

allocated to the K_D sets of the distributed transmission mode meets the following formula:

$$(M^{(L)} - 1)/2 - \left\lfloor \frac{K_L}{K_L + K_D} \cdot (M^{(L)} - 1)/2 \right\rfloor; \text{ and}$$

an allocation ratio of all candidates at aggregation levels where the number of control channel candidates is 2, is 1:1 between the K_L sets of the localised transmission

5 mode and the K_D sets of the distributed transmission mode.

[0019] Optionally, at least one set in the determined K sets for transmitting the control channel is used to allocate control channel candidates at one or two aggregation levels.

[0020] A rule for determining aggregation levels that can be supported by the control channel to be transmitted includes:

10 when the total number of aggregation levels that can be supported by the control channel is N, obtaining, according to the number of valid physical resource elements included in each physical resource block pair, k ($k \leq N$) aggregation levels in the N aggregation levels as aggregation levels of the control channel to be transmitted, or

15 configuring, semi-statically through RRC signaling, k ($k \leq N$) aggregation levels in the N aggregation levels as aggregation levels that can be supported by the control channel to be transmitted.

[0021] A form of semi-static configuration through RRC signaling is a bitmap (Bitmap).

[0022] If the number of aggregation levels of the control channel to be transmitted is N, the numbers of control channel candidates corresponding to any p ($p \leq 4$) aggregation levels in 4 aggregation levels (1, 2, 4, 8) in an original protocol are respectively configured for corresponding aggregation levels in the N aggregation levels of the control channel to be transmitted, and the numbers of control channel candidates corresponding to remaining (4-p) aggregation levels in the 4 aggregation levels (1, 2, 4, 8) in the original protocol are correspondingly configured for remaining N-p aggregation levels in the N aggregation levels
25 of the control channel to be transmitted.

[0023] When the aggregation levels supported by the control channel to be transmitted include 32, and the number of available resource elements in each physical resource block pair except resource elements of other signals, such as a CRS, a DMRS, a CSI-RS, a

levels as aggregation levels of the control channel to be transmitted, or

configuring, semi-statically through RRC signaling, k ($k \leq N$) aggregation levels in the N aggregation levels as aggregation levels that can be supported by the control channel to be transmitted.

5 | **[0039]** A form of semi-static configuration through RRC signaling is a bitmap (Bitmap).

[0040] If the number of aggregation levels of the control channel to be transmitted is N , the numbers of control channel candidates corresponding to any p ($p \leq 4$) aggregation levels in 4 aggregation levels (1, 2, 4, 8) in an original protocol are respectively configured for corresponding aggregation levels in the N aggregation levels of the control channel to be transmitted, and the numbers of control channel candidates corresponding to remaining ($4-p$) aggregation levels in the 4 aggregation levels (1, 2, 4, 8) in the original protocol are correspondingly configured for remaining $N-p$ aggregation levels in the N aggregation levels of the control channel to be transmitted.

[0041] Optionally, the apparatus further includes a detecting unit, where: when the aggregation levels supported by the control channel to be transmitted include 32, and the number of available resource elements in each physical resource block pair except resource elements of other signals, such as a CRS, a DMRS, a CSI-RS, a PDCCH, is greater than or equal to 72, the detecting unit does not detect control channel candidates at aggregation level 32; otherwise, the detecting unit detects the control channel candidates at aggregation level 32; or, when the aggregation levels supported by the control channel to be transmitted do not include 32, and the number of available resource elements in each physical resource block pair except resource elements of other signals, such as a CRS, a DMRS, a CSI-RS, a PDCCH, is less than 72, the detecting unit detects control channel candidates at aggregation level 8.

25 | **[0042]** Optionally, when the control channel to be transmitted is transmitted with an extended cyclic prefix, and the supported aggregation levels include 16, and the number of available resource elements in each physical resource block pair except resource elements of other signals, such as a CRS, a DMRS, a CSI-RS, a PDCCH, is greater than or equal to 72, the detecting unit does not detect control channel candidates at aggregation level 16; otherwise, the detecting unit detects the control channel candidates at aggregation level 16;

30

the UE may allocate the first 3 control channel candidates in the 6 control channel candidates corresponding to aggregation level 1 or 2 to at least one set in the K_L sets. In this embodiment, the allocating the first 3 control channel candidates to at least one set in the K_L sets includes evenly allocating the 3 control channel candidates to the K_L sets, which means, a control channel candidate is allocated to each set sequentially in an incremental cyclic manner. The remaining 3 control channel candidates are allocated to different sets according to the predefined sequence of control channel sets and the position of the start set at the aggregation level. In the embodiment of the present invention, K_L sets of the localised transmission mode are marked with 1, 2, ..., and K_L , and K_D sets of the distributed transmission mode are marked with 1, 2, ..., and K_D . The allocating the remaining half of the control channel candidates at the lower aggregation level 1 or 2 to different sets according to the predefined sequence of control channel sets and the position of the start set at the aggregation level includes: allocating a control channel candidate to each set sequentially from the start set according to the sequence from K_L sets 1, 2, ..., and K_L of the localised transmission mode to K_D sets 1, 2, ..., and K_D of the distributed transmission mode, where the cyclic allocation is performed until the remaining half of the control channel candidates are allocated completely.

[0068] For $K = 4$, $K_L = 2$, and $K_D = 2$, when the start ePDCCH set is set 1 of the localised transmission mode, the result of allocating 6 control channel candidates at set-level aggregation level 1 or 2 to 4 ePDCCH sets is:

Set 1 of the Localised Transmission Mode	Set 2 of the Localised Transmission Mode	Set 1 of the Distributed Transmission Mode	Set 2 of the Distributed Transmission Mode
3	2	1	0

[0069] The first 3 control channel candidates are allocated to sets 1 and 2 of the localised transmission mode, where 2 control channel candidates are in set 1 of the localised

transmission mode, and 1 control channel candidate is in set 1 of the localised transmission mode. The last 3 control channel candidates are sequentially allocated to sets 1 and 2 of the localised transmission mode and set 1 of the distributed transmission mode from set 1 of the localised transmission mode. Therefore, the final result of allocating the 6 control channel candidates to the 4 ePDCCH sets is: 3 control channel candidates are in set 1 of the localised transmission mode, 2 control channel candidates are in set 2 of the localised transmission mode, and 1 control channel candidate is in set 1 of the distributed transmission mode.

[0070] Likewise, for $K = 4$, $K_L = 1$, and $K_D = 3$, when the start ePDCCH set is set 1 of the localised transmission mode, the result of allocating 6 candidates at aggregation level 1 or

2 to 4 ePDCCH sets is:

Set 1 of the Localised Transmission Mode	Set 1 of the Distributed Transmission Mode	Set 2 of the Distributed Transmission Mode	Set 3 of the Distributed Transmission Mode
4	1	1	0

[0071] For $K = 4$, $K_L = 3$, and $K_D = 1$, when the start ePDCCH set is set 3 of the localised transmission mode, the result of allocating 6 candidates at ~~set-level-aggregation level~~ 1 or 2 to 4 ePDCCH sets is:

Set 1 of the Localised Transmission Mode	Set 2 of the Localised Transmission Mode	Set 3 of the Localised Transmission Mode	Set 1 of the Distributed Transmission Mode
1	2	2	1

[0072] For $K = 4$, $K_L = 4$, and $K_D = 0$, when the start ePDCCH set is set 1 of the localised transmission mode, the result of allocating 6 candidates at ~~set-level-aggregation level~~ 1 or 2 to 4 ePDCCH sets is:

Set 1 of the Localised	Set 2 of the Localised	Set 3 of the Localised	Set 4 of the Localised
------------------------	------------------------	------------------------	------------------------

Transmission Mode	Transmission Mode	Transmission Mode	Transmission Mode
2	2	1	1

[0073] For $K = 4$, $K_L = 0$, and $K_D = 4$, when the start ePDCCH set is set 1 of the distributed transmission mode, the result of allocating 6 candidates at set-level aggregation level 1 or 2 to 4 ePDCCH sets is:

Set 1 of the Distributed Transmission Mode	Set 2 of the Distributed Transmission Mode	Set 3 of the Distributed Transmission Mode	Set 4 of the Distributed Transmission Mode
2	2	1	1

