Claims

1. A method for end-to-end beamforming via an end-to-end relay providing communications between a plurality of access nodes (ANs) and a plurality of user terminals, the method comprising:

receiving composite input forward signals by a plurality of cooperating feeder-link constituent receive elements, wherein each of the composite input forward signals is received by a corresponding one of the plurality of cooperating feeder-link constituent receive elements as a superposition of a plurality of forward uplink signals from the plurality of ANs geographically distributed over a AN coverage area;

generating a plurality of forward downlink signals from the composite input forward signals; and

transmitting the plurality of forward downlink signals by a plurality of cooperating user-link constituent transmit elements, wherein the forward downlink signals are transmitted to the plurality of user terminals geographically distributed over a user coverage area at least partially distinct from the AN coverage area.

2. The method of claim 1, wherein the transmitting contributes to forming a plurality of forward user beams in the user coverage area.

3. The method of claim 1, further comprising:

receiving return uplink signals by a plurality of cooperating user-link constituent receive elements from at least some of the plurality of user terminals;

generating a plurality of return downlink signals from the received return uplink signals; and

transmitting the plurality of return downlink signals by a plurality of cooperating feeder-link constituent transmit elements to the plurality of ANs.

4. The method of claim 3, wherein receiving the return uplink signals comprises:

first receiving first return uplink signals, during a first time interval, by the plurality of cooperating user-link constituent receive elements from a first portion of the plurality of user terminals geographically distributed over a first user coverage area; and

second receiving second return uplink signals, during a second time interval, by the plurality of cooperating user-link constituent receive elements from a second portion of the plurality of user terminals geographically distributed over a second user coverage area.

5. The method of claim 4, wherein the AN coverage area is a subset of the first user coverage area, and further comprising:

calibrating the plurality of ANs with the end-to-end relay during the first timeframe.

6. The method of claim 5, wherein the second user coverage area does not overlap the AN coverage area.

7. The method of claim 6, wherein:

during the first time interval, the forward uplink signals are received using a first frequency range, and the return uplink signals are received using a second frequency range different from the first frequency range; and

during the second time interval, the forward uplink signals and the return uplink signals are received using a same frequency range.

8. The method of claim 3, wherein:

the forward uplink signals are received using a first frequency range;

the return downlink signals are transmitted using a second frequency range that is different from the first frequency range;

the return uplink signals are received using the first frequency range; and

the forward downlink signals are transmitted using the second frequency range.

9. The method of claim 3, further comprising:

transmitting the return uplink signals from the at least some of the plurality of user terminals to the plurality of user-link constituent receive elements.

10. The method of claim 3, further comprising:

receiving superpositions of a plurality of the return downlink signals by the plurality of ANs from the plurality of cooperating feeder-link constituent transmit elements to form composite return signals;

combining the composite return signals at a return beamformer to contribute to forming a plurality of return user beams in the user coverage area.

11. The method of claim 10, further comprising:

weighting the composite return signals at the beamformer prior to the combining according to return beam weights.

12. The method of claim 11, further comprising:

synchronizing the composite return signals prior to the combining to account at least for respective path delay differences between the end-to-end relay and the plurality of ANs.

13. The method of claim 12, further comprising:

receiving a relay beacon signal by at least some of the plurality of ANs from the end-to-end relay,

wherein the synchronizing is according to the relay beacon signal.

14. The method of claim 10, further comprising:

synchronizing the composite return signals prior to the combining to account at least for respective path delay differences between the end-to-end relay and the plurality of ANs.

15. The method of claim 1, wherein the user coverage area differs from the AN coverage area.

16. The method of claim 1, wherein the AN coverage area is a single contiguous coverage area.

17. The method of claim 1, wherein the AN coverage area is a subset of the user coverage area, and the AN coverage area is less than one fifth the user coverage area in physical area.

18. The method of claim 1, wherein the transmitting comprises:

first transmitting a first plurality of forward downlink signals by a first plurality of user-link constituent transmit feeds elements to a first plurality of user terminals geographically distributed over a first user coverage area; and

second transmitting a second plurality of forward downlink signals by a second plurality of user-link constituent transmit feeds elements to a second plurality of user terminals geographically distributed over a second user coverage area.

19. The method of claim 18, wherein the second user coverage area is a subset of the first user coverage area.

20. The method of claim 18, wherein the first user coverage area is non-overlapping with the second user coverage area.

21. The method of claim 18, wherein the first transmitting and the second transmitting are performed at different times.

22. The method of claim 18, wherein:

the first transmitting comprises illuminating the first user coverage area with a first plurality of user beams; and

the second transmitting comprises illuminating the second user coverage area with a second plurality of user beams,

such that, during a first time, the first plurality of user beams is active, and the second plurality of user beams is inactive, and

such that, during a second time, the second plurality of user beams is active, and the first plurality of user beams is inactive.

23. The method of claims 18, wherein a first portion of the first user coverage area overlaps the second user coverage area, and a second portion of the first user coverage area does not overlap the second user coverage area.

24. The method of claim 1, further comprising:

receiving a spatial superposition of the plurality of forward downlink signals by one of the user terminals from the user-link constituent transmit elements.

25. The method of claim 1, further comprising:

transmitting the forward uplink signals by the plurality of ANs to the plurality of feeder-link constituent receive elements.

26. The method of claim 25, further comprising:

determining a respective relative timing adjustment for each of the plurality of ANs, such that associated transmissions from the plurality of ANs reach the end-to-end relay substantially in synchrony,

wherein the forward uplink signals are transmitted by the plurality of ANs according to the respective relative timing adjustments.

27. The method of claim 26, further comprising:

receiving a relay beacon signal by at least some of the plurality of ANs from the end-to-end relay,

wherein the respective relative timing adjustments are determined at least in part according to the relay beacon signal.

28. The method of claim 27, further comprising:

receiving loopback transmissions by at least some of the plurality of ANs from the end-to-end relay,

wherein the respective relative timing adjustments are determined at least in part according to the loopback transmissions.

29. The method of claim 26, further comprising:

receiving loopback transmissions by at least some of the plurality of ANs from the end-to-end relay,

wherein the respective relative timing adjustments are determined at least in part according to the loopback transmissions.

30. The method of claim 1, wherein:

a first portion of the user coverage area overlaps with the AN coverage area; and

a second portion of the user coverage area does not overlap with the AN coverage area.