CLAIMS

1. A method performed by a network node of a wireless communication network, for communicating an enhanced Physical Downlink Control Channel, ePDCCH, to a user equipment, UE, the method comprising:

transmitting (606) a configuration message to the UE, the configuration message comprising:

an indication of a first mapping of the ePDCCH to resource elements belonging to a first ePDCCH set, where the resource elements of the first ePDCCH set are different from resource elements used for a first Cell-Specific Reference Signal, CRS, and

an indication of a second mapping of the ePDCCH to resource elements belonging to a second ePDCCH set, where the resource elements of the second ePDCCH set are different from resource elements used for a second Cell-specific Reference signal, CRS, wherein the resource elements used for the second CRS are different from the resource elements used for the first CRS.

2. Method according to claim 1, further comprising:

performing (602) the first mapping of the ePDCCH to resource elements belonging to the first ePDCCH set, and

performing (604) the second mapping of the ePDCCH to resource elements belonging to the second ePDCCH set.

3. Method according to claim 1 or 2, wherein the configuration message comprises an indication of an ePDCCH start symbol for the first ePDCCH set and an indication of an ePDCCH start symbol for the second ePDCCH set.

4. Method according to claim 3, wherein the indicated ePDCCH start symbol is the same start symbol as scheduled for a Packet Data Shared Channel, PDSCH, to be transmitted by the network node.

5. Method according to any of claims 1-4, wherein one or more of the following configuration parameters: number of Cell-specific Reference Signal,

CRS, antenna ports, CRS frequency shift, start position, Multicast/ Broadcast Single Frequency Network, MBSFN, subframe configuration, Zero Power Channel State Information Reference Signal, CSI-RS, resource configuration CSI-RS resource configuration, are shared between the ePDCCH and a Packet Data Shared Channel PDSCH.

6. Method according to any of the preceding claims, further comprising:

selecting (608) one of the first ePDCCH set or the second ePDCCH set for transmission of the ePDCCH to the UE according to a criterion;

allocating (610) the ePDCCH to resource elements according to the selected set, and

transmitting (612) the allocated ePDCCH to the UE.

7. Method according to claim 6, wherein the first CRS signal is from a first network node (110), and the second CRS signal is from a second network node (130), and wherein the selecting criterion is which of the signal from the first network node and the signal from the second network node that has the highest signal strength.

8. Method according to claim 7, wherein the first network node (110) is the network node performing the method and the second network node (130) is an interfering network node.

9. Method according to any of the preceding claims, wherein the resource elements of the first ePDCCH set comprises information of uplink grants and the resource elements of the second ePDCCH set comprises information of downlink assignments.

10. Method according to any of the preceding claims, wherein the configuration message is transmitted (606) in a Radio Resource Control, RRC message.

11. A network node (700) of a wireless communication network, configured for communicating an enhanced Physical Downlink Control Channel, ePDCCH, to a user equipment, UE, the network node comprising:

a transmitting unit (702) for transmitting a configuration message to the UE, the configuration message comprising:

an indication of a first mapping of the ePDCCH to resource elements belonging to a first ePDCCH set, where the resource elements of the first ePDCCH set are different from resource elements used for a first Cell-Specific Reference Signal, CRS,signal, and

an indication of a second mapping of the ePDCCH to resource elements belonging to a second ePDCCH set, where the resource elements of the second ePDCCH set are different from resource elements used for a second Cell-Specific Reference Signal, CRS, signal, wherein the resource elements used for the second CRS are different from the resource elements used for the first CRS.

12. Network node (700) according to claim 11, further comprising:

a performing unit (704) for performing the first mapping of the ePDCCH to resource elements belonging to the first ePDCCH set, and for performing the second mapping of the ePDCCH to resource elements belonging to the second ePDCCH set.

13. Network node (700) according to claim 11 or 12, wherein the configuration message comprises an indication of an ePDCCH start symbol for the first ePDCCH set and an indication of an ePDCCH start symbol for the second ePDCCH set.