5

[0074] For $K = 2$, $K_L = 1$, and $K_D = 1$, assuming that the start ePDCCH set is set 1 of the localised transmission mode, the result of allocating 6 candidates at set-level aggregation level 1 or 2 to 2 ePDCCH sets is:

Set 1 of the Localised Transmission Mode	Set 1 of the Distributed Transmission Mode
5	1

10 [0075] For $K = 2$, $K_L = 2$, and $K_D = 0$, assuming that the start ePDCCH set is set 2 of the localised transmission mode, the result of allocating 6 candidates at set-level aggregation level 1 or 2 to 2 ePDCCH sets is:

Set 1 of the Localised Transmission Mode	Set 2 of the Localised Transmission Mode
3	3

[0076] For $K = 2$, $K_L = 0$, and $K_D = 2$, assuming that the start ePDCCH set is set 1 of

the distributed transmission mode, the result of allocating 6 candidates at set-level aggregation level 1 or 2 to 2 ePDCCH sets is:

Set 1 of the Distributed Transmission Mode	Set 2 of the Distributed Transmission Mode
3	3

[0077] In the above method, after the UE allocates at least one half of the control channel candidates corresponding to a lower aggregation level to at least one set in K_L sets of the localised transmission mode, the UE allocates a control channel candidate to each set sequentially from the start set according to the sequence from K_L sets 1, 2, ..., and K_L of the localised transmission mode to K_D sets 1, 2, ..., and K_D of the distributed transmission mode, where the cyclic allocation is performed until the remaining control channel candidates are allocated completely. Optionally, the allocating the remaining control channel candidates to different sets according to the predefined sequence of control channel sets and the position of a start set at the aggregation level may also include: allocating a control channel candidate in the sets of the localised transmission mode and the sets of the distributed transmission mode from the start set in a head/tail alternation manner according to the sequence of K_L sets 1, 2, ..., and K_L of the localised transmission mode and K_D sets 1, 2, ..., and K_D of the distributed transmission mode, until the remaining half of the control channel candidates are allocated completely.

[0078] For $K = 4$, $K_L = 1$, and $K_D = 3$, when the start ePDCCH set is set 1 of the localised transmission mode, the result of allocating 6 candidates at aggregation level 1 or 2 to 4 ePDCCH sets is:

Set 1 of the Localised Transmission Mode	Set 1 of the Distributed Transmission Mode	Set 2 of the Distributed Transmission Mode	Set 3 of the Distributed Transmission Mode

is performed until the remaining half of the control channel candidates are allocated completely. Preferably, when the number of control channel candidates at the aggregation level is 2, remaining control channel candidates are allocated to all sets different from the type of the set to which the first control channel candidate is allocated. In other words, when the number of candidates at the aggregation level is 2, two control channel candidates are respectively allocated to a set in a region of the distributed transmission mode and a set in a region of localised transmission mode.

[0081] Herein, still assuming that the aggregation levels supported by both the localised transmission mode and the distributed transmission mode are 1, 2, 4, and 8, for the higher aggregation levels 4 and 8, a half of the control channel candidates corresponding to aggregation levels 4 and 8 are first allocated to at least one set in the K_D sets of the distributed transmission mode. In this embodiment, the first control channel candidate is allocated to one of the K_D sets, for example, a control channel candidate is allocated to each set sequentially in an incremental cyclic manner. The remaining half may be allocated to all sets different from the type of the set to which the first control channel candidate is allocated, namely, to a set in the K_L sets of the localised transmission mode.

[0082] For $K = 4$, $K_L = 2$, and $K_D = 2$, when two control channel candidates are respectively allocated to a set in the region of the distributed transmission mode and a set in the region of the localised transmission mode, the result of allocating 2 control channel candidates at set-level aggregation level 4 or 8 to 4 ePDCCH sets is:

Set 1 of the Localised Transmission Mode	Set 2 of the Localised Transmission Mode	Set 1 of the Distributed Transmission Mode	Set 2 of the Distributed Transmission Mode
0	1	1	0

[0083] For $K = 4$, $K_L = 2$, and $K_D = 2$, when the start set is set 1 of the distributed transmission mode, the result of allocating 2 control channel candidates at set-level aggregation level 4 or 8 to 4 ePDCCH sets is:

Set 1 of the Localised Transmission Mode	Set 2 of the Localised Transmission Mode	Set 1 of the Distributed Transmission Mode	Set 2 of the Distributed Transmission Mode
1	0	1	0

[0084] For $K = 2$, $K_L = 1$, and $K_D = 1$, the result of allocating 2 control channel candidates at set-level aggregation level 4 or 8 to 2 ePDCCH sets is:

Set 1 of the Localised Transmission Mode	Set 1 of the Distributed Transmission Mode
1	1

5 [0085] In the above method, after the UE allocates at least one half of the control channel candidates corresponding to a higher aggregation level to at least one set in K_D sets of the distributed transmission mode, the UE allocates a control channel candidate to each set sequentially from the start set according to the sequence from K_L sets 1, 2, ..., and K_L of the localised transmission mode to K_D sets 1, 2, ..., and K_D of the distributed transmission mode, where the cyclic allocation is performed until the remaining control channel candidates are allocated completely. Optionally, the allocating the remaining control channel candidates to different sets according to the predefined sequence of control channel sets and the position of a start set at the aggregation level may also include: allocating a control channel candidate in the sets of the localised transmission mode and the sets of the distributed transmission mode from the start set in a head/tail alternation manner according to the sequence of K_L sets 1, 2, ..., and K_L of the localised transmission mode and K_D sets 1, 2, ..., and K_D of the distributed transmission mode, until the remaining half of the control channel candidates are allocated completely.

[0086] For $K = 4$, $K_L = 2$, and $K_D = 2$, when two control channel candidates are

respectively allocated to a set in the region of the distributed transmission mode and a set in the region of the localised transmission mode, the result of allocating 2 control channel candidates at set-level aggregation level 4 or 8 to 4 ePDCCH sets is:

Set 1 of the Localised Transmission Mode	Set 2 of the Localised Transmission Mode	Set 1 of the Distributed Transmission Mode	Set 2 of the Distributed Transmission Mode
1	0	0	1

- 5 **[0087]** After obtaining the value of K configured by the eNB for the UE, the UE may allocate the control channel candidates to at least one set in the K sets. The allocation method may include 3 cases. In the third case, the allocating all control channel candidates at the aggregation levels supported by both the localised transmission mode and the distributed transmission mode to at least one set in the K_D sets of the distributed transmission mode
10 and at least one set in the K_L sets of the localised transmission mode when both the K_L and K_D are positive integers, may also include:

determining, according to a ratio between the numbers of sets used for the aggregation levels in K_D and K_L , the number of control channel candidates allocated to the K_L and K_D sets, at each aggregation level; or determining, according to a ratio
15 between the total numbers of physical resource blocks in sets used for the aggregation levels in K_D and K_L , the number of control channel candidates allocated to the K_L and K_D sets, at each aggregation level; or determining, according to a ratio of the number of physical resource blocks of each set in sets used for the aggregation levels in K_D and K_L , the number of control channel candidates allocated to each set in the K_L and K_D sets, at each
20 aggregation level.

[0088] After allocating all control channel candidates at the aggregation levels supported by both the distributed transmission mode and the localised transmission mode to at least one set in the K_D sets of the distributed transmission mode and at least one set in the K_L sets of

the localised transmission mode, all control channel candidates at the aggregation level supported by only the distributed transmission mode or the localised transmission mode are allocated to at least one set in the K_D sets of the distributed transmission mode or in the K_L sets of the localised transmission mode, which includes: determining, according to the number of sets used for the aggregation level in K_D or K_L , the number of control channel candidates allocated to each set in the K_L or K_D sets, at the aggregation level; or determining, according to a ratio of the number of physical resource blocks of each set in sets used for the aggregation level in K_D or K_L , the number of control channel candidates allocated to each set in the K_L or K_D sets, at the aggregation level. For example, aggregation levels supported by the control channel to be transmitted may be 1, 2, 4, 8, and 16, and may also be 2, 4, 8, 16, and 32, where an aggregation level supported by only the distributed transmission mode is 16 or 32, and the UE may allocate all control channel candidates at aggregation level 16 or 32 to at least one set in the K_D sets of the distributed transmission mode. Generally, the UE may allocate all control channel candidates at aggregation level 16 or 32 to one set in the K_D sets of the distributed transmission mode. Optionally, the UE also determines, according to the number of sets used for the aggregation level 16 or 32 in K_D , the number of control channel candidates allocated to each set, at the aggregation level 16 or 32, for example, when the number of sets used for the aggregation level 16 or 32 is 2, and the number of control channel candidates is also 2, allocation is performed sequentially in a manner of placing one candidate in each set. Otherwise, allocation is performed by using the following methods:

[0089] Method 1: Firstly, assuming that the number of control channel candidates corresponding to the aggregation level is $M^{(L)}$, and the number of sets is K , perform allocation, according to the number $\lfloor M^{(L)} / K \rfloor$, for each set of the sets supporting the aggregation level, then place one of the remaining $M^{(L)} - \lfloor M^{(L)} / K \rfloor$ candidates cyclically to each set sequentially until all candidates are completely allocated.

