

CLAIMS

What is claimed is:

1. An enhanced antenna array for long distance wireless communication between an airborne platform and a surface base station, the antenna array comprising:
 - a higher-gain beamforming antenna configured to transmit to a base station and receive from the base station, and further configured to form a more directional beam substantially closer to the horizon; and
 - a lower-gain beamforming antenna configured to transmit to a base station and receive from the base station, and further configured to form a less directional beam substantially below the horizon.
2. The system as recited in claim 1, wherein the higher-gain beamforming antenna is configured to have a substantially complete coverage area around the antenna array in the horizontal direction.
3. The system as recited in claim 1, wherein the higher-gain beamforming antenna is configured to have a coverage area of between the horizon and substantially an acute vertical angle below the horizon.
4. The system as recited in claim 3, wherein the substantially an acute vertical angle below the horizon is approximately 10 degrees.
5. The system as recited in claim 1, wherein the lower-gain beamforming antenna is configured to have a substantially complete coverage area around the antenna array in the horizontal direction.
6. The system as recited in claim 1, wherein the lower-gain beamforming antenna is configured to have a coverage area of between a substantially acute vertical angle below the horizon to approximately vertical.

7. The system as recited in claim 6, wherein the substantially an acute vertical angle below the horizon is approximately 10 degrees.
8. The system as recited in claim 1, wherein the lower-gain beamforming antenna includes at least four elements.
9. The system as recited in claim 1, wherein the higher-gain beamforming antenna includes at least four elements.
10. A method for antenna array optimization for long distance wireless communication between an airborne platform and a surface base station, the method comprising:
 - forming a higher-gain directional beam, wherein the higher-gain directional beam is spatially oriented between an airborne platform and a surface base station, and wherein the higher-gain directional beam is oriented substantially closer to the horizon; and
 - forming a lower-gain directional beam, wherein the lower-gain directional beam is spatially oriented between an airborne platform and a surface base station, and wherein the lower-gain directional beam is oriented substantially below the horizon.
11. The method as recited in claim 10, wherein the higher-gain directional beam is configured to be formed within a substantially complete coverage area around an antenna array in the horizontal direction.
12. The method as recited in claim 10, wherein the higher-gain directional beam is configured to be formed within a coverage area of between the horizon and substantially an acute vertical angle below the horizon.

13. The method as recited in claim 12, wherein the substantially an acute vertical angle below the horizon is approximately 10 degrees.
14. The method as recited in claim 10, wherein the lower-gain directional beam is configured to be formed within a substantially complete coverage area around an antenna array in the horizontal direction.
15. The method as recited in claim 10, wherein the lower-gain directional beam is configured to be formed within a coverage area of between a substantially acute vertical angle below the horizon to approximately vertical.
16. The method as recited in claim 15, wherein the substantially an acute vertical angle below the horizon is approximately 10 degrees.
17. An enhanced antenna array for long distance wireless communication between an airborne platform and a surface base station, the antenna array comprising:
 - a higher-gain beamforming antenna, comprised of at least four elements, configured to transmit to a base station and receive from the base station, and further configured to form a more directional beam substantially closer to the horizon, wherein the higher-gain beamforming antenna is configured to have a coverage area of three hundred and sixty degrees around the antenna array in the horizontal direction, and wherein the higher-gain beamforming antenna is configured to have a coverage area of between the horizon and a substantially acute vertical angle below the horizon, and wherein the substantially an acute vertical angle below the horizon is approximately 10 degrees; and
 - a lower-gain beamforming antenna, comprised of at least four elements, configured to transmit to a base station and receive from the base station, and further configured to form a less directional beam substantially below the horizon, wherein the lower-gain beamforming antenna is configured to have a coverage area of three hundred and sixty degrees around the antenna array in the horizontal

direction, and wherein the lower-gain beamforming antenna is configured to have a coverage area of between the substantially acute vertical angle below the horizon to approximately vertical.

