CLAIMS

1. A method for transmitting downlink control information, comprising:

mapping, by a base station, an enhanced physical downlink control channel (E-PDCCH) of a user equipment device (UE) to resource elements allocated for transmitting the E-PDCCH, wherein the resource elements are in L enhanced control channel elements (eCCEs) allocated to the E-PDCCH, wherein L is an aggregation level and is greater than or equal to 1; and

transmitting, by the base station, the E-PDCCH to the UE by using the resource elements mapped with the E-PDCCH;

wherein one or more orthogonal frequency division multiplexing (OFDM) symbols are used by the E-PDCCH, and each OFDM symbol comprises one or more resource elements that are allocated for transmitting the E-PDCCH;

wherein mapping the E-PDCCH to the resource elements in the L eCCEs comprises:

following an order of the OFDM symbols, in each OFDM symbol, mapping the E-PDCCH to the resource elements occupied by the L eCCEs and allocated for transmitting the E-PDCCH according to an order of subcarriers in the OFDM symbol;

wherein the E-PDCCH carries the downlink control information; and

wherein the E-PDCCH and a physical downlink shared channel (PDSCH) invoked by the E-PDCCH are frequency-division multiplexed.

2. The method according to claim 1, wherein the order of the OFDM symbols is the order of the indexes of the OFDM symbols.

3. The method according to claim 1, wherein the order of subcarriers is the order of the indexes of the subcarriers.

4. The method according to claim 1, wherein mapping the E-PDCCH to the resource elements occupied by the L eCCEs and allocated for transmitting the E-PDCCH according to an order of subcarriers in the OFDM symbol comprises:

mapping modulation symbols of the E-PDCCH with index numbers of $j_0 + [0,..., N-1]$

sequentially to a set R of resource elements in the OFDM symbol, wherein the set R is a set of resource elements occupied by the L eCCEs and allocated for transmitting the E-PDCCH in the OFDM symbol;

wherein j_0 is a start position of the modulation symbols of the E-PDCCH mapped in the OFDM symbol; N is the quantity of the resource elements in the set R; and L, N and j_0 are integers.

5. A method for receiving downlink control information, comprising:

receiving, by a user equipment device (UE), a downlink subframe from a base station; and

extracting, by the UE, the downlink control information carried in an enhanced physical downlink control channel (E-PDCCH) from resource elements allocated for transmitting the E-PDCCH in the downlink subframe,

wherein the resource elements are in L enhanced control channel elements (eCCEs) allocated to the E-PDCCH, L is an aggregation level and is greater than or equal to 1, one or more orthogonal frequency division multiplexing (OFDM) symbols are used by the E-PDCCH, and each OFDM symbol comprises one or more resource elements that are allocated for transmitting the E-PDCCH;

wherein extracting the downlink control information carried in the E-PDCCH from the resource elements in the L eCCEs comprises:

following an order of the OFDM symbols, in each OFDM symbol, extracting the E-PDCCH from the resource elements occupied by the L eCCEs and allocated for transmitting the E-PDCCH according to an order of subcarriers in the OFDM symbol;

and wherein the E-PDCCH and a physical downlink shared channel (PDSCH) invoked by the E-PDCCH are frequency-division multiplexed.

6. The method according to claim 5, wherein the order of the OFDM symbols is the order of the indexes of the OFDM symbols.

7. The method according to claim 5, wherein the order of subcarriers is the order of the

indexes of the subcarriers.

8. The method according to claim 5, wherein extracting the E-PDCCH from the resource elements occupied by the L eCCEs and allocated for transmitting the E-PDCCH according to an order of subcarriers in the OFDM symbol comprises:

extracting modulation symbols of the E-PDCCH with index numbers of $j_0 + [0, ..., N-1]$ sequentially from a set R of resource elements in the OFDM symbol, wherein the set R is a set of resource elements occupied by the L eCCEs and mapped with the modulation symbols of the E-PDCCH in the OFDM symbol;

wherein j_0 is a start position of the modulation symbols of the E-PDCCH mapped in the OFDM symbol; *N* is the quantity of the resource elements in the set R; and L, *N* and j_0 are integers.