14. Network node (700) according to claim 13, wherein the indicated ePDCCH start symbol is the same start symbol as scheduled for a Packet Data Shared Channel, PDSCH, to be transmitted by the network node.

15. Network node (700) according to any of claims 11-14, wherein one or more of the following configuration parameters: number of Cell-specific Reference Signal, CRS, antenna ports, CRS frequency shift, start position, Multicast/ Broadcast Single Frequency Network, MBSFN, subframe configuration, Zero Power Channel State Information Reference Signal, CSI-RS, resource

configuration CSI-RS resource configuration, are shared between the ePDCCH and a Packet Data Shared Channel PDSCH.

16. Network node (700) according to any of claims 11-15, further comprising:

a selecting unit (706) for selecting one of the first ePDCCH set or the second ePDCCH set for transmission of the ePDCCH to the UE according to a criterion;

an allocating unit (708) for allocating the ePDCCH to resource elements according to the selected set, and

wherein the transmitting unit (702) is further arranged to transmit the allocated ePDCCH to the UE.

17. Network node (700) according to claim 16, wherein the first CRS signal is from a first network node (110), and the second CRS signal is from a second network node (130), and wherein the selecting criterion is which of the signal from the first network node and the signal from the second network node that has the highest signal strength.

18. A computer program (810) comprising computer readable code means, which when run in a network node (700) causes the network node (700) to perform the following step:

transmitting a configuration message to the UE, the configuration message comprising an indication of a first mapping of the ePDCCH to resource elements belonging to a first ePDCCH set, where the resource elements of the first ePDCCH set are different from resource elements used for a first Cell-Specific Reference Signal, CRS, and an indication of a second mapping of the ePDCCH to resource elements belonging to a second ePDCCH set, where the resource elements of the second ePDCCH set are different from resource elements used for a second Cell-Specific Reference Signal, CRS, wherein the resource elements used for the second CRS are different from the resource elements used for the first CRS.

19. A computer program product (808), comprising computer readable medium and a computer program (810) according to claim 18 stored on the computer readable medium.

20. A method performed by a user equipment, UE, (1000) in a wireless communication network, for communicating an enhanced Physical Downlink Control Channel, ePDCCH, with a network node, the method comprising:

receiving (902) a configuration message from the network node, the configuration message comprising:

an indication of a first mapping of the ePDCCH to resource elements belonging to a first ePDCCH set, where the resource elements of the first ePDCCH set are different from resource elements used for a first Cell-Specific Reference Signal, CRS, and

an indication of a second mapping of the ePDCCH to resource elements belonging to a second ePDCCH set, where the resource elements of the second ePDCCH set are different from resource elements used for a second Cell-Specific Reference Signal, CRS, wherein the resource elements used for the second CRS are different from the resource elements used for the first CRS.

21. Method according to claim 20, wherein the configuration message comprises an indication of an ePDCCH start symbol for the first ePDCCH set and an indication of an ePDCCH start symbol for the second ePDCCH set.

22. Method according to claim 21, wherein the indicated ePDCCH start symbol is the same start symbol as scheduled for a Packet Data Shared Channel, PDSCH, to be transmitted by the network node.

23. Method according to any of claims 19-22, wherein one or more of the following configuration parameters: number of Cell-specific Reference Signal, CRS, antenna ports, CRS frequency shift, start position, Multicast/ Broadcast Single Frequency Network, MBSFN, subframe configuration, Zero Power Channel State Information Reference Signal, CSI-RS, resource configuration CSI-RS

resource configuration, are shared between the ePDCCH and a Packet Data Shared Channel PDSCH.

