CLAIMS

1. A method of wireless communication, comprising:

identifying a plurality of available data resource elements (REs) in a subframe; and

assigning REs from the plurality of available data REs for data transmission to a wireless device in groups of a predetermined number of REs such that all assigned data REs within a group are within a predetermined number of symbols of each other in time domain and within a second predetermined number of subcarriers of each other in frequency domain, thereby resulting in at least one ungrouped RE.

2. The method of claim 1, wherein the plurality of available data REs comprise data REs not assigned to one of a channel state information reference signal (CSI-RS) RE and a muted CSI-RS RE.

3. The method of claim 1, further comprising assigning the at least one ungrouped RE to other transmissions to other wireless devices.

4. The method of claim 1, further comprising using the at least one ungrouped RE for a non-data transmission to the wireless device.

5. The method of claim 1, further comprising refraining from using the at least one ungrouped RE for any transmissions.

6. The method of claim 1, wherein the predetermined number of symbols is zero so that all data REs within a group are on a same OFDM symbol.

7. The method of claim 1, wherein the second predetermined number of REs is one of one and two.

8. The method of claim 1 wherein the grouping is limited to REs within the same resource block.

9. The method of claim 8, further comprising muting CSI-RS transmissions at a pre-determined muting pattern.

10. The method of claim 1, wherein the first predetermined number of REs is a function of a number of transmit antenna ports used for transmission of another reference signal.

11. The method of claim 10, wherein the another reference signal comprises a common reference signal (CRS).

12. The method of claim 1, wherein the groups of the first predetermined number of REs comprise space-frequency block code (SFBC) and space-time block code pairs transmitted using an Alamouti transmit diversity scheme.

13. The method of claim 1, further comprising using the at least one ungrouped RE for transmission to the wireless device using a transmission scheme different from that used for the data transmissions to the wireless device on the grouped REs.

14. A wireless communication apparatus, comprising:

means for identifying a plurality of available data resource elements (REs) in a subframe; and

means for assigning REs from the plurality of available data REs for data transmission to a wireless device in groups of a predetermined number of REs such that all assigned data REs within a group are within a predetermined number of symbols of each other in time domain and within a second predetermined number of subcarriers of each other in frequency domain, thereby resulting in at least one ungrouped RE.

15. The apparatus of claim 14, wherein the plurality of available data REs comprise data REs not assigned to one of a channel state information reference signal (CSI-RS) RE and a muted CSI-RS RE.

16. The apparatus of claim 14, further comprising means for assigning the at least one ungrouped RE to other transmissions from other wireless devices.

17. The apparatus of claim 14, further comprising means for using the at least one ungrouped RE for a non-data transmission to the wireless device.

18. The apparatus of claim 14, further comprising means for refraining from using the at least one ungrouped RE for any transmissions.

19. The apparatus of claim 14, wherein the predetermined number of symbols is zero so that all data REs within a group are on a same OFDM symbol.

20. The apparatus of claim 14, wherein the second predetermined number of REs is one of one and two.

21. The apparatus of claim 14 wherein the grouping is limited to REs within the same resource block.

22. The apparatus of claim 21, further comprising means for muting CSI-RS transmissions at a pre-determined muting pattern.

23. The apparatus of claim 14, wherein the first predetermined number of REs is a function of a number of transmit antenna ports used for transmission of another reference signal.

24. The apparatus of claim 23, wherein the another reference signal comprises a common reference signal (CRS).

25. The apparatus of claim 14, wherein the groups of the first predetermined number of REs comprise space-frequency block code (SFBC) and space-time block code pairs transmitted using an Alamouti transmit diversity scheme.

26. The apparatus of claim 14, further comprising means for using the at least one ungrouped RE for transmission to the wireless device using a transmission scheme different from that used for the data transmissions to the wireless device on the grouped REs.

