

CLAIMS

What is claimed is:

- 1 1. A system (100) for satellite communications, comprising:
2 a transmitter (200) configured to transmit a composite signal and comprising:
3 a plurality of component spreaders (265, 270, 275), wherein each
4 component spreader of the plurality of component spreaders (265, 270, 275) is
5 configured to apply a respective spreading code of a plurality of spreading codes to a
6 common data symbol of a modulated signal to obtain a plurality of spread data
7 symbols, and
8 a plurality of antenna elements (240, 245, 250) coupled with the
9 plurality of component spreaders (265, 270, 275), wherein each antenna of the
10 plurality of antenna elements (240, 245, 250) is configured to obtain one or more
11 spread data symbols of the plurality of spread data symbols and emit an element
12 signal comprising the one or more spread data symbols, the composite signal
13 comprising the element signals emitted from the plurality of antenna elements (240,
14 245, 250); and
15 a receiver (300) configured to receive the composite signal and comprising:
16 a plurality of component despreaders (320, 335), wherein each
17 component despreaders of the plurality of component despreaders (320, 335) is
18 configured to apply a despreading code of a plurality of despreading codes to the
19 composite signal to obtain a plurality of despread data symbols,
20 a plurality of signal component estimators (355, 365) coupled with the
21 plurality of component despreaders (320, 335), wherein each signal component
22 estimator of the plurality of signal component estimators (355, 365) is configured to
23 estimate one or more coefficients for respective despread data symbols of the plurality
24 of despread data symbols, and
25 a summing circuit (350) coupled with the plurality of signal component
26 estimators (355, 365), wherein the summing circuit (350) is configured to combine the
27 plurality of despread data symbols based at least in part on the one or more
28 coefficients estimated for the plurality of despread data symbols to obtain a combined
29 data symbol corresponding to the common data symbol.

- 1 2. The system (100) of claim 1, wherein the receiver (300) further
2 comprises:
3 a plurality of decimators (315, 330) coupled with the plurality of component
4 despreaders (320, 335) and the plurality of signal component estimators (355, 365) and
5 configured to obtain a plurality of decimated data symbols, wherein each decimator of the
6 plurality of decimators (315, 330) is configured to configured to filter and downsample a
7 respective despread data symbol of the plurality of despread data symbols to obtain a
8 decimated data symbol.
- 1 3. The system (100) of claim 2, wherein each signal component estimator
2 of the plurality of signal component estimators (355, 365) is configured to estimate the one or
3 more coefficients for the respective despread data symbols based at least in part on respective
4 decimated data symbols of the plurality of decimated data symbols.
- 1 4. The system (100) of any one of claims 1 through 3, wherein the
2 receiver (300) further comprises:
3 a demodulator (370) that is coupled with the summing circuit (350), wherein
4 the demodulator (370) is configured to demodulate the combined data symbol to obtain a
5 demodulated data symbol; and
6 a decoder (370) that is configured to decode a plurality of demodulated data
7 symbols comprising the demodulated data symbol.
- 1 5. The system (100) of any one of claims 1 through 4, wherein each
2 antenna element of the plurality of antenna elements (240, 245, 250) is configured to obtain a
3 respective spread data symbol of the one or more spread data symbols.
- 1 6. The system (100) of any one of claims 1 through 5, wherein an antenna
2 element of the plurality of antenna elements (240, 245, 250) is configured to obtain a two or
3 more of the plurality of spread data symbols.
- 1 7. The system (100) of any one of claims 1 through 6, wherein two or
2 more of the plurality of antenna elements (240, 245, 250) are configured to obtain a spread
3 data symbol from one of the plurality of component spreaders (265, 270, 275).

1 8. The system (100) of any one of claims 1 through 7, wherein the
2 plurality of despreading codes is the same as the plurality of spreading codes.

1 9. The system (100) of any one of claims 1 through 8, wherein the one or
2 more coefficients comprises magnitude, phase, timing, frequency, or any combination
3 thereof.

1 10. The system (100) of any one of claims 1 through 9, wherein the
2 modulated signal is a first modulated signal, and wherein the transmitter (200) further
3 comprises:
4 a beamformer (205) configured to apply beamforming coefficients to a second
5 modulated signal to obtain a plurality of beamformed data symbols; and
6 a communications manager (253) that is configured to switch between a first
7 mode for transmitting the plurality of beamformed data symbols via the plurality of antenna
8 elements (240, 245, 250) for communication via beamformed spot beams and a second mode
9 that causes the first modulated signal to bypass the beamformer (205).

