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(54) **METHOD FOR MAPPING DOWNLINK DEDICATED PILOTS TO RESOURCE ELEMENTS IN EXTENDED CYCLIC PREFIX FRAME STRUCTURE**

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(57) **ABSTRACT**

A method for mapping downlink dedicated pilot frequencies of an extend cyclic prefix frame structure to physical resource blocks, applied in a long term evolution system, includes the following steps: the first downlink dedicated pilot frequency of each channel is mapped to the specific position of a physical resource block; other downlink dedicated pilot frequencies of the channel are mapping-processed according to the time domain interval, frequency domain interval and the preset regulation; the time domain interval is two or three OFDM symbols, the frequency domain interval is two sub-carriers of the same time domain. By defining the positions of pilot frequencies in the physical resource block, the public pilot frequency can obtain the information of all channels when a base station uses a beam pattern of more than four antennas. Making the channel information obtained by dedicated pilot frequencies contain the real channel information and the process-weight-value of a beam pattern, a UE does not need to obtain the transmission-weight-value of a beam pattern, such as to avoid the feedback cost of weight-values of a beam pattern.

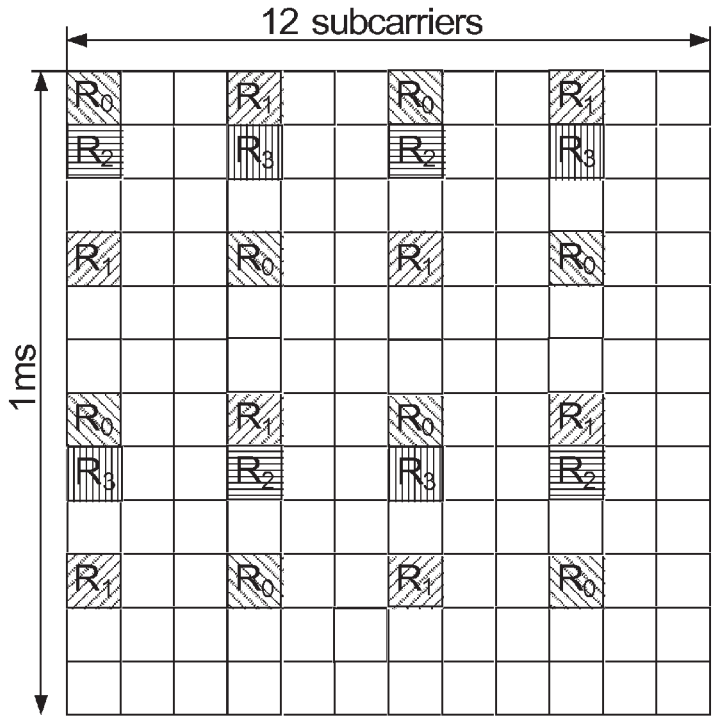


Fig. 1

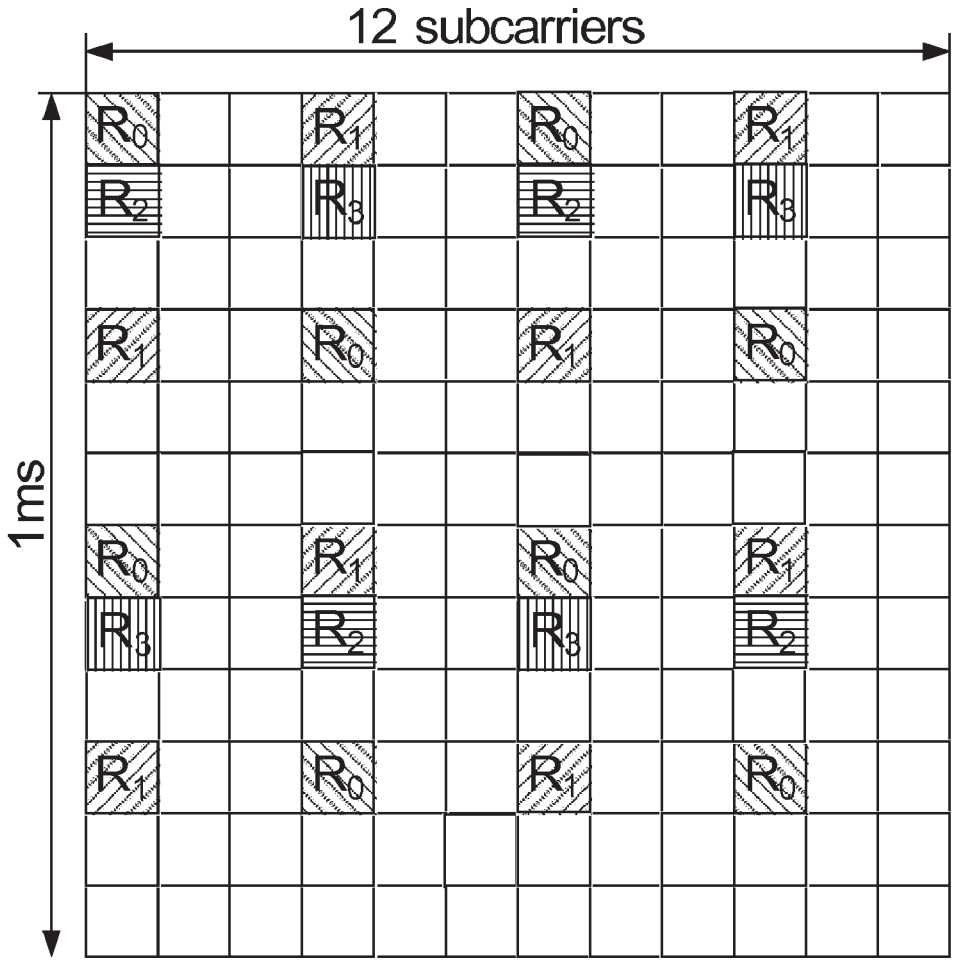


Fig. 2

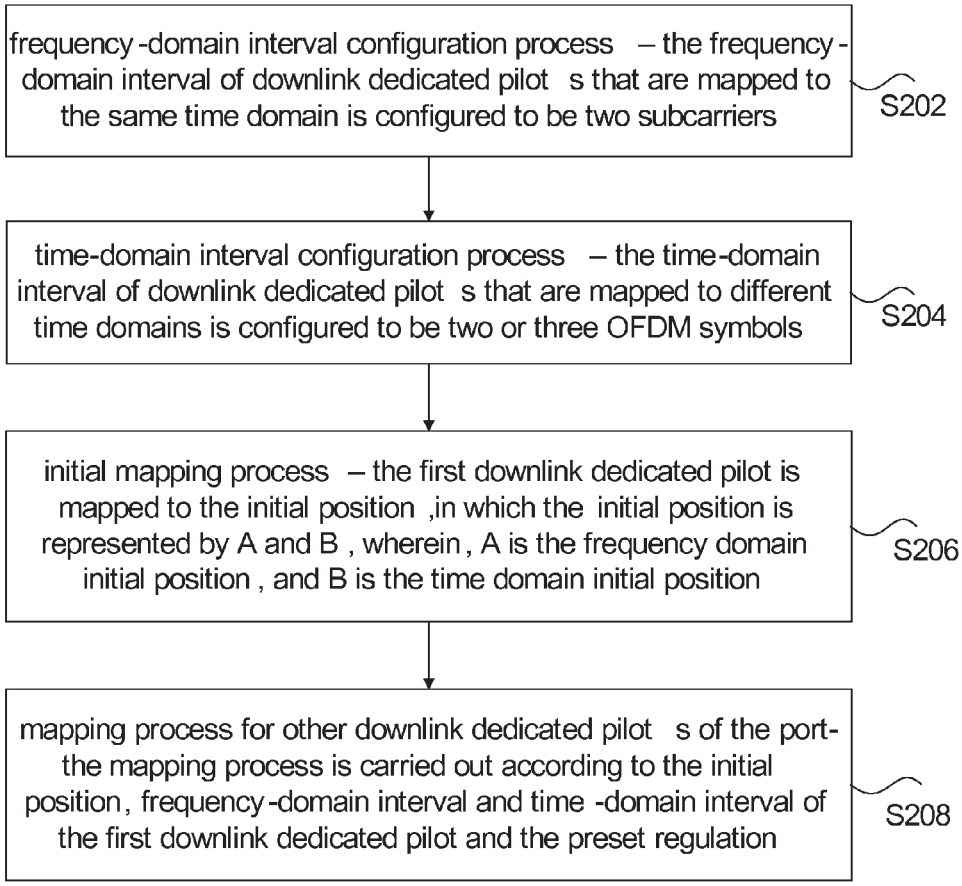

frequency-domain interval configuration process – the frequency-domain interval of downlink dedicated pilot s that are mapped to the same time domain is configured to be two subcarriers
S202
time-domain interval configuration process – the time-domain interval of downlink dedicated pilot s that are mapped to different time domains is configured to be two or three OFDM symbols
S204
initial mapping process – the first downlink dedicated pilot is mapped to the initial position ,in which the initial position is represented by A and B , wherein, A is the frequency domain initial position , and B is the time domain initial position
S206
mapping process for other downlink dedicated pilot s of the port-the mapping process is carried out according to the initial position, frequency-domain interval and time -domain interval of the first downlink dedicated pilot and the preset regulation
S208

