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(54) **METHOD FOR GENERATION OF CYCLIC SHIFT AMOUNT SET AND METHOD FOR GENERATION OF RANDOM ACCESS PREAMBLE**

(75) Inventors: **Peng Hao**, Shenzhen (CN); **Bin Yu**, Shenzhen (CN); **Shuqiang Xia**, Shenzhen (CN); **Bo Dai**, Shenzhen (CN); **Chunli Liang**, Shenzhen (CN)

Correspondence Address:
Oppedahl Patent Law Firm, LLC- China Pat
P O Box 5940
Dillon, CO 80435-5940 (US)

(73) Assignee: **ZTE CORPORATION**, Shenzhen, Guangdong (CN)

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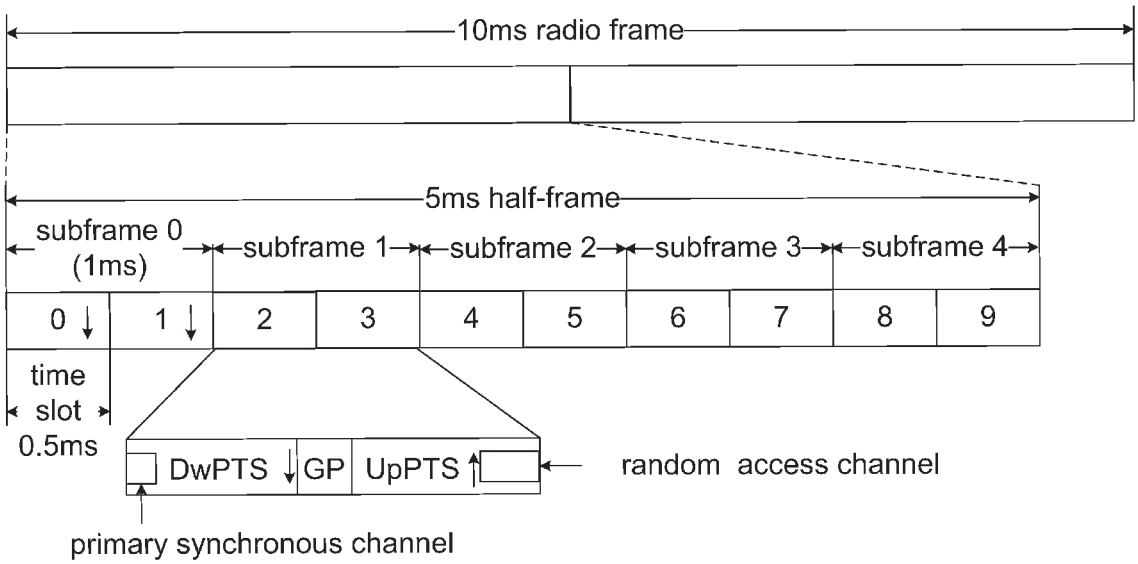
(57) **ABSTRACT**

A Method for generation of Ncs set and a method for generation of random access preamble are disclosed. The method for generation of Ncs set comprises the following steps: determine an upper limit value Ncs_max of Ncs according to a maximum cell radius value which is required to be supported by a random access channel RACH, and select Ncs values which are less than or equal to the Ncs_max to be elements of an initial Ncs set; calculate a root sequence number Nr corresponding to each element in the initial Ncs set according to formula $Nr=\lceil M/\lfloor Npre/Ncs \rfloor \rceil$; and delete elements in the initial Ncs set which have the same Nr value with other elements so as to generate a screening Ncs set in which each element has a different Nr value; if N, the number of the elements in the screening Ncs set, is greater than P, the number of maximum Ncs supported by the system, then delete N−P elements from the set so as to generate a final Ncs set; else regard the screening Ncs set as the final Ncs set; wherein, M is a preamble number required by each cell, and Npre is the length of preamble sequence.



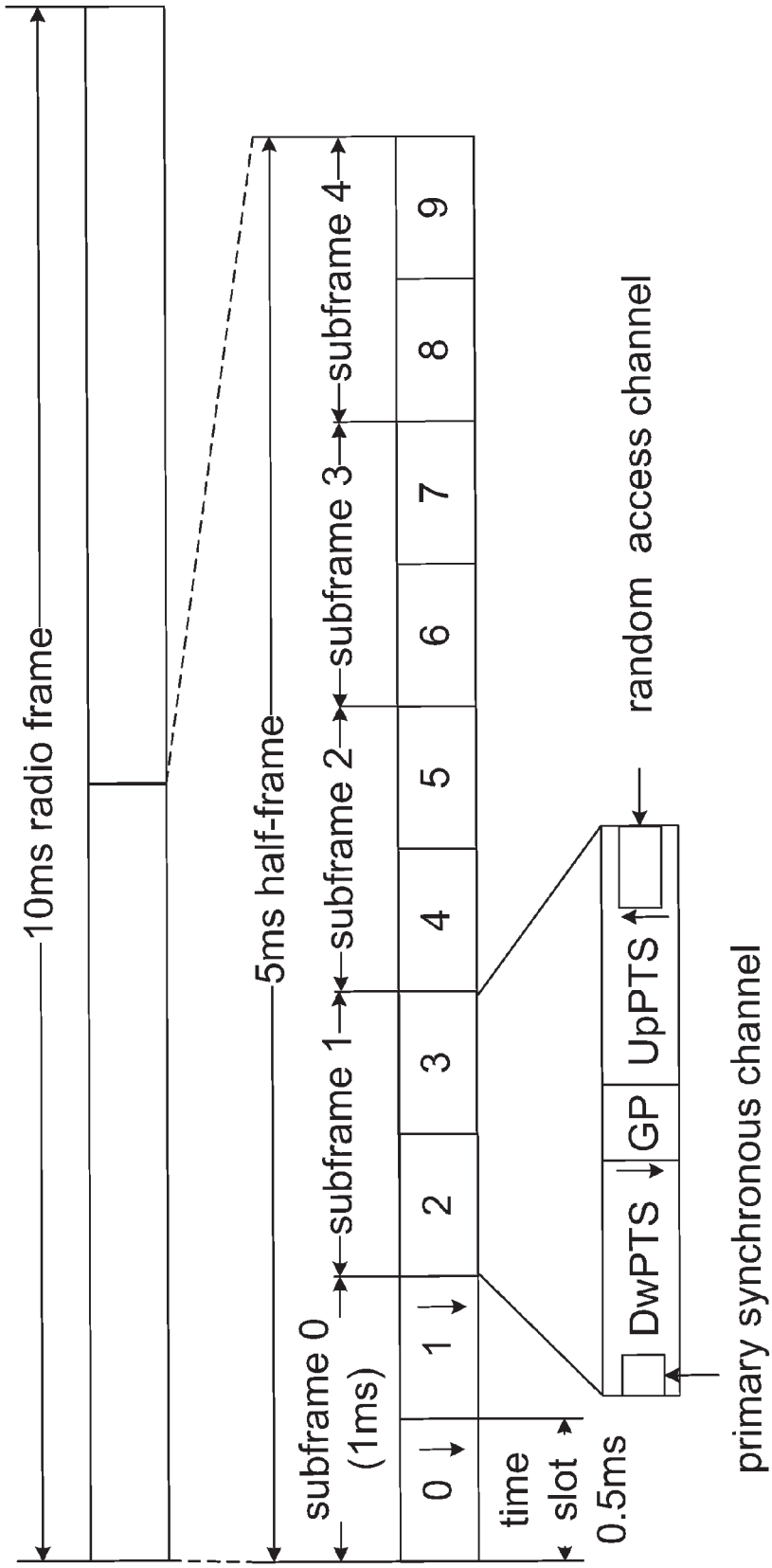
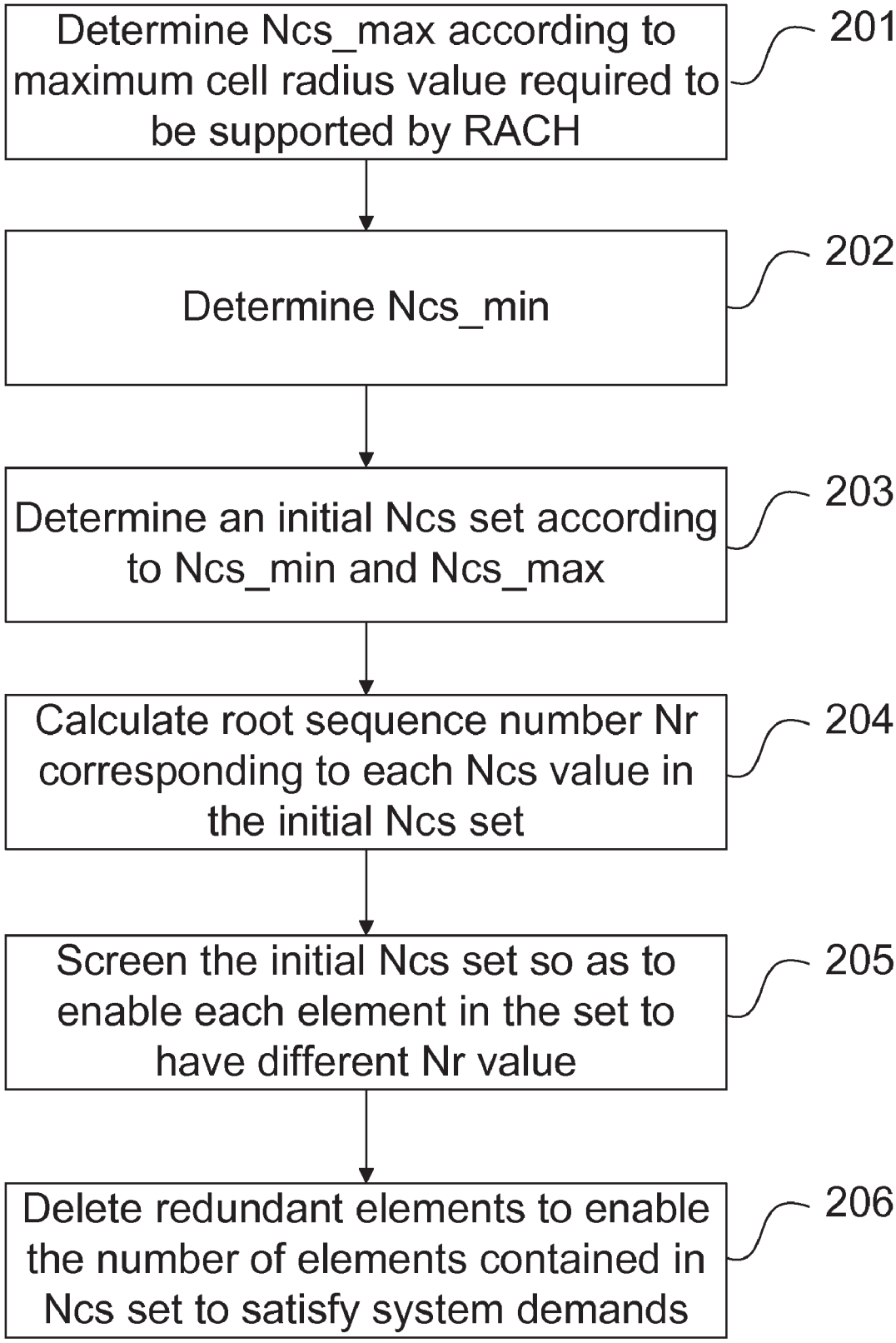

