

CLAIMS

1. A method for a scheduling entity to schedule transmissions with a set of one or more scheduled entities in a wireless communication network, the method comprising:
scheduling a grant comprising a downlink assignment or an uplink grant for a first packet for a first scheduled entity of the set of one or more scheduled entities;
transmitting a first control channel comprising first control information to the first scheduled entity, wherein the first control information comprises the grant for the first packet;
modifying at least one property of a plurality of properties of the grant to produce grant modification information;
adding a second packet to the grant, wherein the first packet is scheduled on a first set of resource elements within a slot and the second packet is scheduled on a second set of resource elements within the slot; and
transmitting a second control channel comprising second control information to the first scheduled entity, wherein the second control information comprises at least the grant modification information and is separate from the first control information.
2. The method of claim 1, wherein the grant modification information comprises an indication that at least part of the first packet will be punctured.
3. The method of claim 2, wherein the second packet comprises ultra-reliable low latency communication (URLLC) traffic for transmission, and wherein the method further comprises:
identifying at least portion of resource elements (REs) allocated to the first packet that are needed to support transmission of the second packet to produce punctured resource information;
and
generating the grant modification information comprising the punctured resource information.
4. The method of claim 1, wherein the first packet is scheduled on a first set of one or more multiple-input-multiple-output (MIMO) layers and the second packet is scheduled on a second set of one or more MIMO layers.

5. The method of claim 4, wherein the first set of resource elements comprises at least part of the second set of resource elements.

6. The method of claim 5, further comprising:
assigning a first hybrid automatic repeat request (HARQ) process identifier (ID) to the first packet; and
assigning a second HARQ process ID to the second packet.

7. The method of claim 6, wherein the first HARQ process ID and the second HARQ process ID are the same.

8. The method of claim 1, further comprising:
scheduling resources for a block acknowledgement comprising a respective acknowledgement bit for each of the first packet and the second packet to produce a block acknowledgement grant;
and
transmitting the block acknowledgement grant to the first scheduled entity within the first control channel.

9. The method of claim 1, further comprising:
scheduling resources for a bundled acknowledgement comprising a single acknowledgement bit for both the first packet and the second packet to produce a bundled acknowledgement grant; and
transmitting the bundled acknowledgement grant to the first scheduled entity within at least one of the first control channel and the second control channel.

10. The method of claim 9, wherein the bundled acknowledgement grant further comprises an indication of a number of packets associated with the bundled acknowledgement grant.

11. The method of claim 9, further comprising:
transmitting the first packet and the second packet to the first scheduled entity;
receiving bundled acknowledgement information utilizing the bundled acknowledgement grant from the first scheduled entity; and

receiving an indication of a number of packets associated with the bundled acknowledgement information from the first scheduled entity.

12. The method of claim 1, wherein adding the second packet to the grant further comprises: selecting a first modulation and coding scheme (MCS) for the first packet; and selecting a second MCS for the second packet, wherein the second MCS is different than the first MCS.

13. The method of claim 1, wherein adding the second packet to the grant further comprises: identifying a first retransmission sequence number of the first packet and a second retransmission sequence number of the second packet, wherein the first retransmission sequence number is different than the second retransmission sequence number.

14. The method of claim 1, wherein modifying the at least one property of the plurality of properties of the grant to produce the grant modification information further comprises: modifying at least one of a time-frequency resource allocation of the grant, a waveform utilized for the grant, or a transmit-diversity scheme utilized for the grant to produce the grant modification information.

15. The method of claim 1, wherein the first control information further comprises a respective modification indication for each property of the plurality of properties of the grant.

16. A method for a scheduling entity to schedule transmissions with a set of one or more scheduled entities in a wireless communication network, the method comprising: scheduling a grant comprising a downlink assignment or an uplink grant for a first packet for a first scheduled entity of the set of one or more scheduled entities; transmitting a first control channel comprising first control information to the first scheduled entity, wherein the first control information comprises the grant for the first packet; modifying at least one property of a plurality of properties of the grant to produce grant modification information; and

transmitting a second control channel comprising second control information to the first scheduled entity, wherein the second control information comprises at least the grant modification information and is separate from the first control information, and, wherein the first control information further comprises a respective modification indication for each property of the plurality of properties of the grant, and the respective modification indication of each of the plurality of properties indicates whether the respective property is further modifiable.