Fig. 3

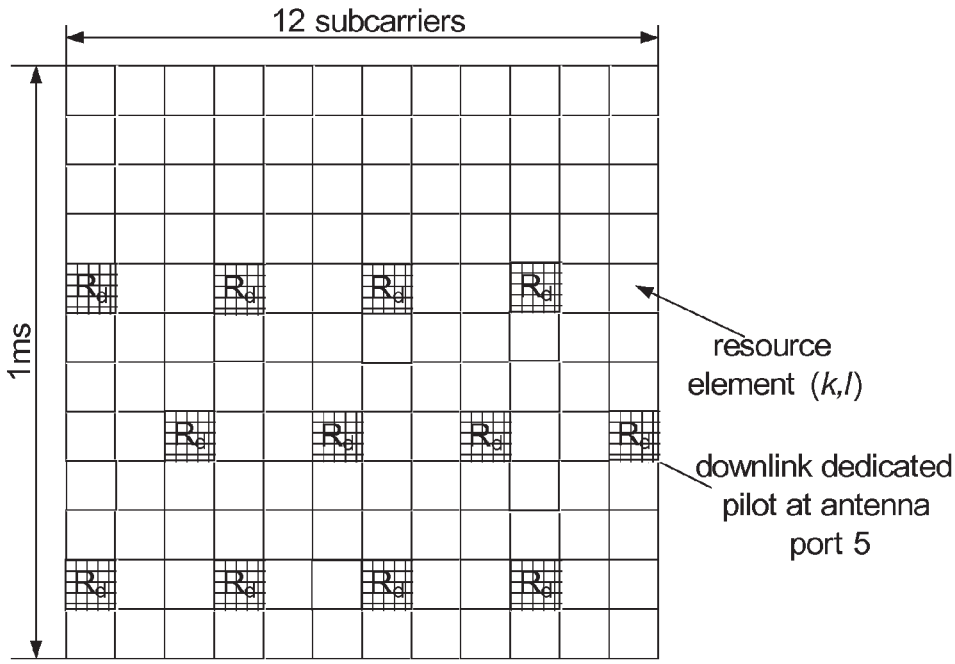

12 subcarriers
1ms
resource
element (k,l)
downlink dedicated
pilot at antenna
port 5

Fig. 4

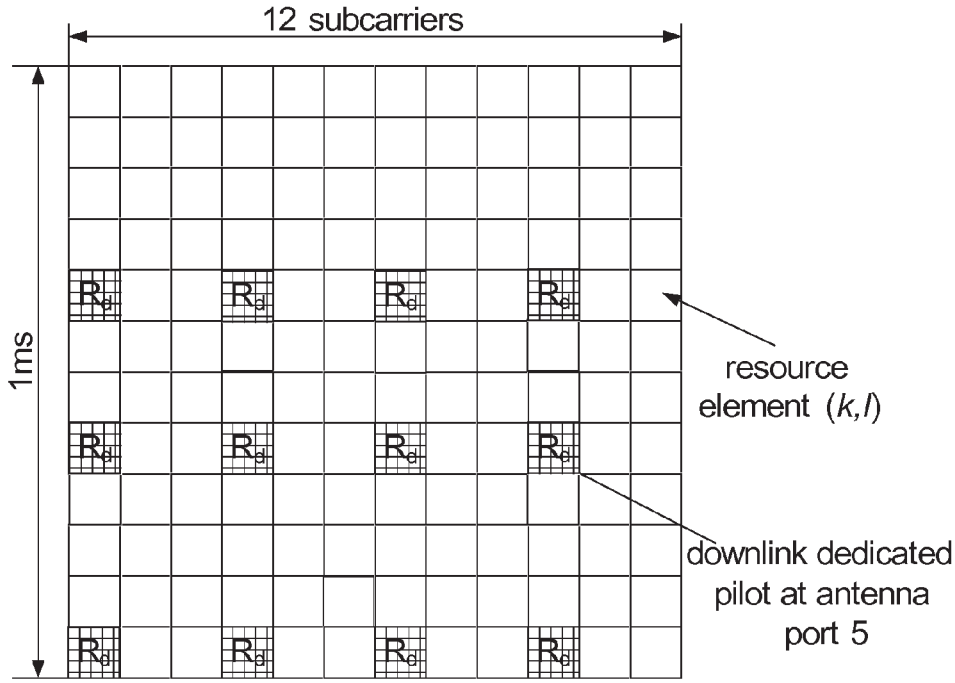

12 subcarriers
1ms
resource
element (k,l)
downlink dedicated
pilot at antenna
port 5

Fig. 5

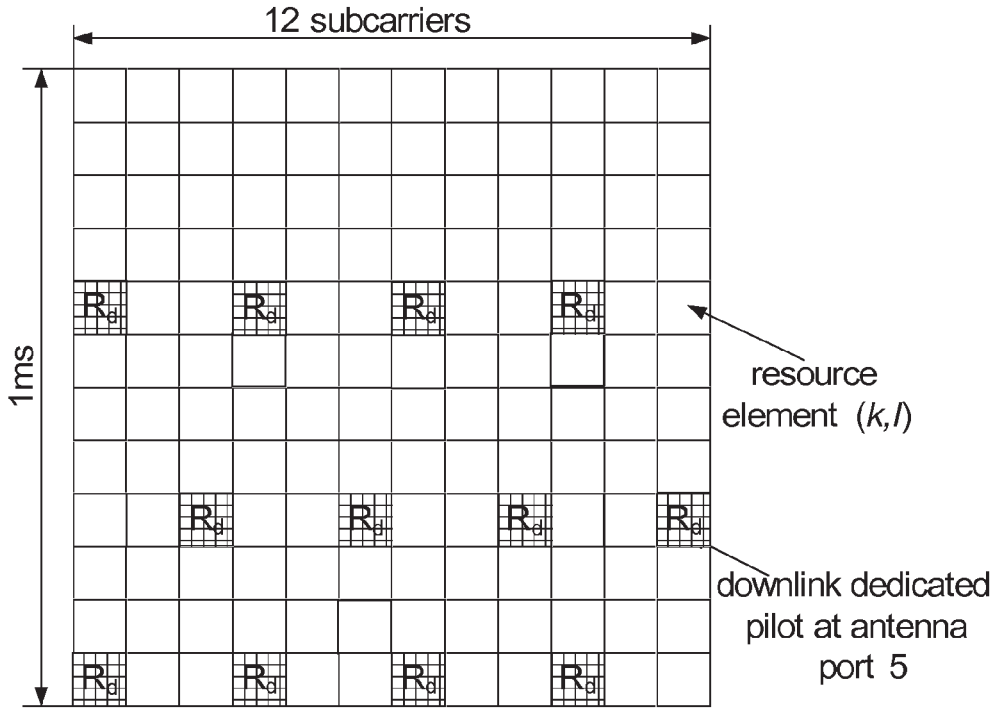

12 subcarriers
1ms
R_d
resource element (k,l)
downlink dedicated pilot at antenna port 5

Fig. 6

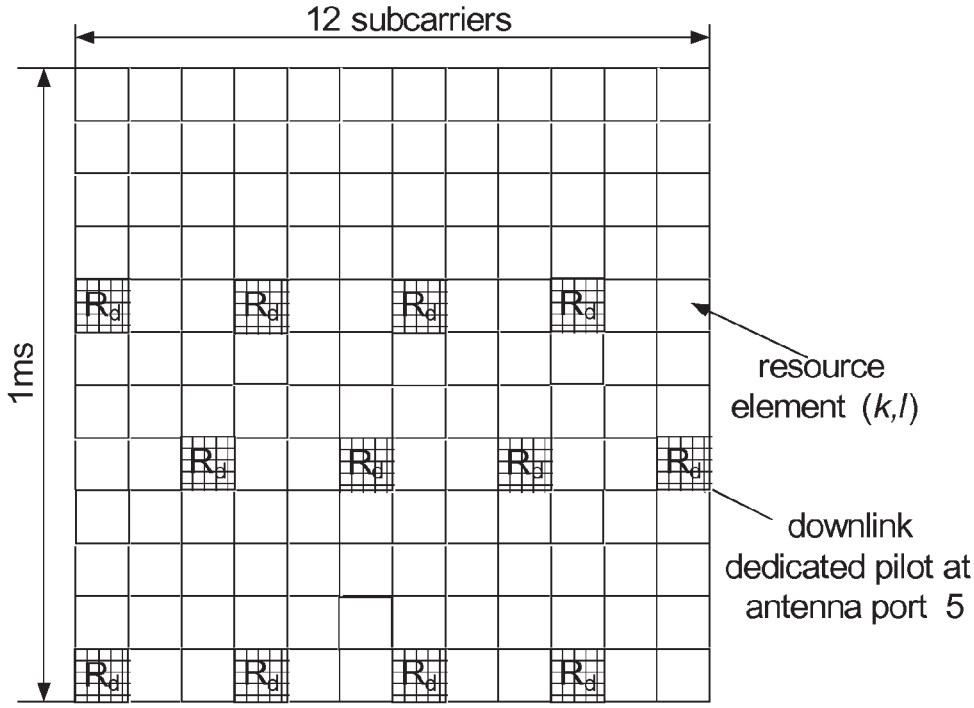

12 subcarriers
1ms
R_d
resource element (k,l)
downlink dedicated pilot at antenna port 5