9. A non-transitory computer-readable storage medium storing program codes thereon for use by a base station, wherein the program codes, when executed by the base station, cause the base station to perform a method that comprises:

mapping an enhanced physical downlink control channel (E-PDCCH) of a user equipment device (UE) to resource elements allocated for transmitting the E-PDCCH, wherein the resource elements are in L enhanced control channel elements (eCCEs) allocated to the E-PDCCH, wherein L is an aggregation level and is greater than or equal to 1; and

transmitting the E-PDCCH to the UE by using the resource elements mapped with the E-PDCCH,

wherein one or more orthogonal frequency division multiplexing (OFDM) symbols are used by the E-PDCCH, and each OFDM symbol comprises one or more resource elements that are allocated for transmitting the E-PDCCH;

wherein mapping the E-PDCCH to the resource elements in the L eCCEs comprises:

following an order of the OFDM symbols, in each OFDM symbol, mapping the E-PDCCH to the resource elements occupied by the L eCCEs and allocated for transmitting the E-PDCCH according to an order of subcarriers in the OFDM symbol;

wherein the E-PDCCH carries downlink control information; and

wherein the E-PDCCH and a physical downlink shared channel (PDSCH) invoked by the E-PDCCH are frequency-division multiplexed.

10. The non-transitory computer-readable storage medium according to claim 9, wherein the order of the OFDM symbols is the order of the indexes of the OFDM symbols.

11. The non-transitory computer-readable storage medium according to claim 9, wherein the order of subcarriers is the order of the indexes of the subcarriers.

12. The non-transitory computer-readable storage medium according to claim 9, wherein mapping the E-PDCCH to the resource elements occupied by the L eCCEs and allocated for transmitting the E-PDCCH according to an order of subcarriers in the OFDM symbol comprises:

mapping modulation symbols of the E-PDCCH with index numbers of $j_0 + [0,..., N-1]$ sequentially to a set R of resource elements in the OFDM symbol, wherein the set R is a set of resource elements occupied by the L eCCEs and allocated for transmitting the E-PDCCH in the OFDM symbol;

wherein j_0 is a start position of the modulation symbols of the E-PDCCH mapped in the OFDM symbol; N is the quantity of the resource elements in the set R; and L, N and j_0 are integers.

13. A non-transitory computer-readable storage medium storing program codes thereon for use by a user equipment device (UE), wherein the program codes, when executed by the UE, cause the UE to perform a method that comprises:

receiving a downlink subframe from a base station; and

extracting downlink control information carried in an enhanced physical downlink control channel (E-PDCCH) from resource elements allocated for transmitting the E-PDCCH in the downlink subframe,

wherein the resource elements are in L enhanced control channel elements (eCCEs) allocated to the E-PDCCH, L is an aggregation level and is greater than or equal to 1, one or more orthogonal frequency division multiplexing (OFDM) symbols are used by the E-PDCCH,

and each OFDM symbol comprises one or more resource elements that are allocated for transmitting the E-PDCCH;

wherein extracting the downlink control information carried in the E-PDCCH from the resource elements in the L eCCEs comprises:

following an order of the OFDM symbols, in each OFDM symbol, extracting the E-PDCCH from the resource elements occupied by the L eCCEs and allocated for transmitting the E-PDCCH according to an order of subcarriers in the OFDM symbol;

and wherein the E-PDCCH and a physical downlink shared channel (PDSCH) invoked by the E-PDCCH are frequency-division multiplexed.

14. The non-transitory computer-readable storage medium according to claim 13, wherein the order of the OFDM symbols is the order of the indexes of the OFDM symbols.

15. The non-transitory computer-readable storage medium according to claim 13, wherein the order of subcarriers is the order of the indexes of the subcarriers.

16. The non-transitory computer-readable storage medium according to claim 13, wherein extracting the E-PDCCH from the resource elements occupied by the L eCCEs and allocated for transmitting the E-PDCCH according to an order of subcarriers in the OFDM symbol comprises:

extracting modulation symbols of the E-PDCCH with index numbers of $j_0 + [0, ..., N-1]$ sequentially from a set R of resource elements in the OFDM symbol, wherein the set R is a set of resource elements occupied by the L eCCEs and mapped with the modulation symbols of the E-PDCCH in the OFDM symbol;

wherein j_0 is a start position of the modulation symbols of the E-PDCCH mapped in the OFDM symbol; N is the quantity of the resource elements in the set R; and L, N and j_0 are integers.