24. Method according to any of claims 19-23, further comprising:

receiving (904) a message from the network node comprising the ePDCCH allocated to a selected one of the first ePDCCH set and the second ePDCCH set;

decoding (906) ePDCCH candidates according to the first mapping and decoding ePDCCH candidates according to the second mapping;

detecting (908) whether the ePDCCH was allocated to the first ePDCCH set or the second ePDCCH set.

25. Method according to any of claims 20-24, wherein the resource elements of the first ePDCCH set comprises information of uplink grants and the resource elements of the second ePDCCH set comprises information of downlink assignments.

26. Method according to any of claims 20-25, wherein the configuration message is received (902) in a Radio Resource Control, RRC message.

27. A user equipment, UE, (1000) in a wireless communication network, configured for communicating an enhanced Physical Downlink Control Channel, ePDCCH, with a network node, the UE comprising:

a receiving unit (1002) for receiving a configuration message from the network node, the configuration message comprising an indication of a first mapping of the ePDCCH to resource elements belonging to a first ePDCCH set, where the resource elements of the first ePDCCH set are different from resource elements used for a first Cell-Specific Reference Signal, CRS, and an indication of a second mapping of the ePDCCH to resource elements belonging to a second ePDCCH set, where the resource elements of the second ePDCCH set are different from resource elements used for a second Cell-Specific Reference Signal, CRS, signal, wherein the resource elements used for the second CRS are different from the resource elements used for the first CRS.

28. UE according to claim 27, wherein the configuration message comprises an indication of an ePDCCH start symbol for the first ePDCCH set and an indication of an ePDCCH start symbol for the second ePDCCH set.

29. UE according to claim 28, wherein the indicated ePDCCH start symbol is the same start symbol as scheduled for a Packet Data Shared Channel, PDSCH, to be transmitted by the network node.

30. UE according to any of claims 27-29, wherein one or more of the following configuration parameters: number of Cell-specific Reference Signal, CRS, antenna ports, CRS frequency shift, start position, Multicast/ Broadcast Single Frequency Network, MBSFN, subframe configuration, Zero Power Channel State Information Reference Signal, CSI-RS, resource configuration CSI-RS resource configuration, are shared between the ePDCCH and a Packet Data Shared Channel PDSCH.

31. UE according to any of claims 27-30, wherein the receiving unit (1002) is further arranged to receive a message from the network node comprising the ePDCCH allocated to a selected one of the first ePDCCH set and the second ePDCCH set, the UE (1000) further comprising:

a decoding unit (1004) for decoding ePDCCH candidates according to the first mapping and for decoding ePDCCH candidates according to the second mapping;

a detecting unit (1006) for detecting whether the ePDCCH was allocated to the first ePDCCH set or to the second ePDCCH set.

32. UE according to any of claims 27-31, wherein the resource elements of the first ePDCCH set comprises information of uplink grants and the resource elements of the second ePDCCH set comprises information of downlink assignments.

33. UE according to any of claims 27-32, wherein the receiving unit (1002) is further arranged to receive the configuration message in a Radio Resource Control, RRC message.

34. A computer program (1110) comprising computer readable code means, which when run in a user equipment, UE, (1000) causes the UE (1000) to perform the following step: receiving a configuration message from a network node, the configuration message comprising an indication of a first mapping of the ePDCCH to resource elements belonging to a first ePDCCH set, where the resource elements of the first ePDCCH set are different from resource elements used for a first Cell-Specific Reference Signal, CRS, and an indication of a second mapping of the ePDCCH to resource elements belonging to a second ePDCCH set, where the resource elements of the second ePDCCH set are different from resource elements used for a second Cell-Specific Reference Signal, CRS, signal, wherein the resource elements used for the second CRS are different from the resource elements used for the first CRS.

35. A computer program product (1108), comprising computer readable medium and a computer program (1110) according to claim 34 stored on the computer readable medium.

