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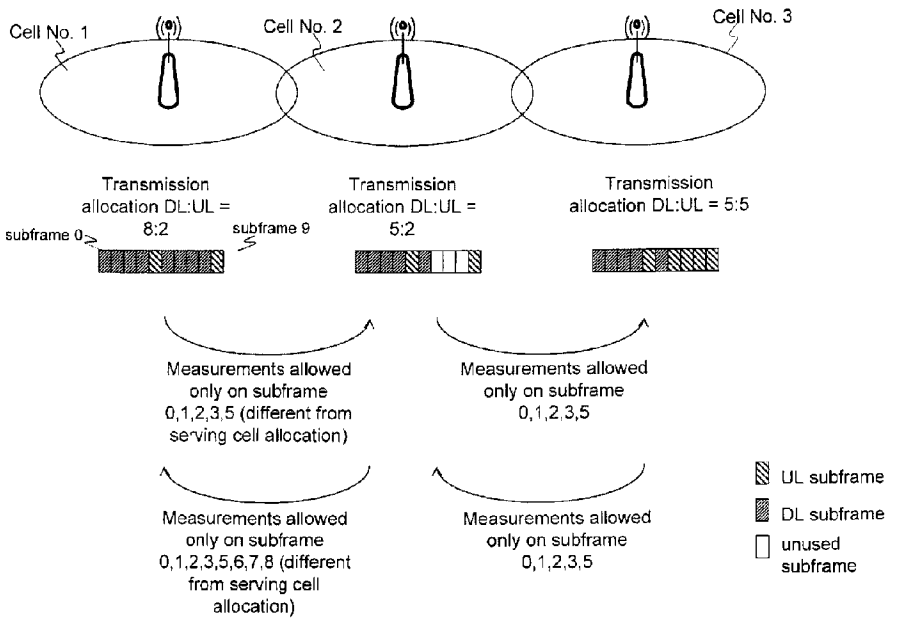
(54) Titre : INFORMATIONS SUR UNE STRUCTURE DE SIGNAUX DE REFERENCE POUR L'OBTENTION DE MESURES RELATIVES A DES CELLULES VOISINES

(54) Title: INFORMATION ON REFERENCE SIGNAL STRUCTURE FOR NEIGHBOURING CELL MEASUREMENTS



(57) Abrégé/Abstract:
The present invention relates to cellular radio communication and in particular to providing information on neighbour cells to enable terminals to perform neighbour cell measurements. In the prior art the terminal attempts to make neighbour cell measurements in a reference signal structure that is the same in the neighbour cell as in the cell the terminal camps in. The present invention is based on the insight that the reference signal structure may differ between neighbouring cell for example in the situation of an MBSFN area that is restricted to a region of all cells of a radio network, or in the situation of TDD mode being applied there may be different regions with different allocation of sub-frames for transmission in the uplink and downlink directions. The present invention solves the problem by broadcast information in a cell indicative of the reference signal structure in neighbour cells.

Abstract

The present invention relates to cellular radio communication and in particular to providing information on neighbour cells to enable terminals to perform neighbour cell measurements. In the prior art the terminal attempts to make neighbour cell measurements in a reference signal structure that is the same in the neighbour cell as in the cell the terminal camps in. The present invention is based on the insight that the reference signal structure may differ between neighbouring cell for example in the situation of an MBSFN area that is restricted to a region of all cells of a radio network, or in the situation of TDD mode being applied there may be different regions with different allocation of sub-frames for transmission in the uplink and downlink directions. The present invention solves the problem by broadcast information in a cell indicative of the reference signal structure in neighbour cells.

INFORMATION ON REFERENCE SIGNAL STRUCTURE FOR NEIGHBOURING CELL MEASUREMENTS

TECHNICAL FIELD OF THE INVENTION

The present invention relates to cellular radio communication and in particular to provide information to mobile terminals that enable the terminals to carry out measurements on cells neighbouring a cell the terminals camp in. The invention also relates to a radio base station adapted for providing the information, to a mobile terminal and a method for the mobile terminal.

DESCRIPTION OF RELATED ART

In the forthcoming evolution of the mobile cellular standards like GSM and WCDMA, new transmission techniques like OFDM are likely to occur. Furthermore, in order to have a smooth migration from the existing cellular systems to the new high capacity high data rate system in existing radio spectrum, the new system has to be able to operate in a flexible bandwidth. An example of such a new flexible cellular system is 3G Long Term Evolution (3G LTE) that can be seen as an evolution of the 3G WCDMA standard. This system will use OFDM as the downlink transmission scheme and will be able to operate on bandwidths ranging from 1.25 MHz to 20 MHz. Furthermore, data rates up to 100 Mb/s will be supported on the largest bandwidth. LTE will support both FDD and TDD as uplink/downlink duplexing schemes. Furthermore, LTE will also support multicast/broadcast services (MBSFN) on the same carrier as unicast data.

An essential part in any cellular system is support of mobility, i.e., the possibility to move the connection between the terminal and the network from one cell to another cell. To support this, neighboring cell measurements

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are used. While the connection is maintained in a serving cell, the terminal measures on some well defined signal in neighboring cells and reports the measurement result to the network. The network can then take a decision, for example based on a signal-to-noise ration measurement made by the terminal, whether the connection should be moved from the serving cell to a new cell.

In order to carry out downlink coherent demodulation, the mobile terminal needs estimates of the downlink channel. A straightforward way to enable channel estimation in case of OFDM transmission is to insert known reference symbols into the OFDM time-frequency grid. In LTE, these reference symbols are jointly referred to as the LTE downlink reference signals.