10ms radio frame
5ms half-frame
subframe 0
(1ms)
subframe 1
subframe 2
subframe 3
subframe 4
0
1
2
3
4
5
6
7
8
9
time
slot
0.5ms
DwPTS
GP
UpPTS
primary synchronous channel
random access channel

Fig. 1

Fig. 2


Determine Ncs_max according to maximum cell radius value required to be supported by RACH
201
Determine Ncs_min
202
Determine an initial Ncs set according to Ncs_min and Ncs_max
203
Calculate root sequence number Nr corresponding to each Ncs value in the initial Ncs set
204
Screen the initial Ncs set so as to enable each element in the set to have different Nr value
205
Delete redundant elements to enable the number of elements contained in Ncs set to satisfy system demands
206

METHOD FOR GENERATION OF CYCLIC SHIFT AMOUNT SET AND METHOD FOR GENERATION OF RANDOM ACCESS PREAMBLE

TECHNICAL FIELD

[0001] The present invention relates to a method for generation of cyclic shift amount set and a method for generation of random access preamble of random access channel in wireless communication system.

BACKGROUND

[0002] FIG. **1** is a frame structure of Time Division Duplex (TDD) mode in Long Term Evolution (LTE) system. In the frame structure, a 10 ms radio frame is divided into two half-frames, and each half-frame is divided into 10 time slots (number from 0 to 9) with a length of 0.5 ms respectively, and two time slots constitute a subframe with a length of 1 ms, and each half-frame consists of five subframes (number from 0 to 4). Wherein, subframe **0** is fixedly used for downlink, and subframe **1** is a special subframe containing 3 particular time slots, which are Downlink Pilot Time Slot (DwPTS), Guard Period (GP) and Uplink Pilot Time Slot (UpPTS) repectively. The former n subframes after subframe **1** are used for uplink transmission ($1 \leqq n \leqq 3$), and the latter 3-n subframes are used for downlink transmission. Random access channel may be transmitted either in the UpPTS or in other uplink subframes, but the structures of this two random access channels are different.

[0003] In the LTE system, Random Access Channel (RACH) uses cyclic shift sequences of Zadoff-Chu (ZC) sequence as preamble, and these cyclic shift sequences can also be called Zero Correlation Zone (ZCZ) sequences.

[0004] In the LTE system, mobile phone first executes downlink synchronization after being turned on, and then begins to detect Broadcast Channel (BCH). Base station informs the mobile phone via the BCH about the available index of the first ZC sequence and step size of cyclic shift (i.e. cyclic shift amount) of the RACH in the cell, and the mobile phone uses a certain mapping rule to calculate sequence numbers of corresponding ZC sequences according to the index, and then generates available ZCZ sequences according to cyclic shift step size and a certain cyclic shift restriction rule. If the amount of the ZCZ sequences is less than a threshold M, the mobile phone increases sequence index by degrees automatically, and uses the next ZC sequence to continue generating ZCZ sequences until the total amount of ZCZ sequences is greater than or equal to said threshold. In the end, the mobile phone randomly selects one sequence from all generated available ZCZ sequences as a random access preamble (hereinafter referred to as preamble for short) to send.

[0005] The selection of cyclic shift amount (Ncs) affects system performances. If the cyclic shift amount is too great, the amount of the ZCZ sequences generated by each ZC sequence will become smaller, so that the reuse factor of ZC sequence decrease (reuse factor is defined as amount of cells using different ZC sequences), and the interference between cells increase; if the cyclic shift amount is too small, the supported covering range will become too small to satisfy the demond of networking. Furthermore, unreasonable design of the cyclic shift amount will also decrease the complete orthogonal probability of two preambles and increase the interference between users in cells.

[0006] Therefore, it is necessary to design a set of reasonable cyclic shift amount to satisfy maximal covering demand of the system, furthermore, under the condition of different covering demands, a suitable cyclic shift amount can be selected to make ZC sequence reuse factor reach the maximum and make two preambles reach the highest orthogonal probability. There has no related technical solution in existing technology yet.

SUMMARY

[0007] The technical problem the present invention aims to solve is to overcome the deficiency of existing technology, and the present invention provides a method for generation of suitable Ncs set under the condition of satisfying the maximal covering demand of the system, so as to decrease the interference between and in cells when random access preamble is generated by cyclic shift amount of random access channel contained in the set.

[0008] To solve above problem, the present invention provides a method for generation of cyclic shift amount set, and the method comprises the following steps:

[0009] A: determining an upper limit value Ncs_max of cyclic shift amount Ncs according to a maximum cell radius value which is required to be supported by a random access channel RACH, and selecting Ncs values which are less than or equal to the Ncs_max to be elements of an initial Ncs set;

[0010] B: calculating a root sequence number Nr corresponding to each element in the initial Ncs set according to formula $Nr=\lceil M/\lfloor Npre/Ncs \rfloor \rceil$; and deleting elements in the initial Ncs set which have the same Nr value with other elements so as to generate a screening Ncs set in which each element has a different Nr value;

[0011] C: if N, the number of elements in the screening Ncs set, is greater than P, the number of maximum NCS supported by the system, then deleting N−P elements from the set so as to generate a final Ncs set; else regarding the screening Ncs set as the final Ncs set;

[0012] wherein, M is a preamble number required by each cell; Npre is the length of preamble sequence.

[0013] Further, in the step A, the Ncs values which are greater than or equal to Ncs_min but also less than or equal to the Ncs_max may be regarded as elements of the initial Ncs set;

wherein,

$$\text{Ncs\_min} = \left\lfloor \frac{Tds \times Npre}{Tpre} \right\rfloor;$$

or Ncs_min is the maximum value of

$$\left\lfloor \frac{Tds \times Npre}{Tpre} \right\rfloor$$

and defined thershold Ncs_th.

[0014] Further, in the step B, for those multiple elements which have the same Nr value in the initial Ncs set, the element which has the minimum Ncs value may be reserved, the other elements may be deleted, and the screening Ncs set in which each element has a different Nr value may be generated.

[0015] Further, in the step C, if the N is greater than the P, P−1 Ncs values arranged from low to high in the screening Ncs set and the maximum Ncs value in the screening Ncs set may be regarded as elements of the final Ncs set, and the other N−P elements may be deleted.

