CLAIMS

The invention claimed is:

1. A method to determine physical uplink control channel (PUCCH) resource allocation comprising receiving, by a user equipment (UE) served by a primary (PCell) and a secondary cell (SCell), downlink subframes in a physical downlink shared channel (PDSCH), wherein the PDSCH is indicated by detection of a physical downlink control channel (PDCCH) in the PCell, and wherein the PUCCH resources are indicated using a first control channel element index of the PDCCH.

2. The method of claim 1, wherein the PUCCH resources are provided for feedback of time division duplexing (TDD) hybrid automatic repeat request (HARQ) acknowledgement (ACK) information.

3. The method of claim 2, further comprising using cross-carrier scheduling of the PDSCH on the SCell.

4. The method of claim 2, wherein between two and four subframes are used to indicate the first control channel element index of the PDCCH.

5. The method of claim 1, wherein the method is performed in compliance with 3rd Generation Partnership Project (3GPP) Release 10 Long Term Evolution Advanced (LTE-A).

6. A user equipment (UE) arranged to determine physical uplink control channel (PUCCH) resource allocation, comprising receiving means to receive downlink subframes in a physical downlink shared channel (PDSCH) of a secondary cell (SCell) as indicated by detection of a physical downlink control channel (PDCCH) on the SCell, wherein the PUCCH resources are indicated using a field in downlink control information transmitted on the PDCCH.

7. The UE of claim 6, wherein the PUCCH resources are further indicated using a primary cell (PCell).

8. The UE of claim 7, wherein the PUCCH resources are implicitly indicated on the PCell and explicitly indicated on the SCell.

9. The UE of claim 6, wherein the UE is served by two serving cells using two component carriers.

10. An apparatus for use in a wireless network, the apparatus comprising processing circuitry arranged to determine physical uplink control channel (PUCCH) resource allocation from a physical downlink shared channel (PDSCH) in a wireless environment comprising a primary cell (PCell) and a secondary cell (SCell), wherein two to four PUCCH resources are implicitly indicated for the PUCCH by one or more PDSCH transmissions on the PCell and the SCell.

11. The apparatus of claim 10, further comprising a radio interface, wherein the radio interface is arranged to receive downlink subframes from the PCell and SCell.

12. The apparatus of claim 11, wherein the apparatus is part of a user equipment (UE) arranged to operate using orthogonal frequency division multiple access (OFDMA) in downlink and single-carrier frequency division multiple access (SC-FDMA) in uplink communications.

13. The apparatus of claim 10, wherein the apparatus is further arranged to determine PUCCH resources using downlink control information carried on the PDCCH.

14. The apparatus of claim 13, wherein the apparatus is further arranged to receive the PUCCH resources from an evolved node B (eNodeB).

15. The apparatus as recited in claim 11, wherein the PUCCH resources are indicated using a first control channel element (CCE) index of the PDCCH on the PCell.

16. The apparatus of claim 11, wherein the apparatus is further arranged to operate using two component carriers.

17. The apparatus of claim 12, wherein the user equipment (UE) is in the form of a tablet, smartphone, netbook, laptop, or a mobile device.

18. An apparatus for use in a wireless network comprising a primary cell (PCell) and a secondary cell (SCell), the apparatus comprising processing circuitry arranged to allocate physical uplink control channel (PUCCH) resources using a physical downlink shared channel

(PDSCH) in the PCell, wherein the apparatus is further arranged to indicate PUCCH resources using a first control channel element index over a physical downlink control channel (PDCCH) of the PCell and wherein between two and four subframes are used to indicate the PUCCH resources.

19. The apparatus of claim 18, further comprising a radio interface arranged to transmit a plurality of downlink subframes in the PCell.

20. The apparatus of claim 19, wherein the apparatus is part of an evolved node B (eNodeB) arranged to communicate with another eNodeB to deploy two serving cells to allocate the PUCCH resources to a user equipment (UE).

21. An apparatus for use in a wireless network comprising a primary cell (PCell) and a secondary cell (SCell), the apparatus comprising processing circuitry arranged to allocate physical uplink control channel (PUCCH) resources, wherein the apparatus is further arranged to indicate at least one of the PUCCH resources using a transmit power control field in downlink control information transmitted on a physical downlink control channel (PDCCH) in the SCell.

22. The apparatus of claim 21, wherein the PUCCH resources are configured by a higher layer of an evolved Node B (eNodeB).

23. The apparatus of claim 21, wherein the apparatus provides the PUCCH resources for a user equipment (UE) to send hybrid automatic repeat request (HARQ) acknowledgement (ACK) / negative acknowledgement (NACK) information to the apparatus.

