I Claim:

1. A satellite comprising:

an optical receiver, having a plurality of digital outputs;

a plurality of modulators, each having a digital input and an analog output, the digital input coupled to one of the plurality of digital outputs of the optical receiver;

a switch matrix having a plurality of switch matrix inputs and a plurality of switch matrix outputs, each switch matrix input coupled to the analog output of a corresponding one of the modulators and each switch matrix output being selectively coupled to one of the switch matrix inputs; and

an antenna having a plurality of antenna inputs, each antenna input coupled to a corresponding one of the switch matrix outputs.

2. The satellite of Claim 1, further comprising a plurality of Low noise amplifiers (LNAs), each coupled between an optical receiver output and a corresponding modulator.

3. The satellite of Claim 1, wherein the antenna is configured to produce plurality of user spot beams.

4. The satellite of Claim 1, wherein the optical receiver comprises a plurality of satellite receiver optical detectors each having a digital output coupled to a corresponding digital output of the optical receiver.

5. The satellite of Claim 4, wherein the digital output has two logical states, the first logical state associated with a received optical signal coupled to the input of the satellite receiver optical detector being above a first intensity level of and the second logical state associated with the signal being below a second intensity level.

6. The satellite of Claim 1, wherein the modulator is a bi-phase modulator.

7. The satellite of Claim 1, wherein the modulator is a quadrature amplitude modulator.

8. The satellite of Claim 1, further comprising at least one frequency converter coupled between a corresponding switch matrix output and a corresponding antenna input.

9. The satellite of Claim 8, further comprising a power amplifier coupled between an output of the frequency converter and the corresponding antenna input.

10. The satellite of Claim 9, further comprising a switch having an input and at least two outputs, the input coupled to the output of at least one power amplifier and each output coupled to one of the plurality of inputs to the antenna.

11. The satellite of Claim 1, further comprising a plurality of optical receivers, each having a plurality of optical receiver outputs, each optical receiver output being coupled to a digital input of corresponding modulator.

12. The satellite of Claim 11, wherein the optical receiver comprises a plurality of satellite receiver optical detectors each having a digital output coupled to a corresponding digital output of the optical receiver and each optical receiver further comprises a steerable lens having an output coupled to the input of at least one of the plurality of satellite receiver optical detectors.

13. The satellite of Claim 12, wherein the steerable lens can be positioned by rotation about at least two axis.

14. The satellite of Claim 12, wherein the steerable lens can be positioned by rotation about at least two axis in response to ground commands.

15. The satellite of Claim 12, wherein the steerable lens can be positioned by rotation about at least two axis in response to on-board processing.

16. The satellite of Claim 1, wherein the matrix switch further comprises a control input configured to receive switch control commands from at least one optical receiver and to selectively couple at least one of the switch matrix inputs to at least one of the switch matrix outputs in response to the switch control commands.

17. A satellite comprising:

an optical receiver, having a plurality of radio frequency (RF) outputs;

a switch matrix having a plurality of switch matrix inputs and a plurality of switch matrix outputs, each switch matrix input coupled to a corresponding one of the plurality of RF outputs; and

an antenna having a plurality of antenna inputs, each antenna feed having an input coupled to a corresponding one of the switch matrix outputs.

18. The satellite of Claim 17, further comprising a plurality of Low noise amplifiers (LNAs), each coupled between an optical receiver output and a corresponding switch matrix input.

19. The satellite of Claim 18, wherein is configured to produce plurality of user spot beams.

20. The satellite of Claim 19, where each antenna feed has an antenna pattern that overlaps to form a user spot beam directed to a user beam coverage area.

21. The satellite of Claims 3 or 19, wherein user spot beams are directed to user beam coverage areas distributed over a satellite service coverage area that is substantially larger than user beam coverage areas.

22. The satellite of Claims 1 or 17, wherein the optical receiver comprises an optical demultiplexer having an input and a plurality of outputs, each output associated with a corresponding optical wavelength.

23. The satellite of Claim 22, wherein the wavelengths associated with the outputs of the optical demultiplexer are grouped in optical bands.