Figure 1 is grid in the time frequency domain, with each square in the grid representing one subcarrier of one OFDM symbol. It serves to demonstrate the LTE downlink reference-signal structure assuming normal cyclic prefix, i.e. seven OFDM symbols per slot. As illustrated in figure 1, downlink reference symbols are inserted within the first and the third last OFDM symbol of each slot and with a frequency-domain spacing of six subcarriers. Furthermore, there is a frequency-domain staggering of three subcarriers between the first and second reference symbols. Within each resource block, consisting of twelve subcarriers during one slot, there are thus four reference symbols. This is true for all sub-frames except sub-frames used for MBSFN-based broadcast/multicast, see further below.

The structure in Figure 1 illustrates the reference-signal structure for the case of a single antenna. For various multi-antenna transmission techniques, there is typically one reference signal transmitted for each antenna (the term 'antenna port' is used in the 3GPP specifications) and the

location of the reference signals for the different antennas may be different.

The reference signals can also be used for other purposes than coherent demodulation. One such example is neighboring cell measurements for mobility, where the terminal measures on the reference signal in neighboring cells to support mobility as described above.

One important part of the LTE requirements in terms of spectrum flexibility is the possibility to deploy LTE-based radio-access in both paired and unpaired spectrum, i.e., LTE should support both FDD- and TDD-based duplex arrangements. Frequency Division Duplex (FDD) as illustrated in the left part of figure 2, implies that downlink and uplink transmission take place in different, sufficiently separated, frequency bands. Time Division Duplex (TDD), as illustrated in the right part of figure 2, implies that downlink and uplink transmission take place in different, non-overlapping time slots. Thus, TDD can operate in unpaired spectrum, whereas FDD requires paired spectrum.

To support TDD operation, a guard time between downlink and uplink timeslots is needed. This can be created by omitting one or several OFDM symbols ("puncturing") in the last sub-frame before the downlink-to-uplink switch. In case a long guard time is needed, some of the reference symbols may need to be punctured in the last sub-frame prior to the switchpoint. The non-punctured part of a subframe used for downlink transmission is sometimes referred to as DwPTS.

In case of TDD operation, uplink and downlink transmission activity should be coordinated between neighboring cells. If this is not done, uplink transmission in one cell may interfere with downlink transmission in the neighboring cell (and vice versa) as illustrated in figure 3. Related to

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measurements, the terminal should only make neighbouring cell measurements during downlink transmission slots.

Multi-cell broadcast implies transmission of the same information from multiple cells. By exploiting this at the terminal, effectively using signal power from multiple cell sites at the detection, a substantial improvement in coverage, or in higher broadcast data rates, can be achieved. In LTE, this is implemented by transmitting not only identical signals from multiple cell sites, with identical coding and modulation, but also synchronize the transmission timing between the cells, the signal at the mobile terminal will appear exactly as a signal transmitted from a single cell site and subject to multi-path propagation. Due to the OFDM robustness to multi-path propagation, such multi-cell transmission, also referred to as Multicast-Broadcast Single Frequency Network (MBSFN) transmission, will then not only improve the received signal strength but also eliminate the inter-cell interference. Thus, with OFDM, multi-cell broadcast/multicast capacity may eventually only be limited by noise and can then, in case of small cells, reach extremely high values.

It should also be noted that the use of MBSFN transmission for multi-cell broadcast/multicast assumes the use of tight synchronization and time alignment of the signals transmitted from different cell sites.

For MBSFN, a different reference signal structure is used as illustrated in figure 4. This is needed as the effective channel seen by the terminal in case of MBSFN transmission appears as more frequency-selective than a single-cell unicast transmission. Thus, as unicast data and MBSFN transmissions are time multiplexed in different time slots, the reference signal structure will differ between slots in case of a mixed carrier transmitting both unicast and MBSFN services. In MBSFN sub-frames, only part of the cell-

specific reference signal is present, it occurs in some the first OFDM symbols of the sub-frame as disclosed in figure 4. The OFDM symbols carrying cell-specific reference symbol in the MBSFN sub-frame is a sub-set of the symbols used in a normal sub-frame for carrying cell-specific reference symbols, as can be concluded by comparing figure 1 and figure 4.

Typically, the terminal assumes the same configuration in the neighboring cell as the current cell. In case neighboring cells are configured differently, e.g., different guard times are used in neighboring cells or the MBSFN sub-frame are allocated differently in neighboring cells, the measurements made in the terminal would not correctly reflect the situation.

SUMMARY OF THE INVENTION

The present invention solves the above problem by a method of broadcasting information in a first cell indicative of a sub-frame specific reference signal structure of the neighbouring cells. The purpose of the broadcasted information is to enable terminals in the first cell to perform neighbour cell measurements.

The invention also relates to a method for a mobile station that measures the reference signal of neighbouring cell assuming it has the physical structure indicated by broadcasting in the cell the mobile terminal camps in. The invention also relates to a mobile station adapted for performing the method.

The invention also relates to a radio base station adapted for performing the method.

In one embodiment, TDD access mode is used, and not all neighbour cells have the same allocation of uplink and

respectively downlink transmissions in various sub-frames. According to the first embodiment of the invention, only sub-frames used for downlink transmissions by all cells neighbouring the first cell are informed of in broadcasting. Alternatively the downlink sub-frames used by respective neighbour cell is indicated by the first cell.

In a second alternative embodiment, some sub-frame/s is/are used for multi-broadcast transmission in one or more of the neighbouring cells, whereas some other of the neighbour cells or the first cell transmit/s a normal sub-frame structure in the same time window. The multi-broadcast sub-frame has another more restricted allocation of symbols for the cell specific reference signal than for the normal sub-frame reference structure. In the second embodiment, is broadcasted a structure of a sub-set of symbols allocated to symbols in common for both the multi-broadcast sub-frame and for the normal sub-frame. Thereby the terminal will use only the subset of symbols for measures on the reference signal in the neighbour cells.