24. An apparatus for wireless communication in a primary cell (PCell) and a secondary cell (SCell) of a time division duplexing (TDD) wireless network, comprising:

processing circuitry arranged to determine physical uplink control channel (PUCCH) resource allocation from physical downlink shared channels (PDSCH) in the wireless network, wherein the PUCCH resources are derived from two or more PDSCH subframe transmissions on the PCell and the SCell.

25. The apparatus of claim 24, wherein the PUCCH is used to feedback hybrid automatic repeat request (HARQ) acknowledgement (ACK) information to an evolved node B (eNodeB).

26. The apparatus of claim 25, wherein two to four PUCCH resources are associated with the PDSCH subframe transmissions.

27. The apparatus of claim 26, wherein the PCell and the SCell are arranged as serving cells for the apparatus.

28. The apparatus of claim 24, wherein the PUCCH resources are associated with an uplink (UL) subframe.

29. The apparatus of claim 24, wherein each PUCCH resource is associated with a subframe transmitted on the PDSCH.

30. The apparatus of claim 24, wherein at least one of the PUCCH resources is indicated using a field in downlink control information transmitted on a PDCCH of the SCell.

31. The apparatus of claim 30, wherein the field in the downlink control information is a transmit power control (TPC) field.

32. An apparatus for wireless communication in a time division duplexing (TDD) wireless network comprising a primary cell (PCell) and a secondary cell (SCell), comprising:

processing circuitry arranged to allocate physical uplink control channel (PUCCH) resources using a physical downlink shared channel (PDSCH) in the wireless network, the PUCCH resources to be derived by a user equipment (UE) from one or more PDSCH subframe transmissions on the PCell and the SCell.

33. The apparatus of claim 32, wherein two to four PUCCH resources are associated with the PDSCH subframe transmissions.

34. The apparatus of claim 32, wherein the PUCCH resources are associated with an uplink (UL) subframe on the PUCCH.

35. The apparatus of claim 32, wherein each PUCCH resource is associated with a subframe transmitted on the PDSCH.

CLAIMS

The invention claimed is:

1. A method for communicating in a wireless network comprising:

receiving one or more synchronization signals from a primary cell (PCell);

receiving an activation command for a secondary cell (SCell);

receiving, in one or more control channel elements (CCEs), a physical downlink control channel (PDCCH) transmission to indicate a physical downlink shared channel (PDSCH) transmission on the SCell; and

determining an allocation of a physical uplink control channel (PUCCH) resource based on a first CCE of the one or more CCEs.

2. The method of claim 1, wherein the PDCCH transmission is a first PDCCH transmission, the PUCCH resource is a first PUCCH resource, and the method further comprises:

receiving, in at least one CCE, a second PDCCH transmission on the SCell, wherein the second PDCCH transmission includes downlink control information having a transmit power control (TPC) field; and

determining an allocation of a second PUCCH resource based on the TPC field.

3. The method of claim 1, wherein the PDSCH transmission is a first PDSCH transmission and the PUCCH resource is an uplink subframe that is to include hybrid automatic repeat request (HARQ) acknowledgment information for the first PDSCH transmission and a second PDSCH transmission on the PCell.

4. The method of claim 1, wherein said determining the allocation comprises:

determining the allocation of the PUCCH resource based on an index of the first CCE.

5. The method of claim 4, wherein the one or more CCEs comprise a plurality of CCEs having associated indices, and the index of the first CCE is a lowest of the indices associated with the plurality of CCEs.

6. The method of claim 1, wherein the PUCCH resource is provided for feedback of time division duplexing (TDD) hybrid automatic repeat request (HARQ) acknowledgement (ACK) information.

7. The method of claim 1, wherein the PUCCH resource is provided for uplink scheduling requests.

8. The method of claim 1, wherein the PUCCH resource is in an uplink subframe and the method further comprises:

transmitting, in the uplink subframe, time division duplexing (TDD) hybrid automatic repeat request (HARQ) acknowledgement (ACK) information for PDSCH transmissions in either two, three, or four downlink subframes.

9. The method of claim 8, wherein the TDD HARQ ACK information includes information for PDSCH transmissions in four downlink subframes and the method further comprises:

receiving PDCCH transmissions in each of the four downlink subframes; and

determining an allocation of four PUCCH resources in the uplink subframe based on the PDCCH transmissions received in each of the four downlink subframes.

10. The method of claim 1, wherein the PUCCH resource is a first PUCCH resource, the PDCCH transmission is a first PDCCH transmission received in a downlink subframe and the method further comprises:

receiving a second PDCCH transmission on the PCell in the downlink

subframe to schedule a PDSCH transmission on the PCell; and

determining an allocation of a second PUCCH resource based on the second PDCCH transmission.