27. A computer program product comprising a non-volatile computer-readable medium having computer-executable instructions stored thereon, said instructions comprising code for:

identifying a plurality of available data resource elements (REs) in a subframe; and

assigning REs from the plurality of available data REs for data transmission to a wireless device in groups of a predetermined number of REs such that all assigned data REs within a group are within a predetermined number of symbols of each other in time domain and within a second predetermined number of subcarriers of each other in frequency domain, thereby resulting in at least one ungrouped RE.

28. An apparatus for wireless communication, comprising:

a processor configured to :

identify a plurality of available data resource elements (REs) in a subframe; and

assign REs from the plurality of available data REs for data transmission to a wireless device in groups of a predetermined number of REs such that all assigned data REs within a group are within a predetermined number of symbols of each other in time domain and within a second predetermined number of subcarriers of each other in frequency domain, thereby resulting in at least one ungrouped RE; and

a memory coupled to the processor.

29. A method of wireless communication, comprising:

assigning, resource elements (REs) of a symbol to a reference signal transmission;

muting at least some of remaining REs of the symbol, thereby refraining from transmitting data on the muted REs; and

transmitting the reference signal by boosting a transmitted power of the reference signal.

30. The method of claim 29, wherein the muted REs comprise transmission resources used for transmission of the reference signal in at least one other cell.

31. The method of claim 29, wherein the reference signal comprises a channel state information reference signal (CSI-RS).

32. A wireless communication apparatus, comprising:

means for, resource elements (REs) of a symbol to a reference signal transmission;

means for muting at least some of remaining REs of the symbol, thereby refraining from transmitting data on the muted REs; and

means for transmitting the reference signal by boosting a transmitted power of the reference signal.

33. The apparatus of claim 32, wherein the muted REs comprise transmission resources used for transmission of a reference signal in at least one other cell.

34. The apparatus of claim 32, wherein the reference signal comprises a channel state information reference signal (CSI-RS).

35. A computer program product comprising a non-volatile computer-readable medium having instructions stored thereon, said instructions comprising code for:

assigning, resource elements (REs) of a symbol to a reference signal transmission;

muting at least some of remaining REs of the symbol, thereby refraining from transmitting data on the muted REs; and

transmitting the reference signal by boosting a transmitted power of the reference signal.

36. An apparatus for wireless communication, comprising:

a processor configured to:

assign resource elements (REs) of a symbol to a reference signal transmission;

mute at least some of remaining REs of the symbol, thereby refraining from transmitting data on the muted REs; and

transmit the reference signal by boosting a transmitted power of the reference signal; and

a memory coupled to the processor.

37. The apparatus of claim 36, wherein the muted REs comprise transmission resources used for transmission of a reference signal in at least one other cell.

38. The apparatus of claim 36, wherein the reference signal comprises a channel state information reference signal (CSI-RS).

39. A wireless communication method, comprising:

assigning an aperiodic transmission resource pattern to a reference signal having a periodicity of multiple subframes; and

transmitting the reference signal according to the aperiodic transmission resource pattern.

40. The method of claim 39 wherein the reference signal comprises a channel state information reference signal (CSI-RS).

41. The method of claim 39 further comprising communicating the aperiodic transmission resource pattern in a downlink message.

42. The method of claim 41, wherein said communicating comprises communicating a bitmap.

43. The method of claim 39, wherein the aperiodic transmission is assigned to avoid a relay device from having to receive and transmit the reference signal in a same subframe of transmission.

44. A wireless communication apparatus comprising:

means for assigning an aperiodic transmission resource pattern to a reference signal having a periodicity of multiple subframes; and

means for transmitting the reference signal according to the aperiodic transmission resource pattern.

45. The apparatus of claim 44, wherein the reference signal comprises a channel state information reference signal (CSI-RS).

46. The apparatus of claim 44, further comprising:

means for communicating the aperiodic transmission resource pattern in a downlink message.

47. The apparatus of claim 46, wherein said communicating means comprises means for communicating a bitmap.

48. The apparatus of claim 44, wherein the aperiodic transmission is assigned to avoid a relay device from having to receive and transmit the reference signal in a same subframe of transmission.