An advantage of the invention is a terminal will make attempts to detect reference signals only in symbols that are carrying the reference signal. Thereby it is possible to have different regions of cells within which the same multicast information is broadcasted, or within which the same allocation of sub-frames for respectively uplink and downlink transmissions is used. The present invention is particular needed in cells bordering the different regions of cells, to enable the terminals to accurately detect the reference signals of all the neighbour cells.

DESCRIPTION OF THE DRAWINGS

Figure 1 is grid in the time frequency domain, with each square in the grind representing an OFDM symbol.

Figure 2 is an illustration of FDD mode versus TDD mode, with the respective allocation of time and frequency to the uplink and downlink transmissions

Figure 3 is a view of two cells and a terminal in each cell illustrating a TDD mode interference situation.

Figure 4 is the same type of figure as figure 1, illustrating a different allocation of symbols to the reference signal.

Figure 5 is a view of cells.

Figure 6 is a flowchart of method.

Figure 7 is an illustration of different allocation of sub-frames for respective uplink and downlink transmissions in three cells.

Figure 8 is a block diagram of a radio base station.

Figure 9 is a flowchart of a method for a mobile station.

Figure 10 is a block diagram of a mobile terminal.

DESCRIPTION OF PREFERRED EMBODIMENTS

For neighbour cell measurements the cell specific reference signal shall be used. Informing of the reference signal structure to be used for neighbouring cells measurement separately from the configuration in the serving cell provides several benefits.

MBSFN transmissions in neighboring cells may use different sub-frames without affecting the possibility to perform accurate neighboring cell measurements. Although using time aligned transmissions for MBSFN is useful in case the full benefits of MBSFN are to be exploited, at the border between different MBSFN regions this is not the case. The invention makes it possible to set up different regions of

broadcasting the same MBSFN data. Within a region the same sub-frame allocation is used for broadcasting the MBSFN data. Thereby the broadcasting of information of interest only in a specific geographical area can be restricted to that area. Figure 5 illustrates a number of cells spread in the geography, some of them included in a MBSFN region. A first cell neighbouring the MBSFN region, transmits normal sub-frames in the same time windows as is used in the MBSFN region for MBSFN sub-frames. Also other cells neighbouring the first cell transmit normal sub-frames in the same time window. The physical structure of the normal frame reference signals is disclosed in figure 1. The reference signal structure of MBSFN sub-frames is disclosed in figure 4. The symbols allocated to carry the reference signal in the MBSFN sub-frame overlap in their sequential position and on the frequency sub-carrier with symbols used for carrying reference signals in the normal sub-frames. The first cell broadcast information on the reference signal being carried by the symbols as in the structure of MBSFN broadcasting. Terminals camping in the first cell will then attempt to detect the cell specific reference signals according to the structure of the reference signal physical structure in the MBSFN sub-frame for all neighbouring cells albeit some of them transmit normal sub-frames. The symbols that carry cell specific reference signal in a MBSFN sub-frame are also used in a normal sub-frame for the same purpose.

Figure 6 is a flowchart of the method of broadcasting in the first cell, according to the two steps:

- Broadcasting a first reference signal, and that has a first physical structure (S1). In the situation described as an example the first cell is not included in the MBSFN region and the first reference signal structure is the structure of the normal sub-frame.

- Broadcasting information indicative of a second reference signal structure and that is to be used by terminals for performing neighbour cell measurements.

An alternative embodiment relates to a TDD access mode system when the first cell is located between two regions applying different allocations sub-frames for respectively UL and DL transmission. A terminal can measure on a neighbour cell only when DL transmission direction is applied in the neighbour cell. When TDD access mode is applied, coordinating the UL and DL transmissions to the same sub-frames in all the cells of a region, and to synchronize the transmissions in the region is advantageous because interference between base stations and between terminals is mitigated. However, there might be a need to differ the balance of allocation of UL resources versus DL resources in response to different demand in different regions. Different uplink-downlink allocations can be used in different cells, assuming proper planning. This is illustrated in figure 5, with a three cells, wherein cell No. 1 and cell No. 3 belongs to two different regions with cell no. 2 in between. The three cells have different allocations of sub-frames for respective UL and DL transmission directions. Cell No.1 to the left have 8 of its 10 sub-frames dedicated for the DL, and they are have the sequential numbers 0,1,2,3,5,6,7,8, leaving the remaining two sub-frames No. 4 and 9 for the UL direction. A cell No. 2 in the middle of figure 5, has 5 sub-frames allocated for the DL direction, i.e. sub-frames numbered 0,1,2,3,5. Two sub-frames are allocated for the UL direction, they are numbered 4 and 9. Three sub-frames, No. 6-8 are left unused. A cell No. 3, to the right in figure 5, has 5 sub-frames each to the UL and to the DL directions. The DL sub-frames are allocated to sub-frames numbers 0,1,2,3,5 and the remaining sub-frames are allocated to the UL direction. In this case, there is a mechanism to reserve sub-frames to one

of the three purposes "uplink", "downlink", or "unused" in contrast to the, in conventional TDD systems, allocation to one of "uplink" or "downlink".

In cell No. 2, the broadcasted information on which sub-frames to use for performing neighbour cell measurements, would, in a first alternative be restricted to sub-frames no. 0,1,2,3,5 because this group is common for both neighbour cell No.1 and neighbour cell No. 3. Also broadcast information in cell No. 1, and cell No. 3 for measurements on respective neighbours should be restricted to the use of sub-frames No. 0,1,2,3,5.

In an alternative embodiment the information broadcasted by is not only sub-frame specific but also neighbour cell specific. Thus, cell No. 2 broadcast that sub-frames No. 0,1,2,3,5,6,7,8 are available for measurements on cell No. 1, whereas for measurements on cell No. 3 only sub-frames 0,1,2,3,5 may be used. This alternative embodiment is also disclosed in the text of figure 7.

Also in the case of MBSFN transmission, the sub-frame structure is neighbour cell specific. The information on the reference signal structure is alternatively cell specific for the various neighbour cells.