[0016] Further, if R=1.4 km, Tpre=133us, Npre=139 or 137, Tds=5.2us, Ncs_th=7, M=64, P=4, then the final Ncs set is {8, 10, 12, 15};

[0017] if R=1.4 km, Tpre=133us, Npre=139 or 137, Tds=5.2us, Ncs_th=7, M=64, P=2, then the final Ncs set is {8, 15};

[0018] if R=1.4 km, Tpre=133us, Npre=139 or 137, Tds=5.2us, Ncs_th=7, M=64, P=3, then the final Ncs set is {8, 10, 15};

[0019] if R=1.4 km, Tpre=133us, Npre=139 or 137, Tds=5.2us, Ncs_th=7, M=64, P=1, then the final Ncs set is {15};

[0020] if R=1.55 km, Tpre=133us, Npre=139 or 137, Tds=5.2us, Ncs_th=7, M=64, P=1, then the final Ncs set is {16};

[0021] if R=1.26 km, Tpre=133us, Npre=139 or 137, Tds=5.2us, Ncs_th=7, M=64, P=1, then the final Ncs set is {14};

[0022] if R=1.11 km, Tpre=133us, Npre=139 or 137, Tds=5.2us, Ncs_th=7, M=64, P=1, then the final Ncs set is {13};

[0023] if R=1.0 km, Tpre=133us, Npre=139 or 137, Tds=5.2us, Ncs_th=7, M=64, P=1, then the final Ncs set is {12};

[0024] if R=0.82 km, Tpre=133us, Npre=139 or 137, Tds=5.2us, Ncs_th=7, M=64, P=1, then the final Ncs set is {11};

[0025] if R=0.68 km, Tpre=133us, Npre=139 or 137, Tds=5.2us, Ncs_th=7, M=64, P=1, then the final Ncs set is {10};

[0026] if R=0.53 km, Tpre=133us, Npre=139 or 137, Tds=5.2us, Ncs_th=7, M=64, P=1, then the final Ncs set is {9};

[0027] if R=0.39 km, Tpre=133us, Npre=139 or 137, Tds=5.2us, Ncs_th=7, M=64, P=1, then the final Ncs set is {8};

[0028] if R=0.24 km, Tpre=133us, Npre=139 or 137, Tds=5.2us, Ncs_th=6, M=64, P=1, then the final Ncs set is {7};

[0029] if R=0.1 km, Tpre=133us, Npre=139 or 137, Tds=5.2us, Ncs_th=6, M=64, P=1, then the final Ncs set is {6};

[0030] if R=1.55 km, Tpre=133us, Npre=139 or 137, Tds=5.2us, Ncs_th=6, M=64, P=4, then the final Ncs set is {6, 8, 10, 16};

[0031] if R=1.4 km, Tpre=133us, Npre=139 or 137, Tds=5.2us, Ncs_th=6, M=64, P=4, then the final Ncs set is {6, 8, 10, 15};

[0032] if R=1.4 km, Tpre=133us, Npre=139 or 137, Tds=5.2us, Ncs_th=6, M=64, P=2, then the final Ncs set is {6, 15};

[0033] if R=1.4 km, Tpre=133us, Npre=139 or 137, Tds=5.2us, Ncs_th=6, M=64, P=3, then the final Ncs set is {6, 8, 15};

[0034] if R=1.4 km, Tpre=133us, Npre=139 or 137, Tds=5.2us, Ncs_th=6, M=16, P=2, then the final Ncs set is {8, 15};

[0035] if R=1.4 km, Tpre=133us, Npre=139 or 137, Tds=5.2us, Ncs_th=6, M=16, P=1, then the final Ncs set is {15};

[0036] if R=0.4 km, Tpre=133us, Npre=139 or 137, Tds=5.2us, Ncs_th=6, M=16, P=1, then the final Ncs set is {8};

[0037] if R=1.6 km, Tpre=133us, Npre=139 or 137, Tds=5.2us, Ncs_th=6, M=16, P=2, then the final Ncs set is {8, 16};

[0038] if R=1.6 km, Tpre=133us, Npre=139 or 137, Tds=5.2us, Ncs_th=6, M=16, P=1, then the final Ncs set is {16};

[0039] if R=1.5 km, Tpre=133us, Npre=139 or 137, Tds=0us, Ncs_th=2, M=16, P=2, then the final Ncs set is {8, 10};

[0040] if R=1.2 km, Tpre=133us, Npre=139 or 137, Tds=0us, Ncs_th=2, M=16, P=2, then the final Ncs set is {8};

[0041] if R=1.5 km, Tpre=133us, Npre=139 or 137, Tds=0us, Ncs_th=2, M=16, P=1, then the final Ncs set is {10};

[0042] if R=1.5 km, Tpre=133us, Npre=139 or 137, Tds=0us, Ncs_th=2, M=64, P=4, then the final Ncs set is {2, 4, 6, 10};

[0043] if R=1.0 km, Tpre=133us, Npre=139 or 137, Tds=5.2us, Ncs_th=7, M=64, P=2, then the final Ncs set is {8, 12};

[0044] if R=1.11 km, Tpre=133us, Npre=139 or 137, Tds=5.2us, Ncs_th=7, M=64, P=2, then the final Ncs set is {8, 13};

[0045] if R=1.26 km, Tpre=133us, Npre=139 or 137, Tds=5.2us, Ncs_th=7, M=64, P=2, then the final Ncs set is {8, 14};

[0046] if R=1.5 km, Tpre=133us, Npre=139 or 137, Tds=0us, Ncs_th=6, M=64, P=2, then the final Ncs set is {6, 10};

[0047] if R=1.5 km, Tpre=133us, Npre=139 or 137, Tds=0us, Ncs_th=4, M=64, P=2, then the final Ncs set is {4, 10};

[0048] if R=1.5 km, Tpre=133us, Npre=139 or 137, Tds=0us, Ncs_th=2, M=64, P=2, then the final Ncs set is {2, 10};

[0049] if R=1.2 km, Tpre=133us, Npre=139 or 137, Tds=0us, Ncs_th=2, M=64, P=4, then the final Ncs set is {2, 4, 6, 8};

[0050] if R=1.5 km, Tpre=133us, Npre=139 or 137, Tds=0us, Ncs_th=4, M=64, P=4, then the final Ncs set is {4, 6, 8, 10};

[0051] if R=1.2 km, Tpre=133us, Npre=139 or 137, Tds=0us, Ncs_th=6, M=64, P=2, then the final Ncs set is {6, 8};

[0052] if R=1.2 km, Tpre=133us, Npre=139 or 137, Tds=0us, Ncs_th=4, M=64, P=2, then the final Ncs set is {4, 8};

[0053] if R=1.2 km, Tpre=133us, Npre=139 or 137, Tds=0us, Ncs_th=2, M=64, P=2, then the final Ncs set is {2, 8};

[0054] if R=0.9 km, Tpre=133us, Npre=139 or 137, Tds=0us, Ncs_th=2, M=64, P=2, then the final Ncs set is {2, 6};

[0055] if R=0.9 km, Tpre=133us, Npre=139 or 137, Tds=0us, Ncs_th=4, M=64, P=2, then the final Ncs set is {4, 6};

[0056] if R=0.6 km, Tpre=133us, Npre=139 or 137, Tds=0us, Ncs_th=2, M=64, P=2, then the final Ncs set is {2, 4};

[0057] if R=0.6 km, Tpre=133us, Npre=139 or 137, Tds=0us, Ncs_th=2, M=64, P=1, then the final Ncs set is {4};

[0058] if R=0.3 km, Tpre=133us, Npre=139 or 137, Tds=0us, Ncs_th=2, M=64, P=1, then the final Ncs set is {2};

[0059] if R=2.2 km, Tpre=133us, Npre=139 or 137, Tds=0us, Ncs_th=2, M=64, P=7, then the final Ncs set is {2, 4, 6, 8, 10, 12, 15}; and

[0060] if R=2.2 km, Tpre=133us, Npre=139 or 137, Tds=0us, Ncs_th=2, M=64, P=8, then the final Ncs set is {2, 4, 6, 8, 10, 12, 13, 15}.

[0061] Further, one of the following sets may be used as the final Ncs set:

[0062] {8, 10, 12, 15}; {8, 15}; {8, 10, 15}; {15}; {16}; {14}; {13}; {12}; {11}; {10}; {9}; {8}; {7}; {6}; {6, 8, 10, 16}; {6, 8, 10, 15}; {6, 15}; {6, 8, 15}; {8, 15}; {15}; {8}; {8, 16}; {16}; {8, 10}; {8}; {10}; {2, 4, 6, 10}; {8, 12}; {8, 13}; {8, 14}; {6, 10}; {4, 10}; {2, 10}; {2, 4, 6, 8}; {4, 6, 8, 10}; {6, 8}; {4, 8}; {2, 8}; {2, 6}; {4, 6}; {2, 4}; {4}; {2}; {2, 4, 6, 8, 10, 12, 15}; {2, 4, 6, 8, 10, 12, 13, 15}.

[0063] Further, in the step A, the following formula may be used to calculate the Ncs_max:

$$\text{Ncs\_max} = \left\lfloor \frac{(R \times 6.7 + Tds) \times Npre}{Tpre} \right\rfloor;$$

wherein, R is the maximum cell radius value which is required to be supported by the RACH, Tpre is the length of the preamble, and Tds is the length of multipath channel delay spread.

[0064] Further, in the step B, for those multiple elements which have the same Nr value in the initial Ncs set, the element which has the maximum Ncs value may be reserved, the other elements may be deleted, and the screening Ncs set in which each element has a different Nr value may be generated.