17. The method of claim 16, wherein the respective modification indication of each of the plurality of properties is set to final when the respective property is no longer modifiable.

18. A scheduling entity in a wireless communication network, comprising:
 a transceiver for wireless communication with a set of one or more scheduled entities;
 a memory; and
 a processor communicatively coupled to the transceiver and the memory, the processor configured to:
 schedule a grant comprising a downlink assignment or an uplink grant for a first packet for a first scheduled entity of a set of one or more scheduled entities in wireless communication with the scheduling entity;
 transmit a first control channel comprising first control information to the first scheduled entity via the transceiver, wherein the first control information comprises the grant for the first packet;
 modify at least one property of a plurality of properties of the grant to produce grant modification information;
 add a second packet to the grant, wherein the first packet is scheduled on a first set of resource elements within a slot and the second packet is scheduled on a second set of resource elements within the slot; and
 transmit a second control channel comprising second control information to the first scheduled entity via the transceiver, wherein the second control information comprises at least the grant modification information and is separate from the first control information.

19. The scheduling entity of claim 18, wherein the grant modification information comprises an indication that at least part of the first packet will be punctured.

20. The scheduling entity of claim 19, wherein the second packet comprises ultra-reliable low latency communication (URLLC) traffic for transmission, and the process is further configured to:

identify at least portion of resource elements (REs) allocated to the first packet that are needed to support transmission of the second packet to produce punctured resource information; and generate the grant modification information comprising the punctured resource information.

21. The scheduling entity of claim 18, wherein the first packet is scheduled on a first set of one or more multiple-input-multiple-output (MIMO) layers and the second packet is scheduled on a second set of one or more MIMO layers.

22. The scheduling entity of claim 21, wherein the first set of resource elements comprises at least part of the second set of resource elements.

23. The scheduling entity of claim 22, wherein the processor is further configured to:
assign a first hybrid automatic repeat request (HARQ) process identifier (ID) to the first packet;
and
assign a second HARQ process ID to the second packet.

24. The scheduling entity of claim 23, wherein the first HARQ process ID and the second HARQ process ID are the same.

25. The scheduling entity of claim 18, wherein the processor is further configured to:
schedule resources for a block acknowledgement comprising a respective acknowledgement bit for each of the first packet and the second packet to produce a block acknowledgement grant;
and
transmit the block acknowledgement grant to the first scheduled entity within the first control channel.

26. The scheduling entity of claim 18, wherein the processor is further configured to:

schedule resources for a bundled acknowledgement comprising a single acknowledgement bit for both the first packet and the second packet to produce a bundled acknowledgement grant; and transmit the bundled acknowledgement grant to the first scheduled entity within at least one of the first control channel and the second control channel.

27. The scheduling entity of claim 26, wherein the bundled acknowledgement grant further comprises an indication of a number of packets associated with the bundled acknowledgement grant.

28. The scheduling entity of claim 26, wherein the processor is further configured to: transmit the first packet and the second packet to the first scheduled entity via the transceiver; receive bundled acknowledgement information utilizing the bundled acknowledgement grant from the first scheduled entity via the transceiver; and receive an indication of a number of packets associated with the bundled acknowledgement information from the first scheduled entity via the transceiver.

29. The scheduling entity of claim 18, wherein the processor is further configured to: select a first modulation and coding scheme (MCS) for the first packet; and select a second MCS for the second packet, wherein the second MCS is different than the first MCS.

30. The scheduling entity of claim 18, wherein the processor is further configured to: identify a first retransmission sequence number of the first packet and a second retransmission sequence number of the second packet, wherein the first retransmission sequence number is different than the second retransmission sequence number.

31. The scheduling entity of claim 18, wherein the processor is further configured to: modify at least one of a time-frequency resource allocation of the grant, a waveform utilized for the grant, or a transmit-diversity scheme utilized for the grant to produce the grant modification information.