In the TDD mode, some of the symbols normally used for carrying the reference signals may be punctured for increasing the Guard period between sub-frames for DL to UL transmission. The last reference symbols in the last DL sub-frame may then be lost. The first cell shall then broadcast information of the reference signal physical structure in the same way as is described for the MBSFN embodiment.

It should further be noted that MBSFN transmission may occur both in FDD mode and in TDD mode. In the case of TDD mode information on what sub-frames to use as well as physical

reference signal structure within each used sub-frame need be broadcasted.

The information indicative of the reference signal structure, need not relate to the all the symbols carrying the reference signals or to all sub-frames used in DL, it may be restricted to sub- frames or to symbols that shall be used by the mobile terminal for making neighbour cell measurements. This is in particular relevant to the embodiments when the information is indicative of the smallest subset of sub-frames or of symbols that are used by all neighbour cells.

Moreover, the broadcasted information only need be indicative of a physical structure. For example different classes of physical structures may have been predefined, and the first cell just broadcast the classification of the different sub-frames.

Figure 8 is a block diagram of a radio base station adapted for performing the invention. The radio base station comprises a radio transceiver including an antenna system, and a data processor controlling the operation of the radio base station according to software. The software is updated to control the broadcasting including an indication of the second reference signal according to the method. The radio base station also comprises an X2 interface for connection to neighbouring radio base station. The signalling information received via the X2 interface is detected by the data processor and the indication of the second reference signal structure as broadcasted can be updated autonomously by the radio base station in accordance with information received via the X2 interface.

Figure 9 is a flowchart of the steps performed by a mobile terminal, or UE (User Equipment) as is the name of the LTE mobile terminal. Initially the mobile is camping in a first

cell, either in connected mode with the first cell acting serving cell or in idle mode. The first cell transmits a cell specific reference signal according to a first physical structure. In the first step, 91, the mobile terminal reads indication on a second physical structure for a reference signal. The indication is broadcasted in the first cell. In a next step, 92, the terminal measures a reference signal in one or more neighbouring cells, assuming the reference signal is carried by symbols according to the indicated second physical structure.

The indication of second physical structure typically indicates one in a predefined a set of physical structures. The mobile terminal as manufactured or as including a SIM-card (Subscription Identity Module), possesses information on the set of possible physical structures for the reference signal.

Figure 10 is a block diagram of the mobile terminal. In comprises a transceiver, including an antenna, and computer including software. The computer and software may be distributed and part if it residing in the SIM-card. The software is adapted for detecting the broadcast indication of a the second physical structure of the reference signal, and to control the measuring of reference signal in neighbouring cells to be made on the symbols that is indicated to carry the reference signal.

So far the invention has been described in a LTE system applying a single antenna. The LTE is also standardised for alternative multi-antenna transmission techniques and then typically one reference signal is transmitted for each antenna and the physical structure of symbols assigned for carrying the respective reference signal within the sub-frames, is almost the same. The reference signal structure of antenna 1 is the same as the reference signal for antenna 0 with, the exception of the OFDM symbol is shifted 3 sub-

carriers in the frequency domain relative to the symbols on carrier 0. The frame timing on the two antennas is synchronized.

The physical structure of the plural reference signals allocated to multi-antenna cells, is one of the predefined sets of physical structure the mobile terminal possesses information on. Accordingly the multi-antenna system physical structure may be broadcasted in a cell, and the mobile terminals assume this physical structure when making neighbour cell measurements.

Abbreviations:

DL downlink

UL uplink

UE User Equipment, i.e. the name of the mobile terminal in the LTE system

MBSFN - a 3GPP specific term used for multibroadcast, i.e. synchronized broadcasting of the same information in a plurality of cells. In some literature this is also referred to as Single-Frequency Network (SFN).

What is claimed is:

1. A method implemented by a radio base station, the method comprising:

transmitting a first cell-specific reference signal in a first cell within first radio resources that differ from second radio resources within which a second cell-specific reference signal is transmitted in a second cell neighboring the first cell; and

transmitting resource information in the first cell indicative of the second radio resources within which the second cell-specific reference signal is transmitted in the second cell.

2. The method of claim 1, wherein the resource information is indicative of only those second radio resources that shall be used by a mobile terminal camping in the first cell for making neighbor cell measurements on the second cell-specific reference signal.

3. The method of claim 1, wherein the resource information is indicative of the smallest subset of radio resources that are used by all cells neighboring the first cell for transmitting cell-specific reference signals.

4. The method of claim 1, wherein the resource information is indicative of the smallest subset of subframes or symbols that are used by all cells neighboring the first cell for transmitting cell-specific reference signals.

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5. The method of claim 1, wherein the resource information indicates a presence of one or more MBSFN sub-frames within the second cell.

6. The method of claim 1, wherein the resource information indicates a difference in an allocation of one or more MBSFN sub-frames within the second cell as compared to that of the first cell.

7. The method of claim 1, wherein the resource information indicates an allocation of one or more MBSFN sub-frames within the second cell relative to that of the first cell.

8. The method of claim 1, wherein the second cell is included in an MBSFN region but the first cell is not, and wherein the resource information indicates an allocation of MBSFN sub-frames within which the second cell-specific reference signal is transmitted.

9. The method of claim 1, wherein the first and the second cell-specific reference signals are carried by sub-frames in a downlink direction and the second cell does not have a same allocation of sub-frames in the downlink direction as the first cell.

10. The method of claim 1, wherein the first cell is located between two regions of cells applying different allocations of subframes for respectively uplink and downlink transmission, and wherein second resource information indicates an allocation of subframes for downlink transmissions in the second cell.