Claims

1. A method performed by a network node of a wireless communication network, for communicating an comprising:

transmitting enhanced Physical Downlink Control Channel, ePDCCH, to a user equipment, UE, the method (606) a configuration message to the UE, the configuration message comprising:

an indication of a first mapping of the ePDCCH to resource elements belonging to a first ePDCCH set, where the resource elements of the first ePDCCH set are different from resource elements used for a first type of signal, and

an indication of a second mapping of the ePDCCH to resource elements belonging to a second ePDCCH set, where the resource elements of the second ePDCCH set are different from resource elements used for a second type of signal,

wherein the first type of signal is a first Cell-Specific Reference Signal, CRS, and the second type of signal is a second Cell-Specific Reference Signal, CRS, wherein the first CRS signal is different from the second CRS signal.

2. Method according to claim 1, further comprising:

performing (602) the first mapping of the ePDCCH to resource elements belonging to the first ePDCCH set, and

performing (604) the second mapping of the ePDCCH to resource elements belonging to the second ePDCCH set.

3. Method according to claim 1 or 2, wherein the configuration message comprises an indication of an ePDCCH start symbol for the first ePDCCH set and an indication of an ePDCCH start symbol for the second ePDCCH set.

4. Method according to claim 3, wherein the indicated ePDCCH start symbol is the same start symbol as scheduled for a Packet Data Shared Channel, PDSCH, to be transmitted by the network node.

5. Method according to any of claims 1-4, wherein one or more of the following configuration parameters: number of Cell-specific Reference Signal,

CRS, antenna ports, CRS frequency shift, start position of the first ePDCCH set or the second ePDCCH set, Multicast/ Broadcast Single Frequency Network, MBSFN, subframe configuration, Zero Power Channel State Information Reference Signal, CSI-RS, resource configuration, are shared between the ePDCCH and a Packet Data Shared Channel PDSCH.

6. Method according to any of claims 1-5, further comprising:

selecting (608) one of the first ePDCCH set or the second ePDCCH set for transmission of the ePDCCH to the UE according to a criterion;

allocating (610) the ePDCCH to resource elements according to the selected set, and

transmitting (612) the allocated ePDCCH to the UE.

7. Method according to claim 6, wherein the first type of signal is a signal from a first network node (110), and the second type of signal is a signal from a second network node (130), and wherein the selecting criterion is which of the signal from the first network node and the signal from the second network node that has the highest signal strength.

8. Method according to claim 7, wherein the first network node (110) is the network node performing the method and the second network node (130) is an interfering network node.

9. Method according to any of claims 1-8, wherein the resource elements of the first ePDCCH set comprises information of uplink grants and the resource elements of the second ePDCCH set comprises information of downlink assignments.

10. Method according to any of claims 1-9, wherein the configuration message is transmitted (606) in a Radio Resource Control, RRC message.

11. A network node (700) of a wireless communication network, configured for communicating an enhanced Physical Downlink Control Channel, ePDCCH, to a user equipment, UE, the network node comprising:

a transmitting unit (702) for transmitting a configuration message to the UE, the configuration message comprising:

an indication of a first mapping of the ePDCCH to resource elements belonging to a first ePDCCH set, where the resource elements of the first ePDCCH set are different from resource elements used for a first type of signal, and

an indication of a second mapping of the ePDCCH to resource elements belonging to a second ePDCCH set, where the resource elements of the second ePDCCH set are different from resource elements used for a second type of signal,

wherein the first type of signal is a first Cell-Specific Reference Signal, CRS, and the second type of signal is a second Cell-Specific Reference Signal, CRS, wherein the first CRS signal is different from the second CRS signal.

12. Network node according to claim 11, further comprising:

a performing unit (704) for performing the first mapping of the ePDCCH to resource elements belonging to the first ePDCCH set, and for performing the second mapping of the ePDCCH to resource elements belonging to the second ePDCCH set.

13. Network node according to claim 11 or 12, wherein the configuration message comprises an indication of an ePDCCH start symbol for the first ePDCCH set and an indication of an ePDCCH start symbol for the second ePDCCH set.

