

CLAIMS

1. A method of wireless communication at a user equipment (UE), comprising: transmitting, to a base station, a capability of the UE to transmit data in a first message of a random access procedure, the random access procedure being a two-step random access procedure or a four-step random access procedure; receiving pre-configured uplink (UL) resources from the base station in a radio resource control (RRC) configured unicast message; and transmitting UL data in the first message of the random access procedure using the pre-configured UL resources, the first message being a msg1 of the random access procedure.
2. The method of claim 1, wherein the UE uses a last, valid timing advance from a previous random access procedure to transmit the first message of the random access procedure comprising the UL data using the pre-configured UL resources.
3. The method of claim 1, wherein the pre-configured UL resources comprise contention-based UL resources, wherein the UE shares the contention-based UL resources with one or more other UEs.
4. The method of claim 1, wherein the pre-configured UL resources comprise contention-free UL resources that are dedicated to the UE.
5. The method of claim 1, wherein receiving the pre-configured UL resources from the base station further comprises receiving the pre-configured UL resources in a broadcast message in a system information block (SIB).
6. The method of claim 1, wherein the pre-configured UL resources are configured based on a cell identification (ID) associated with the base station.
7. The method of claim 1, wherein the pre-configured UL resources overlap with resources configured for a UL legacy channel.
8. The method of claim 1, wherein the pre-configured UL resources comprise demodulation reference signals (DM-RS) resources pre-configured for transmitting DM RS, and data resources pre-configured for transmitting the UL data.
9. The method of claim 8, wherein the DM-RS resources comprise one or more symbols at a start of a subframe.
10. The method of claim 8, wherein the DM-RS resources comprise one or more DM-RS sequences configured for transmitting the DM-RS and an allowed number of cyclic shifts of the one or more DM-RS sequences.
11. The method of claim 10, wherein the one or more DM-RS sequences are configured based on an identification (ID) of the UE.
12. The method of claim 10, wherein a first location in time and frequency of the data resources is linked to the one or more DM-RS sequences or a second location in time and frequency of the DM-RS resources.

13. The method of claim 8, wherein a first bandwidth of the data resources is linked to a second bandwidth of the DM-RS resources.

14. The method of claim 13, wherein the first bandwidth of the data resources is different from the second bandwidth of the DM-RS resources.

15. The method of claim 1, wherein the pre-configured UL resources comprise at least one of a number of repetitions of a subset of the pre-configured UL resources, a first indication of a frequency-domain hopping pattern across repetitions or subframes in the subset of the pre-configured UL resources, a periodicity of the subset of the pre-configured UL resources, a transport block size used for transmitting the UL data, a second indication of a multiplexing scheme for transmitting the UL data in the subset of the pre-configured UL resources, a third indication of one or more demodulation reference signals (DM-RS) sequences configured for transmitting DM-RS, an allowed number of cyclic shifts of the one or more DM-RS sequences, or a fourth indication of power control for transmitting the UL data in the subset of the pre-configured UL resources.

16. The method of claim 15, wherein the multiplexing scheme comprises at least one of: a frequency-domain comb pattern across subcarriers in a symbol, a cover code across symbols or subframes, a cyclic shift of orthogonal sequences across subcarriers, symbols, or subframes, or use of a hybrid automatic repeat request (HARD) redundancy version (RV) index pattern across subframes.

17. The method of claim 16, wherein transmitting the UL data in the first message of the random access procedure on the pre-configured UL resources comprises transmitting the UL data using the multiplexing scheme in an orthogonal manner in contention-based UL resources shared by the UE and one or more other UEs.

18. The method of claim 16, wherein transmitting the UL data in the first message of the random access procedure on the pre-configured UL resources comprises transmitting the DM-RS using the multiplexing scheme in a non-orthogonal manner in contention-based UL resources shared by the UE and one or more other UEs.

19. The method of claim 15, wherein transmitting the UL data in the first message of the random access procedure on the pre-configured UL resources comprises transmitting the UL data with a transmit power based on the fourth indication of the power control.

20. The method of claim 15, wherein transmitting the UL data in the first message of the random access procedure on the pre-configured UL resources comprises transmitting the UL data using no multiplexing scheme in a subset of pre-configured contention-based UL resources shared by the UE and one or more other UEs.

21. The method of claim 1, wherein the pre-configured UL resources comprise a first set of pre-configured UL resources for a first transmission of the UL data and a second set of pre-configured UL resources for a potential retransmission of the UL data.

22. The method of claim 21, wherein transmitting the UL data in the first message of the random access procedure on the pre-configured UL resources comprises transmitting the UL data using the first set of pre-configured UL resources, wherein the method further comprises:

receiving an indication that the base station fails to receive the UL data transmitted using the first set of pre-configured UL resources, and retransmitting the UL data in the first message of the random access procedure on the second set of pre-configured UL resources to the base station.

23. The method of claim 1, wherein the pre-configured UL resources comprise UL resources pre-configured for transmitting the UL data in a connected mode when the UE is triggered by the base station.

24. The method of claim 1, wherein transmitting the capability of the UE to the base station comprises transmitting an indication of a timing drift of the UE.