32. The scheduling entity of claim 18, wherein the first control information further comprises a respective modification indication for each property of the plurality of properties of the grant.

33. A scheduling entity in a wireless communication network, comprising:

a transceiver for wireless communication with a set of one or more scheduled entities;

a memory; and

a processor communicatively coupled to the transceiver and the memory, the processor configured to:

schedule a grant comprising a downlink assignment or an uplink grant for a first packet for a first scheduled entity of a set of one or more scheduled entities in wireless communication with the scheduling entity;

transmit a first control channel comprising first control information to the first scheduled entity via the transceiver, wherein the first control information comprises the grant for the first packet;

modify at least one property of a plurality of properties of the grant to produce grant modification information; and

transmit a second control channel comprising second control information to the first scheduled entity via the transceiver, wherein the second control information comprises at least the grant modification information and is separate from the first control information, wherein the first control information further comprises a respective modification indication for each property of the plurality of properties of the grant, and the respective modification indication of each of the plurality of properties indicates whether the respective property is further modifiable.

34. The scheduling entity of claim 33, wherein the respective modification indication of each of the plurality of properties is set to final when the respective property is no longer modifiable.

35. A scheduling entity in a wireless communication network, comprising:

means for scheduling a grant comprising a downlink assignment or an uplink grant for a first packet for a first scheduled entity of a set of one or more scheduled entities in wireless communication with the scheduling entity;

means for transmitting a first control channel comprising first control information to the first scheduled entity, wherein the first control information comprises the grant for the first packet;

means for modifying at least one property of a plurality of properties of the grant to produce grant modification information;

means for adding a second packet to the grant, wherein the first packet is scheduled on a first set of resource elements within a slot and the second packet is scheduled on a second set of resource elements within the slot; and

means for transmitting a second control channel comprising second control information to the first scheduled entity, wherein the second control information comprises at least the grant modification information and is separate from the first control information.

36. The scheduling entity of claim 35, wherein the grant modification information comprises an indication that at least part of the first packet will be punctured.

37. The scheduling entity of claim 36, wherein the second packet comprises ultra-reliable low latency communication (URLLC) traffic for transmission, and further comprising:

means for identifying at least portion of resource elements (REs) allocated to the first packet that are needed to support transmission of the second packet to produce punctured resource information; and

means for generating the grant modification information comprising the punctured resource information.

38. The scheduling entity of claim 35, wherein the first packet is scheduled on a first set of one or more multiple-input-multiple-output (MIMO) layers and the second packet is scheduled on a second set of one or more MIMO layers.

39. The scheduling entity of claim 38, wherein the first set of resource elements comprises at least part of the second set of resource elements.

40. The scheduling entity of claim 39, further comprising:

means for assigning a first hybrid automatic repeat request (HARQ) process identifier (ID) to the first packet; and

means for assigning a second HARQ process ID to the second packet.

41. The scheduling entity of claim 40, wherein the first HARQ process ID and the second HARQ process ID are the same.

42. The scheduling entity of claim 35, further comprising:

means for scheduling resources for a bundled acknowledgement comprising a single acknowledgement bit for both the first packet and the second packet to produce a bundled acknowledgement grant; and

means for transmitting the bundled acknowledgement grant to the first scheduled entity within at least one of the first control channel and the second control channel.

43. The scheduling entity of claim 42, further comprising:

means for transmitting the first packet and the second packet to the first scheduled entity;

means for receiving bundled acknowledgement information utilizing the bundled acknowledgement grant from the first scheduled entity; and

means for receiving an indication of a number of packets associated with the bundled acknowledgement information from the first scheduled entity.

44. The scheduling entity of claim 35, wherein the bundled acknowledgement grant further comprises an indication of a number of packets associated with the bundled acknowledgement grant.

45. The scheduling entity of claim 35, wherein the means for adding the second packet to the grant further comprises:

means for selecting a first modulation and coding scheme (MCS) for the first packet; and

means for selecting a second MCS for the second packet, wherein the second MCS is different than the first MCS.

