

WHAT IS CLAIMED IS:

1. A radio communications system comprising multiple satellites orbiting the earth in random orbits without attitude control for providing a radio route for data communications between transceivers at two ground station locations, each satellite and ground station comprising a node of the system, wherein each of a plurality of the satellites includes:

a plurality of satellite antennas for receiving radio signals from a plurality of other nodes and for transmitting radio signals, each of multiple satellite antennas comprising a reflector with a plurality of feeds for transmitting radio signals in a like plurality of directions different from each other and for receiving radio signals in the respective different directions;

antenna pairing circuitry for storing address information identifying another node from which the satellite received a routing signal and identifying the satellite antenna and the feed thereof on which the satellite received the routing signal; and

route creation circuitry for transmitting routing signals from a plurality of the satellite antennas, wherein the routing signals include (i) linking information identifying the satellite, and (ii) a quality of the received routing signal indicating a suitability of the satellite and the other node as a radio link in the radio route between the two ground station locations.

2. A system as in claim 1, wherein all of the satellite antennas comprise a reflector with a plurality of feeds for transmitting radio signals in a like plurality of directions different from each other and for receiving radio signals in the respective different directions.

3. A system as in claim 2, wherein corresponding feeds of each of the satellite antennas are disposed in the substantially the same angular orientation relative to the antenna reflector for transmitting radio signals at substantially the same angle relative to an axis of the antenna.

4. A system as in claim 2, wherein each antenna reflector has a parabolic cross section and is circular with a diameter at least 4 times the wavelength of the radio signals (γ) and each feed is spaced from the reflector at least 4 times γ .

5. A system as in claim 4, wherein each antenna includes at least seven feeds, one of which is disposed substantially at the focal point of the parabolic reflector and the remaining feeds are distributed equally around the focal point and spaced radially therefrom.

6. A system as in claim 2, wherein the satellite antennas are arranged to transmit and receive radio signals over substantially the entire spherical space surrounding each of the satellites.

7. A system as in claim 2, wherein the satellite antennas are arranged to transmit and receive radio signals over less than the entire spherical space surrounding each of the satellites.

8. A system as in claim 1, wherein the satellite nodes are designated as a first type and the ground station nodes are designated as a second type, and the two types of nodes do not communicate with each other.

9. A system as in claim 1, wherein the routing signals comprise packets of digital data transmitted from the nodes, each packet including;

a header containing the linking information and the quality of the received routing signal;
and

a payload including a sample data stream used by another node receiving a routing signal to determine the quality of the routing signal received from the satellite.

10. A system as in claim 9, wherein the quality of the received routing signal is expressed as a quantitative figure of merit based at least in part on an error rate of the sample data stream.

11. A method for creating a radio communication route for data communications from a receiving ground station to a sending ground station, wherein the ground stations include a plurality of ground station directional antennas for transmitting and receiving radio signals, the method comprising:

(a) providing multiple satellites orbiting the earth in random orbits without attitude control, wherein each of a plurality of the satellites includes a plurality of satellite antennas and each of multiple satellite antennas comprises a reflector with a plurality of feeds for transmitting radio signals in a like plurality of directions different from each other and for receiving radio signals in the respective different directions;

(b) receiving at a satellite antenna of at least one satellite an initial information signal transmitted from an antenna at a sending ground station;

(c) storing at any satellite receiving the initial information signal at least (i) address information identifying the ground station from which the initial information signal was received, (ii) the satellite antenna on which the initial information signal was received, and (iii) the antenna feed on which the information signal was received;

(d) transmitting linking information signals from a plurality of the antennas of at least one satellite receiving the initial information signal, wherein the linking information signals include (i) linking information identifying the satellite, and (ii) a quality of the received initial information signal indicating a suitability of the satellite and the sending ground station as a radio link in a radio route between the ground stations; and

(e) storing at a receiving ground station receiving at least one linking information signal (i) address information identifying the satellite transmitting the linking information signal, (ii) the receiving ground station antenna on which the linking information signal was received, and (iii) a quality of the initial information signal received at the satellite transmitting the linking information signal; and

(f) determining a quality of a radio route for data communications from the receiving ground station to the sending ground station via a particular satellite based on (i) a quality of the received linking information signal indicating a suitability of the receiving ground station and the particular satellite as a radio link in a radio route between the ground stations, and (ii) the quality of the initial information signal.

12. A method as in claim 11, wherein the satellites are designated as a first type of node and the ground stations are designated as a second type of node, and the two types of nodes do not communicate with each other.

13. A method as in claim 12 further including sending a data transmission from the originating ground station to the destination ground station, wherein the first type of node only transmits radio signals in a first mode and only receives radio signals in a second mode that substantially eliminates interference with transmissions in the first mode, and the second type of node only receives radio signals in the first mode and only transmits radio signals in the second mode.

14. A method as in claim 11, wherein all of the satellite antennas comprise a reflector with a plurality of feeds for transmitting radio signals in a like plurality of directions different from each other and for receiving radio signals in the respective different directions.