" $\lceil \cdot \rceil$ " means rounding up.

[0090] Method 2: According to a ratio of the number of physical resource blocks of each set supporting the aggregation level to the total number of physical resource blocks in all sets that support the aggregation level, first perform the following allocation in the set of the

5 highest or lowest ratio: $\left\lfloor \frac{M^{(L)} \cdot (N_i / N_{total})}{\lceil M^{(L)} \cdot (N_i / N_{total}) \rceil} \right\rfloor$, where N_i is the number of physical resource blocks in set i , and N_{total} is the total number of physical resource blocks in all the sets. Secondly, according to this method, place the remaining $M^{(L)} - \left\lfloor \frac{M^{(L)} \cdot (N_i / N_{total})}{\lceil M^{(L)} \cdot (N_i / N_{total}) \rceil} \right\rfloor$ candidates in a set of a next higher or next lower ratio in a recursive manner until all candidates are allocated completely.

10 **[0091]** Method 3: Mark each set supporting the aggregation level L with $s_1, s_2, s_3, \dots$, and s_T . Firstly, allocate c_i control channel candidates to set s_i according to the following formula, where the number c_i may be indicated by:

$$c_i = \left\lfloor \frac{C_L \times N_i}{\sum_{j=1}^T N_j} \right\rfloor.$$

[0092] Place the remaining $R = C_L - \sum_{j=1}^T c_j$ control channel candidates in R sets according

15 to a preset rule. Herein C_L is the number of control channel candidates corresponding to the aggregation level L .

[0093] The preset rule may be: sorting the R sets according to the number of physical resource block pairs included in each set, marking the sorted R sets with $s_1, s_2, s_3, \dots$, and s_R , where assuming that the number of physical resource block pairs included in the set s_i is N_i , the sorted sets satisfy $N_i \geq N_j$ and $i \leq j$, and placing one control channel candidate in

20 each set of the R sets sequentially according to the sequence of $s_1, s_2, \dots$, and s_R .

[0094] In the above method, the UE allocates all control channel candidates at the aggregation levels supported by both the localised transmission mode and the distributed transmission mode in the aggregation levels supported by the control channel to be

Aggregation Level	Set of the Localised Transmission Mode	Set of the Distributed Transmission Mode
2	4	0
4	6	0
8	1	1
16	1	1
32	0	2

[0097] Optionally, according to the allocation shown in the above tables, the UE may perform proportional allocation of the candidates between different sets according to the number of PRB pairs included in each set of a set type, for example, when the number of control channel candidates allocated to the $K_L = 2$ sets of the localised transmission mode is 3, and the numbers of PRB Pairs included in two sets are 2 and 4 respectively, the 3 control channel candidates are respectively allocated to each set according to the ratio of the number of included PRB Pairs, namely, 1:2. Of course, when the number of control channel candidates is 4, and allocation cannot be performed according to the ratio 1:2, allocation may be performed according to the ratio $\text{ceil}(4/(1 + 2)) - 1 = 1:\text{ceil}(4 * 2/(1 + 2)) = 3$. Ceil means rounding up.

[0098] Optionally, the UE may also obtain, by calculation, the number of control channel candidates allocated to the K_L sets of the localised transmission mode and the K_D sets of the distributed transmission mode. Preferably, for a lower aggregation level supported by the control channel to be transmitted, when the number of control channel candidates corresponding to the lower aggregation level is an even number, the number of control channel candidates allocated to the K_L sets of the localised transmission mode meets the

following formula: $M^{(L)}/2 + \left\lfloor \frac{K_L}{K_L + K_D} \cdot M^{(L)}/2 \right\rfloor$; and the number of control channel

candidates allocated to the $\frac{K_D}{K_L}$ sets of the localised transmission mode meets the

following

formula: $M^{(L)}/2 - \left\lfloor \frac{K_L}{K_L + K_D} \cdot M^{(L)}/2 \right\rfloor$; when the number of control channel candidates

corresponding to the lower aggregation level is an odd number, the number of control channel candidates allocated to the K_L sets of the localised transmission mode meets the following

formula: $(M^{(L)} + 1)/2 + \left\lfloor \frac{K_L}{K_L + K_D} \cdot (M^{(L)} - 1)/2 \right\rfloor$; and the number of control channel

5 candidates allocated to the $\frac{K_D}{K_L}$ sets of the localised transmission mode meets the

following formula: $(M^{(L)} - 1)/2 - \left\lfloor \frac{K_L}{K_L + K_D} \cdot (M^{(L)} - 1)/2 \right\rfloor$; and an allocation ratio of all

candidates at aggregation levels supported by the control channel to be transmitted, except the lower aggregation level, is 1:1 between the K_L sets of the localised transmission mode

and the K_D sets of the distributed transmission mode. When the aggregation levels

10 supported by the control channel to be transmitted are 1, 2, 4, 8, and 16, the lower aggregation levels are 1 and 2; when the aggregation levels supported by the control channel to be transmitted are 2, 4, 8, 16, and 32, the lower aggregation levels are 2 and 4.

[0099] Based on the higher-layer semi-statically configured or the calculated number of control channel candidates at each aggregation level in the K_L sets of the localised

15 transmission mode and K_D sets of the distributed transmission mode, for each aggregation

level, when the number of control channel candidates configured for the K_L sets of the

localised transmission mode is greater than 1, the number of control channel candidates in each set is determined according to the number of physical resource blocks included in each set of the localised transmission mode; or when the number of control channel candidates

20 configured for the K_D sets of the distributed transmission mode is greater than 1, the

number of control channel candidates in each set is determined according to the number of physical resource blocks included in each set of the distributed transmission mode.

[0100] Optionally, the UE may perform proportional allocation of the above candidates between different sets according to the number of PRB pairs included in each set of a set type,

[0135] A form of semi-static configuration through RRC signaling is a bitmap (Bitmap).

[0136] If the number of aggregation levels of the control channel to be transmitted is N, the numbers of control channel candidates corresponding to any p ($p \leq 4$) aggregation levels in 4 aggregation levels (1, 2, 4, 8) in an original protocol are respectively configured for corresponding aggregation levels in the N aggregation levels of the control channel to be transmitted, and the numbers of control channel candidates corresponding to remaining (4-p) aggregation levels in the 4 aggregation levels (1, 2, 4, 8) in the original protocol are correspondingly configured for remaining N-p aggregation levels in the N aggregation levels of the control channel to be transmitted.

[0137] Optionally, the apparatus includes a detecting unit. When the aggregation levels supported by the control channel to be transmitted include 32, and the number of available resource elements in each physical resource block pair except resource elements of other signals, such as a CRS, a DMRS, a CSI-RS, a PDCCH, is greater than or equal to 72, the detecting unit does not detect control channel candidates at aggregation level 32; otherwise, the detecting unit detects the control channel candidates at aggregation level 32; or, when the aggregation levels supported by the control channel to be transmitted do not include 32, and the number of available resource elements in each physical resource block pair except resource elements of other signals, such as a CRS, a DMRS, a CSI-RS, a PDCCH, is less than 72, the detecting unit detects control channel candidates at aggregation level 8.

[0138] When the control channel to be transmitted is transmitted with an extended cyclic prefix, and the supported aggregation levels include 16, and the number of available resource elements in each physical resource block pair except resource elements of other signals, such as a CRS, a DMRS, a CSI-RS, a PDCCH, is greater than or equal to 72, the detecting unit does not detect control channel candidates at aggregation level 16; otherwise, the detecting unit detects the control channel candidates at aggregation level 16; or, when the control channel to be transmitted is transmitted with an extended cyclic prefix, and the supported aggregation levels do not include 16, and the number of available resource elements in each physical resource block pair except resource elements of other signals, such as a CRS, a DMRS, a CSI-RS, a PDCCH, is less than 72, the detecting unit detects PDCCH candidates at aggregation level 8.

