondary cell;

means for receiving from the first radio station, within a procedure for changing a radio station operating the secondary cell of the radio terminal from the second radio station to the third radio station, a request to abort providing user data to the radio terminal in the second cell; and

means for aborting providing the user data upon reception of the request,

wherein the means for receiving is configured to receive the request before the first radio station instructs, by transmitting an RRC connection reconfiguration message, the radio terminal to change the secondary cell.

7. The second radio station according to Claim 6, further comprising means for sending a Sequence Number (SN) Status Transfer message associated with the radio terminal on the second cell to the first radio station,

wherein the Sequence Number (SN) Status Transfer message is used by the third radio station to provide, in the third cell, the user data which has been provided to the radio terminal in the second cell as the secondary cell.

8. A communication control method in a first radio station configured to operate a first cell, the method comprising:

communicating with a radio terminal performing Dual Connectivity which is configured with the first cell as a primary cell and either a second cell operated by a second radio station or a third cell operated by a third radio station as a secondary cell;

sending to the second radio station, within a procedure for changing a radio station

operating the secondary cell of the radio terminal from the second radio station to the third radio station, a request to abort providing user data to the radio terminal in the second cell; and

instructing, by transmitting an Radio Resource Control (RRC) connection reconfiguration message, the radio terminal to change the secondary cell after sending the request to the second radio station.

9. A communication control method in a second radio station configured to operate a second cell, the method comprising:

communicating with a radio terminal performing Dual Connectivity which is configured with a first cell operated by a first radio station as a primary cell and either the second cell or a third cell operated by a third radio station as a secondary cell; and

within a procedure for changing a radio station operating the secondary cell of the radio terminal from the second radio station to the third radio station, receiving, from the first radio station, a request to abort providing user data to the radio terminal in the second cell; and

aborting providing the user data upon reception of the request,

wherein the receiving comprises receiving the request before the first radio station instructs, by transmitting an RRC connection reconfiguration message, the radio terminal to change the secondary cell.