CLAIMS

What is claimed is:

1. An apparatus comprising:

at least one processor; and

at least one non-transitory memory and computer program code, wherein the at least one memory and the computer program code are configured to, with the at least one processor, cause the apparatus to:

determine a starting position of at least one redundancy version of a transport block in a circular buffer based, at least partially, on a position of another redundancy version of the transport block in the circular buffer; and

transmit one or more of the other redundancy version and/or the at least one redundancy version using the determined starting position of the at least one redundancy version of the transport block.

2. The apparatus of claim 1, wherein determining the starting position of the at least one redundancy version comprises the at least one memory and the computer program code being configured to, with the at least one processor, cause the apparatus to:

set the starting position of the at least one redundancy version to be the same as an ending position of the other redundancy version.

3. The apparatus of claim 1, wherein determining the starting position of the at least one redundancy version comprises the at least one memory and the computer program code being configured to, with the at least one processor, cause the apparatus to:

determine a remainder of:

a division of a starting position of the other redundancy version plus a length of the other redundancy version, and

a size of the circular buffer,

wherein the determined starting position comprises the determined remainder.

4. The apparatus of claim 1, wherein determining the starting position of the at least one redundancy version comprises the at least one memory and the computer program code being configured to, with the at least one processor, cause the apparatus to:

determine the starting position of the at least one redundancy version based, at least partially, on at least one scalar.

5. The apparatus of claim 4, wherein a number of redundancy versions of the transport block is equal to a number of

physical uplink shared channel segments used for transport block over multiple segment transmission.

6. The apparatus of claim 4 or 5, wherein determining the starting position of the at least one redundancy version comprises the at least one memory and the computer program code being configured to, with the at least one processor, cause the apparatus to:

determine a remainder of a division of:

a starting position of the other redundancy version plus a size of the other redundancy version plus a scalar of the at least one scalar, and

a size of the circular buffer,

wherein the determined starting position comprises the determined remainder.

7. The apparatus of claim 6, wherein the at least one memory and the computer program code are further configured to, with the at least one processor, cause the apparatus to:

determine a first value and a second value; and

determine the scalar of the at least one scalar, wherein determining the scalar comprises multiplying the first value by a closest integer number smaller than the circular buffer size divided by the second value.

8. The apparatus of claim 7, wherein determining the first value and the second value comprises the at least one memory

and the computer program code are configured to, with the at least one processor, cause the apparatus to at least one of:

receive a radio resource control configuration of at least one of the first value or the second value,

determine at least one of the first value or the second value based on a specification, or

receive an indication of at least one of the first value or the second value in a downlink control information field.

9. The apparatus of any of claims 4 through 6, wherein the at least one memory and the computer program code are further configured to, with the at least one processor, cause the apparatus to determine the at least one scalar based, at least partially, on an indication of a vector, wherein the vector comprises information for determining a number of scalars of the at least one scalar that is less than a number of redundancy versions of the at least one redundancy version, and wherein the determined number of the at least one scalar are cycles across the redundancy versions of the at least one redundancy version.

10. An apparatus comprising:

at least one processor; and

at least one non-transitory memory and computer program code, wherein the at least one memory and the computer program code are configured to, with the at least one processor, cause the apparatus to:

scale a predetermined starting position of at least one redundancy version of encoded bits of a transport block in a circular buffer based, at least partially, on a scaling factor; and

transmit at least the at least one redundancy version using the scaled starting position of the at least one redundancy version of the transport block.

11. The apparatus of claim 10, wherein scaling the predetermined starting position of the at least one redundancy version comprises the at least one memory and the computer program code being configured to, with the at least one processor, cause the apparatus to:

determine a remainder of a division of:

the predetermined starting position multiplied by the scaling factor, and

a size of the circular buffer,

wherein the scaled starting position comprises the determined remainder.

12. The apparatus of claim 10 or 11, wherein the scaling factor is configured to scale the predetermined starting position of the at least one redundancy version towards a beginning or an ending of a codeword.

13. The apparatus of any of claims 10 through 12, wherein the scaling factor comprises a single scaling factor applicable to a plurality of redundancy versions.

14. The apparatus of any of claims 10 through 13, wherein the at least one memory and the computer program code are further configured to, with the at least one processor, cause the apparatus to determine the scaling factor based on a list of values determined based on one of:

a specification,

a radio resource control configuration, or

a system information block configuration,

and a field in a scheduling downlink control information configured to select a value from the list of values.

15. The apparatus of any of claims 10 through 13, wherein the at least one memory and the computer program code are further configured to, with the at least one processor, cause the apparatus to determine the scaling factor based on a ratio between a number of bits conveyed per physical uplink shared channel segment in the circular buffer and a size of the transport block.

16. The apparatus of any of claims 10 through 13, wherein the at least one memory and the computer program code are further configured to, with the at least one processor, cause the apparatus to determine the scaling factor based on a ratio between a number of bits conveyed per physical uplink shared channel segment in the circular buffer and one of:

a size of a gap between an ending position of a first redundancy version and an earliest predetermined starting position of the at least one redundancy version, or

a largest size of a gap between consecutive redundancy versions of a first redundancy version and the at least one redundancy version.

17. The apparatus of claim 15 or 16, wherein the number of bits conveyed per physical uplink shared channel segment in the circular buffer comprises one of:

a maximum number of bits per physical uplink shared channel segment in the circular buffer,

a minimum number of bits per physical uplink shared channel segment in the circular buffer, or

an average number of bits per physical uplink shared channel segment in the circular buffer.

18. The apparatus of any of claims 10 through 13, wherein the at least one memory and the computer program code are further configured to, with the at least one processor, cause the apparatus to determine the scaling factor based, at least partially, on a vector of scaling factors, wherein a scaling factor of the vector of scaling factors corresponds to a redundancy version of the at least one redundancy version.

19. The apparatus of claim 18, wherein the at least one memory and the computer program code are further configured to, with the at least one processor, cause the apparatus to select the

vector of scaling factors from a plurality of vectors of scaling factors based on a field of a downlink control information.

20. The apparatus of any of claims 1 through 19, wherein the at least one memory and the computer program code are further configured to, with the at least one processor, cause the apparatus to:

receive an indication to determine the starting position of one of:

all the at least one redundancy version, or

at least one of the at least one redundancy version.

