

CLAIMS:

1. A method for sending parameters of a precoder from a wireless device to a network node, in a wireless communication system, the method comprising:
 - sending, to the network node, a subset of beams selected from a plurality of orthogonal beams and power levels of the selected subset beams, for a first frequency granularity; and
 - sending, to the network node, phases of the selected subset beams, for a second frequency granularity,
 - wherein the selected beams, the power levels and the phases of the selected subset beams are part of the parameters of the precoder and the first frequency granularity is different from the second granularity.
2. The method of claim 1, wherein the first frequency granularity corresponds to an entire frequency bandwidth and the second granularity corresponds to a frequency subband within the frequency bandwidth.
3. The method of claim 1 or 2, wherein the power levels are the same for all layers of a multi-layer transmission and the phases are specific to each individual layer of the multi-layer transmission.
4. The method of any of claims 1 to 3, wherein the parameters of the precoder are sent in a Channel State Information (CSI) feedback report to the network node.
5. The method of any of claims 1 to 4, wherein the selected subset of beams corresponds to transmission on a single polarization.
6. The method of any of claims 1 to 5, wherein the selected subset of beams is selected in polarization pairs, each polarization pair corresponding to a dual polarized (DP) beam.
7. The method of claim 1, wherein the selected subset of beams is selected by determining beams which have a largest wideband received power.

8. The method of any of claims 1 to 7, further comprising sorting the selected subset beams in order of power strength and quantizing a first beam that is of less strength than a second beam.
9. The method of any of claims 1 to 8, wherein the power levels of the selected subset beams are quantized at a first quantization resolution and the phases of the selected beams are quantized at a second quantization resolution.
10. The method of claim 9, further comprising sending the quantized power levels and quantized phases to the network node.
11. The method of claim 1, wherein sending the selected subset of beams comprises sending indices corresponding to the selected subset of beams.
12. A method for a wireless device for determining parameters of a precoder, in a wireless communication system, the method comprising:
 - selecting a subset of beams from a plurality of orthogonal beams;
 - obtaining power levels of the selected subset of beams for generating a first factor of the precoder; and
 - obtaining phases of the selected subset of beams for generating a second factor of the precoder;wherein the first factor and the second factor are part of the parameters of the precoder and wherein the first factor is generated for a first frequency granularity and the second factor is generated for a second frequency granularity, the first frequency granularity being different from the second granularity.
13. The method of claim 12, wherein the power levels of the selected subset of beams are the same for all layers of a multi-layer transmission and the phases are specific to each individual layer of the multi-layer transmission.
14. The method of claim 12 or 13, wherein the parameters of the precoder are sent in a Channel State Information (CSI) feedback report to the network node.

15. The method of any claims 12-14, wherein the selected subset of beams corresponds to transmission on a single polarization.
16. The method of any claims 12-14, wherein the selected subset of beams is selected in polarization pairs, each polarization pair corresponding to a dual polarized (DP) beam.
17. The method of claim 12, wherein the selected subset of beams is selected by determining beams which have a largest wideband received power.
18. The method of any claims 12-17, further comprising sorting the selected subset of beams in order of power strength and quantizing a first beam that is of less strength than a second beam with a coarser quantization.
19. The method of claim 18, further comprising sending the quantized first beam to the network node.
20. The method of any claims 12-19, further comprising specifying an index of a strongest beam of the selected subset of beams and wherein the rest of the beams in the selected subset is specified in an unordered fashion in a report to the network node.
21. The method of claim 12, wherein the power levels of the selected subset of beams are quantized at a first quantization resolution and the phases of the selected subset of beams are quantized at a second quantization resolution.
22. The method of claim 20, further comprising sending the quantized power levels and quantized phases to the network node.
23. The method of any claims 12-22, wherein the second factor is a function of the second frequency granularity.