[0139] The K_L and K_D for transmitting the control channel are configured, and the number of physical resource block pairs included in each set is configured; or the K_L and K_D for transmitting the control channel are fixed, the number of physical resource block pairs included in each set is configured, and allocation of all control channel candidates at each aggregation level to the K_L and K_D sets is fixed.

[0140] Herein the configuration refers to parameters configured by the base station for the UE through higher-layer signaling, which means, values of the K_L and K_D and the number of physical resource block pairs included in each set may all be configured by the base station for the UE.

[0141] An embodiment of the present invention further provides an apparatus for allocating control channel candidates. As shown in FIG. 3, the apparatus includes a receiver 31, a transmitter 32, a memory 33, and a processor 34 that is connected to the receiver 31, the transmitter 32, and the memory 33, where the receiver may be configured to receive higher-layer signaling sent by a base station. The memory stores a group of program codes, and the processor invokes the program codes in the memory to perform operations.

[0142] The processor 34 is configured to determine K sets for transmitting a control channel, where each set in the K sets includes at least one physical resource block pair, and K is a positive integer greater than 0; the processor 34 is configured to allocate, according to at least one of aggregation levels supported by the control channel, the number of control channel candidates corresponding to each aggregation level, the K sets for transmitting the control channel, and types of the sets, each control channel candidate to at least one set in the K sets determined by the processor 34.

[0143] The K sets for transmitting the control channel include a set of a localised transmission mode and a set of a distributed transmission mode, where the number of sets of the localised transmission mode is K_L , and the number of sets of the distributed transmission mode is K_D , where $K_L + K_D = K$, and K_L and K_D are integers greater than or equal to 0; and the aggregation levels supported by the control channel include one or

[0156] A form of semi-static configuration through RRC signaling is a bitmap (Bitmap).

[0157] If the number of aggregation levels of the control channel to be transmitted is N, the numbers of control channel candidates corresponding to any p ($p \leq 4$) aggregation levels in 4 aggregation levels (1, 2, 4, 8) in an original protocol are respectively configured for corresponding aggregation levels in the N aggregation levels of the control channel to be transmitted, and the numbers of control channel candidates corresponding to remaining (4-p) aggregation levels in the 4 aggregation levels (1, 2, 4, 8) in the original protocol are correspondingly configured for remaining N-p aggregation levels in the N aggregation levels of the control channel to be transmitted.

[0158] Optionally, the apparatus includes a detecting unit. When the aggregation levels supported by the control channel to be transmitted include 32, and the number of available resource elements in each physical resource block pair except resource elements of other signals, such as a CRS, a DMRS, a CSI-RS, a PDCCH, is greater than or equal to 72, the detecting unit does not detect control channel candidates at aggregation level 32; otherwise, the detecting unit detects the control channel candidates at aggregation level 32; or, when the aggregation levels supported by the control channel to be transmitted do not include 32, and the number of available resource elements in each physical resource block pair except resource elements of other signals, such as a CRS, a DMRS, a CSI-RS, a PDCCH, is less than 72, the detecting unit detects control channel candidates at aggregation level 8.

[0159] When the control channel to be transmitted is transmitted with an extended cyclic prefix, and the supported aggregation levels include 16, and the number of available resource elements in each physical resource block pair except resource elements of other signals, such as a CRS, a DMRS, a CSI-RS, a PDCCH, is greater than or equal to 72, the detecting unit does not detect control channel candidates at aggregation level 16; otherwise, the detecting unit detects the control channel candidates at aggregation level 16; or, when the control channel to be transmitted is transmitted with an extended cyclic prefix, and the supported aggregation levels do not include 16, and the number of available resource elements in each physical resource block pair except resource elements of other signals, such as a CRS, a DMRS, a CSI-RS, a PDCCH, is less than 72, the detecting unit detects PDCCH candidates at aggregation level 8.

CLAIMS

What is claimed is:

1. A method for allocating control channel candidates, comprising:

determining K sets for transmitting a control channel, wherein each set in the K sets
5 comprises at least one physical resource block pair, and K is a positive integer greater than 0;
and

allocating each control channel candidate to at least one set in the K sets according to at
least one of aggregation levels supported by the control channel, the number of control
channel candidates corresponding to each aggregation level, the K sets for transmitting the
10 control channel, and types of the sets.

2. The method according to claim 1, wherein: the K sets for transmitting the control
channel comprise a set of a localised transmission mode and a set of a distributed
transmission mode, wherein the number of sets of the localised transmission mode is K_L ,
and the number of sets of the distributed transmission mode is K_D , $K_L + K_D = K$, and

15 K_L and K_D are integers greater than or equal to 0; and

the aggregation levels supported by the control channel comprise one or more of the
following levels:

aggregation levels supported by the localised transmission mode, aggregation levels
supported by the distributed transmission mode, and common aggregation levels supported
20 by both the localised transmission mode and the distributed transmission mode.

3. The method according to claim 2, wherein the allocating control channel candidates at
each aggregation level to at least one set in the K sets according to the aggregation levels
supported by the control channel to be transmitted, the number of control channel candidates
corresponding to each aggregation level and determined according to a preset rule, the K sets
25 for transmitting the control channel, and the types of the sets, comprises:

when K_L is a positive integer, allocating all control channel candidates at the
aggregation levels supported by the localised transmission mode to at least one of the K_L

sets; or

when K_D is a positive integer, allocating all control channel candidates at the aggregation levels supported by the distributed transmission mode to at least one of the K_D sets; or

5 when both K_L and K_D are positive integers, allocating all control channel candidates at each aggregation level in the aggregation levels supported by both the localised transmission mode and the distributed transmission mode to at least one of the K_D sets and at least one of the K_L sets.

4. The method according to claim 3, wherein both K_L and K_D are positive integers,
10 and all control channel candidates at each aggregation level in the aggregation levels supported by both the localised transmission mode and the distributed transmission mode are allocated to at least one of the K_D sets and at least one of the K_L sets, and wherein:

at least one half of all control channel candidates at each first aggregation level in the aggregation levels supported by both the localised transmission mode and the distributed
15 transmission mode are allocated to at least one of the K_L sets; and

at least one half of all control channel candidates at each second aggregation level in the aggregation levels supported by both the localised transmission mode and the distributed transmission mode are allocated to at least one of the K_D sets.

5. The method according to claim 4, wherein:

20 when the aggregation levels supported by both the localised transmission mode and the distributed transmission mode are 1, 2, 4, and 8, the first aggregation levels are 1 and 2, and the second aggregation levels are 4 and 8; and

when the aggregation levels supported by both the localised transmission mode and the distributed transmission mode are 2, 4, 8, and 16, the first aggregation levels are 2 and 4, and
25 the second aggregation levels are 8 and 16.

6. The method according to claim 4 or 5, wherein:

remaining control channel candidates at each aggregation level are allocated to different

sets according to a predefined sequence of control channel sets and/or a position of a start set at the aggregation level.

7. The method according to claim 4 or 5, wherein:

when the number of control channel candidates at the aggregation level is 2, remaining
5 control channel candidates are not placed in any set corresponding to a transmission mode of a first control channel candidate.

8. The method according to claim 6 or 7, wherein:

the position of a start set at each aggregation level is related to the number of control channel candidates at the aggregation level and configuration of K_L and K_D .

10 9. The method according to claim 3, wherein the allocating all control channel candidates at an aggregation level supported by only the distributed transmission mode or the localised transmission mode to at least one set in the K_D sets of the distributed transmission mode or in the K_L sets of the localised transmission mode, comprises:

determining, according to the number of sets used for the aggregation level in K_D or
15 K_L , the number of control channel candidates allocated to each set in the K_D or K_L sets, at the aggregation level; or

determining, according to a ratio of the number of physical resource blocks of each set in sets used for the aggregation level in K_D or K_L , the number of control channel candidates allocated to each set in the K_D or K_L sets, at the aggregation level.