21. The apparatus of claim 20, wherein the indication is based on at least one of:

a bitmap received in scheduling downlink control information,

an indication included in radio resource control signaling,

an indication included in system information block,

an indication included in a downlink control information message,

an indication included in a specification,

a percentage of codeword size not covered by at least one of the at least one redundancy version or the other redundancy version,

a number of systematic bits not covered by at least one of the at least one redundancy version or the other redundancy version,

a ratio between a size of a redundancy version of the at least one redundancy version and a size of the transport block,

a ratio between a size of a redundancy version of the at least one redundancy version and the size of the circular buffer,

a gap between two consecutive redundancy versions of the other redundancy version and the at least one redundancy version, or

a ratio between the size of the redundancy version of the at least one redundancy version and the gap between two consecutive redundancy versions.

22. The apparatus of claim 21, wherein the gap between two consecutive redundancy versions comprises one of:

a maximum gap between two consecutive redundancy versions of the other redundancy version and the at least one redundancy version, or

a minimum gap between two consecutive redundancy versions of the other redundancy version and the at least one redundancy version.

23. The apparatus of any of claims 1 through 22, wherein at least one of the at least one redundancy version or the other

redundancy version is configured to transmit at least one of a plurality of physical uplink shared channel segments used for the transport block over multiple segment transmission.

24. The apparatus of claim 23, wherein at least the one of the plurality of physical uplink shared channel segments spans across multiple slots.

25. A method comprising:

determining a starting position of at least one redundancy version of a transport block in a circular buffer based, at least partially, on a position of another redundancy version of the transport block in the circular buffer; and

transmitting one or more of the other redundancy version and/or the at least one redundancy version using the determined starting position of the at least one redundancy version of the transport block.

26. The method of claim 25, wherein the determining of the starting position of the at least one redundancy version comprises:

setting the starting position of the at least one redundancy version to be the same as an ending position of the other redundancy version.

27. The method of claim 25, wherein the determining of the starting position of the at least one redundancy version comprises:

determining a remainder of:

a division of a starting position of the other redundancy version plus a length of the other redundancy version, and

a size of the circular buffer,

wherein the determined starting position comprises the determined remainder.

28. The method of claim 25, wherein the determining of the starting position of the at least one redundancy version comprises determining the starting position of the at least one redundancy version based, at least partially, on at least one scalar.

29. The method of claim 28, wherein a number of redundancy versions of the transport block is equal to a number of physical uplink shared channel segments used for transport block over multiple segment transmission.

30. The method of claim 28 or 28, wherein the determining of the starting position of the at least one redundancy version comprises determining a remainder of a division of:

a starting position of the other redundancy version plus a size of the other redundancy version plus a scalar of the at least one scalar, and

a size of the circular buffer,

wherein the determined starting position comprises the determined remainder.

31. The method of claim 30, further comprising:

determining a first value and a second value; and

determining the scalar of the at least one scalar, wherein the determining of the scalar comprises multiplying the first value by a closest integer number smaller than the circular buffer size divided by the second value.

32. The method of claim 31, wherein the determining of the first value and the second value comprises at least one of:

receiving a radio resource control configuration of at least one of the first value or the second value,

determining at least one of the first value or the second value based on a specification, or

receiving an indication of at least one of the first value or the second value in a downlink control information field.

33. The method of any of claims 28 through 30, further comprising determining the at least one scalar based, at least partially, on an indication of a vector, wherein the vector comprises information for determining a number of scalars of the at least one scalar that is less than a number of redundancy versions of the at least one redundancy version, and wherein the determined number of the at least one scalar are cycles across the redundancy versions of the at least one redundancy version.

34. A method comprising:

scaling a predetermined starting position of at least one redundancy version of encoded bits of a transport block in a circular buffer based, at least partially, on a scaling factor; and

transmitting at least the at least one redundancy version using the scaled starting position of the at least one redundancy version of the transport block.

35. The method of claim 34, wherein the scaling of the predetermined starting position of the at least one redundancy version comprises determining a remainder of a division of:

the predetermined starting position multiplied by the scaling factor, and

a size of the circular buffer,

wherein the scaled starting position comprises the determined remainder.

36. The method of claim 34 or 35, wherein the scaling factor is configured to scale the predetermined starting position of the at least one redundancy version towards a beginning or an ending of a codeword.

37. The method of any of claims 34 through 36, wherein the scaling factor comprises a single scaling factor applicable to a plurality of redundancy versions.

38. The method of any of claims 34 through 37, further comprising determining the scaling factor based on a list of values determined based on one of:

a specification,

a radio resource control configuration, or

a system information block configuration,

and a field in a scheduling downlink control information configured to select a value from the list of values.

39. The method of any of claims 34 through 37, further comprising determining the scaling factor based on a ratio between a number of bits conveyed per physical uplink shared channel segment in the circular buffer and a size of the transport block.

40. The method of any of claims 34 through 37, further comprising determining the scaling factor based on a ratio between a number of bits conveyed per physical uplink shared channel segment in the circular buffer and one of:

a size of a gap between an ending position of a first redundancy version and an earliest predetermined starting position of the at least one redundancy version, or

a largest size of a gap between consecutive redundancy versions of a first redundancy version and the at least one redundancy version.

41. The method of claim 39 or 40, wherein the number of bits conveyed per physical uplink shared channel segment in the circular buffer comprises one of:

a maximum number of bits per physical uplink shared channel segment in the circular buffer,

a minimum number of bits per physical uplink shared channel segment in the circular buffer, or

an average number of bits per physical uplink shared channel segment in the circular buffer.

42. The method of any of claims 34 through 37, further comprising determining the scaling factor based, at least partially, on a vector of scaling factors, wherein a scaling factor of the vector of scaling factors corresponds to a redundancy version of the at least one redundancy version.

43. The method of claim 42, further comprising selecting the vector of scaling factors from a plurality of vectors of scaling factors based on a field of a downlink control information.

44. The method of any of claims 25 through 43, further comprising receiving an indication to determine the starting position of one of:

all the at least one redundancy version, or

at least one of the at least one redundancy version.