11. The method of any of claims 1-10, wherein the method is performed in compliance with 3rd Generation Partnership Project (3GPP) Release 10 Long Term Evolution Advanced (LTE-A).

12. The method of any of claims 1-10, wherein the PUCCH resource has a format 1b with channel selection.

13. The method of claim 1, wherein the PDCCH transmission is on the PCell.

14. A user equipment (UE) to operate in a wireless network, the UE comprising:

receiving means to receive a downlink frame in a physical downlink shared channel (PDSCH) of a secondary cell (SCell) as indicated by detection of a physical downlink control channel (PDCCH) on the SCell;

scheduling means to determine an indication of a physical uplink control channel (PUCCH) resource using a field in downlink control information transmitted on the PDCCH; and

transmitting means to transmit, in the PUCCH resource, hybrid automatic request (HARQ) acknowledgement (ACK) information.

15. The UE of claim 14, wherein another PUCCH resource is indicated using a primary cell (PCell).

16. The UE of claim 15, wherein the PUCCH resource is explicitly indicated on the SCell and the other PUCCH resource is implicitly indicated on the PCell.

17. An apparatus for use in a wireless network, the apparatus comprising:

processing circuitry to determine a physical uplink control channel (PUCCH) resource allocation from a physical downlink control channel (PDCCH) that indicates a physical downlink shared channel (PDSCH) of a secondary cell (SCell),

wherein two to four PUCCH resources are to be implicitly indicated by one or more PDCCH transmissions on a primary cell (PCell) or the SCell.

18. The apparatus of claim 17, further comprising a radio interface, wherein the radio interface is to receive downlink subframes from the PCell and SCell.

19. The apparatus of claim 18, wherein the apparatus is part of a user equipment (UE) that is to operate using orthogonal frequency division multiple access (OFDMA) in downlink and single-carrier frequency division multiple access (SC-FDMA) in uplink communications.

20. The apparatus of claim 17, wherein the apparatus is to determine a first PUCCH resource of the two to four PUCCH resources using a transmit power control field in downlink control information of a PDCCH transmission on the SCell.

21. The apparatus as recited in claim 17, wherein the apparatus is to determine a first PUCCH resource of the two to four PUCCH resources using a first control channel element (CCE) index of a PDCCH transmission on the PCell.

22. The apparatus of any of claims 17-21, wherein the user equipment (UE) comprises a touchscreen user interface.

23. An apparatus for use in a wireless network comprising a primary cell (PCell) and a secondary cell (SCell), the apparatus comprising:

processing circuitry to allocate, for transmission of hybrid automatic repeat request (HARQ) acknowledgement (ACK) information, one or more physical uplink control channel (PUCCH) resources of an uplink subframe using one or more physical downlink control channel (PDCCH) transmissions in the PCell or SCell,

wherein the apparatus is to indicate a first PUCCH resource of the one or more PUCCH resources using an index of a control channel element carrying a first PDCCH transmission of the one or more PDCCH transmissions, and between two and four downlink subframes are to be used to indicate the allocated PUCCH resources of the uplink subframe.

24. The apparatus of claim 23, wherein the first PDCCH transmission is to be transmitted in a first downlink subframe and the apparatus is to indicate a second PUCCH resource of the one or more PUCCH resources using a second PDCCH transmission of the first downlink subframe.

25. The apparatus of claim 23, wherein the control channel element (CCE) is a first CCE, and the apparatus is to indicate a second PUCCH resource of one or more PUCCH resources using an index of a second CCE carrying the first PDCCH transmission.

26. The apparatus of claim 23, wherein the one or more PDCCH transmissions are in both the PCell and the SCell.

27. The apparatus of claim 26, wherein at least one of the PUCCH resources is explicitly indicated using a field in downlink control information transmitted in a PDCCH transmission of the SCell.

28. An apparatus for use in a wireless network comprising a primary cell (PCell) and a secondary cell (SCell), the apparatus comprising:

processing circuitry to allocate physical uplink control channel (PUCCH) resources,

wherein the apparatus is to explicitly indicate at least one of the PUCCH resources using a field in downlink control information transmitted on a physical downlink control channel (PDCCH) transmission of the SCell.

29. The apparatus of claim 28, wherein the apparatus is allocate the PUCCH resources for a user equipment (UE) to send hybrid automatic repeat request (HARQ) acknowledgement (ACK) information and uplink scheduling requests to the apparatus.

30. The apparatus of claim 28, wherein the field in the downlink control information is a transmit power control (TPC) field.