Fig. 7

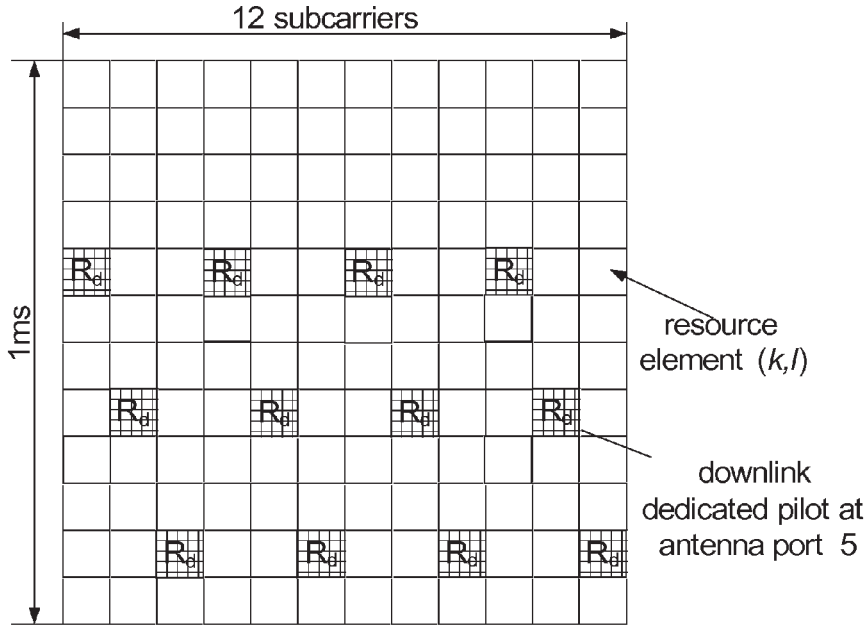
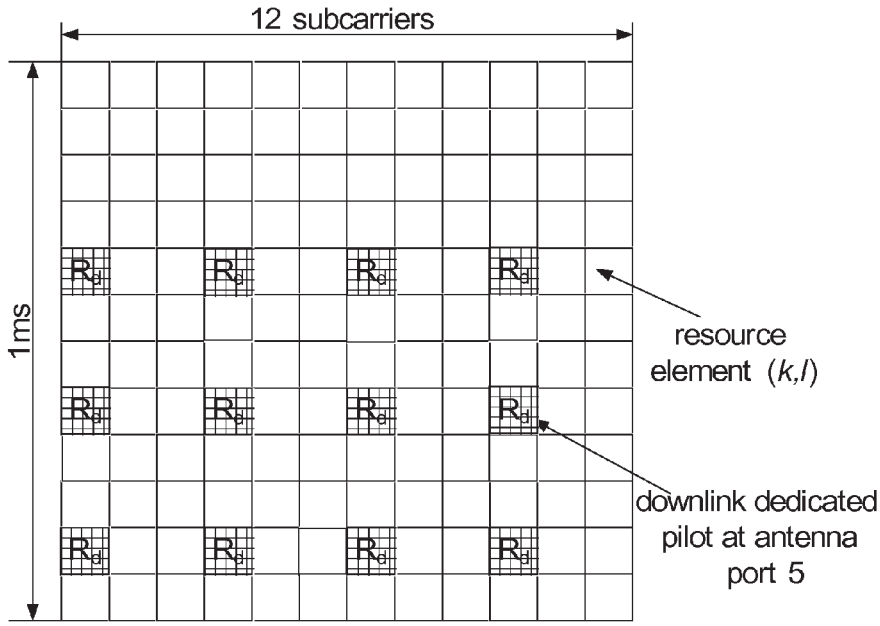

12 subcarriers
1ms
resource element (k,l)
downlink dedicated pilot at antenna port 5

Fig. 8


12 subcarriers
1ms
resource element (k,l)
downlink dedicated pilot at antenna port 5

METHOD FOR MAPPING DOWNLINK DEDICATED PILOTS TO RESOURCE ELEMENTS IN EXTENDED CYCLIC PREFIX FRAME STRUCTURE

TECHNICAL FIELD

[0001] The present invention relates generally to the field of wireless communications, and relates more specifically to a method for mapping downlink dedicated pilots to resource elements in Extended Cyclic Prefix (Extended CP) frame structure in a Long Term Evolution (LTE) system.

BACKGROUND

[0002] In the 3rd Generation Partnership Project (3GPP) TR 36.211 which is an existing version of the Long Term Evolution (LTE) standard, a single layer beamforming technique is supported. In a conventional beamforming, more than 6 transmitting antennas are usually used, however, only four ports cell-specific reference signals are defined in the existing version of the LTE standard, and are adopted in practical application, and channel information of each antenna port is extracted by a corresponding cell-specific reference signals, therefore, it is impossible to acquire the real channel information of each antenna with more than 4 antennas configuration.

[0003] If the number of cell-specific reference signal is increased, for example if 6 to 8 antenna ports are used for cell-specific reference signals, then the overhead of reference signals will be quite great, and there will be a difference in real channel information estimated by uplink/downlink, so the beamforming weight-value feedback information is still needed to be estimated on the real channel information.

SUMMARY

[0004] In view of the above-mentioned problems that, when more than 4 antennas are adopted at the base station for beamforming, it is impossible to acquire all desired channel information from cell-specific reference signals, and that there is a feedback overhead of beamforming weight-value, the present invention provides a method for mapping downlink dedicated pilots to resource elements in Extended CP frame structure, so as to support a beamforming with lower overhead and superior performance.

[0005] To solve the above-mentioned technical problems, the method for mapping downlink dedicated pilots to resource elements in Extended CP frame structure in the present invention, applied in the LTE system, comprises the following steps:

[0006] mapping the first downlink dedicated pilot of each port to the specific position of a physical resource block;

[0007] mapping-processing other downlink dedicated pilots of the port according to a time-domain interval, a frequency-domain interval and a preset regulation; the time-domain interval is two or three Orthogonal Frequency Division Multiplexing(OFDM) symbols, and the frequency-domain interval is two subcarriers of the same time domain.

[0008] Further, the preset regulation is: twelve subcarriers are mapped to a physical resource block in the frequency domain, four downlink dedicated pilots are mapped in a same time domain, and the dedicated pilots are two subcarriers apart.

[0009] Further, only one port of downlink dedicated pilots is transmitted in a physical resource block.

[0010] Further, the corresponding time-domain position of the specific position is the 5th orthogonal frequency division multiplexing symbol, and the corresponding frequency-domain position thereof is the same subcarrier of the first column of cell-specific reference signals in a physical resource block.

[0011] Further, a physical resource block comprises twelve subcarriers in the frequency domain, and twelve orthogonal frequency division multiplexing symbols in the time domain, and the mapping method comprises specifically:

[0012] mapping the first downlink dedicated pilot to the 5th orthogonal frequency division multiplexing symbol in the time domain, and to the Ath subcarrier in the frequency domain; mapping the second downlink dedicated pilot to the 5th orthogonal frequency division multiplexing symbol in the time domain, and to the $(A+3)^{th}$ subcarrier in the frequency domain; mapping the third downlink dedicated pilot to the 5th orthogonal frequency division multiplexing symbol in the time domain, and to the $(A+6)^{th}$ subcarrier in the frequency domain; mapping the fourth downlink dedicated pilot to the 5th orthogonal frequency division multiplexing symbol in the time domain, and to the $(A+9)^{th}$ subcarrier in the frequency domain;

[0013] mapping the fifth downlink dedicated pilot to the 8th orthogonal frequency division multiplexing symbol in the time domain, and to the Bth subcarrier in the frequency domain; mapping the sixth downlink dedicated pilot to the 8th orthogonal frequency division multiplexing symbol in the time domain, and to the $(B+3)^{th}$ subcarrier in the frequency domain; mapping the seventh downlink dedicated pilot to the 8th orthogonal frequency division multiplexing symbol in the time domain, and to the $(B+6)^{th}$ subcarrier in the frequency domain; mapping the eighth downlink dedicated pilot to the 8th orthogonal frequency division multiplexing symbol in the time domain, and to the $(B+9)^{th}$ subcarrier in the frequency domain;

[0014] mapping the ninth downlink dedicated pilot to the 12th orthogonal frequency division multiplexing symbol in the time domain, and to the Cth subcarrier in the frequency domain; mapping the tenth downlink dedicated pilot to the 12th orthogonal frequency division multiplexing symbol in the time domain, and to the $(C+3)^{th}$ subcarrier in the frequency domain; mapping the eleventh downlink dedicated pilot to the 12th orthogonal frequency division multiplexing symbol in the time domain, and to the $(C+6)^{th}$ subcarrier in the frequency domain; mapping the eighth downlink dedicated pilot to the 12th orthogonal frequency division multiplexing symbol in the time domain, and to the $(C+9)^{th}$ subcarrier in the frequency domain.