25. The method of claim 1, wherein the pre-configured UL resources are configured based on a desired coverage extension level.

26. The method of claim 1, wherein demodulation reference signals (DM-RS) are decoded independently of the UL data.

27. The method of claim 1, wherein transmitting the capability of the UE to the base station comprises transmitting information related to timing drift of the UE.

28. A method of wireless communication at a base station, comprising: receiving a capability of one or more user equipment (UEs) indicating that respective UEs are capable of transmitting data in a first message of a random access procedure, the random access procedure being a two-step random access procedure or a four-step random access procedure; allocating pre-configured uplink (UL) resources for the one or more UEs; transmitting the pre-configured UL resources to a first UE of the one or more UEs in a radio resource control (RRC) configured unicast message; and receiving UL data in the first message of the random access procedure on the pre-configured UL resources from the first UE, the first message being a msg1 of the random access procedure.

29. The method of claim 28, wherein the pre-configured UL resources comprise contention-based UL resources, wherein a plurality of the one or more UEs share the contention-based UL resources.

30. The method of claim 28, wherein the pre-configured UL resources comprise contention-free UL resources that are dedicated to one UE of the one or more UEs.

31. The method of claim 28, wherein transmitting the pre-configured UL resources further comprises transmitting the pre-configured UL resources in a broadcast message in a system information blocks (SIB) to a plurality of the one or more UEs.

32. The method of claim 28, wherein allocating the pre-configured UL resources for the one or more UEs comprises allocating the pre-configured UL resources based on a cell identification (ID) associated with the base station.

33. The method of claim 28, wherein the pre-configured UL resources overlap with resources configured for a UL legacy channel.

34. The method of claim 28, wherein allocating the pre-configured UL resources for the one or more UEs comprises allocating pre-configured demodulation reference signals (DM-RS) resources for transmitting DM-RS and allocating pre-configured data resources for transmitting the UL data for the one or more UEs.

35. The method of claim 34, wherein the pre-configured DM-RS resources comprise one or more symbols at a start of a subframe.

36. The method of claim 34, wherein the pre-configured DM-RS resources comprise one or more DM-RS sequences configured for transmitting the DM-RS and an allowed number of cyclic shifts of the one or more DM-RS sequences.

37. The method of claim 36, wherein the one or more DM-RS sequences for the first UE are configured based on an identification (ID) of the first UE.

38. The method of claim 36, wherein a first location in time and frequency of the pre-configured data resources is linked to the one or more DM-RS sequences or a second location in time and frequency of the pre-configured DM-RS resources.

39. The method of claim 34, wherein a first bandwidth of the pre-configured data resources is linked to a second bandwidth of the pre-configured DM-RS resources.

40. The method of claim 39, wherein the first bandwidth of the pre-configured data resources is different from the second bandwidth of the pre-configured DM-RS resources.

41. The method of claim 28, wherein allocating the pre-configured UL resources for the one or more UEs comprises configuring at least one of a number of repetitions of a subset of the pre-configured UL resources, a first indication of a frequency-domain hopping pattern across repetitions or subframes in the subset of the pre-configured UL resources, a periodicity of the subset of the pre-configured UL resources, a transport block size used for transmitting the UL data, a second indication of a multiplexing scheme for transmitting the UL data in the subset of the pre-configured UL resources, a third indication of one or more demodulation reference signals (DM-RS) sequences configured for transmitting DM-RS, an allowed number of cyclic shifts of the one or more DM-RS sequences, or a fourth indication of power control for transmitting the UL data in the subset of the pre-configured UL resources.

42. The method of claim 41, wherein the multiplexing scheme comprises at least one of: a frequency-domain comb pattern across subcarriers in a symbol, a cover code across symbols or subframes, a cyclic shift of orthogonal sequences across subcarriers, symbols, or subframes, or use of a hybrid automatic repeat request (HARD) redundancy version (RV) index pattern across subframes.

43. The method of claim 42, wherein receiving the UL data in the first message of the random access procedure on the pre-configured UL resources from the first UE comprises receiving the UL data based on the multiplexing scheme in an orthogonal manner in the pre-configured UL resources shared by the one or more UEs.

44. The method of claim 42, wherein receiving the UL data in the first message of the random access procedure on the pre-configured UL resources from the first UE comprises receiving

the DM-RS based on the multiplexing scheme in a non-orthogonal manner in the pre-configured UL resources shared by the one or more UEs.

45. The method of claim 41, wherein receiving the UL data in the first message of the random access procedure on the pre-configured UL resources from the first UE comprises receiving the UL data with a transmit power based on the fourth indication of the power control.

46. The method of claim 41, wherein receiving the UL data in the first message of the random access procedure on the pre-configured UL resources from the first UE comprises receiving the UL data with no multiplexing scheme in the pre-configured UL resources shared by the one or more UEs.

47. The method of claim 28, further comprising recovering the UL data transmitted by the first UE from data transmissions by other UEs.

