CLAIMS

What is claimed is:

1. An antenna system (101) of a satellite (105), comprising:

an antenna receiver (240);

a plurality of antenna elements (215) coupled to the antenna receiver (240) via a plurality of flexible couplings (220), wherein deployed positions of the plurality of antenna elements (215) are constrained by their position along a respective flexible coupling (220), and are otherwise unconstrained in one or more spatial dimensions;

a training processor (515) configured to:

receive one or more first signals from the antenna receiver (240) associated with one or more training signals (310) from a first transmitter (110, 170, 185); and

associate each of the plurality of antenna elements (215) with a first respective time of arrival based at least in part on the one or more training signals (310); and

a beam weight processor (520) configured to combine one or more second signals associated with a data signal (315) from a second transmitter (110, 170, 185) received via the antenna receiver (240) according to a plurality of coefficients determined based at least in part on the associations between the plurality of antenna elements (215) and the first respective time of arrivals, the beam weight processor (520) configured to generate one or more third signals for transmission from the plurality of antenna elements (215) to a target receiver based at least in part on a second plurality of coefficients determined based at least in part on the associations between the plurality of antenna elements (215) and the first respective time of arrivals.

2. The antenna system (101) of claim 1, comprising:

a reflector configured to reflect radio waves to a dispersed focal region, wherein the plurality of antenna elements are at least partially within the dispersed focal region.

3. The antenna system (101) of claim 1, wherein the plurality of antenna elements (215) form a volumetric shape.

4. The antenna system (101) of claim 3, wherein at least one dimension of the volumetric shape is more than 100 times a distance of a wavelength of the one or more second signals.

5. The antenna system (101) of claim 3, wherein an orientation of the volumetric shape of the plurality of antenna elements (215) relative to an orbital position of the satellite is unconstrained in one or more spatial dimensions.

6. The antenna system (101) of claim 1, wherein the antenna receiver (240) comprises a plurality of receive chains (235), and wherein a quantity of the receive chains (235) of the antenna receiver (240) is less than a quantity of the plurality of antenna elements (215).

7. The antenna system (101) of claim 1, wherein the antenna receiver (240) comprises a plurality of receive chains (235), and wherein each of the plurality of antenna elements (215) is associated with a different one of the plurality of receive chains (235).

8. The antenna system (101) of claim 1, wherein the second transmitter (110, 170, 185) is the same as the first transmitter (110, 170, 185).

9. The antenna system (101) of claim 1, wherein the second transmitter (110, 170, 185) different from the first transmitter (110, 170, 185).

10. The antenna system (101) of claim 1, the training processor (515) configured to:

receive one or more fourth signals from the antenna receiver (240), the one or more fourth signals associated with a second training signal (310) transmitted by a third transmitter (110, 170, 185);

associate each of the plurality of antenna elements (215) with a second respective time of arrival based at least in part on the one or more fourth signals; and

the beam weight processor (520) configured to update the plurality of coefficients based at least in part on the second respective time of arrivals.

11. An antenna system (101) of a satellite (105), comprising:

an antenna receiver (240);

a plurality of antenna elements (215) coupled to the antenna receiver (240) via a plurality of flexible couplings (220), wherein deployed positions of the plurality of antenna elements (215) are constrained by their position along a respective flexible coupling (220), and are otherwise unconstrained in one or more spatial dimensions;

a training processor (515) configured to:

receive one or more first signals from the antenna receiver (240) associated with one or more training signals (310) from a first transmitter (110, 170, 185);

associate each of the plurality of antenna elements (215) with a first respective time of arrival based at least in part on the one or more training signals (310);

receive one or more third signals from the antenna receiver (240), the one or more third signals associated with a second training signal (310) transmitted by a third transmitter (110, 170, 185);

associate each of the plurality of antenna elements (215) with a second respective time of arrival based at least in part on the second training signal; and

determine spatial information for each of the plurality of antenna elements (215) based at least in part on the first respective time of arrivals and the second respective time of arrivals; and

a beam weight processor (520) configured to combine one or more second signals associated with a data signal (315) from a second transmitter (110, 170, 185) received via the antenna receiver (240) according to a plurality of coefficients determined based at least in part on the associations between the plurality of antenna elements (215) and the first respective time of arrivals.

12. The antenna system (101) of claim 11, the training processor (515) configured to:

determine the plurality of coefficients based at least in part on the spatial information and a location of the second transmitter (110, 170, 185).

13. The antenna system (101) of claim 1, wherein the one or more training signals (310) comprise an indicator of location information associated with the first transmitter (110, 170, 185), an indicator of a user beam for the first transmitter (110, 170,

185), a priority for communications from the first transmitter (110, 170, 185), or a combination thereof.