49. A wireless communication method, comprising:

allocating resources to a transmitter of the reference signal depending on a power class of the transmitter; and

performing, using the allocated resources, transmission of the reference signal from the transmitter.

50. The method of claim 49, wherein the reference signal comprises a channel state information reference signal (CSI-RS).

51. The method of claim 49, wherein the power class comprises one of a macro, a pico and a femto power class.

52. A wireless communication apparatus, comprising:

means for allocating resources to a transmitter of the reference signal depending on a power class of the transmitter; and

means for performing, using the allocated resources, transmission of the reference signal from the transmitter.

53. The apparatus of claim 52, wherein the reference signal comprises a channel state information reference signal (CSI-RS).

54. The apparatus of claim 52, wherein the power class comprises one of a macro, a pico and a femto power class.

55. A computer program product comprising a non-volatile computer-readable medium having instructions stored thereon, said instructions comprising code for:

allocating resources to a transmitter of the reference signal depending on a power class of the transmitter; and

performing, using the allocated resources, transmission of the reference signal from the transmitter.

56. An apparatus for wireless communication, comprising:

a processor configured to:

allocate resources to a transmitter of the reference signal depending on a power class of the transmitter; and

perform, using the allocated resources, transmission of the reference signal from the transmitter; and

a memory coupled to the processor.

57. The apparatus of claim 56, wherein the reference signal comprises a channel state information reference signal (CSI-RS), and wherein the power class comprises one of a macro, a pico and a femto power class.

58. A wireless communication method, comprising:

allocating, from a set of all available transmission resources for a reference signal, a subframe-dependent pattern of transmission resources to the reference signal in a given subframe;

varying the allocated subframe-dependent pattern over a plurality of subframes such that all available transmission resources from the set are used at least once;

wherein, the subframe-dependent pattern in the given subframe is non-overlapping with transmission resources allocated to a first signal and a second signal;

wherein, at least in one subframe from the plurality of subframe, at least one transmission resource from the set is allocated to the first signal instead of the reference signal.

59. The method of claim 58, wherein the first signal comprises one of a physical broadcast channel (PBCH) and an Synchronization Signal (SSS) transmission and the second signal comprises one of a paging signal and a System Information Block (SIB).

60. The method of claim 58, wherein the reference signal comprises a channel state information reference signal (CSI-RS).

61. A wireless communication apparatus, comprising:

means for allocating, from a set of all available transmission resources for a reference signal, a subframe-dependent pattern of transmission resources to the reference signal in a given subframe;

means for varying the allocated subframe-dependent pattern over a plurality of subframes such that all available transmission resources from the set are used at least once;

wherein, the subframe-dependent pattern in the given subframe is non-overlapping with transmission resources allocated to a first signal and a second signal;

wherein, at least in one subframe from the plurality of subframe, at least one transmission resource from the set is allocated to the first signal instead of the reference signal.

62. The apparatus of claim 61, wherein the first signal comprises one of a physical broadcast channel (PBCH) and an Synchronization Signal (SSS) transmission and the second signal comprises one of a paging signal and a System Information Block (SIB).

63. The apparatus of claim 61, wherein the reference signal comprises a channel state information reference signal (CSI-RS).

64. A computer program product comprising a non-volatile computer-readable medium having instructions stored thereon, said instructions comprising code for:

allocating, from a set of all available transmission resources for a reference signal, a subframe-dependent pattern of transmission resources to the reference signal in a given subframe;

varying the allocated subframe-dependent pattern over a plurality of subframes such that all available transmission resources from the set are used at least once;

wherein, the subframe-dependent pattern in the given subframe is non-overlapping with transmission resources allocated to a first signal and a second signal;

wherein, at least in one subframe from the plurality of subframe, at least one transmission resource from the set is allocated to the first signal instead of the reference signal.