48. The method of claim 28, wherein allocating the pre-configured UL resources for the one or more UEs comprises allocating a first set of pre-configured UL resources for a first transmission of the UL data from one of the one or more UEs and a second set of pre-configured UL resources for a potential retransmission of the UL data from the first UE.

49. The method of claim 48, wherein receiving the UL data in the first message of the random access procedure on the pre-configured UL resources from the first UE comprises detecting a failure of receiving the UL data on the first set of pre-configured UL resources, wherein the method further comprises: transmitting an indication of the failure to the first UE, and receiving the UL data in the first message of the random access procedure on the second set of pre-configured UL resources from the first UE.

50. The method of claim 28, wherein receiving the UL data in the first message of the random access procedure on the pre-configured UL resources from the first UE comprises detecting a failure of receiving the UL data on the pre-configured UL resources from the first UE, wherein the method further comprises: configuring additional UL resources for the first UE, and transmitting the additional UL resources to the first UE.

51. The method of claim 28, wherein allocating the pre-configured UL resources for the one or more UEs comprises allocating UL resources for transmitting the UL data in a connected mode by one of the one or more UEs when the first UE is triggered by the base station.

52. The method of claim 28, wherein receiving the capability of the one or more UEs comprises receiving an indication of time drifts of the one or more UEs.

53. The method of claim 28, wherein allocating the pre-configured UL resources for the one or more UEs comprises allocating the pre-configured UL resources based on a coverage extension level.

54. The method of claim 28, wherein receiving the UL data in the first message of the random access procedure on the pre-configured UL resources comprises decoding demodulation reference signals (DM-RS) independently of the UL data.

55. The method of claim 28, wherein receiving the capability of the one or more UEs comprises receiving information related to timing drift of the one or more UEs.
56. The method of claim 28, wherein receiving the UL data in the first message of the random access procedure on the pre-configured UL resources from the first UE is associated with a last, valid timing advance from a previous random access procedure of the first UE.
57. An apparatus for wireless communication at a user equipment (UE), comprising: memory; and at least one processor coupled to the memory and configured to cause the UE to: transmit a capability of the UE to transmit data in a first message of a random access procedure to a base station, the random access procedure being a two-step random access procedure or a four-step random access procedure; receive pre-configured uplink (UL) resources from the base station in a radio resource control (RRC) configured unicast message; and transmit UL data in the first message of the random access procedure using the pre-configured UL resources to the base station, the first message being a msg1 of the random access procedure.
58. An apparatus for wireless communication at a base station, comprising: memory; and at least one processor coupled to the memory and configured to cause the base station to: receive a capability of one or more user equipment (UEs) indicating that respective UEs are capable of transmitting data in a first message of a random access procedure, the random access procedure being a two-step random access procedure or a four-step random access procedure; allocate pre-configured uplink (UL) resources for the one or more UEs; transmit the pre-configured UL resources to a first UE of the one or more UEs in a radio resource control (RRC) configured unicast message; and receive UL data in the first message of the random access procedure on the pre-configured UL resources from the first UE, the first message being a msg1 of the random access procedure.
59. An apparatus for wireless communication at a user equipment (UE), comprising: means for transmitting, to a base station, a capability of the UE to transmit data in a first message of a random access procedure, the random access procedure being a two-step random access procedure or a four-step random access procedure; means for receiving pre-configured uplink (UL) resources from the base station in a radio resource control (RRC) configured unicast message; and means for transmitting UL data in the first message of the random access procedure using the pre-configured UL resources, the first message being a msg1 of the random access procedure.
60. An apparatus for wireless communication, comprising: means for receiving a capability of one or more user equipment (UEs) indicating that respective UEs are capable of transmitting data in a first message of a random access procedure, the random access procedure being a two-step random access procedure or a four-step random access procedure; means for allocating pre-configured uplink (UL) resources for the one or more UEs; means for transmitting the pre-configured UL resources to a first UE of the one or more UEs in a radio resource control (RRC) configured unicast message; and means for receiving UL data in the first message of the random access procedure on the pre-configured UL resources from the first UE, the first message being a msg1 of the random access procedure.
61. A non-transitory computer-readable medium storing computer executable code at a user equipment (UE), the computer executable code, when executed, to cause at least one processor of the UE to: transmit a capability of a first device to transmit data in a first message of a random access procedure to a second device, the random access procedure being

a two-step random access procedure or a four-step random access procedure; receive pre-configured uplink (UL) resources from the second device in a radio resource control (RRC) configured unicast message; and transmit UL data in the first message of the random access procedure using the pre-configured UL resources to the second device, the first message being a msg1 of the random access procedure.

62. A non-transitory computer-readable medium storing computer executable code at a base station, the computer executable code, when executed, to cause at least one processor of the base station to: receive a capability of one or more devices indicating that respective devices are capable of transmitting data in a first message of a random access procedure, the random access procedure being a two-step random access procedure or a four-step random access procedure; allocate pre-configured uplink (UL) resources for the one or more devices; transmit the pre-configured UL resources to a first device of the one or more devices in a radio resource control (RRC) configured unicast message; and receive UL data in the first message of the random access procedure on the pre-configured UL resources from the first device, the first message being a msg1 of the random access procedure.