24. The satellite of Claim 23, wherein wavelengths in the same optical band define unique optical channels.

25. The satellite of Claim 17, wherein the optical receiver comprises a plurality of satellite receiver optical detectors each having an RF output coupled to a corresponding RF output of the optical receiver.

26. The satellite of Claim 25, wherein the RF signal output from the satellite receiver optical detector has an amplitude that tracks the intensity of the optical signal applied to the satellite receiver optical detector input.

27. The satellite of Claims 5 or 26, wherein each optical receiver further comprises a steerable lens having an output coupled to the input of at least one of the plurality of satellite receiver optical detectors.

28. The satellite of Claim 5 or 26, wherein the satellite receiver optical detector is a photo diode.

29. The satellite of Claim 17, further comprising at least one frequency converter coupled between a corresponding switch matrix output and a corresponding antenna input.

30. The satellite of Claim 29, further comprising a power amplifier coupled between an output of one of the frequency converters and a corresponding antenna input.

31. The satellite of Claim 17, further comprising a plurality of optical receivers, each having a plurality of optical receiver outputs, each optical receiver output being coupled to a switch matrix input.

32. A satellite comprising:

an optical receiver, having a plurality of digital outputs;

a plurality of modulators having a digital input and an analog output, the digital input coupled to one of the plurality of digital outputs of the optical receiver;

a beamformer having a plurality of beamformer inputs coupled to corresponding ones of the analog outputs, the number of beamformer inputs being equal to the number of user spot beams to be formed by the beamformer, the beamformer further having a plurality of beamformer outputs; and

an antenna array having a plurality of antenna elements, each antenna element having an input coupled to a corresponding one of the beamformer outputs.

33. The satellite of Claim 32, further comprising a plurality of LNAs, each LNA coupled between one of the plurality of modulators and a corresponding one of the beamformer inputs.

34. The satellite of Claim 32, wherein antenna patterns of at least some of the antenna elements overlap such that signals transmitter therefrom will be superposed upon one another and thus coherently combine to form a user spot beam.

35. The satellite of Claim 32, wherein the user spot beams are directed to user beam coverage areas.

36. The satellite of Claims 35, wherein user spot beams are directed to user beam coverage areas distributed over a satellite service coverage area that is substantially larger than user beam coverage areas.

37. The satellite of Claims 32, wherein the optical receiver comprises an optical demultiplexer having an input and a plurality of outputs, each output associated with a corresponding optical wavelength.

38. The satellite of Claim 37, wherein the wavelengths associated with the outputs of the optical demultiplexer are grouped in optical bands.

39. The satellite of Claim 38, wherein wavelengths in the same optical band define unique optical channels.

40. The satellite of Claim 32, wherein the optical receiver comprises a plurality of satellite receiver optical detectors each having a digital output coupled to a corresponding digital output of the optical receiver.

41. The satellite of Claim 40 wherein each satellite receiver optical detector has an optical input and wherein the digital output has two logical states, the first logical state associated with a received optical signal coupled to the input of the satellite receiver optical detector being above a first intensity level of and the second logical state associated with the signal being below a second intensity level.

42. The satellite of Claim 32, wherein the modulator is a bi-phase modulator.

43. The satellite of Claim 32, wherein the modulator is a QAM modulator.

44. The satellite of Claim 32, further comprising at least one frequency converter coupled between a corresponding beamformer output and a corresponding antenna element input.

45. The satellite of Claim 44, further comprising a power amplifier coupled between an output of a frequency converter and a corresponding antenna element input.

46. The satellite of Claim 32, further comprising a plurality of optical receivers, each having a plurality of optical receiver outputs, each optical receiver output being coupled to a digital input of corresponding modulator.

47. The satellite of Claim 32, further comprising additional beamformers, and additional optical receivers, each additional optical receiver having a plurality of digital outputs, the additional beamformers having a plurality of beamformer inputs coupled to corresponding ones of the analog outputs of the additional optical receivers, the number of beamformer inputs being equal to the number of user spot beams to be formed by the beamformers, the beamformers further having a plurality of beamformer outputs, the number of beamformer outputs from each additional beamformer being equal to the number of beam element signals used to form one user spot beam.