11. A radio base station comprising:

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a transceiver;

a processor and a memory, said memory containing instructions executable by said processor whereby the radio base station is configured to:

transmit, via the transceiver, a first cell-specific reference signal in a first cell within first radio resources that differ from second radio resources within which a second cell-specific reference signal is transmitted in a second cell neighboring the first cell; and

transmit, via the transceiver, resource information in the first cell indicative of the second radio resources within which the second cell-specific reference signal is transmitted in the second cell.

12. The radio base station of claim 11, wherein the resource information is indicative of only those second radio resources that shall be used by a mobile terminal camping in the first cell for making neighbor cell measurements on the second cell-specific reference signal.

13. The radio base station of claim 11, wherein the resource information is indicative of the smallest subset of radio resources that are used by all cells neighboring the first cell for transmitting cell-specific reference signals.

14. The radio base station of claim 11, wherein the resource information is indicative of the smallest subset of subframes or symbols that are used by all cells neighboring the first cell for transmitting cell-specific reference signals.

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15. The radio base station of claim 11, wherein the resource information indicates a presence of one or more MBSFN sub-frames within the second cell.

16. The radio base station of claim 11, wherein the resource information indicates a difference in an allocation of one or more MBSFN sub-frames within the second cell as compared to that of the first cell.

17. The radio base station of claim 11, wherein the resource information indicates an allocation of one or more MBSFN sub-frames within the second cell relative to that of the first cell.

18. The radio base station of claim 11, wherein the second cell is included in an MBSFN region but the first cell is not, and wherein the resource information indicates an allocation of MBSFN sub-frames within which the second cell-specific reference signal is transmitted.

19. The radio base station of claim 11, wherein the first and the second cell-specific reference signals are carried by sub-frames in the downlink direction and the second cell does not have the same allocation of sub-frames in the downlink direction as the first cell.

20. The radio base station of claim 11, wherein the first cell is located between two regions of cells applying different allocations of subframes for respectively uplink and downlink transmission, and wherein the resource information indicates an allocation of subframes for downlink transmissions in the second cell.

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21. A method implemented by a mobile terminal, the method comprising:

camping in a first cell which is transmitting a first cell-specific reference signal within first radio resources that differ from second radio resources within which a second cell-specific reference signal is transmitted in a second cell neighboring the first cell;

detecting resource information transmitted by the first cell indicative of the second radio resources within which the second cell-specific reference signal is transmitted in the second cell; and

measuring the second cell-specific reference signal based on the detected resource information.

22. The method of claim 21, wherein the resource information is indicative of only those second radio resources that shall be used by the mobile terminal camping in the first cell for making neighbor cell measurements on the second cell-specific reference signal.

23. The method of claim 21, wherein the resource information is indicative of the smallest subset of radio resources that are used by all cells neighboring the first cell for transmitting cell-specific reference signals.

24. The method of claim 21, wherein the resource information is indicative of the smallest subset of subframes or symbols that are used by all cells neighboring the first cell for transmitting cell-specific reference signals.

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25. The method of claim 21, wherein the resource information indicates a presence of one or more MBSFN sub-frames within the second cell.

26. The method of claim 21, wherein the resource information indicates a difference in an allocation of one or more MBSFN sub-frames within the second cell as compared to that of the first cell.

27. The method of claim 21, wherein the resource information indicates an allocation of one or more MBSFN sub-frames within the second cell relative to that of the first cell.

28. The method of claim 21, wherein the second cell is included in an MBSFN region but the first cell is not, and wherein the resource information indicates an allocation of MBSFN sub frames within which the second cell-specific reference signal is transmitted.

29. The method according to claim 21, wherein the first and the second cell-specific reference signals are carried by sub-frames in the downlink direction and the second cell does not have the same allocation of sub-frames in the downlink direction as the first cell.

30. The method according to claim 21, wherein the first cell is located between two regions of cells applying different allocations of subframes for respectively uplink and downlink transmission, and wherein the second resource information indicates an allocation of subframes for downlink transmissions in the second cell.

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31. A mobile terminal comprising a processor and a memory, said memory containing instructions executable by said processor whereby the mobile terminal is configured to:

camp in a first cell which is transmitting a first cell-specific reference signal within first radio resources that differ from second radio resources within which a second cell-specific reference signal is transmitted in a second cell neighboring the first cell;

detect resource information transmitted by the first cell indicative of the second radio resources within which the second cell-specific reference signal is transmitted in the second cell; and

measure the second cell-specific reference signal based on the detected resource information.

32. The mobile terminal of claim 31, wherein the resource information is indicative of only those second radio resources that shall be used by the mobile terminal camping in the first cell for making neighbor cell measurements on the second cell-specific reference signal.

33. The mobile terminal of claim 31, wherein the resource information is indicative of the smallest subset of radio resources that are used by all cells neighboring the first cell for transmitting cell-specific reference signals.

34. The mobile terminal of claim 31, wherein the resource information is indicative of the smallest subset of subframes or symbols that are used by all cells neighboring the first cell for transmitting cell-specific reference signals.

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35. The mobile terminal of claim 31, wherein the resource information indicates a presence of one or more MBSFN sub-frames within the second cell.

36. The mobile terminal of claim 31, wherein the resource information indicates a difference in an allocation of one or more MBSFN sub-frames within the second cell as compared to that of the first cell.

37. The mobile terminal of claim 31, wherein the resource information indicates an allocation of one or more MBSFN sub-frames within the second cell relative to that of the first cell.

38. The mobile terminal of claim 31, wherein the second cell is included in an MBSFN region but the first cell is not, and wherein the resource information indicates an allocation of MBSFN sub-frames within which the second cell-specific reference signal is transmitted.

39. The mobile terminal of claim 31, wherein the first and the second cell-specific reference signals are carried by sub-frames in the downlink direction and the second cell does not have the same allocation of sub-frames in the downlink direction as the first cell.

40. The mobile terminal of claim 31, wherein the first cell is located between two regions of cells applying different allocations of subframes for respectively uplink and downlink transmission, and wherein the resource information indicates an allocation of subframes for downlink transmissions in the second cell.