45. The method of claim 44, wherein the indication is based on at least one of:

a bitmap received in scheduling downlink control information,

an indication included in radio resource control signaling,

an indication included in system information block,

an indication included in a downlink control information message,

an indication included in a specification,

a percentage of codeword size not covered by at least one of the at least one redundancy version or the other redundancy version,

a number of systematic bits not covered by at least one of the at least one redundancy version or the other redundancy version,

a ratio between a size of a redundancy version of the at least one redundancy version and a size of the transport block,

a ratio between a size of a redundancy version of the at least one redundancy version and the size of the circular buffer,

a gap between two consecutive redundancy versions of the other redundancy version and the at least one redundancy version, or

a ratio between the size of the redundancy version of the at least one redundancy version and the gap between two consecutive redundancy versions.

46. The method of claim 45, wherein the gap between two consecutive redundancy versions comprises one of:

a maximum gap between two consecutive redundancy versions of the other redundancy version and the at least one redundancy version, or

a minimum gap between two consecutive redundancy versions of the other redundancy version and the at least one redundancy version.

47. The method of any of claims 25 through 46, wherein at least one of the at least one redundancy version or the other redundancy version is configured to transmit at least one of a plurality of physical uplink shared channel segments used for the transport block over multiple segment transmission.

48. The method of claim 47, wherein at least the one of the plurality of physical uplink shared channel segments spans across multiple slots.

49. An apparatus comprising means for performing:

determining a starting position of at least one redundancy version of a transport block in a circular buffer based, at least partially, on a position of another redundancy version of the transport block in the circular buffer; and

transmitting one or more of the other redundancy version and/or the at least one redundancy version using the determined starting position of the at least one redundancy version of the transport block.

50. The apparatus of claim 25, wherein the means configured to perform determining of the starting position of the at least one redundancy version comprises means configured to perform:

setting the starting position of the at least one redundancy version to be the same as an ending position of the other redundancy version.

51. The apparatus of claim 49, wherein the means configured to perform determining of the starting position of the at least one redundancy version comprises means configured to perform:

determining a remainder of:

a division of a starting position of the other redundancy version plus a length of the other redundancy version, and

a size of the circular buffer,

wherein the determined starting position comprises the determined remainder.

52. The apparatus of claim 49, wherein the means configured to perform determining of the starting position of the at least one redundancy version comprises means configured to

perform determining the starting position of the at least one redundancy version based, at least partially, on at least one scalar.

53. The apparatus of claim 52, wherein a number of redundancy versions of the transport block is equal to a number of physical uplink shared channel segments used for transport block over multiple segment transmission.

54. The apparatus of claim 52 or 53, wherein the means configured to perform determining of the starting position of the at least one redundancy version comprises means configured to perform determining a remainder of a division of:

a starting position of the other redundancy version plus a size of the other redundancy version plus a scalar of the at least one scalar, and

a size of the circular buffer,

wherein the determined starting position comprises the determined remainder.

55. The apparatus of claim 54, further comprising means configured to perform:

determining a first value and a second value; and

determining the scalar of the at least one scalar, wherein the determining of the scalar comprises multiplying the first value by a closest integer number

smaller than the circular buffer size divided by the second value.

56. The apparatus of claim 55, wherein the means configured to perform determining of the first value and the second value comprises means configured to perform at least one of:

receiving a radio resource control configuration of at least one of the first value or the second value,

determining at least one of the first value or the second value based on a specification, or

receiving an indication of at least one of the first value or the second value in a downlink control information field.

57. The apparatus of any of claims 52 through 54, further comprising means configured to perform determining the at least one scalar based, at least partially, on an indication of a vector, wherein the vector comprises information for determining a number of scalars of the at least one scalar that is less than a number of redundancy versions of the at least one redundancy version, and wherein the determined number of the at least one scalar are cycles across the redundancy versions of the at least one redundancy version.

58. An apparatus comprising means configured to perform:

scaling a predetermined starting position of at least one redundancy version of encoded bits of a transport block in a circular buffer based, at least partially, on a scaling factor; and

transmitting at least the at least one redundancy version using the scaled starting position of the at least one redundancy version of the transport block.

59. The apparatus of claim 58, wherein the means configured to perform scaling of the predetermined starting position of the at least one redundancy version comprises means configured to perform determining a remainder of a division of:

the predetermined starting position multiplied by the scaling factor, and

a size of the circular buffer,

wherein the scaled starting position comprises the determined remainder.

60. The apparatus of claim 58 or 59, wherein the scaling factor is configured to scale the predetermined starting position of the at least one redundancy version towards a beginning or an ending of a codeword.

61. The apparatus of any of claims 58 through 60, wherein the scaling factor comprises a single scaling factor applicable to a plurality of redundancy versions.

62. The apparatus of any of claims 58 through 61, further comprising means configured to perform determining the scaling factor based on a list of values determined based on one of:

a specification,

a radio resource control configuration, or

a system information block configuration,

and a field in a scheduling downlink control information configured to select a value from the list of values.

63. The apparatus of any of claims 58 through 61, further comprising means configured to perform determining the scaling factor based on a ratio between a number of bits conveyed per physical uplink shared channel segment in the circular buffer and a size of the transport block.

64. The apparatus of any of claims 58 through 63, further comprising means configured to perform determining the scaling factor based on a ratio between a number of bits conveyed per physical uplink shared channel segment in the circular buffer and one of:

a size of a gap between an ending position of a first redundancy version and an earliest predetermined starting position of the at least one redundancy version, or

a largest size of a gap between consecutive redundancy versions of a first redundancy version and the at least one redundancy version.

65. The apparatus of claim 63 or 64, wherein the number of bits conveyed per physical uplink shared channel segment in the circular buffer comprises one of:

a maximum number of bits per physical uplink shared channel segment in the circular buffer,

a minimum number of bits per physical uplink shared channel segment in the circular buffer, or

an average number of bits per physical uplink shared channel segment in the circular buffer.

66. The apparatus of any of claims 58 through 61, further comprising means configured to perform determining the scaling factor based, at least partially, on a vector of scaling factors, wherein a scaling factor of the vector of scaling factors corresponds to a redundancy version of the at least one redundancy version.

67. The apparatus of claim 66, further comprising means configured to perform selecting the vector of scaling factors from a plurality of vectors of scaling factors based on a field of a downlink control information.