1 11. The system (100) of claim 10, wherein the communications manager
2 (253) is further configured to:
3 activate the first mode for a first interval of a period and the second mode for a
4 second interval of the period that is smaller than the first interval.

1 12. The system (100) of any one of claims 1 through 11, wherein the
2 transmitter (200) further comprises:
3 a modulator (255) coupled with the plurality of component spreaders (265,
4 270, 275), the modulator (255) configured to generate a plurality of data symbols comprising
5 the common data symbol.

1 13. The system (100) of any one of claims 1 through 12, further
2 comprising:
3 a satellite (120) comprising the plurality of antenna elements (240, 245, 250),
4 and
5 a gateway (130) communicatively coupled with the satellite (120), wherein the
6 gateway (130) comprises the plurality of component spreaders (265, 270, 275).

- 1 14. The system (100) of any one of claims 1 through 12, further
2 comprising:
3 a satellite (120) that comprises the plurality of component spreaders (265, 270,
4 275) and the plurality of antenna elements (240, 245, 250) of the transmitter (200).
- 1 15. The system (100) of any one of claims 1 through 12, further
2 comprising:
3 a plurality of gateways (130), wherein the transmitter (200) comprises the
4 plurality of gateways, each gateway of the plurality of gateways (130) comprising a
5 respective component spreader of the plurality of component spreaders (265, 270, 275) and a
6 respective antenna element of the plurality of antenna elements (240, 245, 250); and
7 a satellite (120) comprising a plurality of transponders configured to relay the
8 composite signal.
- 1 16. A method for satellite communications, comprising:
2 receiving a composite signal comprising a plurality of spread data symbols
3 associated with a common data symbol;
4 despreading the plurality of spread data symbols to obtain a plurality of
5 despread data symbols;
6 estimating a plurality of coefficients for the plurality of despread data
7 symbols; and
8 combining the plurality of despread data symbols to obtain a combined data
9 symbol corresponding to the common data symbol based at least in part on the estimating.
- 1 17. The method of claim 16, further comprising:
2 using the plurality of coefficients to adjust the plurality of despread data
3 symbols, wherein a plurality of adjusted data symbols are obtained based at least in part on
4 using the plurality of coefficients, wherein the combining comprises:
5 combining the plurality of adjusted data symbols to obtain the
6 combined data symbol.
- 1 18. The method of any one of claims 16 or 17, wherein despreading the
2 plurality of spread data symbols comprises:
3 applying a plurality of despreading codes to the plurality of spread data
4 symbols.

- 1 19. The method of any one of claims 16 through 18, further comprising:
2 decimating the plurality of despread data symbols, wherein the decimating
3 comprises, for each despread data symbol, filtering a set of frequencies from a respective
4 despread data symbol and downsampling the respective despread data symbol after the
5 filtering.
- 1 20. The method of any one of claims 16 through 19, wherein estimating
2 the plurality of coefficients for the plurality of despread data symbols comprises:
3 estimating a magnitude, phase, timing, frequency, or any combination thereof
4 for the plurality of despread data symbols.
- 1 21. The method of any one of claims 16 through 20, further comprising:
2 demodulating the combined data symbol to obtain a demodulated data symbol;
3 and
4 decoding the demodulated data symbol.
- 1 22. An apparatus for satellite communications, comprising:
2 a plurality of component despreaders (320, 335) configured to receive a
3 plurality of spread data symbols associated with a common data symbol and despread the
4 plurality of spread data symbols to obtain a plurality of despread data symbols;
5 a plurality of signal component estimators (355, 365) coupled with the
6 plurality of component despreaders (320, 335) and configured to estimate one or more
7 coefficients of the plurality of despread data symbols; and
8 a summing circuit (350) coupled with the plurality of signal component
9 estimators (355, 365) and configured to combine the plurality of despread data symbols to
10 obtain a combined data symbol corresponding to the common data symbol.
- 1 23. The apparatus of claim 22, further comprising:
2 a plurality of decimators (315, 330) configured to apply a low-pass filter to
3 and downsample the plurality of despread data symbols.
- 1 24. The apparatus of any one of claims 22 or 23, further comprising:
2 a demodulator (370) configured to demodulate the combined data symbol to
3 obtain a demodulated data symbol; and
4 a decoder (370) configured to decode the demodulated data symbol.