65. A wireless communication processor, configured to:

allocate, from a set of all available transmission resources for a reference signal, a subframe-dependent pattern of transmission resources to the reference signal in a given subframe;

vary the allocated subframe-dependent pattern over a plurality of subframes such that all available transmission resources from the set are used at least once;

wherein, the subframe-dependent pattern in the given subframe is non-overlapping with transmission resources allocated to a first signal and a second signal;

wherein, at least in one subframe from the plurality of subframe, at least one transmission resource from the set is allocated to the first signal instead of the reference signal.

66. The processor of claim 65, wherein the first signal comprises one of a physical broadcast channel (PBCH) and an Synchronization Signal (SSS) transmission and the second signal comprises one of a paging signal and a System Information Block (SIB), and wherein the reference signal comprises a channel state information reference signal (CSI-RS).

67. A wireless communication method, comprising:

identifying a plurality of available data resource elements (REs) in a subframe; and

assigning the plurality of available data REs to data transmission in at least one space frequency block coding (SFBC) group and at least one space time block coding (STBC) group, thereby resulting in no unused REs.

68. The method of claim 67, wherein the plurality of available data REs comprise data REs not assigned to one of a channel state information reference signal (CSI-RS) RE and a muted CSI-RS RE.

69. A wireless communication apparatus, comprising:

means for identifying a plurality of available data resource elements (REs) in a subframe; and

means for assigning all of the plurality of remaining data REs to data transmission in at least one space frequency block coding (SFBC) group and at least one space time block coding (STBC) group, thereby resulting in no ungrouped REs.

70. The apparatus of claim 69, wherein the plurality of available data REs comprise data REs not assigned to one of a channel state information reference signal (CSI-RS) RE and a muted CSI-RS RE.

71. A computer program product comprising a non-volatile computer-readable medium having instructions stored thereon, said instructions comprising code for:

identifying a plurality of available data resource elements (REs) in a subframe; and

assigning all of the plurality of remaining data REs to data transmission in at least one space frequency block coding (SFBC) group and at least one space time block coding (STBC) group, thereby resulting in no ungrouped REs.

72. A wireless communication processor, configured to:

identify a plurality of available data resource elements (REs) in a subframe; and

assign all of the plurality of remaining data REs to data transmission in at least one space frequency block coding (SFBC) group and at least one space time block coding (STBC) group, thereby resulting in no ungrouped REs.

73. The processor of claim 72, wherein the plurality of available data REs comprise data REs not assigned to one of a channel state information reference signal (CSI-RS) RE and a muted CSI-RS RE

74. A method of wireless communication, comprising:

receiving a reference signal in a subframe from REs assigned to transmissions of the reference signal, wherein the subframe comprises a plurality of remaining data REs; and

receiving data from at least one of the plurality of remaining data REs, wherein the data is transmitted in groups of a predetermined number of REs such that all assigned data REs within a group are within a predetermined number of symbols in time and a second predetermined number of REs in frequency of each other, thereby resulting in at least one ungrouped RE.

75. The method of claim 74, wherein the reference signal comprises a channel state information reference signal (CSI-RS).

76. The method of claim 74, wherein the groups of the first predetermined number of REs comprise space-frequency block code (SFBC) and space-time block code pairs.

77. The method of claim 74, wherein the data transmission within the group of REs comprises a transmit diversity scheme.

78. The method of claim 77, wherein the transmit diversity comprises an Alamouti scheme.

79. A wireless communication apparatus, comprising:

means for receiving a reference signal in a subframe from REs assigned to transmissions of the reference signal, wherein the subframe comprises a plurality of remaining data REs; and

means for receiving data from at least one of the plurality of remaining data REs, wherein the data is transmitted in groups of a predetermined number of REs such that all assigned data REs within a group are within a predetermined number of symbols in time and a second predetermined number of REs in frequency of each other, thereby resulting in at least one ungrouped RE.

80. The apparatus of claim 79, wherein the reference signal comprises a channel state information reference signal (CSI-RS).