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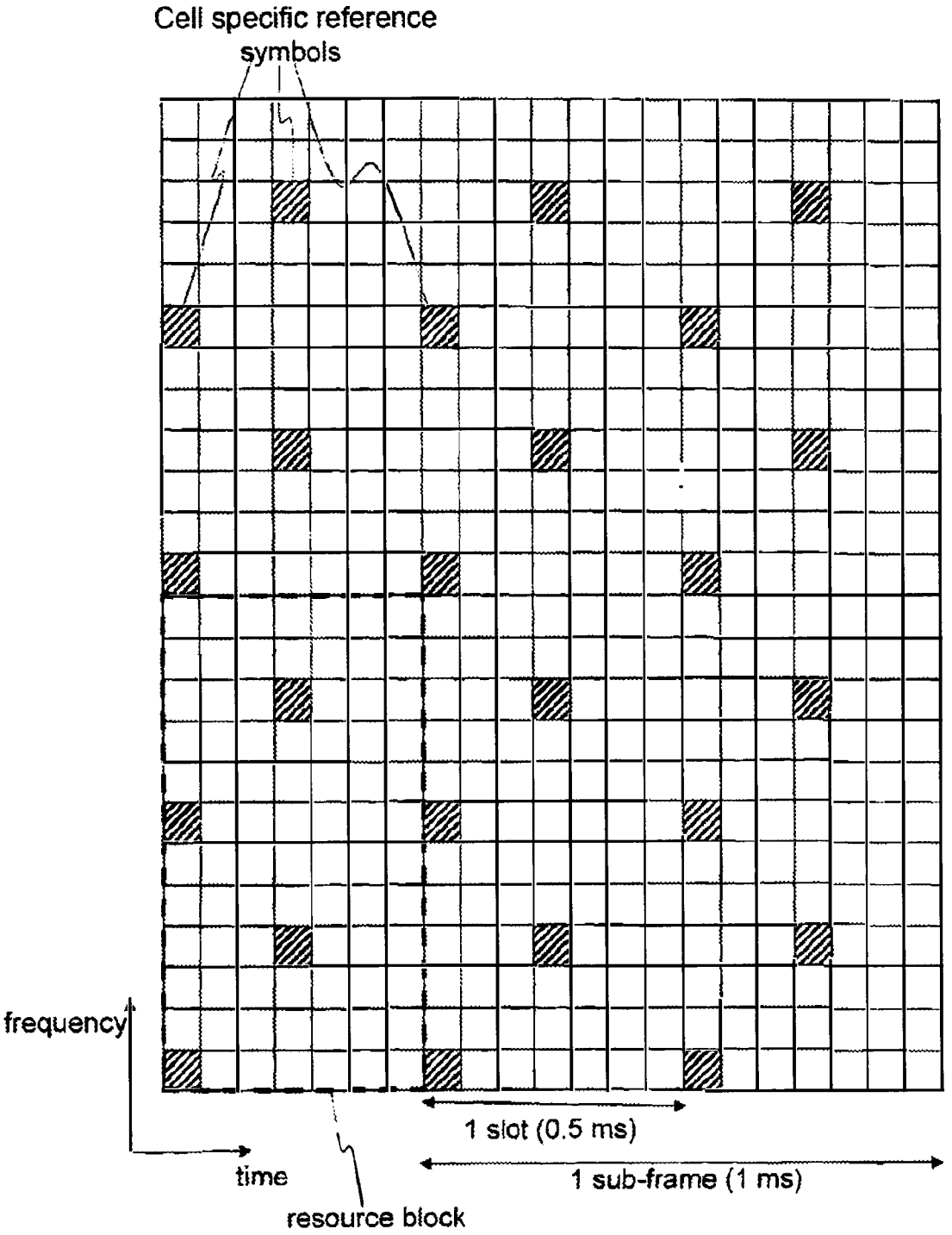