46. The scheduling entity of claim 35, wherein the means for adding the second packet to the grant further comprises:

means for identifying a first retransmission sequence number of the first packet and a second retransmission sequence number of the second packet, wherein the first retransmission sequence number is different than the second retransmission sequence number.

47. The scheduling entity of claim 35, wherein the means for modifying the at least one property of the plurality of properties of the grant to produce the grant modification information further comprises:

modifying at least one of a time-frequency resource allocation of the grant, a waveform utilized for the grant, or a transmit-diversity scheme utilized for the grant to produce the grant modification information.

48. A non-transitory computer-readable medium storing computer executable code, comprising code for causing a scheduling entity in a wireless communication network to:

schedule a grant comprising a downlink assignment or an uplink grant for a first packet for a first scheduled entity of a set of one or more scheduled entities in wireless communication with the scheduling entity;

transmit a first control channel comprising first control information to the first scheduled entity, wherein the first control information comprises the grant for the first packet;

modify at least one property of a plurality of properties of the grant to produce grant modification information;

add a second packet to the grant, wherein the first packet is scheduled on a first set of resource elements within a slot and the second packet is scheduled on a second set of resource elements within the slot; and

transmit a second control channel comprising second control information to the first scheduled entity, wherein the second control information comprises at least the grant modification information and is separate from the first control information.

49. The non-transitory computer-readable medium of claim 48, wherein the grant modification information comprises an indication that at least part of the first packet will be punctured.

50. The non-transitory computer-readable medium of claim 49, wherein the second packet comprises ultra-reliable low latency communication (URLLC) traffic for transmission, and further comprising code for causing the scheduling entity to; identify at least portion of resource elements (REs) allocated to the first packet that are needed to support transmission of the second packet to produce punctured resource information; and generate the grant modification information comprising the punctured resource information.

51. The non-transitory computer-readable medium of claim 48, wherein the first packet is scheduled on a first set of one or more multiple-input-multiple-output (MIMO) layers and the second packet is scheduled on a second set of one or more MIMO layers.

52. The non-transitory computer-readable medium of claim 51, wherein the first set of resource elements comprises at least part of the second set of resource elements.

53. The non-transitory computer-readable medium of claim 52, further comprising code for causing the scheduling entity to:
assign a first hybrid automatic repeat request (HARQ) process identifier (ID) to the first packet;
and
assign a second HARQ process ID to the second packet.

54. The non-transitory computer-readable medium of claim 53, wherein the first HARQ process ID and the second HARQ process ID are the same.

55. The non-transitory computer-readable medium of claim 48, further comprising code for causing the scheduling entity to:
schedule resources for a bundled acknowledgement comprising a single acknowledgement bit for both the first packet and the second packet to produce a bundled acknowledgement grant; and
transmit the bundled acknowledgement grant to the first scheduled entity within at least one of the first control channel and the second control channel.

56. The non-transitory computer-readable medium of claim 55, wherein the bundled acknowledgement grant further comprises an indication of a number of packets associated with the bundled acknowledgement grant.

57. The non-transitory computer-readable medium of claim 55, further comprising code for causing the scheduling entity to:
transmit the first packet and the second packet to the first scheduled entity via the transceiver;
receive bundled acknowledgement information utilizing the bundled acknowledgement grant from the first scheduled entity via the transceiver; and
receive an indication of a number of packets associated with the bundled acknowledgement information from the first scheduled entity via the transceiver.

58. The non-transitory computer-readable medium of claim 48, further comprising code for causing the scheduling entity to:
select a first modulation and coding scheme (MCS) for the first packet; and
select a second MCS for the second packet, wherein the second MCS is different than the first MCS.

59. The non-transitory computer-readable medium of claim 48, further comprising code for causing the scheduling entity to:
identify a first retransmission sequence number of the first packet and a second retransmission sequence number of the second packet, wherein the first retransmission sequence number is different than the second retransmission sequence number.

60. The non-transitory computer-readable medium of claim 48, further comprising code for causing the scheduling entity to:
modify at least one of a time-frequency resource allocation of the grant, a waveform utilized for the grant, or a transmit-diversity scheme utilized for the grant to produce the grant modification information.