81. The apparatus of claim 79, wherein the groups of the first predetermined number of REs comprise space-frequency block code (SFBC) and space-time block code pairs.

82. The apparatus of claim 79, wherein the data transmission within the group of REs comprises a transmit diversity scheme.

83. The apparatus of claim 82, wherein the transmit diversity comprises an Alamouti scheme.

84. A method of wireless communication, comprising:

receiving a reference signal transmission in a subset of resource elements (REs) of a symbol, wherein at least some of remaining REs of the symbol are muted and wherein the reference signal received at a boosted transmission power level; and

transmitting a feedback message based on the received reference signal.

85. The method of claim 84, wherein the reference signal comprises a channel state information reference signal (CSI-RS).

86. A wireless communication apparatus, comprising:

means for receiving a reference signal transmission in a subset of resource elements (REs) of a symbol, wherein at least some of remaining REs of the symbol are

muted and wherein the reference signal received at a boosted transmission power level; and

means for transmitting a feedback message based on the received reference signal.

87. The apparatus of claim 86, wherein the reference signal comprises a channel state information reference signal (CSI-RS).

88. A wireless communication method, comprising:

receiving information about an aperiodic transmission resource pattern assigned to a reference signal, the aperiodic transmission resource pattern having a periodicity of multiple subframes; and

receiving the reference signal according to the aperiodic transmission resource pattern.

89. The method of claim 88, wherein the reference signal comprises a channel state information reference signal (CSI-RS).

90. The method of claim 88, wherein the information comprises a bitmap.

91. A wireless communication apparatus, comprising:

means for receiving information about an aperiodic transmission resource pattern assigned to a reference signal, the aperiodic transmission resource pattern having a periodicity of multiple subframes; and

means for receiving the reference signal according to the aperiodic transmission resource pattern.

92. The apparatus of claim 91, wherein the reference signal comprises a channel state information reference signal (CSI-RS).

93. The apparatus of claim 91, wherein the information comprises a bitmap.

94. A wireless communication method, comprising:

receiving a subframe-dependent pattern of transmission resources assigned to a reference signal, wherein the subframe-dependent pattern is varied over a plurality of subframes such that all available transmission resources are used at least once; and

receiving a control signal in a subframe at a transmission resource allocated to the reference signal in another subframe in the plurality of subframes.

95. The method of claim 94, wherein the reference signal comprises a channel state information reference signal (CSI-RS).

96. The method of claim 94, wherein the receiving the subframe-dependent pattern comprises receiving the subframe-dependent pattern in a higher layer message.

97. A wireless communication apparatus, comprising:

means for receiving a subframe-dependent pattern of transmission resources assigned to a reference signal, wherein the subframe-dependent pattern is varied over a plurality of subframes such that all available transmission resources are used at least once; and

means for receiving a control signal in a subframe at a transmission resource allocated to the reference signal in another subframe in the plurality of subframes.

98. A wireless communication method, comprising:

receiving a reference signal in a subset of resource elements (REs) in a subframe; and

receiving at least one data transmission comprising a space time block coding (STBC) group, in an RE not in the subset of REs of the subframe.

99. The method of claim 98, wherein the reference signal comprises a channel state information reference signal (CSI-RS).

100. A wireless communication apparatus, comprising:

means for receiving a reference signal in a subset of resource elements (REs) in a subframe; and

means for receiving at least one data transmission comprising a space time block coding (STBC) group, in an RE not in the subset of REs of the subframe .

101. A method used in a wireless communication system, the method comprising:

identifying a set of available resource elements in a resource block of a subframe, wherein resource elements in the set of available resource elements can be utilized for channel state information reference signal (CSI-RS) symbols;

selecting a subset of the set of available resource elements, wherein the subset includes sufficient resource elements to accommodate a maximum supported number of transmit antennas; and

utilizing the subset to transmit one or more CSI-RS symbols to a user equipment.