48. A satellite comprising:

an optical receiver, having a plurality of radio frequency (RF) outputs;

a beamformer having a plurality of beamformer inputs coupled to corresponding ones of the analog outputs, the number of beamformer inputs being equal to the number of user spot beams to be formed by the beamformer, the beamformer further having a plurality of beamformer outputs; and

an antenna array having a plurality of antenna elements, each antenna element having an input coupled to a corresponding one of the beamformer outputs.

~~49. The satellite of Claim 48, further comprising a plurality of Low noise amplifiers (LNAs), each coupled between an optical receiver output and a corresponding beamformer input.~~

~~50. The satellite of Claim 48, wherein antenna patterns of at least some of the antenna elements overlap such that signals transmitted therefrom will be superposed upon one another and thus coherently combine to form a user spot beam.~~

~~51. The satellite of Claim 50, wherein user spot beams are directed to user beam coverage areas distributed over a satellite service coverage area that is substantially larger than user beam coverage areas.~~

~~52. The satellite of Claim 51, wherein the optical receiver comprises an optical demultiplexer having an input and a plurality of outputs, each output associated with a corresponding optical wavelength.~~

~~53. The satellite of Claim 52, wherein the wavelengths associated with the outputs of the optical demultiplexer are grouped in optical bands.~~

~~54. The satellite of Claim 53, wherein wavelengths in the same optical band define unique optical channels.~~

~~55. The satellite of Claim 53, wherein optical bands that are selected have an attenuation that is not greater than bands that are not selected.~~

~~56. The satellite of Claim 48, wherein the optical receiver comprises a plurality of satellite receiver optical detectors each having an RF output coupled to a corresponding RF output of the optical receiver.~~

~~57. The satellite of Claim 56, wherein the RF signal output from the satellite receiver detector has an amplitude that tracks the intensity of the optical signal applied to the satellite receiver detector input.~~

~~58. The satellite of Claim 57, wherein each optical receiver further comprises a steerable lens having an output coupled to the input of at least one of the plurality of satellite receiver optical detectors.~~

~~59. The satellite of Claim 57, wherein the satellite receiver optical detector is a photo diode.~~

~~60. The satellite of Claim 48, further comprising at least one frequency converter coupled between a corresponding one of the beamformer outputs and a corresponding one of the antenna element inputs.~~

~~61. The satellite of Claim 60, further comprising a power amplifier coupled between an output of one of the plurality of frequency converters and a corresponding one of the antenna element inputs.~~

~~62. The satellite of Claim 48, further comprising a plurality of optical receivers, each having a plurality of optical receiver outputs, each optical receiver output being coupled to a beamformer input.~~

~~63.~~1. A satellite comprising:

an optical receiver, having a plurality of radio frequency (RF) outputs;

a plurality of LNAs, each having an input and an output, the inputs coupled to a corresponding plurality of optical receiver RF outputs; and

a plurality of power amplifiers (PA), each having an input and an output, the inputs coupled to the outputs of corresponding LNAs; and

an antenna array having a plurality of antenna elements, each antenna element having an input coupled to a corresponding one of the PA outputs.

~~64.~~2. The satellite of Claim ~~63~~1, further comprising a plurality of upconverters, each having an input and an output, the each input coupled to an associated output of a corresponding LNA and each output coupled to an associated one of the plurality of antenna elements.

~~65.~~3. The satellite of Claims ~~64~~ 2 or ~~63~~1, wherein antenna patterns of at least some of the antenna elements overlap such that signals transmitted therefrom will be superposed upon one another and thus coherently combine to form a user spot beam.

~~66.~~4. The satellite of Claims ~~64~~ 2 or ~~65~~3, wherein user spot beams are directed to user beam coverage areas distributed over a satellite service coverage area that is substantially larger than user beam coverage areas.

~~67.~~5. The satellite of Claim ~~66~~4, wherein the optical receiver comprises an optical demultiplexer having an input and a plurality of outputs, each output associated with a corresponding optical wavelength.