[0065] Further, in the step C, if the N is greater than the P, then

[0066] P−1 Ncs values arranged from high to low in the screening Ncs set and the minimum Ncs value in the screening Ncs set may be regarded as elements of the final Ncs set, and the other N−P elements may be deleted; or

[0067] P Ncs values arranged from high to low in the screening Ncs set may be regarded as elements of the final Ncs set, and the other N−P elements may be deleted; or

[0068] P Ncs values arranged from low to high in the screening Ncs set may be regarded as elements of the final Ncs set, and the other N−P elements may be deleted.

[0069] The present invention also provides a method for generation of random access preamble, and the method comprises:

[0070] selecting a cyclic shift amount Ncs from a cyclic shift amount set, and cyclically shifting v×Ncs for root Zadoff-Chu sequence at a predefined start point so as to generate a random access preamble of the root Zadoff-Chu sequence;

[0071] wherein,

$$v = 0, 1, \ldots, \lfloor N_{ZC} / Ncs \rfloor - 1, \quad Ncs \neq 0;$$

N_{ZC} is the length of the root Zadoff-Chu sequence; the cyclic shift amount set is {2, 4, 6, 8, 10, 12, 15}.

[0072] Further, the predefined start point may be 0.

[0073] The Ncs set generated by the method of present invention can satisfy the maximal covering demand of the system. Furthermore, under the condition of different covering demands, a suitable cyclic shift amount can be selected to make ZC sequence reuse factor reach the maximum and make two preambles reach the highest orthogonal probability, therefore the interference between and in cells is decreased.

BRIEF DESCRIPTION OF THE DRAWINGS

[0074] FIG. **1** is a diagram illustrating the frame structure of TDD mode in LTE system; and

[0075] FIG. **2** is a flowchart illustrating a method for generation of cyclic shift amount set of random access channel in wireless communication system in an embodiment of the present invention.

DETAILED DESCRIPTION

[0076] The present invention will be described in details hereinafter with reference to the drawings and embodiments.

[0077] FIG. **2** is a flowchart illustrating a method for generation of cyclic shift amount set of random access channel in wireless communication system in an embodiment of the present invention. As shown in FIG. **2**, the method comprises the following steps:

[0078] **201**: determine an upper limit value Ncs_max of Ncs in Ncs set according to a maximum cell radius value which is required to be supported by RACH;

[0079] in this embodiment, the Ncs_max can be calculated by the following formula:

$$\text{Ncs\_max} = \left\lfloor \frac{(R \times 6.7 + Tds) \times Npre}{Tpre} \right\rfloor; \quad \text{(Formula 1)}$$

[0080] wherein, R is the maximum cell radius value which is required to be supported by the RACH, and the unit is km; Tpre is the length of preamble (or duration), and the unit is us; Npre is the length of preamble sequence; and Tds is the length of multipath channel delay spread; $\lfloor \bullet \rfloor$ denotes rounding down operation.

[0081] **202**: determine a lower limit value Ncs_min of Ncs in Ncs set;

[0082] generally, the Ncs_min can be calculated by the following formula:

$$\text{Ncs\_min} = \left\lfloor \frac{Tds \times Npre}{Tpre} \right\rfloor \quad \text{(Formula 2)}$$

[0083] further, design threshold Ncs_th according to requirement, regard the maximum value between the Ncs_min calculated by formula 2 and the Ncs_th as the final lower limit value Ncs_min of Ncs.

[0084] **203**: determine an initial Ncs set according to the Ncs_min and the Ncs_max, so as to enable any Ncs (integer) in the set is less than or equal to the Ncs_max, but also greater than or equal to the Ncs_min;

[0085] in other words, regard every integer which is less than or equal to the Ncs_max and greater than or equal to the Ncs_min as the element of the initial Ncs set.

[0086] **204**: calculate a root sequence number Nr corresponding to each Ncs value in the initial Ncs set according to the following formula:

$$Nr = \lceil M / \lfloor Npre/Ncs \rfloor \rceil \quad \text{(Formula 3)}$$

wherein, Nr is the root sequence number corresponding to cyclic shift amount Ncs;

[0087] M is the preamble number required by each cell; ⌈/•⌉denotes rounding up operation.

[0088] **205**: screen the initial Ncs set according to the calculated Nr value in the initial Ncs set, and generate a screening Ncs set in which each element (Ncs value) has a different Nr value;

[0089] in this embodiment, in multiple Ncs values with the same Nr value, reserve the maximum Ncs value, i.e. reserve the Ncs value which has the largest corresponding covering range.

[0090] Of course, the minimum Ncs value can also be reserved.

[0091] For example, there are Q Ncs values, each has a corresponding Nr value NR_**1**, then delete the minimum Q−1 values in these Q Ncs values from the initial Ncs set; repeat above operation, so as to make Nr value corresponding to each Ncs value in the initial Ncs set is different.

[0092] **206**: delete redundant elements in the Ncs set, so as to enable the number of Ncs values contained in the Ncs set to satisfy system demand;

[0093] in other words, if the maximum Ncs number supported by the system is P, and the number of elements (Ncs value) in the screening Ncs set generated in step **205** is N, and N>P, then delete N−P elements from the set.

[0094] In this embodiment, the final Ncs set can be composed of P−1 Ncs values which are selected from N elements in the screening Ncs set from low to high and the maximum Ncs value in the screening Ncs set.

[0095] Of course, the final Ncs set can also be composed of P−1 Ncs values selected from high to low and the minimum Ncs value in the initial Ncs set; or the final Ncs set can be composed of maximum or minimum P Ncs values from the set.

[0096] Hereinafter take the Ncs set {2, 4, 6, 8, 10, 12, 15} generated by above method of present invention for example, a method for generation of random access preamble by Ncs set generated according to the present invention is described.

[0097] If root ZC sequence is:

$$x_u(n) = e^{-j\frac{\pi u n(n+1)}{N_{ZC}}}, \quad 0 \le n \le N_{ZC} - 1;$$

[0098] perform cyclic shift to above root ZC sequence to generate random access preamble according to the following formula:

$$x_{u,v}(n) = x_u((n+C_v) \bmod N_{ZC});$$

[0099] wherein, as performing cyclic shift to above root ZC sequence beginning with position 0, the value of C_v is:

$$C_v = \begin{cases} vNcs & v = 0, 1, \ldots, \lfloor N_{ZC}/Ncs \rfloor - 1, \quad N_{CS} \neq 0 \\ 0 & Ncs = 0; \end{cases}$$

[0100] C_v value beginning with other position may be deduced by analogy.

[0101] Wherein, Ncs is cyclic shift amount, which can also be called cyclic shift step size, C_v is cyclic shift generated according to cyclic shift step size, N_{ZC} is the length of ZC sequence. The above Ncs belongs to set {2, 4, 6, 8, 10, 12, 15}.

[0102] Further, after generating cyclic shift sequences according to above method, some cyclic shift sequences can be limited to become random access preamble according to certain cyclic shift limit criterion, i.e. only part of cyclic shift sequences can be selected to be random access preamble.

[0103] Hereinafter preferable Ncs set generated according to the method of the present invention is described.

Embodiment 1

[0104] If R is 1.4 km, Tpre=133us, Npre=139 or 137, Tds=5.2us, Ncs_th=7, M=64, P=4, then

[0105] according to the method of the present invention, Ncs_min=7, Ncs_max=15, then the initial Ncs set is {7, 8, 9, 10, 11, 12, 13, 14, 15}, the corresponding Nr is {4, 4, 5, 5, 6, 6, 7, 8, 8}, and the optional Ncs set after being screened is {8, 10, 12, 13, 15}, because the number of elements in the set is greater than P, select {8, 10, 12, 15} as the final Ncs set.

Embodiment 2

[0106] If R is 1.4 km, Tpre=133us, Npre=139 or 137, Tds=5.2us, Ncs_th=7, M=64, P=2, then

[0107] according to the method of the present invention, Ncs_min=7, Ncs_max=15, then optional Ncs set is {7, 8, 9, 10, 11, 12, 13, 14, 15}, the corresponding Nr is {4, 4, 5, 5, 6, 6, 7, 8, 8}, and the optional Ncs set after being screened is {8, 10, 12, 13, 15}, because the number of elements in the set is greater than P, select {8, 15} as the final Ncs set.

Embodiment 3

[0108] If R is 1.4 km, Tpre=133us, Npre=139 or 137, Tds=5.2us, Ncs_th=7, M=64, P=3, then

[0109] according to the method of the present invention, Ncs_min=7, Ncs_max=15, then optional Ncs set is {7, 8, 9, 10, 11, 12, 13, 14, 15}, the corresponding Nr is {4, 4, 5, 5, 6, 6, 7, 8, 8}, and the optional Ncs set after being screened is {8, 10, 12, 13, 15}, because the number of elements in the set is greater than P, select {8, 10, 15} as the final Ncs set.

Embodiment 4

[0110] If R is 1.4 km, Tpre=133us, Npre=139 or 137, Tds=5.2us, Ncs_th=7, M=64, P=1, then

[0111] according to the method of the present invention, Ncs_min=7, Ncs_max=15, then optional Ncs set is {7, 8, 9, 10, 11, 12, 13, 14, 15}, the corresponding Nr is {4, 4, 5, 5, 6, 6, 7, 8, 8}, and the optional Ncs set after being screened is {8, 10, 12, 13, 15}, because the number of elements in the set is greater than P, select {15} as the final Ncs set.