68. The apparatus of any of claims 49 through 67, further comprising means configured to perform receiving an indication to determine the starting position of one of:

all the at least one redundancy version, or

at least one of the at least one redundancy version.

69. The apparatus of claim 68, wherein the indication is based on at least one of:

a bitmap received in scheduling downlink control information,

an indication included in radio resource control signaling,

an indication included in system information block,

an indication included in a downlink control information message,

an indication included in a specification,

a percentage of codeword size not covered by at least one of the at least one redundancy version or the other redundancy version,

a number of systematic bits not covered by at least one of the at least one redundancy version or the other redundancy version,

a ratio between a size of a redundancy version of the at least one redundancy version and a size of the transport block,

a ratio between a size of a redundancy version of the at least one redundancy version and the size of the circular buffer,

a gap between two consecutive redundancy versions of the other redundancy version and the at least one redundancy version, or

a ratio between the size of the redundancy version of the at least one redundancy version and the gap between two consecutive redundancy versions.

70. The apparatus of claim 69, wherein the gap between two consecutive redundancy versions comprises one of:

a maximum gap between two consecutive redundancy versions of the other redundancy version and the at least one redundancy version, or

a minimum gap between two consecutive redundancy versions of the other redundancy version and the at least one redundancy version.

71. The apparatus of any of claims 49 through 70, wherein at least one of the at least one redundancy version or the other redundancy version is configured to transmit at least one of a plurality of physical uplink shared channel segments used for the transport block over multiple segment transmission.

72. The apparatus of claim 71, wherein at least the one of the plurality of physical uplink shared channel segments spans across multiple slots.

73. A non-transitory computer-readable medium comprising program instructions stored thereon which, when executed with at least one processor, cause the at least one processor to:

determine a starting position of at least one redundancy version of a transport block in a circular buffer based, at least partially, on a position of another redundancy version of the transport block in the circular buffer; and

transmit one or more of the other redundancy version and/or the at least one redundancy version using the

determined starting position of the at least one redundancy version of the transport block.

74. The non-transitory computer-readable medium of claim 73, wherein determining the starting position of the at least one redundancy version comprises the program instructions stored thereon, when executed with the at least one processor, are configured to cause the at least one processor to:

set the starting position of the at least one redundancy version to be the same as an ending position of the other redundancy version.

75. The non-transitory computer-readable medium of claim 73, wherein determining the starting position of the at least one redundancy version comprises the program instructions stored thereon, when executed with the at least one processor, are configured to cause the at least one processor to:

determine a remainder of:

a division of a starting position of the other redundancy version plus a length of the other redundancy version, and

a size of the circular buffer,

wherein the determined starting position comprises the determined remainder.

76. The non-transitory computer-readable medium of claim 73, wherein determining the starting position of the at least one redundancy version comprises the program instructions stored

thereon, when executed with the at least one processor, are configured to cause the at least one processor to:

determine the starting position of the at least one redundancy version based, at least partially, on at least one scalar.

77. The non-transitory computer-readable medium of claim 76, wherein a number of redundancy versions of the transport block is equal to a number of physical uplink shared channel segments used for transport block over multiple segment transmission.

78. The non-transitory computer-readable medium of claim 76 or 77, wherein determining the starting position of the at least one redundancy version comprises the program instructions stored thereon, when executed with the at least one processor, are configured to cause the at least one processor to:

determine a remainder of a division of:

a starting position of the other redundancy version plus a size of the other redundancy version plus a scalar of the at least one scalar, and

a size of the circular buffer,

wherein the determined starting position comprises the determined remainder.

79. The non-transitory computer-readable medium of claim 78, wherein the program instructions stored thereon, when

executed with the at least one processor, are further configured to cause the at least one processor to:

determine a first value and a second value; and

determine the scalar of the at least one scalar, wherein determining the scalar comprises multiplying the first value by a closest integer number smaller than the circular buffer size divided by the second value.

80. The non-transitory computer-readable medium of claim 79, wherein determining the first value and the second value comprises the program instructions stored thereon, when executed with the at least one processor, are configured to cause the at least one processor to at least one of:

receive a radio resource control configuration of at least one of the first value or the second value,

determine at least one of the first value or the second value based on a specification, or

receive an indication of at least one of the first value or the second value in a downlink control information field.

81. The non-transitory computer readable medium of any of claims 76 through 78, wherein the program instructions stored thereon, when executed with the at least one processor, are further configured to cause the at least one processor to determine the at least one scalar based, at least partially, on an indication of a vector, wherein the vector comprises information for determining a number of scalars of the at

least one scalar that is less than a number of redundancy versions of the at least one redundancy version, and wherein the determined number of the at least one scalar are cycles across the redundancy versions of the at least one redundancy version.

82. A non-transitory computer readable medium comprising program instructions stored thereon which, when executed with at least one processor, cause the at least one processor to:

scale a predetermined starting position of at least one redundancy version of encoded bits of a transport block in a circular buffer based, at least partially, on a scaling factor; and

transmit at least the at least one redundancy version using the scaled starting position of the at least one redundancy version of the transport block.

83. The non transitory computer-readable medium of claim 82, wherein scaling the predetermined starting position of the at least one redundancy version comprises the program instructions stored thereon, when executed with the at least one processor, are configured to cause the at least one processor to:

determine a remainder of a division of:

the predetermined starting position multiplied by the scaling factor, and

a size of the circular buffer,

wherein the scaled starting position comprises the determined remainder.

84. The non-transitory computer-readable medium of claim 82 or 83, wherein the scaling factor is configured to scale the predetermined starting position of the at least one redundancy version towards a beginning or an ending of a codeword.

85. The non transitory computer readable medium of any of claims 82 through 84, wherein the scaling factor comprises a single scaling factor applicable to a plurality of redundancy versions.

86. The non-transitory computer-readable medium of any of claims 82 through 85, wherein the program instructions stored thereon, when executed with the at least one processor, are further configured to cause the at least one processor to determine the scaling factor based on a list of values determined based on one of:

a specification,

a radio resource control configuration, or

a system information block configuration,

and a field in a scheduling downlink control information configured to select a value from the list of values.

87. The non transitory computer-readable medium of any of claims 82 through 85, wherein the program instructions stored thereon, when executed with the at least one processor, are

further configured to cause the at least one processor to determine the scaling factor based on a ratio between a number of bits conveyed per physical uplink shared channel segment in the circular buffer and a size of the transport block.

