Claims

1. A method for communicating through an end-to-end relay (503, 1202, 1502, 3403), the method comprising:

receiving a communication signal (521, 525) at each of a plurality of receive antenna elements of the end-to-end relay, the communication signal originating from an Earth transmitter (515, 517), such that each of a subset of the receive antenna elements receives the communication signal at a signal level not substantially less than a signal level corresponding to a peak gain of the receive antenna element;

outputting from each of the plurality of receive antenna elements, a corresponding received signal resulting from the receiving antenna element's reception of the communication signal;

independently amplifying each received signal to form a plurality of amplified received signals; and

transmitting, from each of at least some of a plurality of transmit antenna elements, a different one of the amplified received signals as a downlink signal (522,527), such that at least a subset of the downlink signals illuminates an Earth receiver (515, 517) at a signal level not substantially less than a signal level corresponding to a peak gain of the transmit antenna elements participating in the transmitting.

2. The method of claim 1, wherein the Earth transmitter is a user terminal (517).

3. The method of claim 1, wherein the Earth transmitter is an access node (515).

4. The method of claim 1 or 2, wherein the Earth receiver is an access node (515).

5. The method of claim 1 or 3, wherein the Earth receiver is a user terminal (517).

6. The method of claim 4, wherein transmitting the amplified received signals further comprises transmitting to each of a plurality of additional access nodes.

7. The method of any of claims 1 – 6, wherein the satellite has an uplink satellite coverage area defined by a set of points, at least 25% of the set of points of the uplink satellite coverage area spanning overlapping coverage areas of at least six receive antenna elements.

8. The method of any of claims 1 – 6, wherein the satellite has an uplink satellite coverage area defined by a set of points, at least 25% of the set of points of the uplink satellite coverage area spanning overlapping coverage areas of at least four receive antenna elements.

9. The method of any of claims 1 – 8, wherein each receive antenna element coverage area is defined by a set of points for which a receive component beam antenna gain is within 10 dB of a peak receive component beam antenna gain for the receive antenna element associated with the receive antenna element coverage area.

10. The method of any of claims 1 – 8, wherein each receive antenna element coverage area is defined by a set of points for which a receive component beam antenna gain is within 6 dB of a peak receive component beam antenna gain for the receive antenna element associated with the receive antenna element coverage area.

11. The method of any of claims 1 – 8, wherein each receive antenna element coverage area is defined by a set of points for which a receive component beam antenna gain is within 3 dB of a peak receive component beam antenna gain for the receive antenna element associated with the receive antenna element coverage area.

12. The method of one of claim 1 – 11, wherein the satellite has a downlink satellite coverage area defined by a set of points, at least 25% of the set of points of the downlink satellite coverage area spanning overlapping coverage areas of at least six transmit antenna elements.

13. The method of one of claim 1 – 11, wherein the satellite has a downlink satellite coverage area defined by a set of points, at least 25% of the set of points of the downlink satellite coverage area spanning overlapping coverage areas of at least four transmit antenna elements.

14. The method of claims 12 or 13, wherein each transmit antenna element coverage area is defined by a set of points for which a transmit component beam antenna gain is within 10 dB of a peak transmit component beam antenna gain for the transmit antenna element associated with the transmit antenna element coverage area.

15. The method of claims 12 or 13, wherein each transmit antenna element coverage area is defined by a set of points for which a transmit component beam antenna gain is within 6 dB of a peak transmit component beam antenna gain for the transmit antenna element associated with the transmit antenna element coverage area.

16. The method of claims 12 or 13, wherein each transmit antenna element coverage area

is defined by a set of points for which a transmit component beam antenna gain is within 3 dB of a peak transmit component beam antenna gain for the transmit antenna element associated with the transmit antenna element coverage area.

17. The method of any of claims 1 – 16, wherein receiving the communication signal comprises reflecting the communication signal to create a signal that focuses at a point in a focal plane, wherein receiving the communication signal occurs away from the focal plane.

18. The method of any of claims 1 – 17, wherein transmitting the amplified received signals comprises transmitting from the receive antenna elements to a transmit reflector having a focal plane, wherein transmitting the signals occurs away from the focal plane.

19. The method of any of claims 1 – 18, wherein the communication signal is received on an uplink frequency, and further comprising:

frequency converting at least one of the amplified received signals from the uplink frequency to a downlink frequency to form a frequency converted amplified received signal, and wherein transmitting the amplified received signals includes transmitting the frequency converted amplified received signals.

20. The method of any of claims 1 – 19, wherein the received signals are in a frequency band selected from the group consisting of: C, L, S, X, V, Ka and Ku.

21. The method of any of claims 1 – 20, further comprising transmitting a relay beacon signal.

22. The method of claim 21, wherein the relay beacon signal comprises a pseudo random (PN) sequence.

23. The method of any of claims 1 – 22, each receive antenna element having a receive antenna element coverage area, such that the plurality of receive antenna element coverage areas overlap.

24. The method of any of claims 1 – 23, further including receiving, with the plurality of receive antenna elements, additional signals from a plurality of additional Earth transmitters that are geographically dispersed.

25. The method of claim 1 – 24, further including transmitting from the plurality of receive antenna elements to a plurality of additional Earth receivers that are geographically dispersed.

26. The method of any of claims 1 – 25, wherein each of the subset of the receive antenna elements receives the communication signal originating from the Earth transmitter at a signal level within 10 dB of a maximum signal level received by any of the subset of receive antenna elements.

27. The method of any of claims 1 – 26, wherein the subset comprises at least 10% of the plurality of receive antenna elements.

28. The method of any of claims 1 – 27, wherein the subset comprises at least ten of the plurality of receive antenna elements.

29. The method of any of claims 1 – 28, wherein a subset of the plurality of receive antenna elements transmit signals to the Earth transmitter resulting in a received signal level within 10 dB of a maximum signal level received from any of the transmit antenna elements.

30. The method of any of claims 1 – 29, wherein the subset of the transmitted signals is transmitted by at least 10% of the plurality of transmit antenna elements.

31. The method of any of claims 1 – 29, wherein the subset of the transmitted signals is transmitted by at least ten of the plurality of transmit antenna elements.

32. The method of any of claims 1 – 31, wherein the receiving a communications signal comprises:

receiving from a user terminal during a first receive time interval; and
receiving from an access node during a second receive time interval that does not overlap the first receive time interval.

33. The method of any of claims 1 – 32, wherein the receiving a communications signal comprises:
receiving from a user terminal on a first frequency band; and
receiving from an access node on the first frequency band.

34. The method of any of claims 1 – 33, wherein the transmitting a different one of the amplified received comprises:

transmitting to a user terminal on a second
frequency band; and transmitting to an access node

on the second frequency band.

35. The method of any of claims 1 – 34, wherein the transmitting a different one of the amplified received signals comprises:

transmitting to a user terminal during a first transmit time interval; and
transmitting to an access node during a second transmit time interval that does not overlap the first transmit time interval.