[0015] Wherein, B and C are 1 or 2 or 3.

[0016] Further, there are multiple ports of downlink dedicated pilots in a physical resource block, and the specific time-domain positions to which each port of downlink dedicated pilots is mapped in a physical resource block are located at the 5th orthogonal frequency division multiplexing symbol of the physical resource block, while the specific frequency-domain positions to which each port of downlink dedicated pilots is mapped in a physical resource block are staggered from each other.

[0017] Further, a physical resource block comprises twelve subcarriers in the frequency domain, and twelve orthogonal frequency division multiplexing symbols in the time domain, and the mapping method comprises specifically:

[0018] dividing a port of twelve downlink dedicated pilots into four groups, each group comprising four downlink dedicated pilots that are located at the same orthogonal frequency division multiplexing symbol;

[0019] in the time domain, mapping the first group of downlink dedicated pilots to the 5th orthogonal frequency division multiplexing symbol in the time domain; the second group of downlink dedicated pilots mapped to the 8th orthogonal frequency division multiplexing symbol in the time domain; the third group of downlink dedicated pilots mapped to the 11th or 12th orthogonal frequency division multiplexing symbol in the time domain;

[0020] in the frequency domain, mapping the 1st one of four downlink dedicated pilots of each group to the 1st, 2nd or 3rd subcarrier in the frequency domain, and mapping the 2nd to 4th downlink dedicated pilots to subcarriers that are two subcarriers apart from each other in order in the frequency domain.

[0021] Further, a physical resource block comprises twelve subcarriers in the frequency domain, and twelve orthogonal frequency division multiplexing symbols in the time domain, and the mapping method comprises specifically:

[0022] dividing a port of twelve downlink dedicated pilots into four groups, each group comprising four downlink dedicated pilots that are located at the same orthogonal frequency division multiplexing symbol;

[0023] in the time domain, mapping the first group of downlink dedicated pilots to the 5th orthogonal frequency division multiplexing symbol in the time domain; mapping the second group of downlink dedicated pilots to the 9th orthogonal frequency division multiplexing symbol in the time domain; and mapping the third group of downlink dedicated pilots to the 12th orthogonal frequency division multiplexing symbol in the time domain;

[0024] in the frequency domain, mapping the 1st downlink dedicated pilot of each group of 4 downlink dedicated pilots to the 1st, 2nd or 3rd subcarrier in the frequency domain, and mapping the 2nd to 4th downlink dedicated pilots to subcarriers that are 2 subcarriers apart from each other in order in the frequency domain.

[0025] Further, the 1st, 2nd, 3rd, 4th downlink dedicated pilots are all mapped to the 5th OFDM symbol in the time domain, and to the 1st, 4th, 7th, 10th subcarriers sequentially in the frequency domain;

[0026] the 5th, 6th, 7th, 8th downlink dedicated pilots are all mapped to the 8th OFDM symbol in the time domain, and to the 1st, 4th, 7th, 10th subcarriers sequentially in the frequency domain, or to the 3rd, 6th, 9th, 12th subcarriers sequentially in the frequency domain;

[0027] the 9th, 10th, 11th, 12th downlink dedicated pilots are all mapped to the 11th or 12th OFDM symbol in the time domain, and to the 1st, 4th, 7th, 10th subcarriers sequentially in the frequency domain.

[0028] Further, 1st, 2nd, 3rd, 4th downlink dedicated pilots are all mapped to the 5th OFDM symbol in the time domain, and to 1st, 4th, 7th, 10th subcarriers sequentially in the frequency domain;

[0029] the 5th, 6th, 7th, 8th downlink dedicated pilots are all mapped to the 8th OFDM symbol in the time domain, and to the 2nd, 5th, 8th, 11th subcarriers sequentially in the frequency domain;

[0030] the 9th, 10th, 11th, 12th downlink dedicated pilots are all mapped to the 11th or 12th OFDM symbol in the time domain, and to the 3rd, 6th, 9th, 12th subcarriers sequentially in the frequency domain.

[0031] Further, the 1st, 2nd, 3rd, 4th downlink dedicated pilots are all mapped to the 5th OFDM symbol in the time domain, and to the 1st, 4th, 7th, 10th subcarriers sequentially in the frequency domain;

[0032] the 5th, 6th, 7th, 8th downlink dedicated pilots are all mapped to the 9th OFDM symbol in the time domain, and to the 3rd, 6th, 9th, 12th subcarriers sequentially in the frequency domain;

[0033] the 9th, 10th, 11th, 12th downlink dedicated pilots are all mapped to the 12th OFDM symbol in the time domain, and to the 1st, 4th, 7th, 10th subcarriers sequentially in the frequency domain.

[0034] To sum up, the present invention can bring the following beneficial effects:

[0035] (1) by clarifying the position of a pilot symbol in a physical resource block, the problem that, when more than four antennas are adopted at a base station for beamforming, the cell-specific reference signals cannot acquire all channel information according to existing version of the LTE standard, is solved;

[0036] (2) by making the channel information obtained by dedicated pilots contain the real channel information and the process-weight-value of a beamforming, it is not necessary for UE to obtain the beamforming transmission-weight-value, and it is possible to avoid the feedback overhead of the beamforming weight-values;

[0037] (3) in addition, the design of the start position of dedicated pilots in the time domain raised in this method is more reasonable than that raised in previous dedicated pilot mapping methods, with superior performance based on the same overhead of reference signals;

[0038] (4) since the start position of a dedicated pilot in the frequency domain is right next to that of a cell-specific reference signals, it is convenient to guarantee consistency of position between channel information extraction and application, so as to reduce accumulated error;

[0039] (5) since dedicated pilots are distributed evenly in both the time domain and the frequency domain, the quality of channel estimation is guaranteed.

BRIEF DESCRIPTION OF THE DRAWINGS

[0040] The present invention will be further illustrated in detail with reference to the drawings and specific embodiments hereinafter.

[0041] FIG. **1** is a diagram illustrating a physical resource block that adopts the first two ports of cell-specific reference signals, according to the Extended CP frame structure regulated in 3GPP TR 36.211; in this figure:

[0042] R_0 denotes a cell-specific reference signals transmitted by antenna port 0;

[0043] R_1 denotes a cell-specific reference signals transmitted by antenna port 1;

[0044] R_2 denotes a cell-specific reference signals transmitted by antenna port 2;

[0045] R_3 denotes a cell-specific reference signals transmitted by antenna port 3;

[0046] denotes a resource element.

[0047] FIG. **2** is a flowchart illustrating the method of mapping downlink dedicated pilots to resource elements according to an embodiment of the present invention;

[0048] FIG. **3** is a diagram illustrating embodiment 1 of the method shown in FIG. **2**;

[0049] FIG. **4** is a diagram illustrating embodiment 2 of the method shown in FIG. **2**;

[0050] FIG. **5** is a diagram illustrating embodiment 3 of the method shown in FIG. **2**;

[0051] FIG. **6** is a diagram illustrating embodiment 4 of the method shown in FIG. **2**;

[0052] FIG. **7** is a diagram illustrating embodiment 5 of the method shown in FIG. **2**;

[0053] FIG. **8** is a diagram illustrating embodiment 6 of the method shown in FIG. **2**.

[0054] From FIG. **3** to FIG. **8**, denotes a downlink dedicated pilot; denotes a resource element.

DETAILED DESCRIPTION

[0055] In the existing version of the LTE standard, when more than 4 antennas are adopted at the base station for beamforming, the cell-specific reference signals cannot acquire all channel information, and there is a problem of the feedback overhead of beamforming weight-values. Considering that downlink dedicated pilots of a beamforming are weigh-processed by multiple antennas, it is applicable to incorporate multiple transmitting antennas into one antenna port by way of a weigh-process upon the multiple antennas, namely channel information of all transmitting antennas can be estimated through only one port of downlink dedicated pilots, and the downlink dedicated pilots can estimate channel information that is weigh-processed by multiple antennas, so adopting downlink dedicated pilots is a scheme of low overhead and good performance.