88. The non transitory computer readable medium of any of claims 82 through 85, wherein the program instructions stored thereon, when executed with the at least one processor, are further configured to cause the at least one processor to determine the scaling factor based on a ratio between a number of bits conveyed per physical uplink shared channel segment in the circular buffer and one of:

a size of a gap between an ending position of a first redundancy version and an earliest predetermined starting position of the at least one redundancy version, or

a largest size of a gap between consecutive redundancy versions of a first redundancy version and the at least one redundancy version.

89. The non-transitory computer-readable medium of claim 87 or 88, wherein the number of bits conveyed per physical uplink shared channel segment in the circular buffer comprises one of:

a maximum number of bits per physical uplink shared channel segment in the circular buffer,

a minimum number of bits per physical uplink shared channel segment in the circular buffer, or

an average number of bits per physical uplink shared channel segment in the circular buffer.

90. The non-transitory computer-readable medium of any of claims 82 through 85, wherein the program instructions stored thereon, when executed with the at least one processor, are further configured to cause the at least one processor to determine the scaling factor based, at least partially, on a vector of scaling factors, wherein a scaling factor of the vector of scaling factors corresponds to a redundancy version of the at least one redundancy version.

91. The non-transitory computer-readable medium of claim 90, wherein the program instructions stored thereon, when executed with the at least one processor, are further configured to cause the at least one processor to select the vector of scaling factors from a plurality of vectors of scaling factors based on a field of a downlink control information.

92. The non transitory computer-readable medium of any of claims 73 through 91, wherein the program instructions stored thereon, when executed with the at least one processor, are further configured to cause the at least one processor to:

receive an indication to determine the starting position of one of:

all the at least one redundancy version, or

at least one of the at least one redundancy version.

93. The non-transitory computer-readable medium of claim 92, wherein the indication is based on at least one of:

a bitmap received in scheduling downlink control information,

an indication included in radio resource control signaling,

an indication included in system information block,

an indication included in a downlink control information message,

an indication included in a specification,

a percentage of codeword size not covered by at least one of the at least one redundancy version or the other redundancy version,

a number of systematic bits not covered by at least one of the at least one redundancy version or the other redundancy version,

a ratio between a size of a redundancy version of the at least one redundancy version and a size of the transport block,

a ratio between a size of a redundancy version of the at least one redundancy version and the size of the circular buffer,

a gap between two consecutive redundancy versions of the other redundancy version and the at least one redundancy version, or

a ratio between the size of the redundancy version of the at least one redundancy version and the gap between two consecutive redundancy versions.

94. The non-transitory computer-readable medium of claim 93, wherein the gap between two consecutive redundancy versions comprises one of:

a maximum gap between two consecutive redundancy versions of the other redundancy version and the at least one redundancy version, or

a minimum gap between two consecutive redundancy versions of the other redundancy version and the at least one redundancy version.

95. The non-transitory computer-readable medium of any of claims 73 through 94, wherein at least one of the at least one redundancy version or the other redundancy version is configured to transmit at least one of a plurality of physical uplink shared channel segments used for the transport block over multiple segment transmission.

96. The non-transitory computer-readable medium of claim 95, wherein at least the one of the plurality of physical uplink shared channel segments spans across multiple slots.

97. An apparatus comprising:

at least one processor; and

at least one non-transitory memory and computer program code, wherein the at least one memory and the computer program code are configured to, with the at least one processor, cause the apparatus to:

determine whether a user equipment should use a first method to determine a starting position of at least one redundancy version of a transport block in a circular buffer or a second method to determine the starting position of the at least one redundancy version of the transport block in the circular buffer, wherein the second method comprises determining the starting position of the at least one redundancy version based, at least partially, on one of:

a position of another redundancy version of the transport block in the circular buffer, or

a scaling factor; and

transmit, from the apparatus, an indication to determine the starting position of the at least one redundancy version based on at least one of the first method or the second method.

98. The apparatus of claim 97, wherein the second method comprises setting the starting position of the at least one redundancy version to be the same as an ending position of the other redundancy version.

99. The apparatus of claim 97, wherein the second method comprises determining a remainder of:

a division of a starting position of the other redundancy version plus a length of the other redundancy version, and

a size of the circular buffer.

100. The apparatus of claim 97, wherein the second method comprises determining the starting position of the at least one redundancy version based, at least partially, on at least one scalar.

101. The apparatus of claim 97, wherein the second method comprises determining a remainder of a division of:

a starting position of the other redundancy version plus a size of the other redundancy version plus a scalar of the at least one scalar, and

a size of the circular buffer.

102. The apparatus of claim 101, wherein the at least one memory and the computer program code are further configured to, with the at least one processor, cause the apparatus to transmit an indication of at least one of a first value or a second value, wherein the first value and the second value are configured to indicate the scalar.

103. The apparatus of claim 102, wherein transmitting the indication of at least one of the first value or the second value comprises the at least one memory and the computer

program code are configured to, with the at least one processor, cause the apparatus to transmit at least one of:

a radio resource control configuration of at least one of the first value or the second value, or

a downlink control information including the indication.

104. The apparatus of claim 101, wherein the at least one memory and the computer program code are further configured to, with the at least one processor, cause the apparatus to transmit an indication of a vector, wherein the vector comprises information for determining a number of scalars of the at least one scalar that is less than a number of redundancy versions of the at least one redundancy version, and wherein the determined number of the at least one scalar are cycles across the redundancy versions of the at least one redundancy version.

105. The apparatus of claim 97, wherein the second method comprises determining a remainder of a division of:

the predetermined starting position multiplied by the scaling factor, and

a size of the circular buffer.

106. The apparatus of claim 97, wherein the scaling factor is configured to scale a predetermined starting position of the at least one redundancy version towards a beginning or an ending of a codeword.

107. The apparatus of claim 97 or 106, wherein the scaling factor comprises a single scaling factor applicable to a plurality of redundancy versions.

108. The apparatus of any of claims 97 through 107, wherein the at least one memory and the computer program code are configured to, with the at least one processor, cause the apparatus to transmit at least one of:

a radio resource control configuration,

a system information block configuration, or

a downlink control information

comprising an indication of the scaling factor.