1 25. A method for satellite communications, comprising:
2 switching from a first mode for transmitting beam signals via beamformed
3 spot beams over the geographic area to a second mode that bypasses a beamformer (205)
4 used to form the spot beams;
5 generating a modulated signal comprising data for one or more user terminals
6 (150) based at least in part on switching to the second mode, the modulated signal comprising
7 a plurality of modulated data symbols;
8 applying a plurality of spreading codes to a modulated data symbol of the
9 plurality of modulated data symbols to obtain a plurality of spread data symbols; and
10 transmitting each spread data symbol of the plurality of spread data symbols
11 using one or more antenna elements of a plurality of antenna elements (240, 245, 250).

1 26. The method of claim 25, further comprising:
2 receiving data for a user terminal (515) having a location within a geographic
3 area that is unknown to a transmitter (200) used to transmit the plurality of spread data
4 symbols.

1 27. The method of any one of claims 25 or 26, further comprising:
2 switching from the second mode to the first mode based at least in part on a
3 schedule for switching between the first mode and the second mode.

1 28. The method of claim 27, further comprising:
2 identifying a first interval for operating in the first mode and a second interval
3 for operating in the second mode, wherein switching to the second mode is based at least in
4 part on an occurrence of the second interval.

1 29. The method of any one of claims 27 or 28, further comprising:
2 receiving second data for a second user terminal (415) having a known
3 location within the geographic area;
4 generating a second modulated signal comprising the second data based at
5 least in part on switching to the first mode, the second modulated signal comprising a second
6 plurality of modulated data symbols;
7 applying a plurality of beam weights to a second modulated data symbol of the
8 second plurality of modulated data symbols to obtain a plurality of weighted data symbols;
9 and

10 transmitting each weighted data symbol of the plurality of weighted data
11 symbols using one or more antenna elements of the plurality of antenna elements (240, 245,
12 250).

1 30. The method of any one of claims 25 through 29, further comprising:
2 amplifying the plurality of spread data symbols, wherein the transmitting
3 comprises:

4 transmitting each amplified spread data symbol using one or more
5 antenna elements of the plurality of antenna elements (240, 245, 250).

1 31. An apparatus for satellite communications, comprising:
2 a communications manager (253) configured to switch from a first mode for
3 transmitting beam signals via beamformed spot beams over the geographic area to a second
4 mode that bypasses a beamformer (205) used to form the spot beams;
5 a modulator (255) configured to generate a modulated signal comprising data
6 for one or more user terminals (150) based at least in part on switching to the second mode,
7 the modulated signal comprising a plurality of modulated data symbols;
8 a plurality of component spreaders (265, 270, 275) coupled with the modulator
9 (255) and configured to apply a plurality of spreading codes to a modulated data symbol of
10 the plurality of modulated data symbols to obtain a plurality of spread data symbols; and
11 a plurality of antenna elements (240, 245, 250) coupled with the plurality of
12 component spreaders (265, 270, 275) and configured to transmit each spread data symbol of
13 the plurality of spread data symbols using one or more antenna elements of the plurality of
14 antenna elements (240, 245, 250).

1 32. The apparatus of claim 31, further comprising:
2 a data buffer (257) coupled with the modulator (255) and configured to receive
3 data for a user terminal (515) having an unknown location within a geographic area, wherein
4 the data included in the modulated signal comprises the data for the user terminal (515).

1 33. The apparatus of any one of claims 31 or 32, further comprising:
2 a data buffer (257) coupled with the modulator (255) and configured to receive
3 second data for a user terminal (415) having a known location within the geographic area,
4 wherein the second data included in the modulated signal comprises the data for the user
5 terminal (415), wherein:

6 the communications manager (253) is configured to switch from the
7 second mode to the first mode, and
8 the modulator (255) is configured to generate a second modulated
9 signal comprising the second data based at least in part on switching to the first mode,
10 the second modulated signal comprising a second plurality of modulated data
11 symbols.

1 34. The apparatus of claim 33, further comprising:
2 a plurality of beamformers (205) coupled with the modulator (255) configured
3 to apply a plurality of beam weights to a second modulated data symbol of the second
4 plurality of modulated data symbols to obtain a plurality of weighted data symbols, wherein
5 the plurality of antenna elements (240, 245, 250) are configured to transmit a respected
6 weighted data symbol of the plurality of spread data symbols.

1 35. The apparatus of any one of claims 31 through 34, further comprising:
2 a plurality of amplifiers (225, 230, 235) coupled with the plurality of
3 component spreaders (265, 270, 275) and the plurality of antenna elements (240, 245, 250)
4 and configured to amplify the plurality of spread data symbols.