102. The method of claim 101, wherein the set of available resource elements is disjoint to a set of resource elements employed for common reference signal symbols.

103. The method of claim 101, wherein the set of available resource elements is disjoint to a set of resource elements employed for UE-specific reference signal symbols.

104. The method of claim 101, further comprising:

identifying a number of resource elements in the set of available resource elements; and

switching to space-time block coding based upon the number of resource elements.

105. The method of claim 101, wherein selecting the subset comprises identifying a group of resource elements based upon at least one of a subframe index, a radio frame index, or a cell identifier.

106. The method of claim 104, further comprising assigning resource elements used for space-time block coding in pairs, wherein resource elements in a given pair are less than a pre-determined number of resource elements apart.

107. The method of claim 106, wherein the assigning further comprises assigning resource elements in a second resource block contiguous with the resource block such that at least one pair comprises resource elements from the resource block and the second resource block.

108. The method of claim 106, wherein the resource elements chosen for the SFBC pair are in the same resource block and same OFDM symbol.

109. An apparatus for wireless communication, the apparatus comprising:

means for identifying a set of available resource elements in a resource block of a subframe, wherein resource elements in the set of available resource elements can be utilized for channel state information reference signal (CSI-RS) symbols;

means for selecting a subset of the set of available resource elements, wherein the subset includes sufficient resource elements to accommodate a maximum supported number of transmit antennas; and

means for utilizing the subset to transmit one or more CSI-RS symbols to a user equipment.

110. The apparatus of claim 109, wherein the set of available resource elements is disjoint to a set of resource elements employed for common reference signal symbols.

111. The apparatus of claim 109, wherein the set of available resource elements is disjoint to a set of resource elements employed for UE-specific reference signal symbols.

112. The apparatus of claim 109, further comprising:

means for identifying a number of resource elements in the set of available resource elements; and

means for switching to space-time block coding based upon the number of resource elements.

113. The apparatus of claim 109, wherein the means for selecting the subset comprises means for identifying a group of resource elements based upon at least one of a subframe index, a radio frame index, or a cell identifier.

114. The apparatus of claim 112, wherein the means for switching includes means for assigning resource elements used for space-time block coding in pairs, wherein resource elements in a given pair are less than a pre-determined number of resource elements apart.

115. The apparatus of claim 114, wherein the means for assigning further comprises means for assigning resource elements in a second resource block contiguous with the resource block such that at least one pair comprises resource elements from the resource block and the second resource block.

116. The apparatus of claim 114, wherein the resource elements chosen for the SFBC pair are in the same resource block and same OFDM symbol.

117. A method for allocating resources for a transmission of a reference signal in a wireless communication system, the method comprising:

allocating resources as a function of a number of transmit antennas used for transmission of the reference signal, the function being nested with respect to the number of transmit antennas such that a first resource pattern corresponding to a first number of transmit antennas is a superset of a second resource pattern corresponding a to a second number of transmit antennas when the first number is greater than the second number; and

indicating the allocated resources in an allocation message.

118. The method of claim 117, wherein the reference signal comprises a channel state information reference signal (CSI-RS).

119. The method of claim 117, wherein a resource pattern corresponding to the largest number of antennas is non-overlapping with a pre-allocated resource pattern.

120. The method of claim 119 wherein further comprising limiting the resource pattern corresponding to the largest number of antennas to a predetermined number of subframes.

121. The method of claim 119, wherein the pre-allocated resource pattern is allocated to control signal transmissions.

122. An apparatus for allocating resources for a transmission of a reference signal in a wireless communication system, the apparatus comprising:

means for allocating resources as a function of a number of transmit antennas used for transmission of the reference signal, the function being nested with respect to the number of transmit antennas such that a first resource pattern corresponding to a first number of transmit antennas is a superset of a second resource pattern corresponding a to a second number of transmit antennas when the first number is greater than the second number; and

means for indicating the allocated resources in an allocation message.

CLAIMS

What is claimed is:

1. An invention not claimed in any divisional application.