Embodiment 5

[0112] If R is 1.55 km, Tpre=133us, Npre=139 or 137, Tds=5.2us, Ncs_th=7, M=64, P=1, then

[0113] according to the method of the present invention, Ncs_min=7, Ncs_max=16, then optional Ncs set is {7, 8, 9, 10, 11, 12, 13, 14, 15, 16}, the corresponding Nr is {4, 4, 5, 5, 6, 6, 7, 8, 8, 8}, and the optional Ncs set after being screened is {8, 10, 12, 13, 16}, because the number of elements in the set is greater than P, select {16} as the final Ncs set.

Embodiment 6

[0114] If R is 1.26 km, Tpre=133us, Npre=139 or 137, Tds=5.2us, Ncs_th=7, M=64, P=1, then

[0115] according to the method of the present invention, Ncs_min=7, Ncs_max=14, then optional Ncs set is {7, 8, 9, 10, 11, 12, 13, 14}, the corresponding Nr is {4, 4, 5, 5, 6, 6, 7,

8}, and the optional Ncs set after being screened is {8, 10, 12, 13, 14}, because the number of elements in the set is greater than P, select {14} as the final Ncs set.

Embodiment 7

[0116] If R is 1.11 km, Tpre=133us, Npre=139 or 137, Tds=5.2us, Ncs_th=7, M=64, P=1, then

[0117] according to the method of the present invention, Ncs_min=7, Ncs_max=13, then optional Ncs set is {7, 8, 9, 10, 11, 12, 13}, the corresponding Nr is {4, 4, 5, 5, 6, 6, 7}, and the optional Ncs set after being screened is {8, 10, 12, 13}, because the number of elements in the set is greater than P, select {13} as the final Ncs set.

Embodiment 8

[0118] If R is 1.0 km, Tpre=133us, Npre=139 or 137, Tds=5.2us, Ncs_th=7, M=64, P=1, then

[0119] according to the method of the present invention, Ncs_min=7, Ncs_max=12, then optional Ncs set is {7, 8, 9, 10, 11, 12}, the corresponding Nr is {4, 4, 5, 5, 6, 6}, and the optional Ncs set after being screened is {8, 10, 12}, because the number of elements in the set is greater than P, select {12} as the final Ncs set.

Embodiment 9

[0120] If R is 0.82 km, Tpre=133us, Npre=139 or 137, Tds=5.2us, Ncs_th=7, M=64, P=1, then

[0121] according to the method of the present invention, Ncs_min=7, Ncs_max=11, then optional Ncs set is {7, 8, 9, 10, 11}, the corresponding Nr is {4, 4, 5, 5, 6}, and the optional Ncs set after being screened is {8, 10, 11}, because the number of elements in the set is greater than P, select {11} as the final Ncs set.

Embodiment 10

[0122] If R is 0.68 km, Tpre=133us, Npre=139 or 137, Tds=5.2us, Ncs_th=7, M=64, P=1, then

[0123] according to the method of the present invention, Ncs_min=7, Ncs_max=10, then optional Ncs set is {7, 8, 9, 10}, the corresponding Nr is {4, 4, 5, 5}, and the optional Ncs set after being screened is {8, 10}, because the number of elements in the set is greater than P, select {10} as the final Ncs set.

Embodiment 11

[0124] If R is 0.53 km, Tpre=133us, Npre=139 or 137, Tds=5.2us, Ncs_th=7, M=64, P=1, then

[0125] according to the method of the present invention, Ncs_min=7, Ncs_max=9, then optional Ncs set is {7, 8, 9}, the corresponding Nr is {4, 4, 5}, and the optional Ncs set after being screened is {8, 9}, because the number of elements in the set is greater than P, select {9} as the final Ncs set.

Embodiment 12

[0126] If R is 0.39 km, Tpre=133us, Npre=139 or 137, Tds=5.2us, Ncs_th=7, M=64, P=1, then

[0127] according to the method of the present invention, Ncs_min=7, Ncs_max=8, then optional Ncs set is {7, 8}, the corresponding Nr is {4, 4}, and the optional Ncs set after being screened is {8}, because the number of elements in the set is equal to P, select {8} as the final Ncs set.

Embodiment 13

[0128] If R is 0.24 km, Tpre=133us, Npre=139 or 137, Tds=5.2us, Ncs_th=6, M=64, P=1, then

[0129] according to the method of the present invention, Ncs_min=6, Ncs_max=7, then optional Ncs set is {6, 7}, the corresponding Nr is {3, 4}, and the optional Ncs set after being screened is {6, 7}, because the number of elements in the set is greater than P, select {7} as the final Ncs set.

Embodiment 14

[0130] If R is 0.1 km, Tpre=133us, Npre=139 or 137, Tds=5.2us, Ncs_th=6, M=64, P=1, then

[0131] according to the method of the present invention, Ncs_min=6, Ncs_max=6, then optional Ncs set is {6}, the corresponding Nr is {3}, and the optional Ncs set after being screened is {6}, because the number of elements in the set is equal to P, select {6} as the final Ncs set.

Embodiment 15

[0132] If R is 1.55 km, Tpre=133us, Npre=139 or 137, Tds=5.2us, Ncs_th=6, M=64, P=4, then

[0133] according to the method of the present invention, Ncs_min=6, Ncs_max=16, then optional Ncs set is {6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16}, the corresponding Nr is {3, 4, 4, 5, 5, 6, 6, 7, 8, 8, 8}, and the optional Ncs set after being screened is {6, 8, 10, 12, 13, 16}, because the number of elements in the set is greater than P, select {6, 8, 10, 16} as the final Ncs set.

Embodiment 16

[0134] If R is 1.4 km, Tpre=133us, Npre=139 or 137, Tds=5.2us, Ncs_th=6, M=64, P=4, then

[0135] according to the method of the present invention, Ncs_min=6, Ncs_max=15, then optional Ncs set is {6, 7, 8, 9, 10, 11, 12, 13, 14, 15}, the corresponding Nr is {3, 4, 4, 5, 5, 6, 6, 7, 8, 8}, and the optional Ncs set after being screened is {6, 8, 10, 12, 13, 15}, because the number of elements in the set is greater than P, select {6, 8, 10, 15} as the final Ncs set.

Embodiment 17

[0136] If R is 1.4 km, Tpre=133us, Npre=139 or 137, Tds=5.2us, Ncs_th=6, M=64, P=2, then

[0137] according to the method of the present invention, Ncs_min=6, Ncs_max=15, then optional Ncs set is {6, 7, 8, 9, 10, 11, 12, 13, 14, 15}, the corresponding Nr is {3, 4, 4, 5, 5, 6, 6, 7, 8, 8}, and the optional Ncs set after being screened is {6, 8, 10, 12, 13, 15}, because the number of elements in the set is greater than P, select {6, 15} as the final Ncs set.

Embodiment 18

[0138] If R is 1.4 km, Tpre=133us, Npre=139 or 137, Tds=5.2us, Ncs_th=6, M=64, P=3, then

[0139] according to the method of the present invention, Ncs_min=6, Ncs_max=15, then optional Ncs set is {6, 7, 8, 9, 10, 11, 12, 13, 14, 15}, the corresponding Nr is {3, 4, 4, 5, 5, 6, 6, 7, 8, 8}, and the optional Ncs set after being screened is

{6, 8, 10, 12, 13, 15}, because the number of elements in the set is greater than P, select {6, 8, 15} as the final Ncs set.

Embodiment 19

[0140] If R is 1.4 km, Tpre=133us, Npre=139 or 137, Tds=5.2us, Ncs_th=6, M=16, P=2, then

[0141] according to the method of the present invention, Ncs_min=6, Ncs_max=15, then optional Ncs set is {6, 7, 8, 9, 10, 11, 12, 13, 14, 15}, the corresponding Nr is {1, 1, 1, 2, 2, 2, 2, 2, 2, 2}, and the optional Ncs set after being screened is {8, 15}, because the number of elements in the set is equal to P, select {8, 15} as the final Ncs set.

Embodiment 20

[0142] If R is 1.4 km, Tpre=133us, Npre=139 or 137, Tds=5.2us, Ncs_th=6, M=16, P=1, then

[0143] according to the method of the present invention, Ncs_min=6, Ncs_max=15, then optional Ncs set is {6, 7, 8, 9, 10, 11, 12, 13, 14, 15}, the corresponding Nr is {1, 1, 1, 2, 2, 2, 2, 2, 2, 2}, and the optional Ncs set after being screened is {8, 15}, because the number of elements in the set is greater than P, select {15} as the final Ncs set.

Embodiment 21

[0144] If R is 0.4 km, Tpre=133us, Npre=139 or 137, Tds=5.2us, Ncs_th=6, M=16, P=1, then

[0145] according to the method of the present invention, Ncs_min=6, Ncs_max=8, then optional Ncs set is {6, 7, 8}, the corresponding Nr is {1, 1, 1}, and the optional Ncs set after being screened is {8}, because the number of elements in the set is equal to P, select {8} as the final Ncs set.