[0056] By clarifying the position of a pilot symbol in a physical resource block in the present invention, it is defined at which positions of the Extended CP frame structure in the LTE system should the downlink dedicated pilots be sent, and how the time-domain interval and frequency-domain interval are arranged, so that operation of downlink dedicated pilots in an LTE system is provided with a foundation, and the existing LTE version can support a beamforming with lower overhead and superior performance when applying the dedicated pilot design according to embodiments of the present invention. The above-mentioned Extended CP frame structure may be a resource block (RB) which comprises twelve subcarriers in the frequency domain, and twelve OFDM symbols in the time domain.

[0057] In addition, the method for mapping downlink dedicated pilots to resource elements in a Normal Cyclic Prefix (Normal CP) frame structure was defined at the 52nd meeting of the LTE Standard, on this basis, according to the conclusion of the meeting, the present invention provides a method for mapping downlink dedicated pilots to resource elements in Extended CP frame structure, the method being of low overhead and having good performance.

[0058] According to the method for mapping downlink dedicated pilots to resource elements in Normal CP frame structure defined at the 52nd meeting of LTE Standard, when downlink dedicated pilots of a beamforming are adopted, four ports cell-specific reference signals are inserted for all-around detection of control channels, and the mapping relation between the four ports cell-specific reference signals and the minimum physical resource block is shown in FIG. **1**. FIG. **1** shows the cell-specific reference signals and resource elements respectively transmitted by antenna ports 0 to 3.

[0059] Exemplary embodiments of the present invention will be described with reference to accompanying drawings hereinafter, and it should be understood that, the described exemplary embodiments are only used to describe and illustrate, rather than limit the present invention:

[0060] FIG. **2** is a flowchart illustrating the method of mapping downlink dedicated pilots to resource elements in Extended CP frame structure according to the present invention, which comprises the following steps:

[0061] step S**202**: frequency-domain interval configuration process—the frequency-domain interval of downlink dedicated pilots that are mapped to the same time domain is configured to be two subcarriers;

[0062] step S**204**: time-domain interval configuration process—the time-domain interval of downlink dedicated pilots that are mapped to different time domains is configured to be two or three OFDM symbols;

[0063] step S**206**: initial mapping process—the first downlink dedicated pilot is mapped to a specific position of a physical resource block, the specific position is also called the initial position which is represented by A and B, wherein, A is the frequency domain initial position, and B is the time domain initial position;

[0064] step S**208**: mapping process for other downlink dedicated pilots of the port-the mapping process is carried out according to the initial position, frequency-domain interval and time-domain interval of the first downlink dedicated pilot and the preset regulation.

[0065] The above-mentioned preset regulation is: twelve subcarriers are mapped to a physical resource block in the frequency domain, four downlink dedicated pilots of each port are mapped in the same time domain, and the downlink dedicated pilots are two subcarriers apart from each other. When there are multiple ports of downlink dedicated pilots, each port can be processed according to this method.

[0066] The process of each step mentioned above will be described in detail hereinafter:

[0067] Step S**202**: frequency-domain interval configuration process, which is also called frequency domain density configuration process.

[0068] It is determined in the present invention that, downlink dedicated pilots of each beamforming at an RB are two subcarriers apart from each other; when multiple RBs are transmitted together, frequency-domain density of dedicated pilots are distributed evenly, wherein the interval is two subcarriers.

[0069] The frequency-domain density of dedicated pilots is determined by coherent bandwidth, in order to avoid distortion of channel estimation, the lowest limit of pilot density is determined by a Nyquist sampling theorem. Because the frame structure of Extended CP is specially for the situation of large coverage, in which the frequency-selective fading of a channel becomes more serious, in order to further guarantee the performance of channel estimation, pilot symbols that are four times that adopted in the sampling theorem are adopted in the present invention, thus the frequency-domain interval of pilots S_f is as shown in formula (1):

$$S_f = \frac{1}{4*2\Delta f\tau_{max}} = \frac{1}{4*2*15\text{ kHz}*3700\text{ ns}} 2.5\text{ subcarriers} \quad \text{formula (1)}$$

in formula (1), Δf of is a subcarrier interval, τ_{max} is a maximum channel delay, which can be referred to in 3GPP TR25.996. Therefore, dedicated pilots intervals of two subcarriers in the frequency domain can completely meet the requirement of channel estimation.

[0070] Step **204**: time domain-interval configuration process, which is also called time domain density configuration process.

[0071] The time-domain density of pilot symbols is determined by coherent time, in order to avoid distortion of channel estimation, the lowest limit of pilot density is determined by the Nyquist sampling theorem. To further improve performance of channel estimation, pilot symbols that are four times that adopted in the sampling theorem are adopted in the present invention, thus the time-domain interval of pilots S_t is as shown in formula (2):

$$S_t = \frac{1}{2*2f_dT_f} = \frac{1}{2*2*648\text{ Hz}*\frac{1}{14}\text{ ms}} 5.4\ OFDM\text{ symbols} \quad \text{formula (2)}$$

[0072] in formula (2), f_d is a maximum Doppler frequency offset, it is regulated by LTE that the maximum moving speed of UE is 350 km/h, herein, f_d=648 Hz. T_f is a time of OFDM symbol. Intervals between downlink dedicated pilots are two to three OFDM symbols, which can meet the requirement of channel estimation under high speed.

[0073] After the above-mentioned time-domain and frequency-domain intervals configuration processes, dedicated pilots are evenly distributed in both time domain and frequency domain, which can guarantee the quality of channel estimation.

[0074] Step S**206**: initial mapping process;

[0075] in this step, D is set to be the time domain initial position, while A is set to be: at the same position as the subcarrier where the first cell-specific reference signals of each OFDM symbol of the smallest physical resource block is located, namely, A is located at the same subcarrier as the first column of cell-specific reference signals of a resource block.

[0076] Preferably, A=1 and D=5, namely, the mapped initial position of the first downlink dedicated pilot in the frequency domain is set to be the first subcarrier, while the mapped position in the time domain is the 5th OFDM symbol. This design of initial position of dedicated pilot is more reasonable than that raised previously in other methods for mapping dedicated pilots, with better performance under the same pilot overhead.

[0077] (1) Start Position in the Frequency Domain

[0078] The first row of downlink dedicated pilots of a beamforming starts from the first subcarrier in the frequency domain, start position of dedicated pilots and that of cell-specific reference signals are the same, beamforming weight-values are obtained by uplink or downlink cell-specific reference signals through estimating the real channels, so that pilots of adjacent positions will resume channel information more accurately.

[0079] (2) Start Position in the Time Domain

[0080] Start position of downlink dedicated pilots in the time domain is at the fifth OFDM symbol, so that the dedicated pilots are distributed evenly in a physical block, which can bring better channel estimating performance.

[0081] Step S**208**, in this step, four downlink dedicated pilots are mapped in the same time domain.

[0082] Frequency domain position of dedicated pilot is the same as that of the cell-specific reference signals, which is helpful to improve performance of channel estimation interpolation; and the consistency of channel information extraction and applied position during a beamforming procedure is guaranteed, which can reduce accumulated error.

[0083] 1. According to the above-mentioned method, when there is one port of the downlink dedicated pilots corresponding to a single beam, the mapping method comprises:

[0084] the corresponding position of the initial position in the time domain is at the 5th OFDM symbol, while the position in the frequency domain is set to be the same subcarrier of the first column of cell-specific reference signals in a physical resource block.

[0085] The physical resource block comprises twelve subcarriers in the frequency domain, which are the 1st to 12th subcarriers, as well as twelve OFDM symbols in the time domain, which are the 1st to the 12th OFDM symbols.

[0086] One port of twelve downlink dedicated pilots are divided into four groups in this mapping method, and each group comprises 4 downlink dedicated pilots that are located at the same OFDM symbol.

[0087] in the time domain, the first group of downlink dedicated pilots is mapped to the 5th OFDM symbol in the time domain, the second group of downlink dedicated pilots is mapped to the 8th OFDM symbol in the time domain, and the third group of downlink dedicated pilots is mapped to the 11th or 12th OFDM symbol in the time domain; or, the first group of downlink dedicated pilots is mapped to the 5th OFDM symbol in the time domain, the second group of downlink dedicated pilots is mapped to the 9th OFDM symbol in the time domain, and the third group of downlink dedicated pilots is mapped to the 12th OFDM symbol in the time domain.

