CLAIMS

~~**What is Claimed is:**~~

1. An apparatus for communication, comprising:

an interface configured to obtain a plurality of signals~~; and~~

~~a processing system configured to:~~

~~estimate a plurality of distances between~~ received by a first plurality of antennas ~~and~~ associated with the apparatus, wherein the first plurality of antennas is configured to receive the plurality of signals from a second plurality of antennas associated with another apparatus; and a processing system coupled to the interface and configured to: estimate, based on the plurality of signals~~,~~

obtained by the interface, a plurality of distances between the first plurality of antennas and the second plurality of antennas, determine six degrees of freedom between the apparatus for communication and ~~another~~the other apparatus based on the plurality of distances, and

generate an indication of the six degrees of freedom,

wherein the interface is further configured to output the indication.

2. The apparatus of claim 1, wherein the plurality of signals ~~comprise~~comprises millimeter wave signals.

3. The apparatus of claim 1, wherein the determination of the six degrees of freedom comprises:

determining at least one relative translation parameter and at least one relative rotation parameter from the plurality of distances.

4. The apparatus of claim 3, wherein the determination of the six degrees of freedom further comprises:

solving a system of equations based on the at least one relative translation parameter and the at least one relative rotation parameter.

5. The apparatus of claim 1, wherein the estimation of the plurality of distances comprises conducting a plurality of round-trip-time (RTT) measurements.

6. The apparatus of claim 1, wherein the six degrees of freedom comprise: up-down, right-left, back-forward, roll, yaw, and pitch.

7. The apparatus of claim 1, wherein any separation between any two antennas of the second plurality of antennas is greater than or equal to a distance measurement resolution.

8. The apparatus of claim 1, wherein any separation between any two antennas of the second plurality of antennas is greater than or equal to at least one wavelength of the plurality of signals.

9. The apparatus of claim 1, wherein:

~~the interface is further configured to obtain the plurality of signals from the first plurality of antennas; and~~

~~the first plurality of antennas is configured to receive the plurality of signals from the second plurality of antennas.~~

~~10. The apparatus of claim 1, wherein:~~

~~the first plurality of antennas is associated with the apparatus for communication; and~~

~~the second plurality of antennas is associated with the other apparatus.~~

~~11. The apparatus of claim 1, wherein:~~

the processing system is further configured to determine at least one angle of arrival based on the plurality of signals; and

the determination of the six degrees of freedom is further based on the at least one angle of arrival.

~~12.~~ 10. The apparatus of claim 1, wherein:

the processing system is further configured to determine at least one angle of departure based on the plurality of signals; and

the determination of the six degrees of freedom is further based on the at least one angle of departure.

~~13.~~ 11. The apparatus of claim 1, wherein the determination of the six degrees of freedom comprises:

determining a first estimate of the six degrees of freedom based on the plurality of distances;

determining a second estimate of the six degrees of freedom; and

determining the six degrees of freedom based on the first estimate and the second estimate.

~~14.~~ 12. The apparatus of claim ~~13~~11, wherein the second estimate is based on inertia-based sensing, light-based sensing, or a combination thereof.

~~15.~~ 13. The apparatus of claim 1, wherein:

the processing system is further configured to determine a first set of distances between the first plurality of antennas;

the processing system is further configured to determine a second set of distances between the second plurality of antennas; and

the determination of the six degrees of freedom is further based on the first set of distances and the second set of distances.

~~16.~~ 14. The apparatus of claim 1, wherein:

the processing system is further configured to determine at least one calibration parameter based on a known six degrees of freedom; and

the determination of the six degrees of freedom is further based on the at least one calibration parameter.

~~17.~~ 15. A method of communication, comprising:

obtaining a plurality of signals;

estimating a plurality of distances between a first plurality of antennas and a second plurality of antennas based on the plurality of signals;

determining six degrees of freedom between an apparatus and another apparatus based on the estimated plurality of distances;

generating an indication of the six degrees of freedom; and

outputting the indication.

~~18.~~ 16. The method of claim ~~17~~15, wherein the plurality of signals ~~comprise~~comprises millimeter wave signals.

~~19.~~ 17. The method of claim ~~17~~15, wherein the determination of the six degrees of freedom comprises:

determining at least one relative translation parameter and at least one relative rotation parameter from the plurality of distances.

~~20. The method of claim 19, wherein the determination of the six degrees of freedom further comprises:~~

~~solving a system of equations based on the at least one relative translation parameter and the at least one relative rotation parameter.~~

~~21. The method of claim 17, wherein the estimation of the plurality of distances comprises conducting a plurality of round-trip-time (RTT) measurements.~~

~~22. The method of claim 17, wherein the six degrees of freedom comprise: up-down, right-left, back-forward, roll, yaw, and pitch.~~

~~23. The method of claim 17, wherein any separation between any two antennas of the second plurality of antennas is greater than or equal to a distance measurement resolution.~~

~~24. The method of claim 17, wherein any separation between any two antennas of the second plurality of antennas is greater than or equal to at least one wavelength of the plurality of signals.~~

~~25. The method of claim 17, wherein:~~

~~the plurality of signals is obtained from the~~

18. A wireless node, comprising: a first plurality of antennas; ~~and~~

~~the first plurality of antennas receive the plurality of signals from the second plurality of antennas.~~