14. The antenna system (101) of claim 1, wherein the training processor (515) is configured to:

decrypt the one or more first signals to obtain the one or more training signals (310); and

validate the one or more training signals (310) based on the decrypting.

15. A method for receiving radio waves at an antenna system (101) of a satellite (105), comprising:

receiving one or more first signals using a plurality of antenna elements (215), the one or more first signals corresponding to a training signal (310) transmitted by a first transmitter, wherein the plurality of antenna elements (215) are each coupled with one of a plurality of flexible couplings (220), and wherein deployed positions of the plurality of antenna elements (215) are constrained by their position along a respective flexible coupling (220), and are otherwise unconstrained in one or more spatial dimensions;

associating each of the plurality of antenna elements (215) with a first respective time of arrival based at least in part on the one or more first signals;

receiving one or more second signals using the plurality of antenna elements (215), the one or more second signals corresponding to a data signal (315) transmitted by a second transmitter;

combining the one or more second signals according to a plurality of coefficients determined based at least in part on the associations between the plurality of antenna elements (215) and the first respective time of arrivals;

generating one or more third signals for transmission from the plurality of antenna elements (215) to a target receiver (110, 170, 185) based at least in part on a second plurality of coefficients determined based at least in part on the associations between the plurality of antenna elements and the first respective time of arrivals; and

transmitting the one or more third signals from the plurality of antenna elements (215).

16. The method of claim 15, wherein the plurality of antenna elements (215) form a volumetric shape.

17. The method of claim 16, wherein at least one dimension of the volumetric shape is more than 100 times a distance of a wavelength of the one or more second signals.

18. The method of claim 16, wherein an orientation of the volumetric shape of the plurality of antenna elements (215) relative to an orbital position of the satellite (105) is unconstrained in one or more spatial dimensions.

19. The method of claim 15, wherein receiving the one or more first and second signals comprises receiving the one or more first and second signals via a plurality of receive chains (235).

20. The method of claim 19, wherein a quantity of the plurality of receive chains (235) is less than a quantity of the plurality of antenna elements (215).

21. The method of claim 19, wherein each of the plurality of antenna elements (215) is associated with a different one of the plurality of receive chains (235).

22. The method of claim 15, wherein the second transmitter (110, 170, 185) is the same as the first transmitter (110, 170, 185).

23. The method of claim 15, wherein the second transmitter (110, 170, 185) is different from the first transmitter (110, 170, 185).

24. The method of claim 15, comprising:

receiving one or more fourth signals using the plurality of antenna elements (215), the one or more fourth signals associated with one or more second training signals (310) from a third transmitter (110, 170, 185);

associating each of the plurality of antenna elements (215) with a second respective time of arrival based at least in part on the one or more fourth signals; and

updating the plurality of coefficients based at least in part on the second respective time of arrivals.

25. A method for receiving radio waves at an antenna system (101) of a satellite (105), comprising:

receiving one or more first signals using a plurality of antenna elements (215), the one or more first signals corresponding to a training signal (310) transmitted by a first

transmitter, wherein the plurality of antenna elements (215) are each coupled with one of a plurality of flexible couplings (220), and wherein deployed positions of the plurality of antenna elements (215) are constrained by their position along a respective flexible coupling (220), and are otherwise unconstrained in one or more spatial dimensions;

associating each of the plurality of antenna elements (215) with a first respective time of arrival based at least in part on the one or more first signals;

receiving one or more second signals using the plurality of antenna elements (215), the one or more second signals corresponding to a data signal (315) transmitted by a second transmitter;

receiving one or more third signals associated with a second training signal (310) transmitted by a third transmitter (110, 170, 185);

associating each of the plurality of antenna elements (215) with a second respective time of arrival based at least in part on the second training signal;

determining spatial information for each of the plurality of antenna elements (215) based at least in part on the first respective time of arrivals and the second respective time of arrivals; and

combining the one or more second signals according to a plurality of coefficients determined based at least in part on the associations between the plurality of antenna elements (215) and the first respective time of arrivals.

26. The method of claim 25, comprising:

determining the plurality of coefficients based at least in part on the spatial information and a location of the second transmitter (110, 170, 185).

27. The method of claim 15, wherein the training signal comprises an indicator of location information associated with the first transmitter (110, 170, 185), an indicator of a user beam for the first transmitter (110, 170, 185), a priority for communications from the first transmitter (110, 170, 185), or a combination thereof.

28. The method of claim 15, comprising:

decrypting the one or more first signals to obtain the training signal (310); and

validating the training signal (310) based on the decrypting.