109. The apparatus of claim 108, wherein the indication of the scaling factor comprises an indication of one of a plurality of scaling factors.

110. The apparatus of any of claims 97 through 109, wherein transmitting the indication comprises the at least one memory and the computer program code are configured to, with the at least one processor, cause the apparatus to transmit at least one of:

a bitmap in scheduling downlink control information,

an indication included in radio resource control signaling,

an indication included in system information block, or

an indication included in a downlink control information message.

111. The apparatus of any of claims 97 through 110, wherein at least one of the at least one redundancy version or the other redundancy version is configured to carry at least one of a plurality of physical uplink shared channel segments used for the transport block over multiple segment transmission.

112. The apparatus of claim 111, wherein at least the one of the plurality of physical uplink shared channel segments spans across multiple slots.

113. A method comprising:

determining whether a user equipment should use a first method to determine a starting position of at least one redundancy version of a transport block in a circular buffer or a second method to determine the starting position of the at least one redundancy version of the transport block in the circular buffer, wherein the second method comprises determining the starting position of the at least one redundancy version based, at least partially, on one of:

a position of another redundancy version of the transport block in the circular buffer, or

a scaling factor; and

transmitting an indication to determine the starting position of the at least one redundancy version based on at least one of the first method or the second method.

114. The method of claim 113, wherein the second method comprises setting the starting position of the at least one redundancy version to be the same as an ending position of the other redundancy version.

115. The method of claim 113, wherein the second method comprises determining a remainder of:

a division of a starting position of the other redundancy version plus a length of the other redundancy version, and

a size of the circular buffer.

116. The method of claim 113, wherein the second method comprises determining the starting position of the at least one redundancy version based, at least partially, on at least one scalar.

117. The method of claim 113, wherein the second method comprises determining a remainder of a division of:

a starting position of the other redundancy version plus a size of the other redundancy version plus a scalar of the at least one scalar, and

a size of the circular buffer.

118. The method of claim 117, further comprising transmitting an indication of at least one of a first value or a second

value, wherein the first value and the second value are configured to indicate the scalar.

119. The method of claim 118, wherein the transmitting of the indication of at least one of the first value or the second value comprises transmitting at least one of:

a radio resource control configuration of at least one of the first value or the second value, or

a downlink control information including the indication.

120. The method of claim 117, further comprising transmitting an indication of a vector, wherein the vector comprises information for determining a number of scalars of the at least one scalar that is less than a number of redundancy versions of the at least one redundancy version, and wherein the determined number of the at least one scalar are cycles across the redundancy versions of the at least one redundancy version.

121. The method of claim 113, wherein the second method comprises determining a remainder of a division of:

the predetermined starting position multiplied by the scaling factor, and

a size of the circular buffer.

122. The method of claim 113, wherein the scaling factor is configured to scale a predetermined starting position of the at least one redundancy version towards a beginning or an ending of a codeword.

123. The method of claim 113 or 122, wherein the scaling factor comprises a single scaling factor applicable to a plurality of redundancy versions.

124. The method of any of claims 113 through 123, further comprising transmitting at least one of:

a radio resource control configuration,

a system information block configuration, or

a downlink control information

comprising an indication of the scaling factor.

125. The method of claim 124, wherein the indication of the scaling factor comprises an indication of one of a plurality of scaling factors.

126. The method of any of claims 113 through 125, wherein the transmitting of the indication comprises transmitting at least one of:

a bitmap in scheduling downlink control information,

an indication included in radio resource control signaling,

an indication included in system information block, or

an indication included in a downlink control information message.

127. The method of any of claims 113 through 126, wherein at least one of the at least one redundancy version or the other

redundancy version is configured to carry at least one of a plurality of physical uplink shared channel segments used for the transport block over multiple segment transmission.

128. The method of claim 127, wherein at least the one of the plurality of physical uplink shared channel segments spans across multiple slots.

129. An apparatus comprising means for performing:

determining whether a user equipment should use a first method to determine a starting position of at least one redundancy version of a transport block in a circular buffer or a second method to determine the starting position of the at least one redundancy version of the transport block in the circular buffer, wherein the second method comprises determining the starting position of the at least one redundancy version based, at least partially, on one of:

a position of another redundancy version of the transport block in the circular buffer, or

a scaling factor; and

transmitting an indication to determine the starting position of the at least one redundancy version based on at least one of the first method or the second method.

130. The apparatus of claim 129, wherein the second method comprises setting the starting position of the at least one redundancy version to be the same as an ending position of the other redundancy version.

131. The apparatus of claim 129, wherein the second method comprises determining a remainder of:

a division of a starting position of the other redundancy version plus a length of the other redundancy version, and

a size of the circular buffer.

132. The apparatus of claim 131, wherein the second method comprises determining the starting position of the at least one redundancy version based, at least partially, on at least one scalar.

133. The apparatus of claim 131, wherein the second method comprises determining a remainder of a division of:

a starting position of the other redundancy version plus a size of the other redundancy version plus a scalar of the at least one scalar, and

a size of the circular buffer.

134. The apparatus of claim 133, further comprising means configured to perform transmitting an indication of at least one of a first value or a second value, wherein the first value and the second value are configured to indicate the scalar.

135. The apparatus of claim 118, wherein the means configured to perform transmitting the indication of at least one of the first value or the second value comprises means configured to perform transmitting at least one of:

a radio resource control configuration of at least one of the first value or the second value, or

a downlink control information including the indication.

136. The apparatus of claim 133, further comprising means configured to perform transmitting an indication of a vector, wherein the vector comprises information for determining a number of scalars of the at least one scalar that is less than a number of redundancy versions of the at least one redundancy version, and wherein the determined number of the at least one scalar are cycles across the redundancy versions of the at least one redundancy version.

137. The apparatus of claim 129, wherein the second method comprises determining a remainder of a division of:

the predetermined starting position multiplied by the scaling factor, and

a size of the circular buffer.

138. The apparatus of claim 129, wherein the scaling factor is configured to scale a predetermined starting position of the at least one redundancy version towards a beginning or an ending of a codeword.

139. The apparatus of claim 129 or 138, wherein the scaling factor comprises a single scaling factor applicable to a plurality of redundancy versions.