Embodiment 22

[0146] If R is 1.6 km, Tpre=133us, Npre=139 or 137, Tds=5.2us, Ncs_th=6, M=16, P=2, then

[0147] according to the method of the present invention, Ncs_min=6, Ncs_max=16, then optional Ncs set is {6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16}, the corresponding Nr is {1, 1, 1, 2, 2, 2, 2, 2, 2, 2, 2}, and the optional Ncs set after being screened is {8, 16}, because the number of elements in the set is equal to P, select {8, 16} as the final Ncs set.

Embodiment 23

[0148] If R is 1.6 km, Tpre=133us, Npre=139 or 137, Tds=5.2us, Ncs_th=6, M=16, P=1, then

[0149] according to the method of the present invention, Ncs_min=6, Ncs_max=16, then optional Ncs set is {6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16}, the corresponding Nr is {1, 1, 1, 2, 2, 2, 2, 2, 2, 2, 2}, and the optional Ncs set after being screened is {8, 16}, because the number of elements in the set is greater than P, select {16} as the final Ncs set.

Embodiment 24

[0150] If R is 1.5 km, Tpre=133us, Npre=139 or 137, Tds=0, Ncs_th=2, M=16, P=2, then

[0151] according to the method of the present invention, Ncs_min=2, Ncs_max=10, then optional Ncs set is {2, 3, 4, 5, 6, 7, 8, 9, 10}, the corresponding Nr is {1, 1, 1, 1, 1, 1, 1, 2, 2}, and the optional Ncs set after being screened is {8, 10}, because the number of elements in the set is equal to P, select {8, 10} as the final Ncs set.

Embodiment 25

[0152] If R is 1.2 km, Tpre=133us, Npre=139 or 137, Tds=0, Ncs_th=2, M=16, P=2, then

[0153] according to the method of the present invention, Ncs_min=2, Ncs_max=8, then optional Ncs set is {2, 3, 4, 5, 6, 7, 8}, the corresponding Nr is {1, 1, 1, 1, 1, 1, 1}, and the optional Ncs set after being screened is {8}, because the number of elements in the set is less than P, select {8} as the final Ncs set.

Embodiment 26

[0154] If R is 1.5 km, Tpre=133us, Npre=139 or 137, Tds=0, Ncs_th=2, M=16, P=1, then

[0155] according to the method of the present invention, Ncs_min=2, Ncs_max=1, then optional Ncs set is {2, 3, 4, 5, 6, 7, 8, 9, 10}, the corresponding Nr is {1, 1, 1, 1, 1, 1, 1, 2, 2}, and the optional Ncs set after being screened is {8, 10}, because the number of elements in the set is greater than P, select {10} as the final Ncs set.

Embodiment 27

[0156] If R is 1.5 km, Tpre=133us, Npre=139 or 137, Tds=0, Ncs_th=2, M=64, P=4, then

[0157] according to the method of the present invention, Ncs_min=2, Ncs_max=10, then optional Ncs set is {2, 3, 4, 5, 6, 7, 8, 9, 10}, the corresponding Nr is {1, 2, 2, 3, 3, 4, 4, 5, 5}, and the optional Ncs set after being screened is {2, 4, 6, 8, 10}, because the number of elements in the set is greater than P, select {2, 4, 6, 10} as the final Ncs set.

Embodiment 28

[0158] If R is 1.0 km, Tpre=133us, Npre=139 or 137, Tds=5.2us, Ncs_th=7, M=64, P=2, then

[0159] according to the method of the present invention, Ncs_min=7, Ncs_max=12, then optional Ncs set is {7, 8, 9, 10, 11, 12}, the corresponding Nr is {4, 4, 5, 5, 6, 6}, and the optional Ncs set after being screened is {8, 10, 12}, because the number of elements in the set is greater than P, select {8, 12} as the final Ncs set.

Embodiment 29

[0160] If R is 1.11 km, Tpre=133us, Npre=139 or 137, Tds=5.2us, Ncs_th=7, M=64, P=2, then

[0161] according to the method of the present invention, Ncs_min=7, Ncs_max=13, then optional Ncs set is {7, 8, 9, 10, 11, 12, 13}, the corresponding Nr is {4, 4, 5, 5, 6, 6, 7}, the optional Ncs set after being screened is {8, 10, 12, 13}, because the number of elements in the set is greater than P, select {8, 13} as the final Ncs set.

Embodiment 30

[0162] If R is 1.26 km, Tpre=133us, Npre=139 or 137, Tds=5.2us, Ncs_th=7, M=64, P=2, then

[0163] according to the method of the present invention, Ncs_min=7, Ncs_max=14, then optional Ncs set is {7, 8, 9, 10, 11, 12, 13, 14}, the corresponding Nr is {4, 4, 5, 5, 6, 6, 7, 8}, and the optional Ncs set after being screened is {8, 10, 12,

13, 14}, because the number of elements in the set is greater than P, select {8, 14} as the final Ncs set.

Embodiment 31

[0164] If R is 1.5 km, Tpre=133us, Npre=139 or 137, Tds=0, Ncs_th=6, M=64, P=2, then

[0165] according to the method of the present invention, Ncs_min=6, Ncs_max=10, then optional Ncs set is {6, 7, 8, 9, 10}, the corresponding Nr is {3, 4, 4, 5, 5}, and the optional Ncs set after being screened is {6, 8, 10}, because the number of elements in the set is greater than P, select {6, 10} as the final Ncs set.

Embodiment 32

[0166] If R is 1.5 km, Tpre=133us, Npre=139 or 137, Tds=0, Ncs_th=4, M=64, P=2, then

[0167] according to the method of the present invention, Ncs_min=4, Ncs_max=10, then optional Ncs set is {4, 5, 6, 7, 8, 9, 10}, the corresponding Nr is {2, 3, 3, 4, 4, 5, 5}, and the optional Ncs set after being screened is {4, 6, 8, 10}, because the number of elements in the set is greater than P, select {4, 10} as the final Ncs set.

Embodiment 33

[0168] If R is 1.5 km, Tpre=133us, Npre=139 or 137, Tds=0, Ncs_th=2, M=64, P=2, then

[0169] according to the method of the present invention, Ncs_min=2, Ncs_max=10, then optional Ncs set is {2, 3, 4, 5, 6, 7, 8, 9, 10}, the corresponding Nr is {1, 2, 2, 3, 3, 4, 4, 5, 5}, and the optional Ncs set after being screened is {2, 4, 6, 8, 10}, because the number of elements in the set is greater than P, select {2, 10} as the final Ncs set.

Embodiment 34

[0170] If R is 1.2 km, Tpre=133us, Npre=139 or 137, Tds=0, Ncs_th=2, M=64, P=4, then

[0171] according to the method of the present invention, Ncs_min=2, Ncs_max=8, then optional Ncs set is {2, 3, 4, 5, 6, 7, 8}, the corresponding Nr is {1, 2, 2, 3, 3, 4, 4}, and the optional Ncs set after being screened is {2, 4, 6, 8}, because the number of elements in the set is equal to P, select {2, 4, 6, 8} as the final Ncs set.

Embodiment 35

[0172] If R is 1.5 km, Tpre=133us, Npre=139 or 137, Tds=0, Ncs_th=4, M=64, P=4, then

[0173] according to the method of the present invention, Ncs_min=4, Ncs_max=10, then optional Ncs set is {4, 5, 6, 7, 8, 9, 10}, the corresponding Nr is {2, 3, 3, 4, 4, 5, 5}, and the optional Ncs set after being screened is {4, 6, 8, 10}, because the number of elements in the set is equal to P, select {4, 6, 8, 10} as the final Ncs set.

Embodiment 36

[0174] If R is 1.2 km, Tpre=133us, Npre=139 or 137, Tds=0, Ncs_th=6, M=64, P=2, then according to the method of the present invention, Ncs_min=6, Ncs_max=8, then optional Ncs set is {6, 7, 8}, the corresponding Nr is {3, 4, 4}, and the optional Ncs set after being screened is {6, 8}, because the number of elements in the set is equal to P, select {6, 8} as the final Ncs set.

Embodiment 37

[0175] If R is 1.2 km, Tpre=133us, Npre=139 or 137, Tds=0, Ncs_th=4, M=64, P=2, then

[0176] according to the method of the present invention, Ncs_min=4, Ncs_max=8, then optional Ncs set is {4, 5, 6, 7, 8}, the corresponding Nr is {2, 3, 3, 4, 4}, and the optional Ncs set after being screened is {4, 6, 8}, because the number of elements in the set is greater than P, select {4, 8} as the final Ncs set.

Embodiment 38

[0177] If R is 1.2 km, Tpre=133us, Npre=139 or 137, Tds=0, Ncs_th=2, M=64, P=2, then

[0178] according to the method of the present invention, Ncs_min=2, Ncs_max=8, then optional Ncs set is {2, 3, 4, 5, 6, 7, 8}, the corresponding Nr is {1, 2, 2, 3, 3, 4, 4}, and the optional Ncs set after being screened is {2, 4, 6, 8}, because the number of elements in the set is greater than P, select {2, 8} as the final Ncs set.