20 10. The method according to claim 3, wherein both K_L and K_D are positive integers, all control channel candidates at each aggregation level in the aggregation levels supported by both the localised transmission mode and the distributed transmission mode are allocated to at least one of the K_D sets and at least one of the K_L sets, wherein:

according to a ratio between the numbers of sets used for the aggregation level in K_D
25 and K_L , the numbers of control channel candidates allocated to the K_L and K_D sets are determined, at each aggregation level; or

according to a ratio between the total numbers of physical resource blocks in sets used for the aggregation levels in K_D and K_L , the numbers of control channel candidates allocated to the K_L and K_D sets are determined, at each aggregation level; or

according to a ratio of the number of physical resource blocks of each set in sets used for the aggregation level in K_D and K_L , the number of control channel candidates allocated to each set in the K_L and K_D sets are determined, at each aggregation level.

11. The method according to claim 2, wherein:

at each aggregation level, the numbers of control channel candidates allocated to the K_L and K_D sets are configured.

12. The method according to claim 11, wherein:

the configuration is a higher-layer semi-static configuration.

13. The method according to claim 3, wherein:

at each aggregation level, when the number of control channel candidates configured for the K_L (greater than 1) sets is greater than 1, the number of control channel candidates in each set is determined according to the number of physical resource blocks comprised in each set that can support the aggregation level in the K_L sets or the number of sets that can support the aggregation level in the K_L sets, or

when the number of control channel candidates configured for the K_D (greater than 1) sets is greater than 1, the number of control channel candidates in each set is determined according to the number of physical resource blocks comprised in each set that can support the aggregation level in the K_D sets or the number of sets that can support the aggregation level in the K_D sets.

14. The method according to claim 1 or 2, wherein:

at each aggregation level supported by the control channel to be transmitted, the number of control channel candidates allocated to the K_L sets of the localised transmission mode

and the number of control channel candidates allocated to the K_D sets of the distributed transmission mode are functions of at least one of the number of control channel candidates at the aggregation level, the number K_L of sets of the localised transmission mode, and the number K_D of sets of the distributed transmission mode.

5 15. The method according to claim 14, wherein:

when the number of control channel candidates corresponding to the aggregation levels supported by both the localised transmission mode and the distributed transmission mode is an even number, the number of control channel candidates allocated to the K_L sets of the localised transmission mode meets the following formula: $M^{(L)}/2 + \left\lfloor \frac{K_L}{K_L + K_D} \cdot M^{(L)}/2 \right\rfloor$;

10 and the number of control channel candidates allocated to the K_D sets of the distributed transmission mode meets the following formula: $M^{(L)}/2 - \left\lfloor \frac{K_L}{K_L + K_D} \cdot M^{(L)}/2 \right\rfloor$;

when the number of control channel candidates corresponding to the lower aggregation levels is an odd number, the number of control channel candidates allocated to the K_L sets of the localised transmission mode meets the following formula:

15 $(M^{(L)} + 1)/2 + \left\lfloor \frac{K_L}{K_L + K_D} \cdot (M^{(L)} - 1)/2 \right\rfloor$; and the number of control channel candidates

allocated to the K_D sets of the distributed transmission mode meets the following formula:

$(M^{(L)} - 1)/2 - \left\lfloor \frac{K_L}{K_L + K_D} \cdot (M^{(L)} - 1)/2 \right\rfloor$; and

an allocation ratio of all candidates at aggregation levels where the number of control channel candidates is 2, is 1:1 between the K_L sets of the localised transmission mode and

20 the K_D sets of the distributed transmission mode.

16. The method according to claim 1 or 2, wherein:

at least one set in the determined K sets for transmitting the control channel is used to allocate control channel candidates at one or two aggregation levels.

17. The method according to claim 1 or 2, wherein a rule for determining aggregation levels that can be supported by the control channel to be transmitted comprises:

when the total number of aggregation levels that can be supported by the control channel is N, obtaining, according to the number of valid physical resource elements comprised in each physical resource block pair, k ($k \leq N$) aggregation levels in the N aggregation levels as aggregation levels of the control channel to be transmitted, or

configuring, semi-statically through RRC signaling, k ($k \leq N$) aggregation levels in the N aggregation levels as aggregation levels that can be supported by the control channel to be transmitted.

18. The method according to claim 17, wherein a form of semi-static configuration through RRC signaling is a bitmap Bitmap.

19. The method according to claim 17, wherein:

if the number of aggregation levels of the control channel to be transmitted is N, the numbers of control channel candidates corresponding to any p ($p \leq 4$) aggregation levels in 4 aggregation levels (1, 2, 4, 8) in an original protocol are respectively configured for corresponding aggregation levels in the N aggregation levels of the control channel to be transmitted, and the numbers of control channel candidates corresponding to remaining (4-p) aggregation levels in the 4 aggregation levels (1, 2, 4, 8) in the original are correspondingly configured for remaining N-p aggregation levels in the N aggregation levels of the control channel to be transmitted.

20. The method according to claim 1, wherein:

when the aggregation levels supported by the control channel to be transmitted comprise 32, and the number of available resource elements in each physical resource block pair except resource elements of other signals, such as a CRS, a DMRS, a CSI-RS, a PDCCH, is greater than or equal to 72, a user terminal does not detect control channel candidates at aggregation level 32; otherwise, the user terminal detects the control channel candidates at aggregation level 32;

or

when the aggregation levels supported by the control channel to be transmitted do not comprise 32, and the number of available resource elements in each physical resource block

pair except resource elements of other signals, such as a CRS, a DMRS, a CSI-RS, a PDCCH, is less than 72, a user terminal detects control channel candidates at aggregation level 8.

21. The method according to claim 1, wherein:

when the control channel to be transmitted is transmitted with an extended cyclic prefix,
5 and the supported aggregation levels comprise 16, and the number of available resource elements in each physical resource block pair except resource elements of other signals, such as a CRS, a DMRS, a CSI-RS, a PDCCH, is greater than or equal to 72, a user terminal does not detect control channel candidates at aggregation level 16; otherwise, the user terminal detects the control channel candidates at aggregation level 16;

10 or, when the control channel to be transmitted is transmitted with an extended cyclic prefix, and the supported aggregation levels do not comprise 16, and the number of available resource elements in each physical resource block pair except resource elements of other signals, such as a CRS, a DMRS, a CSI-RS, a PDCCH, is less than 72, a user terminal detects PDCCH candidates at aggregation level 8.

15 22. The method according to claim 2, wherein:

the K_L and K_D for transmitting the control channel are configured, and the number of physical resource block pairs comprised in each set is configured; or

the K_L and K_D for transmitting the control channel are fixed, the number of physical resource block pairs comprised in each set is configured, and allocation of all control channel
20 candidates at each aggregation level to the K_L and K_D sets is fixed.

23. An apparatus for allocating control channel candidates, comprising:

a determining unit, configured to determine K sets for transmitting a control channel, wherein each set in the K sets comprises at least one physical resource block pair, and K is a positive integer greater than 0; and

25 an allocating unit, configured to allocate, according to at least one of aggregation levels supported by the control channel, the number of control channel candidates corresponding to each aggregation level, the K sets for transmitting the control channel, and types of the sets, each control channel candidate to at least one set in the K sets determined by the determining unit.

24. The apparatus according to claim 23, wherein: the K sets for transmitting the control channel comprise a set of a localised transmission mode and a set of a distributed transmission mode, wherein the number of sets of the localised transmission mode is K_L , and the number of sets of the distributed transmission mode is K_D , $K_L + K_D = K$, and

5 K_L and K_D are integers greater than or equal to 0; and

the aggregation levels supported by the control channel comprise one or more of the following levels:

aggregation levels supported by the localised transmission mode, aggregation levels supported by the distributed transmission mode, and common aggregation levels supported by both the localised transmission mode and the distributed transmission mode.

25. The apparatus according to claim 23, wherein the allocating unit is specifically configured to:

when K_L is a positive integer, allocate all control channel candidates at the aggregation levels supported by the localised transmission mode to at least one of the K_L sets; or

when K_D is a positive integer, allocate all control channel candidates at the aggregation levels supported by the distributed transmission mode to at least one of the K_D sets; or

when both K_L and K_D are positive integers, allocate all control channel candidates at each aggregation level in the aggregation levels supported by both the localised transmission mode and the distributed transmission mode to at least one of the K_D sets and at least one of the K_L sets.