17. A base station, comprising one or more processors, a transmitter, and a memory storing program instructions;

wherein the one or more processors are configured to execute the program instructions to:

map an enhanced physical downlink control channel (E-PDCCH) of a user equipment device (UE) to resource elements allocated for transmitting the E-PDCCH, wherein the resource elements are in L enhanced control channel elements (eCCEs) allocated to the E-PDCCH, wherein L is an aggregation level and is greater than or equal to 1; and

wherein the transmitter is configured to:

transmit the E-PDCCH to the UE by using the resource elements mapped with the E-PDCCH;

wherein one or more orthogonal frequency division multiplexing (OFDM) symbols are used by the E-PDCCH, and each OFDM symbol comprises one or more resource elements that are allocated for transmitting the E-PDCCH;

wherein in mapping the E-PDCCH to the resource elements in the L eCCEs, the one or more processors are configured to execute the program instructions to:

following an order of the OFDM symbols, in each OFDM symbol, map the E-PDCCH to the resource elements occupied by the L eCCEs and allocated for transmitting the E-PDCCH according to an order of subcarriers in the OFDM symbol;

wherein the E-PDCCH carries ~~the~~ downlink control information; and

wherein the E-PDCCH and a physical downlink shared channel (PDSCH) invoked by the E-PDCCH are frequency-division multiplexed.

18. The base station according to claim 17, wherein the order of the OFDM symbols is the order of the indexes of the OFDM symbols.

19. The base station according to claim 17, wherein the order of subcarriers is the order of the indexes of the subcarriers.

20. The base station according to claim 17, wherein in mapping the E-PDCCH to the resource elements occupied by the L eCCEs and allocated for transmitting the E-PDCCH according to an order of subcarriers in the OFDM symbol, the one or more processors are configured to execute the program instructions to:

map modulation symbols of the E-PDCCH with index numbers of $j_0 + [0,..., N-1]$

sequentially to a set R of resource elements in the OFDM symbol, wherein the set R is a set of resource elements occupied by the L eCCEs and allocated for transmitting the E-PDCCH in the OFDM symbol;

wherein j_0 is a start position of the modulation symbols of the E-PDCCH mapped in the OFDM symbol; N is the quantity of the resource elements in the set R; and L, N and j_0 are integers.

21. A user equipment device (UE), comprising one or more processors, a receiver, and a memory storing program instructions;

wherein the receiver is configured to receive a downlink subframe from a base station; and

wherein the one or more processors are configured to execute the program instructions to:

extract downlink control information carried in an enhanced physical downlink control channel (E-PDCCH) from resource elements allocated for transmitting the E-PDCCH in the downlink subframe;

wherein the resource elements are in L enhanced control channel elements (eCCEs) allocated to the E-PDCCH, L is an aggregation level and is greater than or equal to 1, one or more orthogonal frequency division multiplexing (OFDM) symbols are used by the E-PDCCH, and each OFDM symbol comprises one or more resource elements that are allocated for transmitting the E-PDCCH;

wherein in extracting the downlink control information carried in the E-PDCCH from the resource elements in the L eCCEs, the one or more processors are configured to execute the program instructions to:

following an order of the OFDM symbols, in each OFDM symbol, extract the E-PDCCH from the resource elements occupied by the L eCCEs and allocated for transmitting the E-PDCCH according to an order of subcarriers in the OFDM symbol;

wherein the E-PDCCH and a physical downlink shared channel (PDSCH) invoked by the E-PDCCH are frequency-division multiplexed.

22. The UE according to claim 21, wherein the order of the OFDM symbols is the order of the indexes of the OFDM symbols.

23. The UE according to claim 21, wherein the order of subcarriers is the order of the indexes of the subcarriers.

24. The UE according to claim 21, wherein in extracting the E-PDCCH from the resource elements occupied by the L eCCEs and allocated for transmitting the E-PDCCH according to an order of subcarriers in the OFDM symbol, the one or more processors are configured to execute the program instructions to:

extract modulation symbols of the E-PDCCH with index numbers of $j_0 + [0, ..., N-1]$ sequentially from a set R of resource elements in the OFDM symbol, wherein the set R is a set of resource elements occupied by the L eCCEs and mapped with the modulation symbols of the E-PDCCH in the OFDM symbol;

wherein j_0 is a start position of the modulation symbols of the E-PDCCH mapped in the OFDM symbol; N is the quantity of the resource elements in the set R; and L, N and j_0 are integers.