~~68.~~6. The satellite of Claim ~~67~~5, wherein the wavelengths associated with the outputs of the optical demultiplexer are grouped in optical bands.

~~69.~~7. The satellite of Claim ~~68~~6, wherein wavelengths in the same optical band define unique optical channels.

~~70.~~8. The satellite of Claim ~~68~~6, wherein optical bands that are selected have an attenuation that is not greater than bands that are not selected.

~~71.~~9. The satellite of Claims ~~64~~ 2 or ~~63~~1, wherein the optical receiver comprises a plurality of satellite receiver optical detectors each having an RF output coupled to a corresponding RF output of the optical receiver.

~~72.~~10. The satellite of Claim ~~71~~9, wherein the RF signal output from the satellite receiver optical detector has an amplitude that tracks the intensity of the optical signal applied to the satellite receiver optical detector input.

~~73.~~11. The satellite of Claim ~~72~~10, wherein each optical receiver further comprises a steerable lens having an output coupled to the input of at least one of the plurality of satellite receiver optical detectors.

~~74.~~12. The satellite of Claim ~~73~~11, wherein the steerable lens can be positioned by rotation about at least two axis in response to ground commands.

~~75.~~13. The satellite of Claim ~~73~~11, wherein the steerable lens can be positioned by rotation about at least two axis in response to on-board processing.

~~76.~~14. The satellite of Claim ~~72~~10, wherein the satellite receiver optical detector is a photo diode.

~~77.~~15. A satellite access node (SAN) comprising:

a plurality of optical modulators each having an electrical input and an optical output, at least one electrical input configured to receive a beam element signal and at least one electrical input configured to receive a timing pilot signal;

an optical combiner for combining the optical outputs of the plurality of optical modulators; and

an optical transmitter configured to transmit an optical signal to a satellite.

~~78.~~16. The SAN of Claim ~~77~~15, further comprising a timing module having inputs configured to receive the beam element signals and the timing pilot signal and a plurality of outputs configured to output appropriately delayed beam element signals and timing pilot signal, the output coupled to the electrical inputs of the plurality of optical modulators.

~~79.~~17. The SAN of Claims ~~77~~ 15 or ~~78~~ 16 each of the plurality of optical modulators comprise at least one light source operating at an optical wavelength within one of four optical bands.

~~80.~~18. The SAN of Claim ~~79~~ 17 wherein the four optical bands are centered at approximately 1100nm, 1300nm, 1550nm and 2100nm.

~~81.~~19. The SAN of Claim ~~79~~ 17 wherein the wavelength of each light source within the same optical band is approximately 0.8 nm wide.

~~82.~~20. The SAN of Claim ~~79~~ 17 wherein the electrical input to the plurality of optical modulators is further configured to receive a signal having a bandwidth of approximately 3.5 GHz.

~~83.~~21. The SAN of Claim ~~77~~ 15 or ~~78~~ 16 further comprising a plurality of baseband to IF converters, each having:

an output;

a plurality of frequency converters having outputs; and

a summing circuit having a plurality of inputs and an output, each input coupled to a corresponding one of the plurality of frequency converter outputs

wherein the output of each of the plurality of baseband to IF converters is coupled to the electrical input of a corresponding one of the plurality of optical modulators.

~~84.~~22. The SAN of Claim ~~83~~21, wherein the plurality of frequency converters have inputs configured to receive beam element signals.

~~85.~~23. The SAN of Claim ~~83~~21, wherein at least one of the frequency converters is configured to receive a timing pilot signal.

~~86.~~24. The SAN of Claim ~~77~~ 15 or ~~78~~ 16 further comprising an optical receiver configured to receive an optical signal and to output a plurality of beam element signals.

~~87.~~25. The SAN of Claim ~~86~~24, wherein the optical receiver is further configured to output at least one timing pilot signal.