Embodiment 39

[0179] If R is 0.9 km, Tpre=133us, Npre=139 or 137, Tds=0, Ncs_th=2, M=64, P=2, then

[0180] according to the method of the present invention, Ncs_min=2, Ncs_max=6, then optional Ncs set is {2, 3, 4, 5, 6}, the corresponding Nr is {1, 2, 2, 3, 3}, and the optional Ncs set after being screened is {2, 4, 6}, because the number of elements in the set is greater than P, select {2, 6} as the final Ncs set.

Embodiment 40

[0181] If R is 0.9 km, Tpre=133us, Npre=139 or 137, Tds=0, Ncs_th=4, M=64, P=2, then

[0182] according to the method of the present invention, Ncs_min=4, Ncs_max=6, then optional Ncs set is {4, 5, 6}, the corresponding Nr is {2, 3, 3}, and the optional Ncs set after being screened is {4, 6}, because the number of elements in the set is equal to P, select {4, 6} as the final Ncs set.

Embodiment 41

[0183] If R is 0.6 km, Tpre=133us, Npre=139 or 137, Tds=0, Ncs_th=2, M=64, P=2, then

[0184] according to the method of the present invention, Ncs_min=2, Ncs_max=4, then optional Ncs set is {2, 3, 4}, the corresponding Nr is {1, 2, 2}, and the optional Ncs set after being screened is {2, 4}, because the number of elements in the set is equal to P, select {2, 4} as the final Ncs set.

Embodiment 42

[0185] If R is 0.6 km, Tpre=133us, Npre=139 or 137, Tds=0, Ncs_th=2, M=64, P=1, then

[0186] according to the method of the present invention, Ncs_min=2, Ncs_max=4, then optional Ncs set is {2, 3, 4}, the corresponding Nr is {1, 2, 2}, and the optional Ncs set

after being screened is {2, 4}, because the number of elements in the set is greater than P, select {4} as the final Ncs set.

Embodiment 43

[0187] If R is 0.3 km, Tpre=133us, Npre=139 or 137, Tds=0, Ncs_th=2, M=64, P=1, then

[0188] according to the method of the present invention, Ncs_min=2, Ncs_max=2, then optional Ncs set is {2}, the corresponding Nr is {1}, and the optional Ncs set after being screened is {2}, because the number of elements in the set is equal to P, select {2} as the final Ncs set.

Embodiment 44

[0189] If R is 2.2 km, Tpre=133us, Npre=139 or 137, Tds=0us, Ncs_th=2, M=64, P=7, then

[0190] according to the method of the present invention, Ncs_min=2, Ncs_max=15, then optional Ncs set is {2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15}, the corresponding Nr is {1, 2, 2, 3, 3, 4, 4, 5, 5, 6, 6, 7, 8, 8}, and the optional Ncs set after being screened is {2, 4, 6, 8, 10, 12, 13, 15}, because the number of elements in the set is greater than P, select {2, 4, 6, 8, 10, 12, 15} as the final Ncs set.

Embodiment 45

[0191] If R is 2.2 km, Tpre=133us, Npre=139 or 137, Tds=0us, Ncs_th=2, M=64, P=8, then

[0192] according to the method of the present invention, Ncs_min=2, Ncs_max=15, then optional Ncs set is {2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15}, the corresponding Nr is {1, 2, 2, 3, 3, 4, 4, 5, 5, 6, 6, 7, 8, 8}, and the optional Ncs set after being screened is {2, 4, 6, 8, 10, 12, 13, 15}, because the number of elements in the set is equal to P, select {2, 4, 6, 8, 10, 12, 13, 15} as the final Ncs set.

[0193] The above discussions are only the embodiments of the present invention. The invention should not be construed as limited to the embodiments illustrated above. The present invention can have all kinds of modifications and changes for those skilled in the art. Any modifications, substitute or improvements without departing from the spirit and principles of the present invention are deemed to be included in the scope of the present invention, as defined by the claims.

INDUSTRIAL APPLICABILITY

[0194] Ncs set generated by the method of the present invention can satisfy the maximal covering demand of the system. Meanwhile, under the condition of different covering demands, a suitable Ncs can be selected to make ZC sequence reuse factor reach the maximum and make generated preambles reach the highest orthogonal probability, therefore interference between and in cells is decreased.

What is claimed is:

1. A method for generation of cyclic shift amount set, comprising the following steps:

A: determining an upper limit value Ncs_max of cyclic shift amount Ncs according to a maximum cell radius value which is required to be supported by a random access channel RACH, and selecting Ncs values which are less than or equal to the Ncs_max to be elements of an initial Ncs set;

B: calculating a root sequence number Nr corresponding to each element in the initial Ncs set according to formula Nr=⌈M/⌊Npre/Ncs⌋⌉; and deleting elements in the initial Ncs set which have the same Nr value with other elements so as to generate a screening Ncs set in which each element has a different Nr value;

C: if N, the number of elements in the screening Ncs set, is greater than P, the number of maximum NCS supported by the system, then deleting N−P elements from the set so as to generate a final Ncs set; else regarding the screening Ncs set as the final Ncs set;

wherein, M is a preamble number required by each cell; Npre is the length of preamble sequence.

2. The method according to claim **1**, wherein,

in the step A, the Ncs values which are greater than or equal to Ncs_min but also less than or equal to Ncs_max are regarded as elements of the initial Ncs set;

wherein,

$$\text{Ncs\_min} = \left\lfloor \frac{Tds \times Npre}{Tpre} \right\rfloor;$$

or Ncs_min is the maximum value of

$$\left\lfloor \frac{Tds \times Npre}{Tpre} \right\rfloor$$

and defined thershold Ncs_th.

3. The method according to claim **1**, wherein,

in the step B, for those multiple elements which have the same Nr value in the initial Ncs set, the element which has the minimum Ncs value is reserved, the other elements are deleted, and the screening Ncs set in which each element has a different Nr value is generated.

4. The method according to claim **1**, wherein,

in the step C, if the N is greater than the P, P−1 Ncs values arranged from low to high in the screening Ncs set and the maximum Ncs value in the screening Ncs set are regarded as elements of the final Ncs set, and the other N−P elements are deleted.

5. The method according to claim **1**, wherein,

if R=1.4 km, Tpre=133us, Npre=139 or 137, Tds=5.2us, Ncs_th=7, M=64, P=4, then the final Ncs set is {8, 10, 12, 15};

if R=1.4 km, Tpre=133us, Npre=139 or 137, Tds=5.2us, Ncs_th=7, M=64, P=2, then the final Ncs set is {8, 15};

if R=1.4 km, Tpre=133us, Npre=139 or 137, Tds=5.2us, Ncs_th=7, M=64, P=3, then the final Ncs set is {8, 10, 15};

if R=1.4 km, Tpre=133us, Npre=139 or 137, Tds=5.2us, Ncs_th=7, M=64, P=1, then the final Ncs set is {15};

if R=1.55 km, Tpre=133us, Npre=139 or 137, Tds=5.2us, Ncs_th=7, M=64, P=1, then the final Ncs set is {16};

if R=1.26 km, Tpre=133us, Npre=139 or 137, Tds=5.2us, Ncs_th=7, M=64, P=1, then the final Ncs set is {14};

if R=1.11 km, Tpre=133us, Npre=139 or 137, Tds=5.2us, Ncs_th=7, M=64, P=1, then the final Ncs set is {13};

if R=1.0 km, Tpre=133us, Npre=139 or 137, Tds=5.2us, Ncs_th=7, M=64, P=1, then the final Ncs set is {12};

if R=0.82 km, Tpre=133us, Npre=139 or 137, Tds=5.2us, Ncs_th=7, M=64, P=1, then the final Ncs set is {11};

if R=0.68 km, Tpre=133us, Npre=139 or 137, Tds=5.2us, Ncs_th=7, M=64, P=1, then the final Ncs set is {10};

if R=0.53 km, Tpre=133us, Npre=139 or 137, Tds=5.2us, Ncs_th=7, M=64, P=1, then the final Ncs set is {9};

if R=0.39 km, Tpre=133us, Npre=139 or 137, Tds=5.2us, Ncs_th=7, M=64, P=1, then the final Ncs set is {8};

if R=0.24 km, Tpre=133us, Npre=139 or 137, Tds=5.2us, Ncs_th=6, M=64, P=1, then the final Ncs set is {7};

if R=0.1 km, Tpre=133us, Npre=139 or 137, Tds=5.2us, Ncs_th=6, M=64, P=1, then the final Ncs set is {6};

if R=1.55 km, Tpre=133us, Npre=139 or 137, Tds=5.2us, Ncs_th=6, M=64, P=4, then the final Ncs set is {6, 8, 10, 16};

if R=1.4 km, Tpre=133us, Npre=139 or 137, Tds=5.2us, Ncs_th=6, M=64, P=4, then the final Ncs set is {6, 8, 10, 15};

if R=1.4 km, Tpre=133us, Npre=139 or 137, Tds=5.2us, Ncs_th=6, M=64, P=2, then the final Ncs set is {6, 15};

if R=1.4 km, Tpre=133us, Npre=139 or 137, Tds=5.2us, Ncs_th=6, M=64, P=3, then the final Ncs set is {6, 8, 15};

if R=1.4 km, Tpre=133us, Npre=139 or 137, Tds=5.2us, Ncs_th=6, M=16, P=2, then the final Ncs set is {8, 15};