25. An apparatus, implemented in a base station, comprising one or more processors and a memory storing program instructions for execution by the processors;

wherein by executing the program instructions, the one or more processors are configured to perform operations of:

mapping an enhanced physical downlink control channel (E-PDCCH) of a user equipment device (UE) to resource elements allocated for transmitting the E-PDCCH, wherein the resource elements are in L enhanced control channel elements (eCCEs) allocated to the E-PDCCH, wherein L is an aggregation level and is greater than or equal to 1; and

controlling the base station to transmit the E-PDCCH to the UE by using the resource elements mapped with the E-PDCCH;

wherein one or more orthogonal frequency division multiplexing (OFDM) symbols are used by the E-PDCCH, and each OFDM symbol comprises one or more resource elements that are allocated for transmitting the E-PDCCH;

wherein the operation of mapping the E-PDCCH to the resource elements in the L eCCEs comprises:

following an order of the OFDM symbols, in each OFDM symbol, mapping the E-PDCCH to the resource elements occupied by the L eCCEs and allocated for transmitting the E-PDCCH according to an order of subcarriers in the OFDM symbol;

wherein the E-PDCCH carries ~~the~~ downlink control information; and

wherein the E-PDCCH and a physical downlink shared channel (PDSCH) invoked by the E-PDCCH are frequency-division multiplexed.

26. The apparatus according to claim 25, wherein the order of the OFDM symbols is the order of the indexes of the OFDM symbols.

27. The apparatus according to claim 25, wherein the order of subcarriers is the order of the indexes of the subcarriers.

28. The apparatus according to claim 25, wherein the operation of mapping the E-PDCCH to the resource elements occupied by the L eCCEs and allocated for transmitting the E-PDCCH according to an order of subcarriers in the OFDM symbol comprises:

mapping modulation symbols of the E-PDCCH with index numbers of $j_0 + [0,..., N-1]$ sequentially to a set R of resource elements in the OFDM symbol, wherein the set R is a set of resource elements occupied by the L eCCEs and allocated for transmitting the E-PDCCH in the OFDM symbol;

wherein j_0 is a start position of the modulation symbols of the E-PDCCH mapped in the OFDM symbol; N is the quantity of the resource elements in the set R; and L, N and j_0 are integers.

29. An apparatus, implemented in a user equipment device (UE), comprising one or more processors and a memory storing program instructions for execution by the processors;

wherein, by executing the program instructions, the one or more processors are configured to perform operations of:

controlling the UE to receive a downlink subframe from a base station; and

extracting downlink control information carried in an enhanced physical downlink

control channel (E-PDCCH) from resource elements allocated for transmitting the E-PDCCH in the downlink subframe;

wherein the resource elements are in L enhanced control channel elements (eCCEs) allocated to the E-PDCCH, L is an aggregation level and is greater than or equal to 1, one or more orthogonal frequency division multiplexing (OFDM) symbols are used by the E-PDCCH, and each OFDM symbol comprises one or more resource elements that are allocated for transmitting the E-PDCCH;

wherein the operation of extracting the downlink control information carried in the E-PDCCH from the resource elements in the L eCCEs comprises:

following an order of the OFDM symbols, in each OFDM symbol, extracting the E-PDCCH from the resource elements occupied by the L eCCEs and allocated for transmitting the E-PDCCH according to an order of subcarriers in the OFDM symbol;

wherein the E-PDCCH and a physical downlink shared channel (PDSCH) invoked by the E-PDCCH are frequency-division multiplexed.

30. The apparatus according to claim 29, wherein the order of the OFDM symbols is the order of the indexes of the OFDM symbols.

31. The apparatus according to claim 29, wherein the order of subcarriers is the order of the indexes of the subcarriers.

32. The apparatus according to claim 29, wherein the operation of extracting the E-PDCCH from the resource elements occupied by the L eCCEs and allocated for transmitting the E-PDCCH according to an order of subcarriers in the OFDM symbol comprises:

extracting modulation symbols of the E-PDCCH with index numbers of $j_0 + [0, ..., N-1]$ sequentially from a set R of resource elements in the OFDM symbol, wherein the set R is a set of resource elements occupied by the L eCCEs and mapped with the modulation symbols of the E-PDCCH in the OFDM symbol;

wherein j_0 is a start position of the modulation symbols of the E-PDCCH mapped in the OFDM symbol; N is the quantity of the resource elements in the set R; and L, N and j_0 are

integers.