26. The apparatus according to claim 25, wherein the allocating unit being configured to allocate all control channel candidates at each aggregation level in the aggregation levels supported by both the localised transmission mode and the distributed transmission mode to at least one of the K_D sets and at least one of the K_L sets when both K_L and K_D are

positive integers, comprises:

allocating at least one half of all control channel candidates at each first aggregation level in the aggregation levels supported by both the localised transmission mode and the distributed transmission mode to at least one of the K_L sets; and

5 allocating at least one half of all control channel candidates at each second aggregation level in the aggregation levels supported by both the localised transmission mode and the distributed transmission mode to at least one of the K_D sets.

27. The apparatus according to claim 26, wherein:

10 when the aggregation levels supported by both the localised transmission mode and the distributed transmission mode are 1, 2, 4, and 8, the first aggregation levels are 1 and 2, and the second aggregation levels are 4 and 8; and

when the aggregation levels supported by both the localised transmission mode and the distributed transmission mode are 2, 4, 8, and 16, the first aggregation levels are 2 and 4, and the second aggregation levels are 8 and 16.

15 28. The apparatus according to claim 26 or 27, wherein:

remaining control channel candidates at each aggregation level are allocated to different sets according to a predefined sequence of control channel sets and/or a position of a start set at the aggregation level.

29. The apparatus according to claim 26 or 27, wherein:

20 when the number of control channel candidates at the aggregation level is 2, remaining control channel candidates are not placed in any set corresponding to a transmission mode of a first control channel candidate.

30. The apparatus according to claim 28 or 29, wherein:

25 the position of a start set at each aggregation level is related to the number of control channel candidates at the aggregation level and configuration of K_L and K_D .

31. The apparatus according to claim 25, wherein the allocating unit being configured to allocate all control channel candidates at an aggregation level supported by only the distributed transmission mode or the localised transmission mode to at least one set in the

K_D sets of the distributed transmission mode or the K_L sets of the localised transmission mode, comprises:

determining, according to the number of sets used for the aggregation level in K_D or K_L , the number of control channel candidates allocated to each set in the K_D or K_L sets, at the aggregation level; or

determining, according to a ratio of the number of physical resource blocks of each set in sets used for the aggregation level in K_D or K_L , the number of control channel candidates allocated to each set in the K_D or K_L sets, at the aggregation level.

32. The apparatus according to claim 25, wherein the allocating unit being configured to allocate all control channel candidates at each aggregation level in the aggregation levels supported by both the localised transmission mode and the distributed transmission mode to at least one of the K_D sets and at least one of the K_L sets when both K_L and K_D are positive integers, comprises:

determining, according to a ratio between the numbers of sets used for the aggregation level in K_D and K_L , the numbers of control channel candidates allocated to the K_L and K_D sets, at each aggregation level; or

determining, according to a ratio between the total numbers of physical resource blocks in sets used for the aggregation level in K_D and K_L , the numbers of control channel candidates allocated to the K_L and K_D sets, at each aggregation level; or

determining, according to a ratio of the number of physical resource blocks of each set in sets used for the aggregation level in K_D and K_L , the number of control channel candidates allocated to each set in the K_L and K_D sets, at each aggregation level.

33. The apparatus according to claim 24, wherein:

at each aggregation level, the numbers of control channel candidates allocated to the

K_L and K_D sets are configured.

34. The apparatus according to claim 33, wherein:

the configuration is a higher-layer semi-static configuration.

35. The apparatus according to claim 25, wherein:

at each aggregation level, when the number of control channel candidates configured for

5 the K_L (greater than 1) sets is greater than 1, the allocating unit is configured to determine the number of control channel candidates in each set according to the number of physical resource blocks comprised in each set that can support the aggregation level in the K_L sets or the number of sets that can support the aggregation level in the K_L sets, or

when the number of control channel candidates configured for the K_D (greater than 1)

10 sets is greater than 1, the allocating unit is configured to determine the number of control channel candidates in each set according to the number of physical resource blocks comprised in each set that can support the aggregation level in the K_D sets or the number of sets that can support the aggregation level in the K_D sets.

36. The apparatus according to claim 25 or 26, wherein:

15 at each aggregation level supported by the control channel to be transmitted, the number of control channel candidates allocated to the K_L sets of the localised transmission mode and the number of control channel candidates allocated to the K_D sets of the distributed transmission mode are functions of at least one of the number of control channel candidates at the aggregation level, the number K_L of sets of the localised transmission mode, and the
20 number K_D of sets of the distributed transmission mode.

37. The apparatus according to claim 36, wherein:

when the number of control channel candidates corresponding to the aggregation levels supported by both the localised transmission mode and the distributed transmission mode is an even number, the number of control channel candidates allocated to the K_L sets of the

25 localised transmission mode meets the following formula: $M^{(L)} / 2 + \left\lfloor \frac{K_L}{K_L + K_D} \cdot M^{(L)} / 2 \right\rfloor$;

and the number of control channel candidates allocated to the K_D sets of the distributed

transmission mode meets the following formula: $M^{(L)}/2 - \left\lfloor \frac{K_L}{K_L + K_D} \cdot M^{(L)}/2 \right\rfloor$;

when the number of control channel candidates corresponding to the lower aggregation levels is an odd number, the number of control channel candidates allocated to the K_L sets

5 of the localised transmission mode meets the following formula:

$(M^{(L)} + 1)/2 + \left\lfloor \frac{K_L}{K_L + K_D} \cdot (M^{(L)} - 1)/2 \right\rfloor$; and the number of control channel candidates

allocated to the K_D sets of the distributed transmission mode meets the following formula:

$(M^{(L)} - 1)/2 - \left\lfloor \frac{K_L}{K_L + K_D} \cdot (M^{(L)} - 1)/2 \right\rfloor$; and

an allocation ratio of all candidates at aggregation levels where the number of control
10 channel candidates is 2, is 1:1 between the K_L sets of the localised transmission mode and the K_D sets of the distributed transmission mode.

38. The apparatus according to claim 23 or 24, wherein the allocating unit is configured to determine that at least one set in the K sets for transmitting the control channel is used to allocate control channel candidates at one or two aggregation levels.

15 39. The apparatus according to claim 23 or 24, wherein a rule for determining aggregation levels that can be supported by the control channel to be transmitted comprises:

when the total number of aggregation levels that can be supported by the control channel is N, obtaining, according to the number of valid physical resource elements comprised in each physical resource block pair, k ($k \leq N$) aggregation levels in the N aggregation levels
20 as aggregation levels of the control channel to be transmitted, or

configuring, semi-statically through RRC signaling, k ($k \leq N$) aggregation levels in the N aggregation levels as aggregation levels that can be supported by the control channel to be transmitted.

40. The apparatus according to claim 39, wherein a form of semi-static configuration
25 through RRC signaling is a bitmap Bitmap.

41. The apparatus according to claim 39, wherein:

if the number of aggregation levels of the control channel to be transmitted is N, the numbers of control channel candidates corresponding to any p ($p \leq 4$) aggregation levels in 4 aggregation levels (1, 2, 4, 8) in an original protocol are respectively configured for corresponding aggregation levels in the N aggregation levels of the control channel to be transmitted, and the numbers of control channel candidates corresponding to remaining (4-p) aggregation levels in the 4 aggregation levels (1, 2, 4, 8) in the original protocol are correspondingly configured for remaining N-p aggregation levels in the N aggregation levels of the control channel to be transmitted.

42. The apparatus according to claim 23, further comprising a detecting unit, wherein:

when the aggregation levels supported by the control channel to be transmitted comprise 32, and the number of available resource elements in each physical resource block pair except resource elements of other signals, such as a CRS, a DMRS, a CSI-RS, a PDCCH, is greater than or equal to 72, the detecting unit does not detect control channel candidates at aggregation level 32; otherwise, the detecting unit detects the control channel candidates at aggregation level 32;

or

when the aggregation levels supported by the control channel to be transmitted do not comprise 32, and the number of available resource elements in each physical resource block pair except resource elements of other signals, such as a CRS, a DMRS, a CSI-RS, a PDCCH, is less than 72, the detecting unit detects control channel candidates at aggregation level 8.