~~88.~~26. A satellite system ground network comprising:

a beamformer comprising:

a plurality of beamformer inputs, each configured to receive signals to be directed to a user spot beam;

a plurality of beamformer outputs, each configured to output a beam element signal;

at least one pilot output configured to output a timing pilot signal; and

a SAN comprising:

a plurality of optical modulators each having an electrical input and an optical output, at least one electrical input coupled to a corresponding output from the beamformer and at least one electrical input configured to receive a first timing pilot signal;

an optical combiner coupled to the optical outputs of the plurality of optical modulators; and

an optical transmitter configured to transmit an optical signal to a satellite.

~~89.~~27. The network of Claim ~~88~~26, wherein the beamformer applies beam weights to each beam element signal such that when the beam weight signals are demodulated by a satellite and transmitted by an antenna array, they superpose to form user spot beams.

~~90.~~28. The network of Claim ~~89~~27, wherein the number of user spot beams formed is equal to the number of beamformer inputs.

~~91.~~29. The network of Claim ~~88~~26, further comprising at least a second SAN having at least one electrical input coupled to a corresponding output from the beamformer and at least one electrical input configured to receive a second timing pilot signal, wherein the first timing pilot signal and the second timing pilot signal are aligned.

~~92.~~30. The network of Claim ~~91~~29, wherein the beamformer further comprises a timing module, and wherein the first and second timing pilot signals are generated by the timing module.

~~93.~~31. The network of Claim ~~91~~29, wherein the second pilot timing signal is a copy of the first timing pilot signal.

~~94.~~32. The network of Claim ~~93~~31, wherein the number of copies of the timing pilot signals is equal to the number of SANs to which the beamformer is coupled.

~~95.~~33. The network of Claim ~~91~~29, wherein the SANs each have a SAN optical receiver configured to receive an optical signal from a satellite and to demultiplex and demodulate a timing pilot signal from the optical signal.

~~96.~~34. The network of Claim ~~95~~33, wherein the beamformer further comprises a timing control input, and wherein the SAN further comprises a timing pilot modem coupled to the SAN optical receiver, the timing pilot modem having an output coupled to the beamformer timing control input.

~~97.~~35. The network of Claim ~~96~~34, wherein the timing module within the beamformer generates a delay in the transmission of beam elements signals in response to signals presented to the timing control input.

~~98.~~36. The network of Claim ~~95~~33, where the SAN further comprises a timing module coupled between the beamformer and each optical modulator, the timing module having a timing control input coupled to receive the timing pilot signal from the SAN optical receiver.

~~99.~~37. The network of Claim ~~98~~36, wherein the timing module within the SAN generates a delay in the transmission of beam elements signals in response to signals presented to the timing control input.

~~100. A satellite communication system comprising:~~

~~at least one SAN comprising:~~

~~an optical transmitter comprising at least one optical modulator, each optical modulator having an electrical input and an optical output;~~

~~an optical combiner having at least one input, each input coupled to the optical output of a corresponding one of the at least one optical modulators; and~~

~~a lens;~~

~~a satellite comprising:~~

~~an optical receiver having a lens pointed to receive the optical output of the lens of one of the SANs, and a plurality of digital outputs;~~

~~a plurality of electrical modulators, each having a digital input and an analog output, the digital input coupled to one of the plurality of digital outputs of the optical receiver;~~

~~a switch matrix having a plurality of switch matrix inputs and a plurality of switch matrix outputs, each switch matrix input coupled to the analog output of a corresponding one of the electrical modulators and each switch matrix output being selectively coupled to one of the switch matrix inputs; and~~

~~an antenna having a plurality of antenna inputs, each antenna input coupled to a corresponding one of the switch matrix outputs.~~

~~101. The system of Claim 100, further comprising a plurality of Low noise amplifiers (LNAs), each coupled between an optical receiver output and a corresponding modulator.~~

~~102. The system of Claim 100, wherein the antenna is configured to produce plurality of user spot beams.~~

~~103. The system of Claim 100, wherein the optical receiver comprises a plurality of satellite receiver optical detectors each having a digital output coupled to a corresponding digital output of the optical receiver.~~

~~104. The system of Claim 103, wherein the digital output has two logical states, the first logical state associated with a received optical signal coupled to the input of the satellite receiver optical detector being above a first intensity level of and the second logical state associated with the signal being below a second intensity level.~~