14. Network node according to claim 13, wherein the indicated ePDCCH start symbol is the same start symbol as scheduled for a Packet Data Shared Channel, PDSCH, to be transmitted by the network node.

15. Network node according to any of claims 11-14, wherein one or more of the following configuration parameters: number of Cell-specific Reference Signal, CRS, antenna ports, CRS frequency shift, start position of the first ePDCCH set or the second ePDCCH set, Multicast/ Broadcast Single Frequency Network, MBSFN, subframe configuration, Zero Power Channel State Information Reference Signal, CSI-RS, resource configuration, are shared between the ePDCCH and a Packet Data Shared Channel PDSCH.

16. Network node according to any of claims 11-15, further comprising:

a selecting unit (706) for selecting one of the first ePDCCH set or the second ePDCCH set for transmission of the ePDCCH to the UE according to a criterion;

an allocating unit (708) for allocating the ePDCCH to resource elements according to the selected set, and

wherein the transmitting unit (702) is further arranged to transmit the allocated ePDCCH to the UE.

17. Network node according to claim 16, wherein the first type of signal is a signal from a first network node (110), and the second type of signal is a signal from a second network node (130), and wherein the selecting criterion is which of the signal from the first network node and the signal from the second network node that has the highest signal strength.

18. A computer program (810) comprising computer readable code means, which when run in a network node (700) causes the network node (700) to perform the following step:

transmitting a configuration message to the UE, the configuration message comprising an indication of a first mapping of the ePDCCH to resource elements belonging to a first ePDCCH set, where the resource elements of the first ePDCCH set are different from resource elements used for a first type of signal, and an indication of a second mapping of the ePDCCH to resource elements belonging to a second ePDCCH set, where the resource elements of the second ePDCCH set are different from resource elements used for a second type of signal,

wherein the first type of signal is a first Cell-Specific Reference Signal, CRS, and the second type of signal is a second Cell-Specific Reference Signal, CRS, wherein the first CRS signal is different from the second CRS signal.

19. A computer program product, comprising computer readable medium and a computer program (810) according to claim 18 stored on the computer readable medium.

20. A method performed by a user equipment, UE, (1000) in a wireless communication network, for communicating an enhanced Physical Downlink Control Channel, ePDCCH, with a network node, the method comprising:

receiving (902) a configuration message from the network node, the configuration message comprising:

an indication of a first mapping of the ePDCCH to resource elements belonging to a first ePDCCH set, where the resource elements of the first ePDCCH set are different from resource elements used for a first type of signal, and

an indication of a second mapping of the ePDCCH to resource elements belonging to a second ePDCCH set, where the resource elements of the second ePDCCH set are different from resource elements used for a second type of signal,

wherein the first type of signal is a first Cell-Specific Reference Signal, CRS, and the second type of signal is a second Cell-Specific Reference Signal, CRS, wherein the first CRS signal is different from the second CRS signal.

21. Method according to claim 20, wherein the configuration message comprises an indication of an ePDCCH start symbol for the first ePDCCH set and an indication of an ePDCCH start symbol for the second ePDCCH set.

22. Method according to claim 21, wherein the indicated ePDCCH start symbol is the same start symbol as scheduled for a Packet Data Shared Channel, PDSCH, to be transmitted by the network node.

23. Method according to any of claims 20-22, wherein one or more of the following configuration parameters: number of Cell-specific Reference Signal, CRS, antenna ports, CRS frequency shift, start position of the first ePDCCH set or the second ePDCCH set, Multicast/ Broadcast Single Frequency Network, MBSFN, subframe configuration, Zero Power Channel State Information Reference Signal, CSI-RS, resource configuration, are shared between the ePDCCH and a Packet Data Shared Channel PDSCH.