140. The apparatus of any of claims 129 through 139, further comprising means configured to perform transmitting at least one of:

a radio resource control configuration,

a system information block configuration, or

a downlink control information

comprising an indication of the scaling factor.

141. The apparatus of claim 140, wherein the indication of the scaling factor comprises an indication of one of a plurality of scaling factors.

142. The apparatus of any of claims 129 through 141, wherein the means configured to perform transmitting of the indication comprises means configured to perform transmitting at least one of:

a bitmap in scheduling downlink control information,

an indication included in radio resource control signaling,

an indication included in system information block, or

an indication included in a downlink control information message.

143. The apparatus of any of claims 129 through 142, wherein at least one of the at least one redundancy version or the other redundancy version is configured to carry at least one of a plurality of physical uplink shared channel segments

used for the transport block over multiple segment transmission.

144. The apparatus of claim 143, wherein at least the one of the plurality of physical uplink shared channel segments spans across multiple slots.

145. A non-transitory computer-readable medium comprising program instructions stored thereon which, when executed with at least one processor, cause the at least one processor to:

determine whether a user equipment should use a first method to determine a starting position of at least one redundancy version of a transport block in a circular buffer or a second method to determine the starting position of the at least one redundancy version of the transport block in the circular buffer, wherein the second method comprises determining the starting position of the at least one redundancy version based, at least partially, on one of:

a position of another redundancy version of the transport block in the circular buffer, or

a scaling factor; and

transmit an indication to determine the starting position of the at least one redundancy version based on at least one of the first method or the second method.

146. The non-transitory computer-readable medium of claim 145, wherein the second method comprises setting the starting

position of the at least one redundancy version to be the same as an ending position of the other redundancy version.

147. The non-transitory computer-readable medium of claim 145, wherein the second method comprises determining a remainder of:

a division of a starting position of the other redundancy version plus a length of the other redundancy version, and

a size of the circular buffer.

148. The non transitory computer-readable medium of claim 145, wherein the second method comprises determining the starting position of the at least one redundancy version based, at least partially, on at least one scalar.

149. The non-transitory computer-readable medium of claim 145, wherein the second method comprises determining a remainder of a division of:

a starting position of the other redundancy version plus a size of the other redundancy version plus a scalar of the at least one scalar, and

a size of the circular buffer.

150. The non-transitory computer-readable medium of claim 149, wherein the program instructions stored thereon are configured to, when executed with at least one processor, cause the at least one processor to transmit an indication of at least one of a first value or a second value, wherein the

first value and the second value are configured to indicate the scalar.

151. The non-transitory computer readable medium of claim 150, wherein transmitting the indication of at least one of the first value or the second value comprises the program instructions stored thereon are configured to, when executed with at least one processor, cause the at least one processor to transmit at least one of:

a radio resource control configuration of at least one of the first value or the second value, or

a downlink control information including the indication.

152. The non transitory computer-readable medium of claim 149, wherein the program instructions stored thereon are configured to, when executed with at least one processor, cause the at least one processor to transmit an indication of a vector, wherein the vector comprises information for determining a number of scalars of the at least one scalar that is less than a number of redundancy versions of the at least one redundancy version, and wherein the determined number of the at least one scalar are cycles across the redundancy versions of the at least one redundancy version.

153. The non-transitory computer-readable medium of claim 145, wherein the second method comprises determining a remainder of a division of:

the predetermined starting position multiplied by the scaling factor, and

a size of the circular buffer.

154. The non-transitory computer-readable medium of claim 145, wherein the scaling factor is configured to scale a predetermined starting position of the at least one redundancy version towards a beginning or an ending of a codeword.

155. The non-transitory computer-readable medium of claim 145 or 154, wherein the scaling factor comprises a single scaling factor applicable to a plurality of redundancy versions.

156. The non-transitory computer-readable medium of any of claims 145 through 155, wherein the program instructions stored thereon are configured to, when executed with at least one processor, cause the at least one processor to transmit at least one of:

a radio resource control configuration,

a system information block configuration, or

a downlink control information

comprising an indication of the scaling factor.

157. The non transitory computer readable medium of claim 156, wherein the indication of the scaling factor comprises an indication of one of a plurality of scaling factors.

158. The non-transitory computer-readable medium of any of claims 145 through 157, wherein transmitting the indication comprises the program instructions stored thereon are

configured to, when executed with at least one processor, cause the at least one processor to transmit at least one of:

a bitmap in scheduling downlink control information,

an indication included in radio resource control signaling,

an indication included in system information block, or

an indication included in a downlink control information message.

159. The non-transitory computer-readable medium of any of claims 145 through 158, wherein at least one of the at least one redundancy version or the other redundancy version is configured to carry at least one of a plurality of physical uplink shared channel segments used for the transport block over multiple segment transmission.

160. The non-transitory computer readable medium of claim 159, wherein at least the one of the plurality of physical uplink shared channel segments spans across multiple slots.

CLAIMS

What is claimed is:

1. An apparatus comprising:

at least one processor; and

at least one non-transitory memory and computer program code, wherein the at least one memory and the computer program code are configured to, with the at least one processor, cause the apparatus to:

determine a starting position of at least one redundancy version of a transport block in a circular buffer based, at least partially, on a position of another redundancy version of the transport block in the circular buffer; and

transmit one or more of the other redundancy version and/or the at least one redundancy version using the determined starting position of the at least one redundancy version of the transport block.

2. The apparatus of claim 1, wherein determining the starting position of the at least one redundancy version comprises the at least one memory and the computer program code being configured to, with the at least one processor, cause the apparatus to:

set the starting position of the at least one redundancy version to be the same as an ending position of the other redundancy version.

3. The apparatus of claim 1, wherein determining the starting position of the at least one redundancy version comprises the at least one memory and the computer program

code being configured to, with the at least one processor, cause the apparatus to:

determine a remainder of:

a division of a starting position of the other redundancy version plus a length of the other redundancy version, and

a size of the circular buffer,

wherein the determined starting position comprises the determined remainder.

4. The apparatus of claim 1, wherein determining the starting position of the at least one redundancy version comprises the at least one memory and the computer program code being configured to, with the at least one processor, cause the apparatus to:

determine the starting position of the at least one redundancy version based, at least partially, on at least one scalar.

