

CLAIMS

1. An apparatus for wireless communications, comprising: a processing system configured to generate a first transmit beamforming refinement frame; a first interface configured to output the first transmit beamforming refinement frame for transmission to a wireless node, wherein a first portion of the first transmit beamforming refinement frame is output for transmission via a first transmit beamforming sector and further wherein training fields of the first transmit beamforming refinement frame are output for transmission via two or more second transmit beamforming sectors; and a second interface configured to obtain a first feedback frame from the wireless node indicating one of the second transmit beamforming sectors, wherein the apparatus is configured to use the indicated second transmit beamforming sector for communication with the wireless node; wherein: the second interface is further configured to obtain a second transmit beamforming refinement frame, from the wireless node, wherein a first portion of the second transmit beamforming refinement frame is obtained using a first receive beamforming sector and training fields of the second transmit beamforming refinement frame are obtained while the apparatus is in an omnidirectional receive antenna mode; the processing system is configured to select a third transmit beamforming sector based on the training fields of the second transmit beamforming refinement frame and to generate a second feedback frame indicating the third transmit beamforming sector; and the first interface is further configured to output the second feedback frame for transmission.
2. The apparatus of claim 1, wherein the first feedback frame is obtained after the second transmit beamforming refinement frame had been obtained.
3. The apparatus of claim 1, wherein: the second interface is further configured to obtain a second receive beamforming refinement frame, from the wireless node, wherein a first portion of the second receive beamforming refinement frame is obtained using the first receive beamforming sector and training fields of the second receive beamforming refinement frame are obtained using different second receive beamforming sectors; the processing system is configured to generate a second feedback frame acknowledging receipt of the second receive beamforming refinement frame; and the first interface is further configured to output the second feedback frame for transmission.
4. The apparatus of claim 3, wherein the second feedback frame is output for transmission after the second receive beamforming refinement frame had been obtained.
5. An apparatus for wireless communications, comprising: a processing system configured to generate a first transmit beamforming refinement frame; a first interface configured to output the first transmit beamforming refinement frame for transmission to a wireless node, wherein a first portion of the first transmit beamforming refinement frame is output for transmission via a first transmit beamforming sector and further wherein training fields of the first transmit beamforming refinement frame are output for transmission via two or more second transmit beamforming sectors; and a second interface configured to obtain a first feedback frame from the

wireless node indicating one of the second transmit beamforming sectors, wherein the apparatus is configured to use the indicated second transmit beamforming sector for communication with the wireless node; wherein: the processing system is further configured to generate a first receive beamforming refinement frame; and the first interface is further configured to output the first receive beamforming refinement frame for transmission to the wireless node, wherein a first portion of the first receive beamforming refinement frame is output for transmission via the first transmit beamforming sector and training fields of the first receive beamforming refinement frame are output for transmission using the indicated second transmit beamforming sector.

6. The apparatus of claim 5, wherein: the processing system is further configured to generate a request frame to reserve a medium for wireless communication between the apparatus and the wireless node during a time duration; the first interface is further configured to output the request frame for transmission via the medium; and the first transmit beamforming refinement frame and the first receive beamforming refinement frame are output for transmission via the medium during the time duration.

7. The apparatus of claim 5, wherein: the processing system is further configured to generate a second receive beamforming refinement frame for transmission to the wireless node, if the apparatus does not obtain acknowledgement, from the wireless node, of the first receive beamforming refinement frame.

8. An apparatus for wireless communications, comprising: a first interface configured to obtain a first transmit beamforming refinement frame from a wireless node, wherein: a first portion of the first transmit beamforming refinement frame is obtained via a first receive beamforming sector, and training fields of the first transmit beamforming refinement frame are obtained while the apparatus is in an omnidirectional receive antenna mode; a processing system configured to select a first transmit beamforming sector that was used to transmit one of the training fields, based on received signal quality of the one of the training fields, and to generate a first feedback frame indicating the first transmit beamforming sector; and a second interface configured to output the first feedback frame for transmission to the wireless node.

9. The apparatus of claim 8, wherein: the first interface is further configured to obtain a first receive beamforming refinement frame; a first portion of the first receive beamforming refinement frame is obtained using the first receive beamforming sector; training fields of the first receive beamforming refinement frame are obtained using different second receive beamforming sectors; and the processing system is configured to process the training fields to select one of the different second receive beamforming sectors for the apparatus to use for communication with the wireless node.

10. The apparatus of claim 9, wherein: the first interface is further configured to obtain a request frame to reserve a medium for wireless communication between the apparatus and the wireless node during a time duration; the processing system is further configured to generate a response frame acknowledging the request frame; the second interface is further configured to output the

response frame for transmission, via the medium; and the first transmit beamforming refinement frame and first receive beamforming refinement frame are obtained via the medium during the time duration.