15. A method as in claim 14, wherein corresponding feeds of each of the satellite antennas are disposed in the substantially the same angular orientation relative to the antenna reflector for transmitting radio signals at substantially the same angle relative to an axis of the antenna.

16. A method as in claim 15, wherein each antenna reflector has a parabolic cross section and is circular with a diameter at least 4 times the wavelength of the radio signals (γ) and each feed is spaced from the reflector at least 4 times γ .

17. A method as in claim 16, wherein each antenna includes at least seven feeds, one of which is disposed substantially at the focal point of the parabolic reflector and the remaining feeds are distributed equally around the focal point and spaced radially therefrom.

18. A method as in claim 14, wherein the satellite antennas are arranged to transmit and receive radio signals over substantially the entire spherical space surrounding each of the satellites.

19. A method as in claim 11 further including communicating a data transmission comprising packets of digital data from an origin comprising a receiving ground station to a destination comprising a sending ground station, each data transmission packet including a header including the address information of the destination and a payload including a data stream representing the content of the transmission, wherein:

the origin transmits the packet of digital data to the particular satellite using the receiving ground station antenna on which the linking information signal was received; and

the particular satellite transmits the packet of digital data transmission to the destination using the feed of the antenna of the particular satellite on which the initial information signal was received.

20. A method as in claim 11, wherein the determining step is performed by the receiving ground station without a central computer communicating with the satellites or other ground stations.

21. A method as in claim 11, further comprising deploying the satellites with a rotational velocity about an axis of rotation.

22. A method as in claim 21, wherein a predetermined plurality of the satellites rotate in a first direction about a rotational axis and a second predetermined plurality rotate in a second direction about a rotational axis.

23. A method as in claim 22, wherein predetermined numbers of the satellites rotate in opposite directions..

24. A radio communication route for data communication from an originating ground station to a destination ground station, the route comprising at least one of multiple satellites orbiting the earth without attitude control in random orbits that communicate with the ground stations, each including a plurality of antennas for receiving radio signals from multiple directions and transmitting radio signals in multiple directions, wherein the satellite includes:

a plurality of antennas for receiving radio signals from multiple directions and transmitting radio signals in multiple directions, each of multiple satellite antennas comprising a reflector with a plurality of feeds for transmitting radio signals in a like plurality of directions different from each other and for receiving radio signals in the respective different directions;

antenna pairing circuitry for storing address information identifying a destination ground station from which an initial information signal was transmitted and antenna information identifying the satellite antenna and the feed thereof on which the initial information signal was received; and

route creation circuitry for transmitting linking information signals from a plurality of the satellite antennas, the linking information signals including linking information identifying the satellite to an originating ground station receiving the linking information signal on one of the ground station antennas, whereby data transmissions received at the originating ground station and designating a particular destination ground station are transmitted by the originating ground station using the ground station antenna on which the linking information was received and the satellite transmits the data transmission using the satellite antenna feed identified by the stored antenna information.

25. A radio communication route as in claim 24, wherein:
the satellites rotate about a rotational axis; and

each of the plurality of the satellites further includes a plurality of solar panels constructed to impart a moment on the satellite about the rotational axis.

26. A method for transmitting data between two nodes over a radio communication route including another node, wherein each node includes a plurality of antennas each comprising a reflector with a plurality of feeds for transmitting radio signals in a like plurality of directions different from each other and for receiving radio signals in the respective different directions, the method comprising:

- a) transmitting a first routing message from a plurality of the antennas of a first node N1;
- b) identifying one or more feeds of a first antenna and one or more feeds of a second antenna at a node N2 that receive the first routing message from node N1;
- c) designating the feed of the first antenna at node N2 with the highest quality signal and the feed of the second antenna with the highest quality signal;
- d) selecting from the designated feeds at node N2 the feed with the higher signal quality;
- e) transmitting from node N2 a second routing message including the transmitting node identity, the identity of node N1, and the signal quality of a radio link between node N1 and node N2;
- f) identifying one or more feeds of a first antenna and one or more feeds of a second antenna at a node N3 that receive the first routing message from node N1;
- g) designating the feed of the first antenna at node N3 with the highest quality signal and the feed of the second antenna with the highest quality signal;
- h) selecting from the designated feeds at node N3 the feed with the higher signal quality;
- i) transmitting from node N3 a third routing message including the transmitting node identity, the identity of node N1, and the signal quality of a radio link between node N1 and node N3; and

j) providing the data to a fourth node N4 that received the second and third routing messages, sending the data to the node N2 or N3 that provides the higher quality radio route to node N1, and transmitting the data to node N1 from the selected feed of the node N2 or N3 receiving the data sent from the node N4.

27. A method as in claim 26, wherein the antennas in at least the nodes N2 and N3 each comprise a circular reflector having a parabolic cross section.

28. A method as in claim 27, wherein each antenna includes at least seven feeds, one of which is disposed substantially at the focal point of the parabolic reflector and the remaining feeds are distributed equally around the focal point and spaced radially therefrom.