5. The apparatus of claim 4, wherein a number of redundancy versions of the transport block is equal to a number of physical uplink shared channel segments used for transport block over multiple segment transmission.

6. The apparatus of claim 4 or 5, wherein determining the starting position of the at least one redundancy version comprises the at least one memory and the computer program code being configured to, with the at least one processor, cause the apparatus to:

determine a remainder of a division of:

a starting position of the other redundancy version plus a size of the other redundancy version plus a scalar of the at least one scalar, and

a size of the circular buffer,

wherein the determined starting position comprises the determined remainder.

7. The apparatus of claim 6, wherein the at least one memory and the computer program code are further configured to, with the at least one processor, cause the apparatus to:

determine a first value and a second value; and

determine the scalar of the at least one scalar, wherein determining the scalar comprises multiplying the first value by a closest integer number smaller than the circular buffer size divided by the second value.

8. The apparatus of claim 7, wherein determining the first value and the second value comprises the at least one memory and the computer program code are configured to, with the at least one processor, cause the apparatus to at least one of:

receive a radio resource control configuration of at least one of the first value or the second value,

determine at least one of the first value or the second value based on a specification, or

receive an indication of at least one of the first value or the second value in a downlink control information field.

9. The apparatus of any of claims 4 through 6, wherein the at least one memory and the computer program code are further configured to, with the at least one processor, cause the apparatus to determine the at least one scalar based, at least partially, on an indication of a vector, wherein the vector comprises information for determining a number of scalars of the at least one scalar that is less than a number of redundancy versions of the at least one redundancy version, and wherein the determined number of the at least one scalar are cycles across the redundancy versions of the at least one redundancy version.

10. An apparatus comprising:

at least one processor; and

at least one non-transitory memory and computer program code, wherein the at least one memory and the computer program code are configured to, with the at least one processor, cause the apparatus to:

scale a predetermined starting position of at least one redundancy version of encoded bits of a transport block in a circular buffer based, at least partially, on a scaling factor; and

transmit at least the at least one redundancy version using the scaled starting position of the at least one redundancy version of the transport block.

11. The apparatus of claim 10, wherein scaling the predetermined starting position of the at least one redundancy version comprises the at least one memory and the computer program code being configured to, with the at least one processor, cause the apparatus to:

determine a remainder of a division of:

the predetermined starting position multiplied by the scaling factor, and

a size of the circular buffer,

wherein the scaled starting position comprises the determined remainder.

12. The apparatus of claim 10 or 11, wherein the scaling factor is configured to scale the predetermined starting position of the at least one redundancy version towards a beginning or an ending of a codeword.

13. The apparatus of any of claims 10 through 12, wherein the scaling factor comprises a single scaling factor applicable to a plurality of redundancy versions.

14. The apparatus of any of claims 10 through 13, wherein the at least one memory and the computer program code are further configured to, with the at least one processor, cause the apparatus to determine the scaling factor based on a list of values determined based on one of:

a specification,

a radio resource control configuration, or

a system information block configuration,

and a field in a scheduling downlink control information configured to select a value from the list of values.

15. The apparatus of any of claims 10 through 13, wherein the at least one memory and the computer program code are further configured to, with the at least one processor, cause the apparatus to determine the scaling factor based on a ratio between a number of bits conveyed per physical

uplink shared channel segment in the circular buffer and a size of the transport block.

16. The apparatus of any of claims 10 through 13, wherein the at least one memory and the computer program code are further configured to, with the at least one processor, cause the apparatus to determine the scaling factor based on a ratio between a number of bits conveyed per physical uplink shared channel segment in the circular buffer and one of:

a size of a gap between an ending position of a first redundancy version and an earliest predetermined starting position of the at least one redundancy version, or

a largest size of a gap between consecutive redundancy versions of a first redundancy version and the at least one redundancy version.

17. The apparatus of claim 15 or 16, wherein the number of bits conveyed per physical uplink shared channel segment in the circular buffer comprises one of:

a maximum number of bits per physical uplink shared channel segment in the circular buffer,

a minimum number of bits per physical uplink shared channel segment in the circular buffer, or

an average number of bits per physical uplink shared channel segment in the circular buffer.

18. The apparatus of any of claims 10 through 13, wherein the at least one memory and the computer program code are further configured to, with the at least one processor, cause the apparatus to determine the scaling factor based,

at least partially, on a vector of scaling factors, wherein a scaling factor of the vector of scaling factors corresponds to a redundancy version of the at least one redundancy version.

19. The apparatus of claim 18, wherein the at least one memory and the computer program code are further configured to, with the at least one processor, cause the apparatus to select the vector of scaling factors from a plurality of vectors of scaling factors based on a field of a downlink control information.

20. The apparatus of any of claims 1 through 19, wherein the at least one memory and the computer program code are further configured to, with the at least one processor, cause the apparatus to:

receive an indication to determine the starting position of one of:

all the at least one redundancy version, or

at least one of the at least one redundancy version.

21. The apparatus of claim 20, wherein the indication is based on at least one of:

a bitmap received in scheduling downlink control information,

an indication included in radio resource control signaling,

an indication included in system information block,

an indication included in a downlink control information message,

an indication included in a specification,

a percentage of codeword size not covered by at least one of the at least one redundancy version or the other redundancy version,

a number of systematic bits not covered by at least one of the at least one redundancy version or the other redundancy version,

a ratio between a size of a redundancy version of the at least one redundancy version and a size of the transport block,

a ratio between a size of a redundancy version of the at least one redundancy version and the size of the circular buffer,

a gap between two consecutive redundancy versions of the other redundancy version and the at least one redundancy version, or

a ratio between the size of the redundancy version of the at least one redundancy version and the gap between two consecutive redundancy versions.

22. The apparatus of claim 21, wherein the gap between two consecutive redundancy versions comprises one of:

a maximum gap between two consecutive redundancy versions of the other redundancy version and the at least one redundancy version, or

a minimum gap between two consecutive redundancy versions of the other redundancy version and the at least one redundancy version.

23. The apparatus of any of claims 1 through 22, wherein at least one of the at least one redundancy version or the other redundancy version is configured to transmit at least one of a plurality of physical uplink shared channel segments used for the transport block over multiple segment transmission.

24. The apparatus of claim 23, wherein at least the one of the plurality of physical uplink shared channel segments spans across multiple slots.