24. The method of claim 23, wherein the first frequency granularity corresponds to an entire frequency bandwidth and the second frequency granularity corresponds to a frequency subband within the frequency bandwidth.
25. The method of claim 12, wherein, for a precoder of rank 2, the phases of the selected subset of beams for a first layer is a function of the phases of the selected subset of beams for a second layer.
26. The method of any claims 12-24, wherein the power levels are uniformly quantized between a first value and a second value, wherein the first value is a minimum power level.
27. The method of any of claims 12 to 26, wherein obtaining the power levels comprises obtaining power levels relative to the other beams in the selected subset of beams and wherein obtaining the phases comprises obtaining co-phasing factors.
28. A wireless device for sending parameters of a precoder to a network node, in a wireless communication system, the wireless device comprising a processing circuitry configured to cause the wireless device to:
- send, to the network node, a subset of beams selected from a plurality of orthogonal beams and power levels of the selected subset beams, for a first frequency granularity; and
 - send, to the network node, phases of the selected subset beams, for a second frequency granularity,
- wherein the selected beams, the power levels and the phases of the selected subset beams are part of the parameters of the precoder and the first frequency granularity is different from the second granularity.
29. The wireless device of claim 28, wherein the processing circuitry comprises a processor, a memory and a network interface both connected to the processor, the memory containing instructions that, when executed, cause the processor to perform the operations of sending the selected subset of beams with the power levels and sending the phases of the selected subset of beams.

30. The wireless device of claim 28 or 29, wherein the first frequency granularity corresponds to an entire frequency bandwidth and the second granularity corresponds to a frequency subband within the frequency bandwidth.
31. The wireless device of claim 28 or 29, wherein the power levels are the same for all layers of a multi-layer transmission and the phases are specific to each individual layer of the multi-layer transmission.
32. The wireless device of any of claims 28 to 31, wherein the selected subset of beams corresponds to transmission on a single polarization.
33. The wireless device of any of claims 29 to 32, wherein the processor is configured to select the subset of beams in polarization pairs, each polarization pair corresponding to a dual polarized, DP, beam.
34. The wireless device of claim 29, wherein the processor is configured to select the subset of beams by determining beams which have a largest wideband received power.
35. The wireless device of any of claims 29 to 34, wherein the processor is configured to sort the selected subset of beams in order of power strength and to quantize a first beam that is of less strength than a second beam.
36. The wireless device of any of claims 29 to 35, wherein the processor is configured to quantize at a first quantization resolution the power levels of the selected subset of beams and to quantize at a second quantization resolution the phases of the selected subset of beams.
37. A wireless device for determining parameters of a precoder, in a wireless communication system, the wireless device comprising a processing circuitry configured to:
- select a subset of beams from a plurality of orthogonal beams;
 - obtain power levels of the selected subset of beams for generating a first factor of the precoder; and

obtain phases of the selected subset of beams for generating a second factor of the precoder;

wherein the first factor and the second factor are part of the parameters of the precoder and wherein the first factor is generated for a first frequency granularity and the second factor is generated for a second frequency granularity, the first frequency granularity being different from the second granularity.

38. The wireless device of claim 37, wherein the processing circuitry comprises a processor, a memory and a network interface both connected to the processor, the memory containing instructions that, when executed, cause the processor to select the subset of beams, to obtain the power levels and the phases of the selected subset of beams.
39. The wireless device of claim 37 or 38, wherein the power levels of the selected subset of beams are the same for all layers of a multi-layer transmission and the phases are specific to each individual layer of the multi-layer transmission.
40. The wireless device of any claims 37-39, wherein the processor is configured to send the parameters of the precoder in a Channel State Information (CSI) feedback report to the network node.
41. The wireless device of any claims 37 to 40, wherein the selected subset of beams corresponds to transmission on a single polarization.
42. The wireless device of any of claims 38-40, wherein the processor is configured to select the subset of beams in polarization pairs, each polarization pair corresponding to a dual polarized, DP, beam.
43. The wireless device of any claims 38 to 42, wherein the processor is further configured to select the subset of beams by determining beams which have a largest wideband received power.