43. The apparatus according to claim 23, wherein:

when the control channel to be transmitted is transmitted with an extended cyclic prefix, and the supported aggregation levels comprise 16, and the number of available resource elements in each physical resource block pair except resource elements of other signals, such as a CRS, a DMRS, a CSI-RS, a PDCCH, is greater than or equal to 72, the detecting unit does not detect control channel candidates at aggregation level 16; otherwise, the detecting unit detects the control channel candidates at aggregation level 16;

or, when the control channel to be transmitted is transmitted with an extended cyclic prefix, and the supported aggregation levels do not comprise 16, and the number of available

resource elements in each physical resource block pair except resource elements of other signals, such as a CRS, a DMRS, a CSI-RS, a PDCCH, is less than 72, the detecting unit detects PDCCH candidates at aggregation level 8.

44. The apparatus according to claim 24, wherein:

5 the K_L and K_D for transmitting the control channel are configured, and the number of physical resource block pairs comprised in each set is configured; or

 the K_L and K_D for transmitting the control channel are fixed, the number of physical resource block pairs comprised in each set is configured, and allocation of all control channel candidates at each aggregation level to the K_L and K_D sets is fixed.

10 45. An apparatus for allocating control channel candidates, comprising a receiver, a transmitter, a memory, and a processor that is connected to the receiver, the transmitter, and the memory, wherein the memory stores a group of program codes, and the processor invokes the program codes in the memory to perform the operations according to any one of claims 1 to 22.

CLAIMS

What is claimed is:

1. A method for allocating control channel candidates, comprising:

determining K sets for transmitting a control channel, wherein each set in the K sets

5 comprises at least one physical resource block pair, and K is an integer greater than 0; and

allocating control channel candidates at each aggregation level to at least one set in the K sets according to at least one of the following factors: aggregation levels supported by the control channel, the number of control channel candidates corresponding to each aggregation level, the K sets for transmitting the control channel, and types of the sets.

10 2. The method according to claim 1, wherein: the K sets for transmitting the control channel comprise one or both of a set of a localised transmission mode and a set of a distributed transmission mode, wherein the number of sets of the localised transmission mode is K_L , and the number of sets of the distributed transmission mode is K_D , $K_L + K_D =$ K, and K_L and K_D are integers greater than or equal to 0; and

15 the aggregation levels supported by the control channel comprise one or more of the following levels:

aggregation levels supported by the localised transmission mode, aggregation levels supported by the distributed transmission mode, and common aggregation levels supported by both the localised transmission mode and the distributed transmission mode.

20 3. The method according to claim 2, wherein the allocating control channel candidates at each aggregation level to at least one set in the K sets comprises:

allocating the control channel candidates at each aggregation level to at least one set in the K sets according to the aggregation levels supported by the control channel, the number of control channel candidates corresponding to each aggregation level, the K sets for transmitting the control channel, and the types of the sets.

25 4. The method according to claim 3, wherein the allocating the control channel candidates at each aggregation level to at least one set in the K sets according to the

aggregation levels supported by the control channel, the number of control channel corresponding to each aggregation level, the K sets for transmitting the control channel, and the types of the sets, comprises:

when K_L is a positive integer, allocating all control channel candidates at the aggregation levels supported by the localised transmission mode to at least one of the K_L sets; or

when K_D is a positive integer, allocating all control channel candidates at the aggregation levels supported by the distributed transmission mode to at least one of the K_D sets; or

when both K_L and K_D are positive integers, allocating all control channel candidates at each aggregation level in the aggregation levels supported by both the localised transmission mode and the distributed transmission mode to at least one of the K_L sets and at least one of the K_D sets.

5. The method according to claim 4, wherein when both K_L and K_D are positive integers, the allocating all control channel candidates at each aggregation level in the aggregation levels supported by both the localised transmission mode and the distributed transmission mode to at least one of the K_L sets and at least one of the K_D sets comprises:

allocating at least one half of all control channel candidates at each first aggregation level in the aggregation levels supported by both the localised transmission mode and the distributed transmission mode to at least one of the K_L sets; and

allocating at least one half of all control channel candidates at each second aggregation level in the aggregation levels supported by both the localised transmission mode and the distributed transmission mode to at least one of the K_D sets.

6. The method according to claim 5, wherein:

when the aggregation levels supported by both the localised transmission mode and the

distributed transmission mode are 1, 2, 4, and 8, the first aggregation levels are 1 and 2, and the second aggregation levels are 4 and 8; and

when the aggregation levels supported by both the localised transmission mode and the distributed transmission mode are 2, 4, 8, and 16, the first aggregation levels are 2 and 4, and the second aggregation levels are 8 and 16.

7. The method according to claim 5 or 6, wherein:

remaining control channel candidates at each aggregation level are allocated to different sets according to a predefined sequence of control channel sets and/or a position of a start set at the aggregation level.

8. The method according to claim 4, wherein all control channel candidates at an aggregation level supported by only the distributed transmission mode or the localised transmission mode are allocated to at least one set in the K_D sets of the distributed transmission mode or in the K_L sets of the localised transmission mode.

9. The method according to claim 8, wherein allocating all control channel candidates at an aggregation level supported by only the distributed transmission mode or the localised transmission mode to at least one set in the K_D sets of the distributed transmission mode or in the K_L sets of the localised transmission mode comprises:

determining, according to the number of sets used for the aggregation level in K_D or K_L sets, the number of control channel candidates allocated to each set in the K_D or K_L sets, at the aggregation level; or

determining, according to a ratio of the number of physical resource blocks of each set in sets used for the aggregation level in K_D or K_L sets, the number of control channel candidates allocated to each set in the K_D or K_L sets, at the aggregation level.

10. The method according to claim 9, wherein the determining, according to a ratio of the number of physical resource blocks of each set in sets used for the aggregation level in K_D or K_L sets, the number of control channel candidates allocated to each set in the K_D

or K_L sets, at the aggregation level comprises:

allocating c_i control channel candidates to set s_i supporting an aggregation level L ,

wherein the number c_i is indicated by $c_i = \left\lfloor \frac{C_L \times N_i}{\sum_{j=1}^T N_j} \right\rfloor$, L is the aggregation level supported by

only the distributed transmission mode or the localised transmission mode, C_L is the

5 number of control channel candidates at the aggregation level L ; s_i is a set supporting the aggregation level L , c_i is the number of control channel candidates allocated to the set s_i , $i \in [1, T]$, and T is a positive integer;

allocating remaining R control channel candidates to R sets according to a preset rule,

wherein the number R is indicated by $R = C_L - \sum_{j=1}^T c_j$,

10 and the preset rule comprises: allocating one control channel candidate to each set of the R sets according to a descending order of the number of physical resource block pairs included in each set.

11. The method according to claim 4, wherein when both K_L and K_D are positive integers, the allocating all control channel candidates at each aggregation level in the
15 aggregation levels supported by both the localised transmission mode and the distributed transmission mode to at least one of the K_L sets and at least one of the K_D sets, comprises:

determining, according to a ratio between the numbers of sets used for the aggregation level in K_D and K_L , the numbers of control channel candidates allocated to the K_L and

20 K_D sets at each aggregation level; or

determining, according to a ratio between the total numbers of physical resource blocks in sets used for the aggregation levels in K_D and K_L , the numbers of control channel candidates allocated to the K_L and K_D sets at each aggregation level; or

determining, according to a ratio of the number of physical resource blocks of each set

in sets used for the aggregation level in K_D and K_L , the number of control channel candidates allocated to each set in the K_L and K_D sets at each aggregation level.

12. The method according to claim 4, wherein:

at each aggregation level, when the number of control channel candidates configured for the K_L sets is greater than 1, the number of control channel candidates in each set is determined according to the number of physical resource blocks comprised in each set that can support the aggregation level in the K_L sets or the number of sets that can support the aggregation level in the K_L sets, wherein K_L is greater than 1; or

when the number of control channel candidates configured for the K_D sets is greater than 1, the number of control channel candidates in each set is determined according to the number of physical resource blocks comprised in each set that can support the aggregation level in the K_D sets or the number of sets that can support the aggregation level in the K_D sets, wherein K_D is greater than 1.