~~26. The method of claim 17, wherein:~~

~~the first plurality of antennas is associated with the apparatus; and~~

~~the second plurality of antennas is associated with the other apparatus.~~

~~27. The method of claim 17, further comprising:~~

~~determining at least one angle of arrival based on the plurality of signals,~~

~~wherein the determination of the six degrees of freedom is further based on the at least one angle of arrival.~~

~~28. The method of claim 17, further comprising:~~

~~determining at least one angle of departure based on the plurality of signals,~~

~~wherein the determination of the six degrees of freedom is further based on the at least one angle of departure.~~

~~29. The method of claim 17, wherein the determination of the six degrees of freedom comprises:~~

~~determining a first estimate of the six degrees of freedom based on the plurality of distances;~~

~~determining a second estimate of the six degrees of freedom; and~~

~~determining the six degrees of freedom based on the first estimate and the second estimate.~~

~~30. The method of claim 29, wherein the second estimate is based on inertia-based sensing, light-based sensing, or a combination thereof.~~

~~31. The method of claim 17, further comprising:~~

~~determining a first set of distances between the first plurality of antennas; and~~

~~determining a second set of distances between the second plurality of antennas,~~

~~wherein the determination of the six degrees of freedom is further based on the first set of distances and the second set of distances.~~

~~32. The method of claim 17, further comprising:~~

~~determining at least one calibration parameter based on a known six degrees of freedom,~~

~~wherein the determination of the six degrees of freedom is further based on the at least one calibration parameter.~~

~~33. A wireless node, comprising:~~

~~a first plurality of antennas;~~

a receiver configured to receive a plurality of signals via the first plurality of antennas;

a processing system configured to:

estimate a plurality of distances between the first plurality of antennas and a second plurality of antennas based on the plurality of signals,

determine six degrees of freedom between the wireless node and another wireless node based on the estimated plurality of distances, and

generate an indication of the six degrees of freedom; and

an interface configured to output the indication.

~~34. An apparatus for communication, comprising:~~

~~means for obtaining a plurality of signals;~~

means for estimating a plurality of distances between a first plurality of antennas and a second plurality of antennas based on the plurality of signals;

means for determining six degrees of freedom between the apparatus for communication and another apparatus based on the plurality of distances;

means for generating an indication of the six degrees of freedom; and

means for outputting the indication.

35. The apparatus of claim 34, wherein the plurality of signals comprise millimeter wave signals.

36. The apparatus of claim 34, wherein the determination of the six degrees of freedom comprises:

determining at least one relative translation parameter and at least one relative rotation parameter from the plurality of distances.

37. The apparatus of claim 36, wherein the determination of the six degrees of freedom further comprises:

solving a system of equations based on the at least one relative translation parameter and the at least one relative rotation parameter.

38. The apparatus of claim 34, wherein the estimation of the plurality of distances comprises conducting a plurality of round-trip-time (RTT) measurements.

39. The apparatus of claim 34, wherein the six degrees of freedom comprise: up-down, right-left, back-forward, roll, yaw, and pitch.

40. The apparatus of claim 34, wherein any separation between any two antennas of the second plurality of antennas is greater than or equal to a distance measurement resolution.

41. The apparatus of claim 34, wherein any separation between any two antennas of the second plurality of antennas is greater than or equal to at least one wavelength of the plurality of signals.

42. The apparatus of claim 34, wherein:

the means for obtaining is configured to obtain the plurality of signals from the first plurality of antennas; and

the first plurality of antennas is configured to receive the plurality of signals from the second plurality of antennas.

43. The apparatus of claim 34, wherein:

the first plurality of antennas is associated with the apparatus for communication; and

the second plurality of antennas is associated with the other apparatus.

44. The apparatus of claim 34, further comprising:

means for determining at least one angle of arrival based on the plurality of signals,

wherein the determination of the six degrees of freedom is further based on the at least one angle of arrival.

45. The apparatus of claim 34, further comprising:

means for determining at least one angle of departure based on the plurality of signals,

wherein the determination of the six degrees of freedom is further based on the at least one angle of departure.

46. The apparatus of claim 34, wherein the determination of the six degrees of freedom comprises:

determining a first estimate of the six degrees of freedom based on the plurality of distances;

determining a second estimate of the six degrees of freedom; and

determining the six degrees of freedom based on the first estimate and the second estimate.

47. The apparatus of claim 46, wherein the second estimate is based on inertia-based sensing, light-based sensing, or a combination thereof.

48. The apparatus of claim 34, further comprising:

means for determining a first set of distances between the first plurality of antennas and a second set of distances between the second plurality of antennas,

wherein the determination of the six degrees of freedom is further based on the first set of distances and the second set of distances.

49. The apparatus of claim 34, further comprising:

means for determining at least one calibration parameter based on a known six degrees of freedom,

wherein the determination of the six degrees of freedom is further based on the at least one calibration parameter.

50. A computer-readable medium storing computer-executable code, including code to:

obtain a plurality of signals;

estimate a plurality of distances between a first plurality of antennas and a second plurality of antennas based on the plurality of signals;

determine six degrees of freedom between an apparatus and another apparatus based on the plurality of distances;

generate an indication of the six degrees of freedom; and

output the indication.