18. An enhanced antenna array for long distance wireless communication between a surface platform and at least two base stations, the antenna array comprising:

a higher-gain beamforming antenna configured to transmit to a first base station and to receive from the first base station, and further configured to form a more directional beam towards the first base station; and

a lower-gain beamforming antenna configured to transmit to a second base station and to receive from the second base station, and further configured to form a less directional beam towards the second base station.

19. The system as recited in claim 18, wherein the higher-gain beamforming antenna is configured to have a substantially complete coverage area around the antenna array in the horizontal direction.

20. The system as recited in claim 18, wherein the lower-gain beamforming antenna is configured to have a substantially complete coverage area around the antenna array in the horizontal direction.

21. The system as recited in claim 18, wherein the lower-gain beamforming antenna includes at least four elements.

22. The system as recited in claim 18, wherein the higher-gain beamforming antenna includes at least four elements.

What is claimed is:

1. An antenna array for long distance wireless communication between an airborne platform and a surface base station, the antenna array comprising: a higher-gain beamforming antenna configured to transmit to a base station and receive from the base station, and further configured to form a more directional beam substantially closer to the horizon; and a lower-gain beamforming antenna configured to transmit to a base station and receive from the base station, and further configured to form a less directional beam substantially below the horizon as compared to the more directional beam, wherein the lower-gain beamforming antenna has a gain less than the higher-gain beamforming antenna, wherein the less directional beam has a larger width than the more directional beam, and wherein the less directional beam and the more directional beam may be directed independently.
2. The system as recited in claim 1, wherein the higher-gain beamforming antenna is configured to have a substantially complete coverage area around the antenna array in the horizontal direction.
3. The system as recited in claim 1, wherein the higher-gain beamforming antenna is configured to have a coverage area of between the horizon and substantially an acute vertical angle below the horizon.
4. The system as recited in claim 3, wherein the substantially an acute vertical angle below the horizon is approximately 10 degrees.
5. The system as recited in claim 1, wherein the lower-gain beamforming antenna is configured to have a substantially complete coverage area around the antenna array in the horizontal direction.
6. The system as recited in claim 1, wherein the lower-gain beamforming antenna is configured to have a coverage area of between a substantially acute vertical angle below the horizon to approximately vertical.
7. The system as recited in claim 6, wherein the substantially an acute vertical angle below the horizon is approximately 10 degrees.
8. The system as recited in claim 1, wherein the lower-gain beamforming antenna includes at least four elements.
9. The system as recited in claim 1, wherein the higher-gain beamforming antenna includes at least four elements.

10. A method for antenna array optimization for long distance wireless communication between an airborne platform and a surface base station, the method comprising: forming a higher-gain directional beam, wherein the higher-gain directional beam is spatially oriented between an airborne platform and a surface base station, and wherein the higher-gain directional beam is oriented substantially closer to the horizon; and; forming a lower-gain directional beam, wherein the lower-gain directional beam is spatially oriented between an airborne platform and a surface base station, and wherein the lower-gain directional beam is oriented substantially below the horizon as compared to the higher-gain directional beam, wherein the lower-gain directional beam has a gain less than the higher-gain directional beam, wherein the lower-gain directional beam has a larger width than the higher-gain directional beam, and wherein the less directional beam and the more directional beam may be directed independently.

11. The method as recited in claim 10, wherein the higher-gain directional beam is configured to be formed within a substantially complete coverage area around an antenna array in the horizontal direction.

12. The method as recited in claim 10, wherein the higher-gain directional beam is configured to be formed within a coverage area of between the horizon and substantially an acute vertical angle below the horizon.

13. The method as recited in claim 12, wherein the substantially an acute vertical angle below the horizon is approximately 10 degrees.

14. The method as recited in claim 10, wherein the lower-gain directional beam is configured to be formed within a substantially complete coverage area around an antenna array in the horizontal direction.

15. The method as recited in claim 10, wherein the lower-gain directional beam is configured to be formed within a coverage area of between a substantially acute vertical angle below the horizon to approximately vertical.