[0088] in the frequency domain, the 1st one of four downlink dedicated pilots in one group is mapped to the 1st, 2nd or 3rd subcarrier in the frequency domain, while the 2nd to 4th downlink dedicated pilots are mapped to subcarriers that are two subcarriers apart from each other in order in the frequency domain.

[0089] Specifically:

[0090] the first downlink dedicated pilot is mapped to the 5th OFDM symbol in the time domain, while to the Ath subcarrier in the frequency domain; the second downlink dedicated pilot is mapped to the 5th OFDM symbol in the time domain, while to the $(A+3)^{th}$ subcarrier in the frequency domain; the third downlink dedicated pilot is mapped to the 5th OFDM symbol in the time domain, while to the $(A+6)^{th}$ subcarrier in the frequency domain; the fourth downlink dedicated pilot is mapped to the 5th OFDM symbol in the time domain, while to the $(A+9)^{th}$ subcarrier in the frequency domain, wherein A=1, 2 or 3;

[0091] the fifth downlink dedicated pilot is mapped to the 8th OFDM symbol in the time domain, while to the Bth subcarrier in the frequency domain; the sixth downlink dedicated pilot is mapped to the 8th OFDM symbol in the time domain, while to the $(B+3)^{th}$ subcarrier in the frequency domain; the seventh downlink dedicated pilot is mapped to the 8th OFDM symbol in the time domain, while to the $(B+6)^{th}$ subcarrier in

the frequency domain; the eighth downlink dedicated pilot is mapped to the 8th OFDM symbol in the time domain, while to the $(B+9)^{th}$ subcarrier in the frequency domain, wherein B=1, 2 or 3;

[0092] the ninth downlink dedicated pilot is mapped to the 11th or 12th OFDM symbol in the time domain, while to the Cth subcarrier in the frequency domain; the tenth downlink dedicated pilot is mapped to the 11th or 12th OFDM symbol in the time domain, while to the $(C+3)^{th}$ subcarrier in the frequency domain; the eleventh downlink dedicated pilot is mapped to the 11th or 12th OFDM symbol in the time domain, while to the $(C+6)^{th}$ subcarrier in the frequency domain; the eighth downlink dedicated pilot is mapped to the 11th or 12th OFDM symbol in the time domain, while to the $(C+9)^{th}$ subcarrier in the frequency domain, wherein C=1, 2 or 3.

[0093] A, B and C can be chosen from 1 to 3.

[0094] In addition, the fifth, sixth, seventh and eighth downlink dedicated pilots can also be mapped to the 9th OFDM symbol in the time domain, and mapping in the frequency domain is the same as above. Accordingly, the ninth, tenth, eleventh and twelfth downlink dedicated pilots are mapped to the 12th OFDM symbol in the time domain, and mapping in the frequency domain is the same as above.

[0095] The above-mentioned downlink dedicated pilots should be configured in a manner which avoids the cell-specific reference signals.

[0096] 2. There are multiple ports of downlink dedicated pilots (generally no more than 3 ports), corresponding to multiple beams;

[0097] corresponding positions in the time domain of all ports' initial positions are same, located at the 5th OFDM symbol, while corresponding positions in the frequency domain are staggered (frequency-domain position of the first port's initial position can be set to the same subcarrier as that of the first column of cell-specific reference signals in a physical resource block, while initial positions of other ports are staggered with that of the first).

[0098] According to the above steps and design principle, method of the present invention will be further illustrated in detail with reference to some embodiments hereinafter:

Embodiment 1

[0099] as shown in FIG. **3**, since A=1 and D=5, in this embodiment of the present invention, downlink dedicated pilots are mapped to the 5th, 8th and 11th OFDM symbols respectively in the time domain.

[0100] On such a basis, the operation in step S**208** of mapping other downlink dedicated pilots is specifically:

[0101] the second downlink dedicated pilot is mapped to the 5th OFDM symbol in the time domain, while to the $(A+3=4)^{th}$ subcarrier in the frequency domain;

[0102] the third downlink dedicated pilot is mapped to the 5th OFDM symbol in the time domain, while to the $(A+6=7)^{th}$ subcarrier in the frequency domain;

[0103] the fourth downlink dedicated pilot is mapped to the 5th OFDM symbol in the time domain, while to the $(A+9=10)^{th}$ subcarrier in the frequency domain;

[0104] the fifth downlink dedicated pilot is mapped to the 8th OFDM symbol in the time domain, while to the $(B=3)^{th}$ subcarrier in the frequency domain;

[0105] the sixth downlink dedicated pilot is mapped to the 8th OFDM symbol in the time domain, while to the $(B+3=6)^{th}$ subcarrier in the frequency domain;

[0106] the seventh downlink dedicated pilot is mapped to the 8th OFDM symbol in the time domain, while to the $(B+6=9)^{th}$ subcarrier in the frequency domain;

[0107] the eighth downlink dedicated pilot is mapped to the 8th OFDM symbol in the time domain, while to the $(B+9=12)^{th}$ subcarrier in the frequency domain;

[0108] the ninth downlink dedicated pilot is mapped to the 11th OFDM symbol in the time domain, while to the $(C=1)^{th}$ subcarrier in the frequency domain;

[0109] the tenth downlink dedicated pilot is mapped to the 11th OFDM symbol in the time domain, while to the $(C+3=4)^{th}$ subcarrier in the frequency domain;

[0110] the eleventh downlink dedicated pilot is mapped to the 11th OFDM symbol in the time domain, while to the $(C+6=7)^{th}$ subcarrier in the frequency domain;

[0111] the twelfth downlink dedicated pilot is mapped to the 11th OFDM symbol in the time domain, while to the $(C+9=10)^{th}$ subcarrier in the frequency domain.

Embodiment 2

[0112] as shown in FIG. **4**, since A=1 and B=5, in this embodiment of the present invention, downlink dedicated pilots are mapped to the 5th, 8th and 12th OFDM symbols respectively in the time domain.

[0113] On such a basis, the operation in step S**208** of mapping other downlink dedicated pilots is specifically:

[0114] the second downlink dedicated pilot is mapped to the 5th OFDM symbol in the time domain, while to the $(A+3=4)^{th}$ subcarrier in the frequency domain;

[0115] the third downlink dedicated pilot is mapped to the 5th OFDM symbol in the time domain, while to the $(A+6=7)^{th}$ subcarrier in the frequency domain;

[0116] the fourth downlink dedicated pilot is mapped to the 5th OFDM symbol in the time domain, while to the $(A+9=10)^{th}$ subcarrier in the frequency domain;

[0117] the fifth downlink dedicated pilot is mapped to the 8th OFDM symbol in the time domain, while to the $(A=1)^{th}$ subcarrier in the frequency domain;

[0118] the sixth downlink dedicated pilot is mapped to the 8th OFDM symbol in the time domain, while to the $(A+3=4)^{th}$ subcarrier in the frequency domain;

[0119] the seventh downlink dedicated pilot is mapped to the 8th OFDM symbol in the time domain, while to the $(A+6=7)^{th}$ subcarrier in the frequency domain;

[0120] the eighth downlink dedicated pilot is mapped to the 8th OFDM symbol in the time domain, while to the $(A+9=10)^{th}$ subcarrier in the frequency domain;

[0121] the ninth downlink dedicated pilot is mapped to the 12th OFDM symbol in the time domain, while to the $(A=1)^{th}$ subcarrier in the frequency domain;

[0122] the tenth downlink dedicated pilot is mapped to the 12th OFDM symbol in the time domain, while to the $(A+3=4)^{th}$ subcarrier in the frequency domain;

[0123] the eleventh downlink dedicated pilot is mapped to the 12th OFDM symbol in the time domain, while to the $(A+6=7)^{th}$ subcarrier in the frequency domain;

[0124] the twelfth downlink dedicated pilot is mapped to the 12th OFDM symbol in the time domain, while to the $(A+9=10)^{th}$ subcarrier in the frequency domain.

Embodiment 3

[0125] as shown in FIG. **5**, since A=1 and D=5, in this embodiment of the present invention, downlink dedicated

pilots are mapped to the 5th, 9th and 12th OFDM symbols respectively in the time domain.