13. The method according to claim 12, wherein when the number of control channel candidates configured for the K_L or K_D sets is greater than 1, determining the number of control channel candidates in each set according to the number of physical resource blocks comprised in each set that can support the aggregation level in the K_L or K_D sets comprises:

allocating c_i control channel candidates to set s_i supporting an aggregation level L ,

wherein the number c_i is indicated by $c_i = \left\lfloor \frac{C_L \times N_i}{\sum_{j=1}^T N_j} \right\rfloor$, L is an aggregation level, C_L is the

number of control channel candidates at the aggregation level L ; s_i is a set supporting the aggregation level L , c_i is the number of control channel candidates allocated to the set s_i , $i \in [1, T]$, and T is a positive integer;

allocating remaining R control channel candidates to R sets according to a preset rule,

wherein the number R is indicated by $R = C_L - \sum_{j=1}^T c_j$,

and the preset rule comprises: allocating one control channel candidate to each set of the R sets according to a descending order of the number of physical resource block pairs included in each set.

5

14. An apparatus for allocating control channel candidates, comprising:

a determining unit, configured to determine K sets for transmitting a control channel, wherein each set in the K sets comprises at least one physical resource block pair, and K is an integer greater than 0; and

10

an allocating unit, configured to allocate, according to at least one of the following factors: aggregation levels supported by the control channel, the number of control channel candidates corresponding to each aggregation level, the K sets for transmitting the control channel, and types of the sets, control channel candidates at each aggregation level to at least one set in the K sets determined by the determining unit.

15

15. The apparatus according to claim 14, wherein: the K sets for transmitting the control channel comprise one or both of a set of a localised transmission mode and a set of a distributed transmission mode, wherein the number of sets of the localised transmission mode is K_L , and the number of sets of the distributed transmission mode is K_D , $K_L + K_D = K$, and K_L and K_D are integers greater than or equal to 0; and

20

the aggregation levels supported by the control channel comprise one or more of the following levels:

aggregation levels supported by the localised transmission mode, aggregation levels supported by the distributed transmission mode, and common aggregation levels supported by both the localised transmission mode and the distributed transmission mode.

25

16. The apparatus according to claim 15, wherein the allocating unit is configured to allocate the control channel candidates at each aggregation level to at least one set in the K sets according to the aggregation levels supported by the control channel, the number of control channel candidates corresponding to each aggregation level, the K sets for

transmitting the control channel, and the types of the sets.

17. The apparatus according to claim 16, wherein the allocating unit is configured to:

allocate, when K_L is a positive integer, all control channel candidates at the aggregation levels supported by the localised transmission mode to at least one of the K_L sets; or

allocate, when K_D is a positive integer, all control channel candidates at the aggregation levels supported by the distributed transmission mode to at least one of the K_D sets; or

allocate, when both K_L and K_D are positive integers, all control channel candidates at each aggregation level in the aggregation levels supported by both the localised transmission mode and the distributed transmission mode to at least one of the K_L sets and at least one of the K_D sets.

18. The apparatus according to claim 17, wherein the allocating unit being configured to allocate all control channel candidates at each aggregation level in the aggregation levels supported by both the localised transmission mode and the distributed transmission mode to at least one of the K_L sets and at least one of the K_D sets when both K_L and K_D are positive integers, comprises:

allocating at least one half of all control channel candidates at each first aggregation level in the aggregation levels supported by both the localised transmission mode and the distributed transmission mode to at least one of the K_L sets; and

allocating at least one half of all control channel candidates at each second aggregation level in the aggregation levels supported by both the localised transmission mode and the distributed transmission mode to at least one of the K_D sets.

19. The apparatus according to claim 18, wherein:

when the aggregation levels supported by both the localised transmission mode and the distributed transmission mode are 1, 2, 4, and 8, the first aggregation levels are 1 and 2, and

the second aggregation levels are 4 and 8; and

when the aggregation levels supported by both the localised transmission mode and the distributed transmission mode are 2, 4, 8, and 16, the first aggregation levels are 2 and 4, and the second aggregation levels are 8 and 16.

5 20. The apparatus according to claim 18 or 19, wherein:

remaining control channel candidates at each aggregation level are allocated to different sets according to a predefined sequence of control channel sets and/or a position of a start set at the aggregation level.

10 21. The apparatus according to claim 17, wherein the allocating unit is configured to allocate all control channel candidates at an aggregation level supported by only the distributed transmission mode or the localised transmission mode to at least one set in the K_D sets of the distributed transmission mode or the K_L sets of the localised transmission mode.

15 22. The apparatus according to claim 21, wherein the allocating unit being configured to allocate all control channel candidates at an aggregation level supported by only the distributed transmission mode or the localised transmission mode to at least one set in the K_D sets of the distributed transmission mode or the K_L sets of the localised transmission mode, comprises:

20 determine, according to the number of sets used for the aggregation level in K_D or K_L sets, the number of control channel candidates allocated to each set in the K_D or K_L sets, at the aggregation level; or

determine, according to a ratio of the number of physical resource blocks of each set in sets used for the aggregation level in K_D or K_L sets, the number of control channel candidates allocated to each set in the K_D or K_L sets, at the aggregation level.

25 23. The apparatus according to claim 22, wherein when the the number of control channel candidates allocated to each set in the K_D or K_L sets is determined according to a ratio of the number of physical resource blocks of each set in sets used for the aggregation

level in K_D or K_L sets, the allocating unit is configured to:

allocate c_i control channel candidates to set s_i supporting an aggregation level L ,

wherein the number c_i is indicated by $c_i = \left\lfloor \frac{C_L \times N_i}{\sum_{j=1}^T N_j} \right\rfloor$, L is the aggregation level supported by

only the distributed transmission mode or the localised transmission mode, C_L is the

5 number of control channel candidates at the aggregation level L ; s_i is a set supporting the aggregation level L , c_i is the number of control channel candidates allocated to the set s_i , $i \in [1, T]$, and T is a positive integer;

allocate remaining R control channel candidates to R sets according to a preset rule,

wherein the number R is indicated by $R = C_L - \sum_{j=1}^T c_j$,

10 and the preset rule comprises: allocating one control channel candidate to each set of the R sets according to a descending order of the number of physical resource block pairs included in each set.

24. The apparatus according to claim 17, wherein the allocating unit being configured to allocate all control channel candidates at each aggregation level in the aggregation levels
15 supported by both the localised transmission mode and the distributed transmission mode to at least one of the K_L sets and at least one of the K_D sets when both K_L and K_D are positive integers, comprises:

determining, according to a ratio between the numbers of sets used for the aggregation level in K_D and K_L , the numbers of control channel candidates allocated to the K_L and

20 K_D sets, at each aggregation level; or

determining, according to a ratio between the total numbers of physical resource blocks in sets used for the aggregation level in K_D and K_L , the numbers of control channel candidates allocated to the K_L and K_D sets, at each aggregation level; or

determining, according to a ratio of the number of physical resource blocks of each set

in sets used for the aggregation level in K_D and K_L , the number of control channel candidates allocated to each set in the K_L and K_D sets, at each aggregation level.

25. The apparatus according to claim 17, wherein:

at each aggregation level, when the number of control channel candidates configured for the K_L sets is greater than 1, the allocating unit is configured to determine the number of control channel candidates in each set according to the number of physical resource blocks comprised in each set that can support the aggregation level in the K_L sets or the number of sets that can support the aggregation level in the K_L sets, wherein K_L is greater than 1; or

when the number of control channel candidates configured for the K_D sets is greater than 1, the allocating unit is configured to determine the number of control channel candidates in each set according to the number of physical resource blocks comprised in each set that can support the aggregation level in the K_D sets or the number of sets that can support the aggregation level in the K_D sets, wherein K_D is greater than 1.

26. The apparatus according to claim 25, wherein when the number of control channel candidates configured for the K_L or K_D sets is greater than 1, and the number of control channel candidates in each set is determined according to the number of physical resource blocks comprised in each set that can support the aggregation level in the K_L or K_D sets, the allocating unit is configured to:

allocate c_i control channel candidates to set s_i supporting an aggregation level L ,

wherein the number c_i is indicated by $c_i = \left\lfloor \frac{C_L \times N_i}{\sum_{j=1}^T N_j} \right\rfloor$, L is an aggregation level, C_L is the

number of control channel candidates at the aggregation level L ; s_i is a set supporting the aggregation level L , c_i is the number of control channel candidates allocated to the set s_i , $i \in [1, T]$, and T is a positive integer;

allocate remaining R control channel candidates to R sets according to a preset rule,

wherein the number R is indicated by $R = C_L - \sum_{j=1}^T c_i$,

and the preset rule comprises: allocating one control channel candidate to each set of the R sets according to a descending order of the number of physical resource block pairs included in each set.