16. The method as recited in claim 15, wherein the substantially an acute vertical angle below the horizon is approximately 10 degrees.

17. An enhanced antenna array for long distance wireless communication between an airborne platform and a surface base station, the antenna array comprising: a higher-gain beamforming antenna, comprised of at least four elements, configured to transmit to a base station and receive from the base station, and further configured to form a more directional beam substantially closer to the horizon, wherein the higher-gain beamforming antenna is configured to have a coverage area of three hundred and sixty degrees around the antenna array in the horizontal direction, and wherein the higher-gain beamforming antenna is configured to have a coverage area of between

the horizon and a substantially acute vertical angle below the horizon, and wherein the substantially an acute vertical angle below the horizon is approximately 10 degrees; and a lower-gain beamforming antenna, comprised of at least four elements, configured to transmit to a base station and receive from the base station, and further configured to form a less directional beam substantially below the horizon, wherein the lower-gain beamforming antenna is configured to have a coverage area of three hundred and sixty degrees around the antenna array in the horizontal direction, and wherein the lower-gain beamforming antenna is configured to have a coverage area of between the substantially acute vertical angle below the horizon to approximately vertical, wherein the lower-gain beamforming antenna has a gain less than the higher-gain beamforming antenna, wherein the less directional beam has a larger width than the more directional beam, and wherein the less directional beam and the more directional beam may be directed independently.

18. An enhanced antenna array for long distance wireless communication between a surface platform and at least two base stations, the antenna array comprising: a higher-gain beamforming antenna configured to transmit to a first base station and to receive from the first base station, and further configured to form a more directional beam towards the first base station; and a lower-gain beamforming antenna configured to transmit to a second base station and to receive from the second base station, and further configured to form a less directional beam towards the second base station, wherein the lower-gain beamforming antenna has a gain less than the higher-gain beamforming antenna, wherein the less directional beam has a larger width than the more directional beam, and wherein the less directional beam and the more directional beam may be directed independently.

19. The system as recited in claim 18, wherein the higher-gain beamforming antenna is configured to have a substantially complete coverage area around the antenna array in the horizontal direction.

20. The system as recited in claim 18, wherein the lower-gain beamforming antenna is configured to have a substantially complete coverage area around the antenna array in the horizontal direction.

21. The system as recited in claim 18, wherein the lower-gain beamforming antenna includes at least four elements.

22. The system as recited in claim 18, wherein the higher-gain beamforming antenna includes at least four elements.

23. An antenna array for long distance wireless communication between an airborne platform and a surface base station, the antenna array comprising: a higher-gain beamforming antenna configured to transmit to an airborne platform and receive from the airborne platform, and further configured to form a more directional beam substantially closer to the horizon; and a lower-gain beamforming antenna configured to transmit to an airborne platform and receive from the airborne platform, and further configured to form a less directional beam substantially above the horizon as compared to the more directional beam, wherein the lower-gain beamforming antenna has a gain less than the higher-gain beamforming antenna, wherein the less directional beam has a larger width than the more directional beam, and wherein the less directional beam and the more directional beam may be directed independently.
24. The system as recited in claim 23, wherein the higher-gain beamforming antenna is configured to have a substantially complete coverage area around the antenna array in the horizontal direction.
25. The system as recited in claim 23, wherein the higher-gain beamforming antenna is configured to have a coverage area of between the horizon and substantially an acute vertical angle above the horizon.
26. The system as recited in claim 25, wherein the substantially an acute vertical angle above the horizon is approximately 10 degrees.
27. The system as recited in claim 23, wherein the lower-gain beamforming antenna is configured to have a substantially complete coverage area around the antenna array in the horizontal direction.
28. The system as recited in claim 26, wherein the lower-gain beamforming antenna is configured to have a coverage area of between a substantially acute vertical angle above the horizon to approximately vertical.
29. The system as recited in claim 23, wherein each the lower-gain beamforming antenna and the higher-gain beamforming antenna include at least four elements.