[0126] On such a basis, the operation in step S**208** of mapping other downlink dedicated pilots is specifically:

[0127] the second downlink dedicated pilot is mapped to the 5th OFDM symbol in the time domain, while to the $(A+3=4)^{th}$ subcarrier in the frequency domain;

[0128] the third downlink dedicated pilot is mapped to the 5th OFDM symbol in the time domain, while to the $(A+6=7)^{th}$ subcarrier in the frequency domain;

[0129] the fourth downlink dedicated pilot is mapped to the 5th OFDM symbol in the time domain, while to the $(A+9=10)^{th}$ subcarrier in the frequency domain;

[0130] the fifth downlink dedicated pilot is mapped to the 9th OFDM symbol in the time domain, while to the $(B=3)^{th}$ subcarrier in the frequency domain;

[0131] the sixth downlink dedicated pilot is mapped to the 9th OFDM symbol in the time domain, while to the $(B+3=6)^{th}$ subcarrier in the frequency domain;

[0132] the seventh downlink dedicated pilot is mapped to the 9th OFDM symbol in the time domain, while to the $(B+6=9)^{th}$ subcarrier in the frequency domain;

[0133] the eighth downlink dedicated pilot is mapped to the 9th OFDM symbol in the time domain, while to the $(B+9=12)^{th}$ subcarrier in the frequency domain;

[0134] the ninth downlink dedicated pilot is mapped to the 12th OFDM symbol in the time domain, while to the $(C=1)^{th}$ subcarrier in the frequency domain;

[0135] the tenth downlink dedicated pilot is mapped to the 12th OFDM symbol in the time domain, while to the $(C+3=4)^{th}$ subcarrier in the frequency domain;

[0136] the eleventh downlink dedicated pilot is mapped to the 12th OFDM symbol in the time domain, while to the $(C+6=7)^{th}$ subcarrier in the frequency domain;

[0137] the twelfth downlink dedicated pilot is mapped to the 12th OFDM symbol in the time domain, while to the $(C+9=10)^{th}$ subcarrier in the frequency domain.

Embodiment 4

[0138] as shown in FIG. **6**, since A=1 and D=5, in this embodiment of the present invention, downlink dedicated pilots are mapped to the 5th, 8th and 12th OFDM symbols respectively in the time domain.

[0139] On such a basis, the operation in step S**208** of mapping other downlink dedicated pilots is specifically:

[0140] the second downlink dedicated pilot is mapped to the 5th OFDM symbol in the time domain, while to the $(A+3=4)^{th}$ subcarrier in the frequency domain;

[0141] the third downlink dedicated pilot is mapped to the 5th OFDM symbol in the time domain, while to the $(A+6=7)^{th}$ subcarrier in the frequency domain;

[0142] the fourth downlink dedicated pilot is mapped to the 5th OFDM symbol in the time domain, while to the $(A+9=10)^{th}$ subcarrier in the frequency domain;

[0143] the fifth downlink dedicated pilot is mapped to the 8th OFDM symbol in the time domain, while to the $(B=3)^{th}$ subcarrier in the frequency domain;

[0144] the sixth downlink dedicated pilot is mapped to the 8th OFDM symbol in the time domain, while to the $(B+3=6)^{th}$ subcarrier in the frequency domain;

[0145] the seventh downlink dedicated pilot is mapped to the 8th OFDM symbol in the time domain, while to the $(B+6=9)^{th}$ subcarrier in the frequency domain;

[0146] the eighth downlink dedicated pilot is mapped to the 8th OFDM symbol in the time domain, while to the $(B+9=12)^{th}$ subcarrier in the frequency domain;

[0147] the ninth downlink dedicated pilot is mapped to the 12th OFDM symbol in the time domain, while to the $(C=1)^{th}$ subcarrier in the frequency domain;

[0148] the tenth downlink dedicated pilot is mapped to the 12th OFDM symbol in the time domain, while to the $(C+3=4)^{th}$ subcarrier in the frequency domain;

[0149] the eleventh downlink dedicated pilot is mapped to the 12th OFDM symbol in the time domain, while to the $(C+6=7)^{th}$ subcarrier in the frequency domain;

[0150] the twelfth downlink dedicated pilot is mapped to the 12th OFDM symbol in the time domain, while to the $(C+9=10)^{th}$ subcarrier in the frequency domain.

Embodiment 5

[0151] as shown in FIG. **7**, since A=1 and D=5, in this embodiment of the present invention, downlink dedicated pilots are mapped to the 5th, 8th and 11th OFDM symbols respectively in the time domain.

[0152] On such a basis, the operation in step S**208** of mapping other downlink dedicated pilots is specifically:

[0153] the second downlink dedicated pilot is mapped to the 5th OFDM symbol in the time domain, while to the $(A+3=4)^{th}$ subcarrier in the frequency domain;

[0154] the third downlink dedicated pilot is mapped to the 5th OFDM symbol in the time domain, while to the $(A+6=7)^{th}$ subcarrier in the frequency domain;

[0155] the fourth downlink dedicated pilot is mapped to the 5th OFDM symbol in the time domain, while to the $(A+9=10)^{th}$ subcarrier in the frequency domain;

[0156] the fifth downlink dedicated pilot is mapped to the 8th OFDM symbol in the time domain, while to the $(B=2)^{th}$ subcarrier in the frequency domain;

[0157] the sixth downlink dedicated pilot is mapped to the 8th OFDM symbol in the time domain, while to the $(B+3=5)^{th}$ subcarrier in the frequency domain;

[0158] the seventh downlink dedicated pilot is mapped to the 8th OFDM symbol in the time domain, while to the $(B+6=8)^{th}$ subcarrier in the frequency domain;

[0159] the eighth downlink dedicated pilot is mapped to the 8th OFDM symbol in the time domain, while to the $(B+9=11)^{th}$ subcarrier in the frequency domain;

[0160] the ninth downlink dedicated pilot is mapped to the 11th OFDM symbol in the time domain, while to the $(C=3)^{th}$ subcarrier in the frequency domain;

[0161] the tenth downlink dedicated pilot is mapped to the 11th OFDM symbol in the time domain, while to the $(C+3=6)^{th}$ subcarrier in the frequency domain;

[0162] the eleventh downlink dedicated pilot is mapped to the 11th OFDM symbol in the time domain, while to the $(C+6=9)^{th}$ subcarrier in the frequency domain;

[0163] the twelfth downlink dedicated pilot is mapped to the 11th OFDM symbol in the time domain, while to the $(C+9=12)^{th}$ subcarrier in the frequency domain.

Embodiment 6

[0164] as shown in FIG. **8**, since A=1 and D=5, in this embodiment of the present invention, downlink dedicated pilots are mapped to the 5th, 8th and 11th OFDM symbols respectively in the time domain.

[0165] On such a basis, the operation in step S**208** of mapping other downlink dedicated pilots is specifically:

[0166] the second downlink dedicated pilot is mapped to the 5th OFDM symbol in the time domain, and to the $(A+3=4)^{th}$ subcarrier in the frequency domain;

[0167] the third downlink dedicated pilot is mapped to the 5th OFDM symbol in the time domain, while to the $(A+6=7)^{th}$ subcarrier in the frequency domain;

[0168] the fourth downlink dedicated pilot is mapped to the 5th OFDM symbol in the time domain, while to the $(A+9=10)^{th}$ subcarrier in the frequency domain;

[0169] the fifth downlink dedicated pilot is mapped to the 8th OFDM symbol in the time domain, while to the $(B=1)^{th}$ subcarrier in the frequency domain;

[0170] the sixth downlink dedicated pilot is mapped to the 8th OFDM symbol in the time domain, while to the $(B+3=4)^{th}$ subcarrier in the frequency domain;

[0171] the seventh downlink dedicated pilot is mapped to the 8th OFDM symbol in the time domain, while to the $(B+6=7)^{th}$ subcarrier in the frequency domain;

[0172] the eighth downlink dedicated pilot is mapped to the 8th OFDM symbol in the time domain, while to the $(B+9=10)^{th}$ subcarrier in the frequency domain;

[0173] the ninth downlink dedicated pilot is mapped to the 11th OFDM symbol in the time domain, while to the $(C=1)^{th}$ subcarrier in the frequency domain;

[0174] the tenth downlink dedicated pilot is mapped to the 11th OFDM symbol in the time domain, while to the $(C+3=4)^{th}$ subcarrier in the frequency domain;

[0175] the eleventh downlink dedicated pilot is mapped to the 11th OFDM symbol in the time domain, while to the $(C+6=7)^{th}$ subcarrier in the frequency domain;

[0176] the twelfth downlink dedicated pilot is mapped to the 11th OFDM symbol in the time domain, while to the $(C+9=10)^{th}$ subcarrier in the frequency domain.

[0177] It can be seen from the above description that, in the present invention, by presetting the frequency-domain interval and time-domain interval, and by determining the position of the first downlink dedicated pilot (start position in the frequency domain and start position in the time domain), and according to the preset regulation, the position of a pilot symbol in a physical resource block can be determined.

[0178] The downlink dedicated pilot structure supports any number of antennas as well as a single layer beamforming of antenna spacing. Downlink dedicated pilots are distinguished by beams, and the present invention concerns itself with a single-beamforming, so the dedicated pilot structure provided by embodiments of the present invention comprises only one port of dedicated pilots, as to those skilled in the art, the situation of multiple beams can be deduced according to relevant pilot density, for example, two ports of dedicated pilots are adopted in two beams, and the rest can be done in the same manner.