~~105. The system of Claim 100, wherein the modulator is a bi-phase modulator.~~

~~106. The system of Claim 100, wherein the modulator is a quadrature amplitude modulator.~~

~~107. The system of Claim 100, further comprising at least one frequency converter coupled between a corresponding switch matrix output and a corresponding antenna input.~~

~~108. The system of Claim 107, further comprising a power amplifier coupled between an output of the frequency converter and the corresponding antenna input.~~

~~109. The system of Claim 108, further comprising a switch having an input and at least two outputs, the input coupled to the output of at least one power amplifier and each output coupled to one of the plurality of inputs to the antenna.~~

~~110. The system of Claim 100, further comprising a plurality of optical receivers, each having a plurality of optical receiver outputs, each optical receiver output being coupled to a digital input of corresponding modulator.~~

~~111. The system of Claim 110, wherein the optical receiver comprises a plurality of satellite receiver optical detectors each having a digital output coupled to a corresponding digital output of the optical receiver and each optical receiver further comprises a steerable lens having an output coupled to the input of at least one of the plurality of satellite receiver optical detectors.~~

~~112. The satellite of Claim 111, wherein the steerable lens can be positioned by rotation about at least two axis in response to ground commands.~~

~~113. The satellite of Claim 111, wherein the steerable lens can be positioned by rotation about at least two axis in response to on-board processing.~~

~~114. The system of Claim 111, wherein the steerable lens can be positioned by rotation about at least two axis.~~

~~115. The system of Claim 100, wherein the matrix switch further comprises a control input configured to receive switch control commands from at least one optical receiver and to selectively couple at least one of the switch matrix inputs to at least one of the switch matrix outputs in response to the switch control commands.~~

~~116. A satellite communication system comprising:~~

~~at least one SAN comprising:~~

~~an optical transmitter comprising at least one optical modulator, each optical modulator having an electrical input and an optical output;~~

~~an optical combiner having at least one input, each input coupled to the optical output of a corresponding one of the at least one optical modulators; and~~

~~a lens; and~~

~~a satellite comprising:~~

~~an optical receiver configured to receive the optical signal from the lens, the optical receiver having a plurality of radio frequency (RF) outputs;~~

~~a switch matrix having a plurality of switch matrix inputs and a plurality of switch matrix outputs, each switch matrix input coupled to a corresponding one of the plurality of RF outputs; and~~

~~an antenna having a plurality of antenna inputs, each antenna feed having an input coupled to a corresponding one of the switch matrix outputs.~~

~~117. The system of Claim 116, further comprising a plurality of Low noise amplifiers (LNAs), each coupled between an optical receiver output and a corresponding switch matrix input.~~

~~118. The system of Claim 117, wherein is configured to produce plurality of user spot beams.~~

~~119. The system of Claim 118, where each antenna feed has an antenna pattern that overlaps to form a user spot beam directed to a user beam coverage area.~~

~~120. The system of Claims 102 or 118, wherein user spot beams are directed to user beam coverage areas distributed over a satellite service coverage area that is substantially larger than user beam coverage areas.~~

~~121. The system of Claims 100 or 116, wherein the optical receiver comprises an optical demultiplexer having an input and a plurality of outputs, each output associated with a corresponding optical wavelength.~~

~~122. The system of Claim 121, wherein the wavelengths associated with the outputs of the optical demultiplexer are grouped in optical bands.~~

~~123. The system of Claim 122, wherein wavelengths in the same optical band define unique optical channels.~~

~~124. The system of Claim 116, wherein the optical receiver comprises a plurality of satellite receiver optical detectors each having an RF output coupled to a corresponding RF output of the optical receiver.~~

~~125. The system of Claim 124, wherein the RF signal output from the satellite receiver optical detector has an amplitude that tracks the intensity of the optical signal applied to the satellite receiver optical detector input.~~

~~126. The system of Claims 104 or 125, wherein each optical receiver further comprises a steerable lens having an output coupled to the input of at least one of the plurality of satellite receiver optical detectors.~~