44. The wireless device of any claims 38 to 43, wherein the processor is configured to sort the selected subset of beams in order of power strength and to quantize a first beam that is of less strength than a second beam with a coarser quantization.
45. The wireless device of claim 44, wherein the processor is configured to send the quantized first beam to the network node.
46. The wireless device of any claims 38 to 45, wherein the processor is configured to specify an index of a strongest beam of the selected subset of beams and wherein the rest of the beams in the selected subset is specified in an unordered fashion in a report to the network node.
47. The wireless device of any claims 38 to 46, wherein the processor is configured to quantize the power levels of the selected subset of beams at a first quantization resolution and the phases of the selected subset of beams at a second quantization resolution.
48. The wireless device of claim 47, wherein the processor is configured to send the quantized power levels and quantized phases to the network node.
49. The wireless device of any claims 37 to 48, wherein the second factor is a function of the second frequency granularity.
50. The wireless device of claim 49, wherein the first frequency granularity corresponds to an entire frequency bandwidth and the second frequency granularity corresponds to a frequency subband within the frequency bandwidth.
51. The wireless device of any claims 37-38, wherein, for a precoder of rank 2, the phases of the selected subset of beams for a first layer is a function of the phases of the selected subset of beams for a second layer.
52. The wireless device of claim 38, wherein the processor is configured to quantize uniformly the power levels between a first value and a second value, wherein the first value is a minimum power level.

53. The wireless device of any of claims 38 to 52, wherein the processor obtains the power levels relative to the other beams in the selected subset of beams.

54. A method for determining transmission parameters in a wireless communication system, the method comprising:

responsive to transmitting reference signals to the wireless device, receiving precoder parameters which include a subset of beams selected from a plurality of orthogonal beams and power levels of the selected subset of beams, for a first frequency granularity, and phases of the selected subset of beams for a second frequency granularity, wherein the first frequency granularity is different from the second frequency granularity; and

determining the transmission parameters based on the received precoder parameters.

55. A method for determining transmission parameters in a wireless communication system, the method comprising:

responsive to transmitting reference signals to the wireless device, receiving precoder parameters which include a subset of beams selected from a plurality of orthogonal beams, a first factor associated with power levels of the selected subset of beams, and a second factor associated with phases of the selected subset of beams, wherein the first factor is generated for a first frequency granularity and the second factor is generated for a second frequency granularity, the first frequency granularity being different from the second frequency granularity; and

determining the transmission parameters based on the received precoder parameters.

56. A network node for determining transmission parameters in a wireless communication system, the network node comprising a processing circuitry configured to cause the network node to:

responsive to transmitting reference signals to the wireless device, receive precoder parameters which include a subset of beams selected from a plurality of orthogonal beams and power levels of the selected subset of beams, for a first frequency granularity, and phases of the selected subset of beams for a second frequency

granularity, wherein the first frequency granularity is different from the second frequency granularity; and

determine the transmission parameters based on the received precoder parameters.

57. The network node of claim 56, wherein the processing circuitry comprises a processor, a memory and a network interface both connected to the processor, the memory containing instructions that, when executed, cause the processor to perform the operations of receiving and determining.

58. A network node for determining transmission parameters in a wireless communication system, the network node comprising a processing circuitry configured to cause the network node to:

responsive to transmitting reference signals to the wireless device, receive precoder parameters which include a subset of beams selected from a plurality of orthogonal beams, a first factor associated with power levels of the selected subset of beams, and a second factor associated with phases of the selected subset of beams, wherein the first factor is generated for a first frequency granularity and the second factor is generated for a second frequency granularity, the first frequency granularity being different from the second frequency granularity; and

determine the transmission parameters based on the received precoder parameters.

59. The network node of claim 58, wherein the processing circuitry comprises a processor, a memory and a network interface both connected to the processor, the memory containing instructions that, when executed, cause the processor to perform the operations of receiving and determining.