[0179] The present invention is not limited to the above described exemplary embodiments. For those skilled in the art, various modifications and changes can be made to the present invention. Any modification, equivalent substitute and improvement within the spirit of the present invention is deemed to be included within the scope of the present invention, as defined by the claims.

What is claimed is:

1. A method for mapping downlink dedicated pilots to resource elements in Extended Cyclic Prefix (Extended CP) frame structure, applied in a Long Term Evolution (LTE) system, comprising the following steps:

mapping the first downlink dedicated pilot of each port to the specific position of a physical resource block;

mapping-processing other downlink dedicated pilots of the port according to the time-domain interval, frequency-domain interval and the preset regulation; and

the time-domain interval being two or three Orthogonal Frequency Division Multiplexing symbols, and the frequency-domain interval being two subcarriers in the same time domain.

2. The mapping method according to claim **1**, wherein, the preset regulation is: 12 subcarriers are mapped to the physical resource blocks in the frequency domain, while one port of four downlink dedicated pilots is mapped in the same time domain, and the dedicated pilots are two subcarriers apart from each other.

3. The mapping method according to claim **1**, wherein, only one port of downlink dedicated pilots is transmitted in the physical resource block.

4. The mapping method according to claim **3**, wherein, the corresponding time-domain position of the specific position is the 5th orthogonal frequency division multiplexing symbol, and the corresponding frequency-domain position thereof is the same subcarrier of the first column of cell-specific reference signals in the physical resource block.

5. The mapping method according to claim **3**, wherein, the physical resource block comprises twelve subcarriers in the frequency domain, and twelve orthogonal frequency division multiplexing symbols in the time domain, the mapping method comprises specifically:

mapping the first downlink dedicated pilot to the 5th orthogonal frequency division multiplexing symbol in the time domain, and to the Ath subcarrier in the frequency domain; mapping the second downlink dedicated pilot to the 5th orthogonal frequency division multiplexing symbol in the time domain, and to the $(A+3)^{th}$ subcarrier in the frequency domain; mapping the third downlink dedicated pilot to the 5th orthogonal frequency division multiplexing symbol in the time domain, and to the $(A+6)^{th}$ subcarrier in the frequency domain; mapping the fourth downlink dedicated pilot to the 5th orthogonal frequency division multiplexing symbol in the time domain, and to the $(A+9)^{th}$ subcarrier in the frequency domain;

mapping the fifth downlink dedicated pilot to the 8th orthogonal frequency division multiplexing symbol in the time domain, and to the Bth subcarrier in the frequency domain; mapping the sixth downlink dedicated pilot to the 8th orthogonal frequency division multiplexing symbol in the time domain, and to the $(B+3)^{th}$ subcarrier in the frequency domain; mapping the seventh downlink dedicated pilot to the 8th orthogonal frequency division multiplexing symbol in the time domain, and to the $(B+6)^{th}$ subcarrier in the frequency domain; mapping the eighth downlink dedicated pilot to the 8th orthogonal frequency division multiplexing symbol in the time domain, and to the $(B+9)^{th}$ subcarrier in the frequency domain;

mapping the ninth downlink dedicated pilot to the 12th orthogonal frequency division multiplexing symbol in the time domain, and to the Cth subcarrier in the frequency domain; mapping the tenth downlink dedicated pilot to the 12th orthogonal frequency division multi-

plexing symbol in the time domain, and to the $(C+3)^{th}$ subcarrier in the frequency domain; mapping the eleventh downlink dedicated pilot to the 12th orthogonal frequency division multiplexing symbol in the time domain, and to the $(C+6)^{th}$ subcarrier in the frequency domain; mapping the twelfth downlink dedicated pilot to the 12th orthogonal frequency division multiplexing symbol in the time domain, and to the $(C+9)^{th}$ subcarrier in the frequency domain;

wherein, B and C equal to 1 or 2 or 3.

6. The mapping method according to claim **1**, wherein, there are multiple ports of downlink dedicated pilots in the physical resource block, and the specific time-domain positions to which each port of downlink dedicated pilots is mapped in the physical resource block are located at the 5th orthogonal frequency division multiplexing symbol of the physical resource block, while the specific frequency-domain positions to which every port of downlink dedicated pilots is mapped in a physical resource block being staggered from one another.

7. The mapping method according to claim **3**, wherein, the physical resource block comprises twelve subcarriers in the frequency domain, and twelve orthogonal frequency division multiplexing symbols in the time domain, and the mapping method comprises specifically:

dividing a port of twelve downlink dedicated pilots into three groups, each group comprising four downlink dedicated pilots that are located at the same orthogonal frequency division multiplexing symbol;

in the time domain, mapping the first group of downlink dedicated pilots to the 5th orthogonal frequency division multiplexing symbol in the time domain; mapping the second group of downlink dedicated pilots to the 8th orthogonal frequency division multiplexing symbol in the time domain; and mapping the third group of downlink dedicated pilots to the 11th or 12th orthogonal frequency division multiplexing symbol in the time domain;

in the frequency domain, mapping the 1st one of 4 downlink dedicated pilots in each group to the 1st or 2nd or 3rd subcarrier in the frequency domain, and mapping the 2nd to 4th downlink dedicated pilots to subcarriers that are two subcarriers apart from each other in order in the frequency domain.

8. The mapping method according to claim **3**, wherein, the physical resource block comprises twelve subcarriers in the frequency domain, and twelve orthogonal frequency division multiplexing symbols in the time domain, and the mapping method comprises specifically:

dividing a port of twelve downlink dedicated pilots into three groups, each group comprising four downlink dedicated pilots that are located at the same orthogonal frequency division multiplexing symbol;

in the time domain, mapping the first group of downlink dedicated pilots to the 5th orthogonal frequency division multiplexing symbol in the time domain; mapping the second group of downlink dedicated pilots to the 9th orthogonal frequency division multiplexing symbol in the time domain; and mapping the third group of downlink dedicated pilots to the 12th orthogonal frequency division multiplexing symbol in the time domain;

in the frequency domain, mapping the 1st one of four downlink dedicated pilots in each group to the 1st, 2nd or 3rd subcarrier in the frequency domain, and mapping the 2nd to 4th downlink dedicated pilots to subcarriers that are two subcarriers apart from each other in order in the frequency domain.

9. The mapping method according to claim **7**, wherein:

the 1st, 2nd, 3rd, 4th downlink dedicated pilots are all mapped to the 5th OFDM symbol in the time domain, and to the 1st, 4th, 7th, 10th subcarriers sequentially in the frequency domain;

the 5th, 6th, 7th, 8th downlink dedicated pilots are all mapped to the 8th OFDM symbol in the time domain, and to the 1st, 4th, 7th, 10th subcarriers sequentially in the frequency domain, or to the 3rd, 6th, 9th, 12th subcarriers sequentially in the frequency domain;

the 9th, 10th, 11th, 12th downlink dedicated pilots are all mapped to the 11th or 12th OFDM symbol in the time domain, and to the 1st, 4th, 7th, 10th subcarriers sequentially in the frequency domain.

10. The mapping method according to claim **7**, wherein:

the 1st, 2nd, 3rd, 4th downlink dedicated pilots are all mapped to the 5th OFDM symbol in the time domain, and to the 1st, 4th, 7th, 10th subcarriers sequentially in the frequency domain;

the 5th, 6th, 7th, 8th downlink dedicated pilots are all mapped to the 8th OFDM symbol in the time domain, and to the 2nd, 5th, 8th, 11th subcarriers sequentially in the frequency domain;

the 9th, 10th, 11th, 12th downlink dedicated pilots are all mapped to the 11th or 12th OFDM symbol in the time domain, and to the 3rd, 6th, 9th, 12th subcarriers sequentially in the frequency domain.

11. The mapping method according to claim **8**, wherein:

the 1st, 2nd, 3rd, 4th downlink dedicated pilots are all mapped to the 5th OFDM symbol in the time domain, and to the 1st, 4th, 7th, 10th subcarriers sequentially in the frequency domain;

the 5th, 6th, 7th, 8th downlink dedicated pilots are all mapped to the 9th OFDM symbol in the time domain, and to the 3rd, 6th, 9th, 12th subcarriers sequentially in the frequency domain;

the 9th, 10th, 11th, 12th downlink dedicated pilots are all mapped to the 12th OFDM symbol in the time domain, and to the 1st, 4th, 7th, 10th subcarriers sequentially in the frequency domain.

12. The mapping method according to claim **2**, wherein, only one port of downlink dedicated pilots is transmitted in the physical resource block.

13. The mapping method according to claim **2**, wherein, there are multiple ports of downlink dedicated pilots in the physical resource block, and the specific time-domain positions to which each port of downlink dedicated pilots is mapped in the physical resource block are located at the 5th orthogonal frequency division multiplexing symbol of the physical resource block, while the specific frequency-domain positions to which every port of downlink dedicated pilots is mapped in a physical resource block being staggered from one another.

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