24. Method according to any of claims 20-23, further comprising:

receiving (904) a message from the network node comprising the ePDCCH allocated to a selected one of the first ePDCCH set and the second ePDCCH set;

decoding (906) ePDCCH candidates according to the first mapping and decoding ePDCCH candidates according to the second mapping;

detecting (908) whether the ePDCCH was allocated to the first ePDCCH set or the second ePDCCH set.

25. Method according to any of claims 20-24, wherein the resource elements of the first ePDCCH set comprises information of uplink grants and the resource elements of the second ePDCCH set comprises information of downlink assignments.

26. Method according to any of claims 20-25, wherein the configuration message is received (902) in a Radio Resource Control, RRC message.

27. A user equipment, UE, (1000) in a wireless communication network, configured for communicating an enhanced Physical Downlink Control Channel, ePDCCH, with a network node, the UE comprising:

a receiving unit (1002) for receiving a configuration message from the network node, the configuration message comprising an indication of a first mapping of the ePDCCH to resource elements belonging to a first ePDCCH set, where the resource elements of the first ePDCCH set are different from resource elements used for a first type of signal, and an indication of a second mapping of the ePDCCH to resource elements belonging to a second ePDCCH set, where the resource elements of the second ePDCCH set are different from resource elements used for a second type of signal,

wherein the first type of signal is a first Cell-Specific Reference Signal, CRS, and the second type of signal is a second Cell-Specific Reference Signal, CRS, wherein the first CRS signal is different from the second CRS signal.

28. UE according to claim 27, wherein the configuration message comprises an indication of an ePDCCH start symbol for the first ePDCCH set and an indication of an ePDCCH start symbol for the second ePDCCH set.

29. UE according to claim 28, wherein the indicated ePDCCH start symbol is the same start symbol as scheduled for a Packet Data Shared Channel, PDSCH, to be transmitted by the network node.

30. UE according to any of claims 27-29, wherein one or more of the following configuration parameters: number of Cell-specific Reference Signal,

CRS, antenna ports, CRS frequency shift, start position of the first ePDCCH set or the second ePDCCH set, Multicast/ Broadcast Single Frequency Network, MBSFN, subframe configuration, Zero Power Channel State Information Reference Signal, CSI-RS, resource configuration, are shared between the ePDCCH and a Packet Data Shared Channel PDSCH.

31. UE according to any of claims 27-30, wherein the receiving unit (1002) is further arranged to receive a message from the network node comprising the ePDCCH allocated to a selected one of the first ePDCCH set and the second ePDCCH set, the UE (1000) further comprising:

a decoding unit (1004) for decoding ePDCCH candidates according to the first mapping and for decoding ePDCCH candidates according to the second mapping;

a detecting unit (1006) for detecting whether the ePDCCH was allocated to the first ePDCCH set or to the second ePDCCH set.

32. UE according to any of claims 27-31, wherein the resource elements of the first ePDCCH set comprises information of uplink grants and the resource elements of the second ePDCCH set comprises information of downlink assignments.

33. UE according to any of claims 27-32, wherein the receiving unit (1002) is further arranged to receive the configuration message in a Radio Resource Control, RRC message.

34. A computer program (1110) comprising computer readable code means, which when run in a user equipment, UE, (1000) causes the UE (1000) to perform the following step: receiving a configuration message from a network node, the configuration message comprising an indication of a first mapping of the ePDCCH to resource elements belonging to a first ePDCCH set, where the resource elements of the first ePDCCH set are different from resource elements used for a first type of signal, and an indication of a second mapping of the ePDCCH to resource elements belonging to a second ePDCCH set, where the resource elements of the second ePDCCH set are different from resource elements used for a second type of signal,

wherein the first type of signal is a first Cell-Specific Reference Signal,

CRS, and the second type of signal is a second Cell-Specific Reference Signal, CRS, wherein the first CRS signal is different from the second CRS signal.

35. A computer program medium, comprising computer readable medium and a computer program (1110) according to claim 34 stored on the computer readable medium.