FIG. 1
PRIOR ART

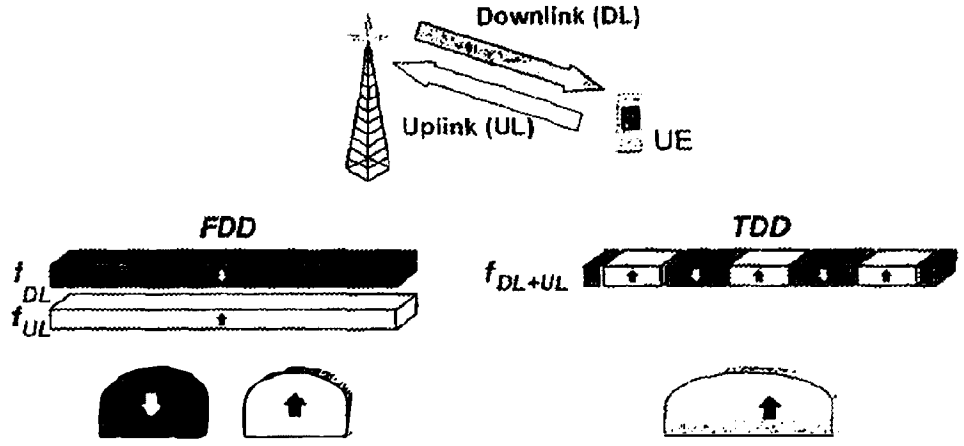

FIG. 2

PRIOR ART

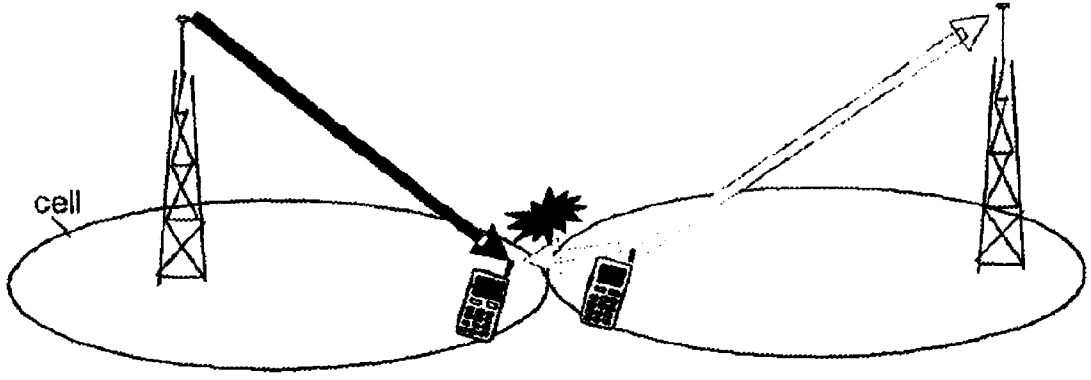

FIG. 3

PRIOR ART

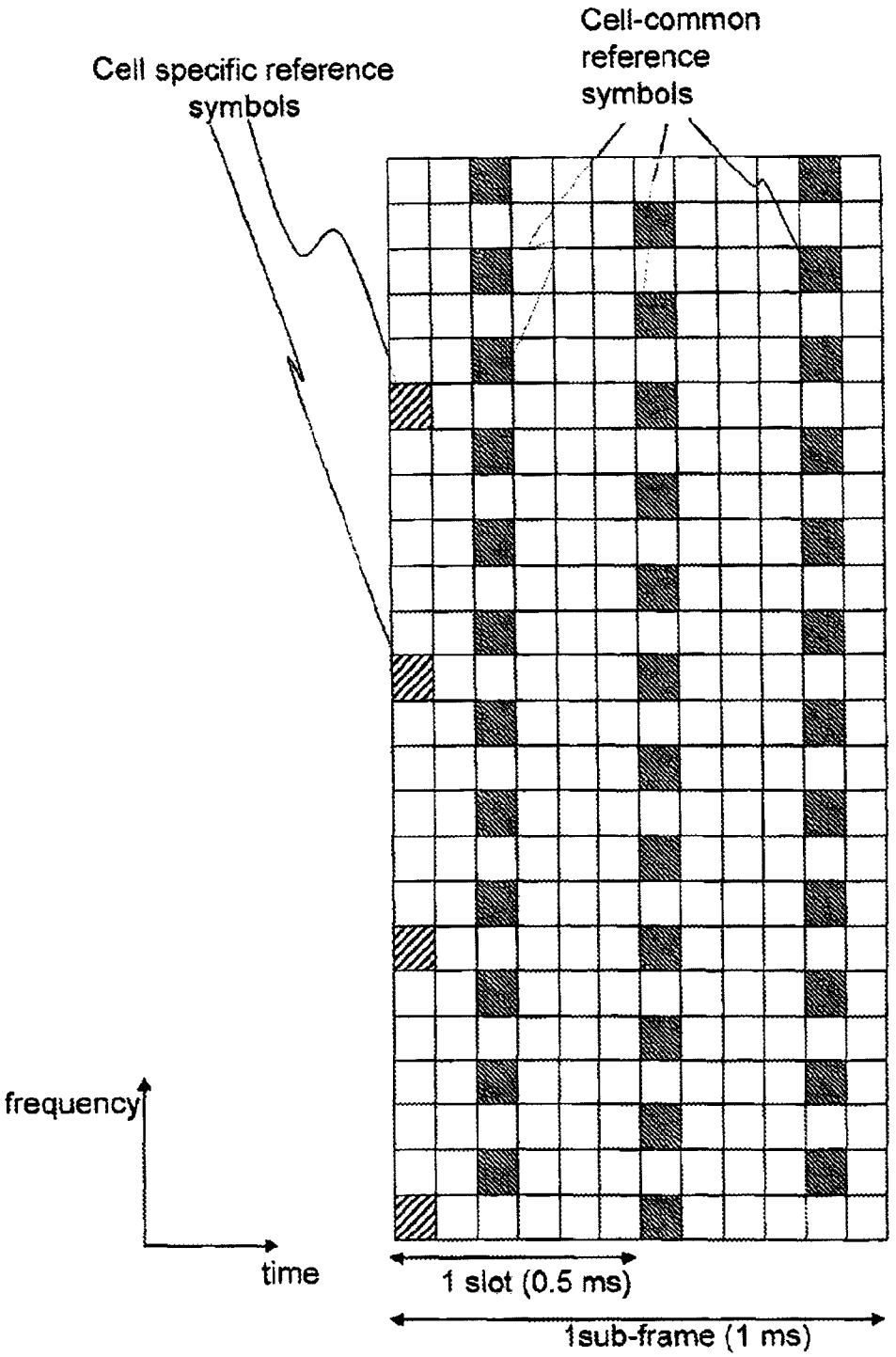

FIG. 4

PRIOR ART

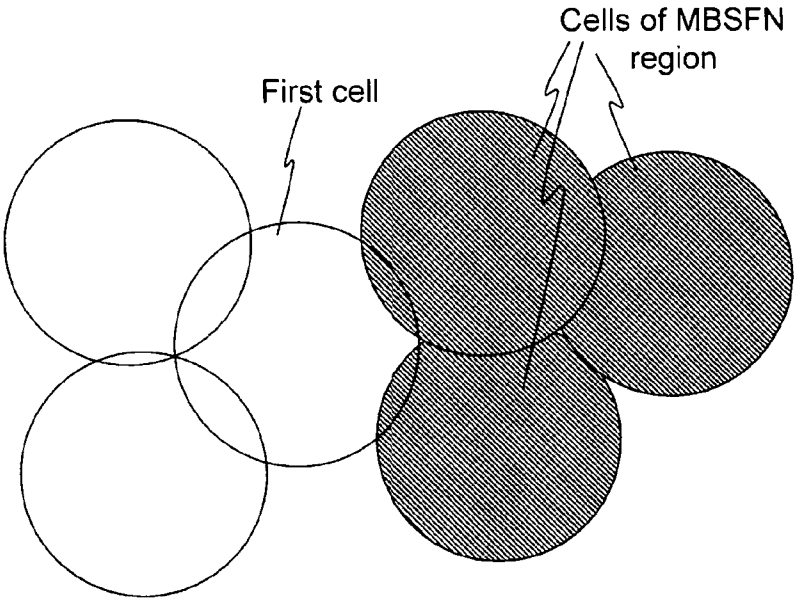

Fig. 5

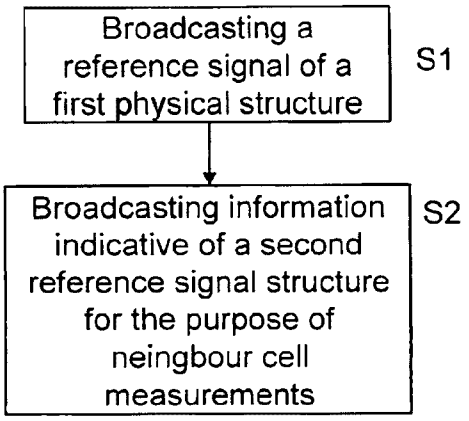

Fig. 6

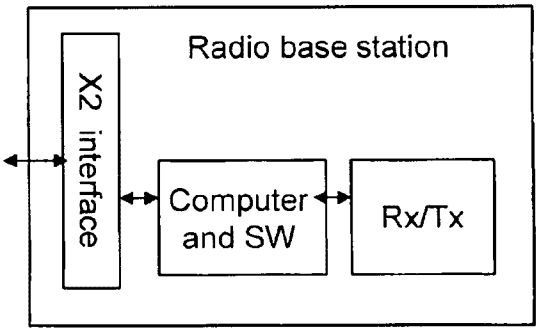

Fig. 8

Fig. 7

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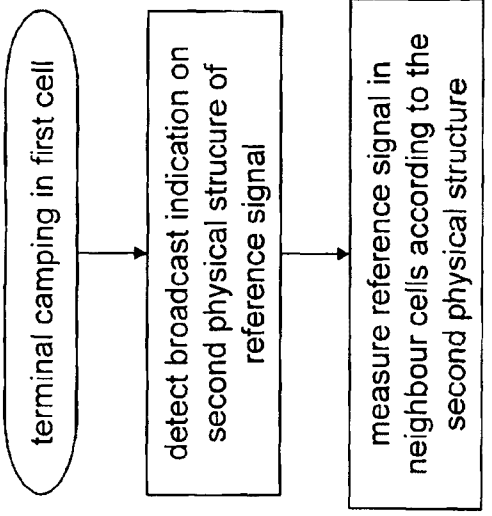

Fig.9