if R=1.4 km, Tpre=133us, Npre=139 or 137, Tds=5.2us, Ncs_th=6, M=16, P=1, then the final Ncs set is {15};

if R=0.4 km, Tpre=133us, Npre=139 or 137, Tds=5.2us, Ncs_th=6, M=16, P=1, then the final Ncs set is {8};

if R=1.6 km, Tpre=133us, Npre=139 or 137, Tds=5.2us, Ncs_th=6, M=16, P=2, then the final Ncs set is {8, 16};

if R=1.6 km, Tpre=133us, Npre=139 or 137, Tds=5.2us, Ncs_th=6, M=16, P=1, then the final Ncs set is {16};

if R=1.5 km, Tpre=133us, Npre=139 or 137, Tds=0us, Ncs_th=2, M=16, P=2, then the final Ncs set is {8, 10};

if R=1.2 km, Tpre=133us, Npre=139 or 137, Tds=0us, Ncs_th=2, M=16, P=2, then the final Ncs set is {8};

if R=1.5 km, Tpre=133us, Npre=139 or 137, Tds=0us, Ncs_th=2, M=16, P=1, then the final Ncs set is {10};

if R=1.5 km, Tpre=133us, Npre=139 or 137, Tds=0us, Ncs_th=2, M=64, P=4, then the final Ncs set is {2, 4, 6, 10};

if R=1.0 km, Tpre=133us, Npre=139 or 137, Tds=5.2us, Ncs_th=7, M=64, P=2, then the final Ncs set is {8, 12};

if R=1.11 km, Tpre=133us, Npre=139 or 137, Tds=5.2us, Ncs_th=7, M=64, P=2, then the final Ncs set is {8, 13};

if R=1.26 km, Tpre=133us, Npre=139 or 137, Tds=5.2us, Ncs_th=7, M=64, P=2, then the final Ncs set is {8, 14};

if R=1.5 km, Tpre=133us, Npre=139 or 137, Tds=0us, Ncs_th=6, M=64, P=2, then the final Ncs set is {6, 10};

if R=1.5 km, Tpre=133us, Npre=139 or 137, Tds=0us, Ncs_th=4, M=64, P=2, then the final Ncs set is {4, 10};

if R=1.5 km, Tpre=133us, Npre=139 or 137, Tds=0us, Ncs_th=2, M=64, P=2, then the final Ncs set is {2, 10};

if R=1.2 km, Tpre=133us, Npre=139 or 137, Tds=0us, Ncs_th=2, M=64, P=4, then the final Ncs set is {2, 4, 6, 8};

if R=1.5 km, Tpre=133us, Npre=139 or 137, Tds=0us, Ncs_th=4, M=64, P=4, then the final Ncs set is {4, 6, 8, 10};

if R=1.2 km, Tpre=133us, Npre=139 or 137, Tds=0us, Ncs_th=6, M=64, P=2, then the final Ncs set is {6, 8};

if R=1.2 km, Tpre=133us, Npre=139 or 137, Tds=0us, Ncs_th=4, M=64, P=2, then the final Ncs set is {4, 8};

if R=1.2 km, Tpre=133us, Npre=139 or 137, Tds=0us, Ncs_th=2, M=64, P=2, then the final Ncs set is {2, 8};

if R=0.9 km, Tpre=133us, Npre=139 or 137, Tds=0us, Ncs_th=2, M=64, P=2, then the final Ncs set is {2, 6};

if R=0.9 km, Tpre=133us, Npre=139 or 137, Tds=0us, Ncs_th=4, M=64, P=2, then the final Ncs set is {4, 6};

if R=0.6 km, Tpre=133us, Npre=139 or 137, Tds=0us, Ncs_th=2, M=64, P=2, then the final Ncs set is {2, 4};

if R=0.6 km, Tpre=133us, Npre=139 or 137, Tds=0us, Ncs_th=2, M=64, P=1, then the final Ncs set is {4};

if R=0.3 km, Tpre=133us, Npre=139 or 137, Tds=0us, Ncs_th=2, M=64, P=1, then the final Ncs set is {2};

if R=2.2 km, Tpre=133us, Npre=139 or 137, Tds=0us, Ncs_th=2, M=64, P=7, then the final Ncs set is {2, 4, 6, 8, 10, 12, 15}; and

if R=2.2 km, Tpre=133us, Npre=139 or 137, Tds=0us, Ncs_th=2, M=64, P=8, then the final Ncs set is {2, 4, 6, 8, 10, 12, 13, 15}.

6. The method according to claim **1**, wherein, one of the following sets is used as the final Ncs set:

{8, 10, 12, 15}; {8, 15}; {8, 10, 15}; {15}; {16}; {14}; {13}; {12}; {11}; {10}; {9}; {8}; {7}; {6}; {6, 8, 10, 16}; {6, 8, 10, 15}; {6, 15}; {6, 8, 15}; {8, 15}; {15}; {8}; {8, 16}; {16}; {8, 10}; {8}; {10}; {2, 4, 6, 10}; {8, 12}; {8, 13}; {8, 14}; {6, 10}; {4, 10}; {2, 10}; {2, 4, 6, 8}; {4, 6, 8, 10}; {6, 8}; {4, 8}; {2, 8}; {2, 6}; {4, 6}; {2, 4}; {4}; {2}; {2, 4, 6, 8, 10, 12, 15}; {2, 4, 6, 8, 10, 12, 13, 15}.

7. The method according to claim **1**, wherein, in the step A, the following formula is used to calculate the Ncs_max:

$$\text{Ncs\_max} = \left\lfloor \frac{(R \times 6.7 + Tds) \times Npre}{Tpre} \right\rfloor;$$

wherein, R is the maximum cell radius value which is required to be supported by the random access channel, Tpre is the length of the preamble, and Tds is the length of multi-path channel delay spread.

8. The method according to claim **1**, wherein,

in the step B, for those multiple elements which have the same Nr value in the initial Ncs set, the element which has the maximum Ncs value is reserved, the other elements are deleted, and the screening Ncs set in which each element has a different Nr value is generated.

9. The method according to claim **1**, wherein,

in the step C, if the N is greater than the P, then

P−1 Ncs values arranged from high to low in the screening Ncs set and the minimum Ncs value in the screening Ncs set are regarded as elements of the final Ncs set, and the other N−P elements are deleted; or

P Ncs values arranged from high to low in the screening Ncs set are regarded as elements of the final Ncs set, and the other N−P elements are deleted; or

P Ncs values arranged from low to high in the screening Ncs set are regarded as elements of the final Ncs set, and the other N−P elements are deleted.

10. A method for generation of random access preamble, comprising:

selecting a cyclic shift amount Ncs from a cyclic shift amount set, and cyclically shifting v×Ncs for root Zadoff-Chu sequence at a predefined start point so as to generate a random access preamble of the root Zadoff-Chu sequence;

wherein,

$$v = 0, 1, \ldots, \lfloor N_{ZC} / Ncs \rfloor - 1, \quad Ncs \neq 0;$$

N_{ZC} is the length of the root Zadoff-Chu sequence; the cyclic shift amount set is {2, 4, 6, 8, 10, 12, 15}.

11. The method according to claim **10**, wherein, the predefined start point is 0.

12. The method according to claim **2**, wherein,

in the step C, if the N is greater than the P, P−1 Ncs values arranged from low to high in the screening Ncs set and the maximum Ncs value in the screening Ncs set are regarded as elements of the final Ncs set, and the other N−P elements are deleted.

13. The method according to claim **3**, wherein,

in the step C, if the N is greater than the P, P−1 Ncs values arranged from low to high in the screening Ncs set and the maximum Ncs value in the screening Ncs set are regarded as elements of the final Ncs set, and the other N−P elements are deleted.

14. The method according to claim **2**, wherein, in the step A, the following formula is used to calculate the Ncs_max:

$$\text{Ncs\_max} = \left\lfloor \frac{(R \times 6.7 + Tds) \times Npre}{Tpre} \right\rfloor;$$

wherein, R is the maximum cell radius value which is required to be supported by the random access channel, Tpre is the length of the preamble, and Tds is the length of multipath channel delay spread.

15. The method according to claim **2**, wherein,

in the step C, if the N is greater than the P, then

P−1 Ncs values arranged from high to low in the screening Ncs set and the minimum Ncs value in the screening Ncs set are regarded as elements of the final Ncs set, and the other N−P elements are deleted; or

P Ncs values arranged from high to low in the screening Ncs set are regarded as elements of the final Ncs set, and the other N−P elements are deleted; or

P Ncs values arranged from low to high in the screening Ncs set are regarded as elements of the final Ncs set, and the other N−P elements are deleted.

16. The method according to claim **3**, wherein,

in the step C, if the N is greater than the P, then

P−1 Ncs values arranged from high to low in the screening Ncs set and the minimum Ncs value in the screening Ncs set are regarded as elements of the final Ncs set, and the other N−P elements are deleted; or

P Ncs values arranged from high to low in the screening Ncs set are regarded as elements of the final Ncs set, and the other N−P elements are deleted; or

P Ncs values arranged from low to high in the screening Ncs set are regarded as elements of the final Ncs set, and the other N−P elements are deleted.

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