11. The apparatus of claim 8, wherein: the processing system is configured to generate a second transmit beamforming refinement frame; the second interface is further configured to output for transmission the second transmit beamforming refinement frame, wherein a first portion of the second transmit beamforming refinement frame is output for transmission using a second transmit beamforming sector and training fields of the second transmit beamforming refinement frame are output for transmission using different transmit beamforming sectors; the first interface is configured to obtain a second feedback frame indicating a third transmit beamforming sector that was used to transmit one of the training fields of the second transmit beamforming refinement frame; and the apparatus is configured to use the third transmit beamforming sector for beamformed transmissions.

12. The apparatus of claim 11, wherein the first feedback frame is output for transmission after the second transmit beamforming refinement frame is output for transmission.

13. The apparatus of claim 11, wherein: the processing system is configured to generate a second receive beamforming refinement frame; the first interface is further configured to output the second receive beamforming refinement frame for transmission, wherein a first portion of the second receive beamforming refinement frame is output for transmission using the second transmit beamforming sector and training fields of the second receive beamforming refinement frame are output for transmission using the third transmit beamforming sector; the processing system is configured to generate a third feedback frame acknowledging receipt of the second receive beamforming refinement frame; and the first interface is further configured to output the third feedback frame for transmission.

14. The apparatus of claim 13, wherein the second feedback frame is obtained after the second receive beamforming refinement frame is output for transmission.

15. An apparatus for wireless communications, comprising: a processing system configured to generate a receive beamforming refinement frame; and a first interface configured to output the receive beamforming refinement frame for transmission to a wireless node, wherein: a first portion of the receive beamforming refinement frame is output for transmission via a first transmit beamforming sector, and training fields of the receive beamforming refinement frame are output for transmission via a second transmit beamforming sector; a second interface configured to obtain an acknowledgement frame from the wireless node indicating success of a beamforming refinement procedure, wherein the processing system is further configured to cause the apparatus to stop using the first transmit beamforming sector after receiving the acknowledgement frame.

16. An apparatus for wireless communications, comprising: a processing system configured to

generate a receive beamforming refinement frame; and a first interface configured to output the receive beamforming refinement frame for transmission to a wireless node, wherein: a first portion of the receive beamforming refinement frame is output for transmission via a first transmit beamforming sector, and training fields of the receive beamforming refinement frame are output for transmission via a second transmit beamforming sector; and a second interface configured to obtain a feedback frame from the wireless node indicating the second transmit beamforming sector, wherein: the processing system is configured to generate a transmit beamforming refinement frame; the first interface is further configured to output the transmit beamforming refinement frame for transmission to the wireless node, wherein a first portion of the transmit beamforming refinement frame is output for transmission via the first transmit beamforming sector and further wherein training fields of the transmit beamforming refinement frame are output for transmission via at least two transmit beamforming sectors including the second transmit beamforming sector; and the feedback frame is obtained after outputting the transmit beamforming refinement frame for transmission to the wireless node.

17. An apparatus for wireless communications, comprising: a first interface configured to obtain a receive beamforming refinement frame from a wireless node, wherein a first portion of the receive beamforming refinement frame is obtained via a first receive beamforming sector and further wherein training fields of the receive beamforming refinement frame are obtained via at least two second receive beamforming sectors; a processing system configured to: process the training fields to select one of the second receive beamforming sectors for the apparatus to use for communication with the wireless node; and generate an acknowledgement frame indicating success of a beamforming refinement procedure; and a second interface configured to output the acknowledgment frame for transmission to the wireless node.

18. An apparatus for wireless communications, comprising: a first interface configured to obtain a receive beamforming refinement frame from a wireless node, wherein a first portion of the receive beamforming refinement frame is obtained via a first receive beamforming sector and further wherein training fields of the receive beamforming refinement frame are obtained via at least two second receive beamforming sectors; a processing system configured to: process the training fields to select one of the second receive beamforming sectors for the apparatus to use for communication with the wireless node; and generate a feedback frame indicating a transmit beamforming sector for the wireless node to use for transmission of the training fields of the receive beamforming refinement frame; and a second interface configured to output the feedback frame for transmission to the wireless node.

19. The apparatus of claim 18, wherein: the first interface is further configured to obtain a transmit beamforming refinement frame from the wireless node, wherein a first portion of the transmit beamforming refinement frame is obtained via the first receive beamforming sector and further wherein training fields of the transmit beamforming refinement frame are obtained while the apparatus is in an omnidirectional receive antenna mode; and the transmit beamforming sector indicated in the feedback frame comprises a transmit beamforming sector that was used to transmit one of the training fields of the transmit beamforming refinement frame.