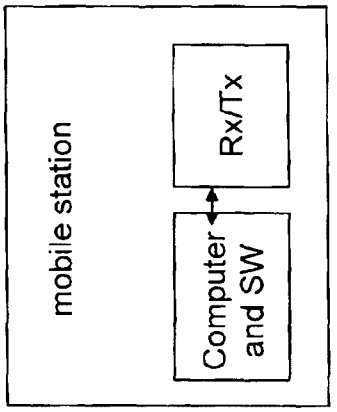

Fig.10

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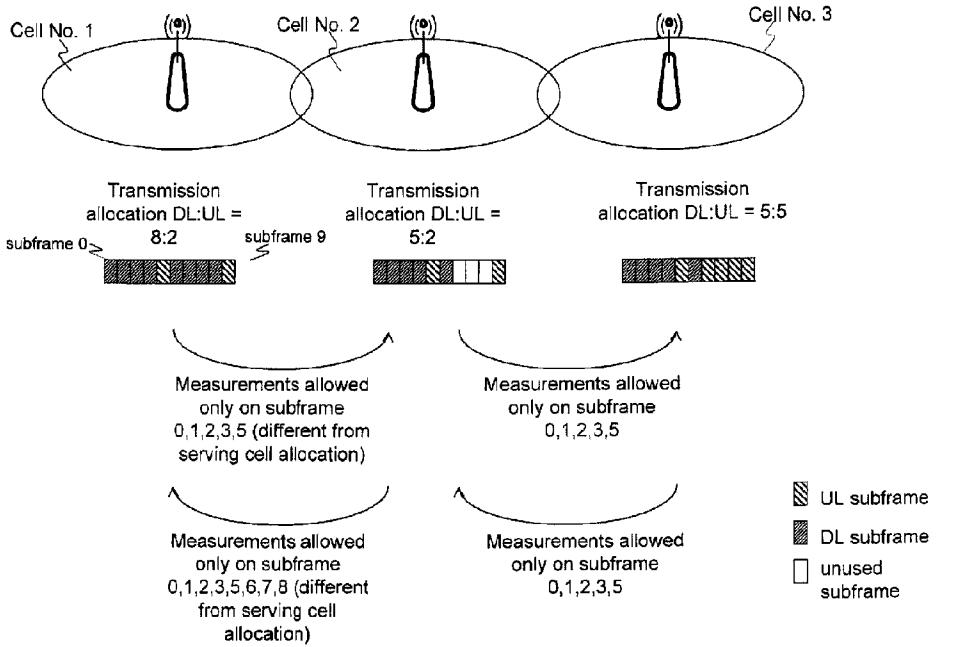
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Cell No. 2
Cell No. 3
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Measurements allowed only on subframe 0,1,2,3,5
Measurements allowed only on subframe 0,1,2,3,5,6,7,8 (different from serving cell allocation)
Measurements allowed only on subframe 0,1,2,3,5
UL subframe
DL subframe
unused subframe