~~127. The satellite of Claim 126, wherein the steerable lens can be positioned by rotation about at least two axis in response to ground commands.~~

~~128. The satellite of Claim 126, wherein the steerable lens can be positioned by rotation about at least two axis in response to on-board processing.~~

~~129. The system of Claims 104 or 125, wherein the satellite receiver optical detector is a photo diode.~~

~~130. The system of Claim 116, further comprising at least one frequency converter coupled between a corresponding switch matrix output and a corresponding antenna input.~~

~~131. The system of Claim 130, further comprising a power amplifier coupled between an output of one of the frequency converters and a corresponding antenna input.~~

~~132. The system of Claim 116, further comprising a plurality of optical receivers, each having a plurality of optical receiver outputs, each optical receiver output being coupled to a switch matrix input.~~

~~133. A satellite communication system comprising:~~

~~at least one SAN comprising:~~

~~an optical transmitter comprising at least one optical modulator, each optical modulator having an electrical input and an optical output;~~

~~an optical combiner having at least one input, each input coupled to the optical output of a corresponding one of the at least one optical modulators; and~~

~~a lens; and~~

~~a satellite comprising:~~

~~at least one an optical receiver configured to receive optical signals from the optical transmitter, the optical receiver having a plurality of digital outputs;~~

~~a plurality of electrical modulators having a digital input and an analog output, the digital input coupled to one of the plurality of digital outputs of the optical receiver;~~

~~a beamformer having a plurality of beamformer inputs coupled to corresponding ones of the analog outputs, the number of beamformer inputs being equal to the number of user spot beams to be formed by the beamformer, the beamformer further having a plurality of beamformer outputs; and~~

~~an antenna array having a plurality of antenna elements, each antenna element having an input coupled to a corresponding one of the beamformer outputs.~~

~~134. The system of Claim 133, further comprising a plurality of LNAs, each LNA coupled between one of the plurality of electrical modulators and a corresponding one of the beamformer inputs.~~

~~135. The system of Claim 133, wherein antenna patterns of at least some of the antenna elements overlap such that signals transmitter therefrom will be superposed upon one another and thus coherently combine to form a user spot beam.~~

~~136. The system of Claim 133, wherein the user spot beams are directed to user beam coverage areas.~~

~~137. The system of Claims 136, wherein user spot beams are directed to user beam coverage areas distributed over a satellite service coverage area that is substantially larger than user beam coverage areas.~~

~~138. The system of Claims 133, wherein the optical receiver comprises an optical demultiplexer having an input and a plurality of outputs, each output associated with a corresponding optical wavelength.~~

~~139. The system of Claim 138, wherein the wavelengths associated with the outputs of the optical demultiplexer are grouped in optical bands.~~

~~140. The system of Claim 139, wherein wavelengths in the same optical band define unique optical channels.~~

~~141. The system of Claim 133, wherein the optical receiver comprises a plurality of satellite receiver optical detectors each having a digital output coupled to a corresponding digital output of the optical receiver.~~

~~142. The system of Claim 141 wherein each satellite receiver optical detector has an optical input and wherein the digital output has two logical states, the first logical state associated with a received optical signal coupled to the input of the satellite receiver optical detector being above a first intensity level of and the second logical state associated with the signal being below a second intensity level.~~

~~143. The system of Claim 133, wherein the modulator is a bi-phase modulator.~~

~~144. The system of Claim 133, wherein the modulator is a QAM modulator.~~

~~145. The system of Claim 133, further comprising at least one frequency converter coupled between a corresponding beamformer output and a corresponding antenna element input.~~

~~146. The system of Claim 145, further comprising a power amplifier coupled between an output of a frequency converter and a corresponding antenna element input.~~

~~147. The system of Claim 133, further comprising a plurality of optical receivers, each having a plurality of optical receiver outputs, each optical receiver output being coupled to a digital input of corresponding modulator.~~

~~148. The system of Claim 133, further comprising additional beamformers, and additional optical receivers, each additional optical receiver having a plurality of digital outputs, the additional beamformers having a plurality of beamformer inputs coupled to corresponding ones of the RF outputs of the additional optical receivers, the number of beamformer inputs being equal to the number of user spot beams to be formed by the beamformers, the beamformers further having a plurality of beamformer outputs, the number of beamformer outputs from each additional beamformer being equal to the number of beam element signals used to form one user spot beam.~~

~~149. A satellite comprising:~~

~~an optical receiver, having a plurality of radio frequency (RF) outputs;~~

~~a beamformer having a plurality of beamformer inputs coupled to corresponding ones of the RF outputs, the number of beamformer inputs being equal to the number of user spot beams to be formed by the beamformer, the beamformer further having a plurality of beamformer outputs; and~~

~~an antenna array having a plurality of antenna elements, each antenna element having an input coupled to a corresponding one of the beamformer outputs.~~

~~150. The satellite of Claim 149, further comprising a plurality of Low noise amplifiers (LNAs), each coupled between an optical receiver output and a corresponding beamformer input.~~

~~151. The satellite of Claim 149, wherein antenna patterns of at least some of the antenna elements overlap such that signals transmitted therefrom will be superposed upon one another and thus coherently combine to form a user spot beam.~~

~~152. The satellite of Claim 151, wherein user spot beams are directed to user beam coverage areas distributed over a satellite service coverage area that is substantially larger than user beam coverage areas.~~

~~153. The satellite of Claim 152, wherein the optical receiver comprises an optical demultiplexer having an input and a plurality of outputs, each output associated with a corresponding optical wavelength.~~

~~154. The satellite of Claim 153, wherein the wavelengths associated with the outputs of the optical demultiplexer are grouped in optical bands.~~

~~155. The satellite of Claim 154, wherein wavelengths in the same optical band define unique optical channels.~~

~~156. The satellite of Claim 154, wherein optical bands that are selected have an attenuation that is not greater than bands that are not selected.~~

~~157. The satellite of Claim 149, wherein the optical receiver comprises a plurality of satellite receiver optical detectors each having an RF output coupled to a corresponding RF output of the optical receiver.~~

~~158. The satellite of Claim 157, wherein the RF signal output from the satellite receiver detector has an amplitude that tracks the intensity of the optical signal applied to the satellite receiver detector input.~~

~~159. The satellite of Claim 158, wherein each optical receiver further comprises a steerable lens having an output coupled to the input of at least one of the plurality of satellite receiver optical detectors.~~

~~160. The satellite of Claim 159, wherein the steerable lens can be positioned by rotation about at least two axis in response to ground commands.~~

~~161. The satellite of Claim 159, wherein the steerable lens can be positioned by rotation about at least two axis in response to on-board processing.~~

~~162. The satellite of Claim 158, wherein the satellite receiver optical detector is a photo diode.~~

~~163. The satellite of Claim 149, further comprising at least one frequency converter coupled between a corresponding one of the beamformer outputs and a corresponding one of the antenna element inputs.~~

~~164. The satellite of Claim 163, further comprising a power amplifier coupled between an output of one of the plurality of frequency converters and a corresponding one of the antenna element inputs.~~

~~165. The satellite of Claim 149, further comprising a plurality of optical receivers, each having a plurality of optical receiver outputs, each optical receiver output being coupled to a beamformer input.~~

~~166. A satellite communication system comprising:~~

~~a beamformer comprising:~~

~~a plurality of beamformer inputs, each configured to receive signals to be directed to a user spot beam;~~

~~a plurality of beamformer outputs, each configured to output a beam element signal;~~

~~at least one pilot output configured to output a timing pilot signal; and~~

~~at least one SAN comprising:~~

~~a plurality of optical modulators each having an electrical input and an optical output, at least one electrical input coupled to a corresponding output from the beamformer and at least one electrical input configured to receive a first timing pilot signal;~~

~~an optical combiner coupled to the optical outputs of the plurality of optical modulators; and~~

~~an optical transmitter configured to transmit an optical signal to a satellite;~~

~~the satellite comprising:~~

~~a satellite optical receiver having an steerable lens pointed at the SAN and configured to receive the optical signal transmitted by the optical transmitter, the satellite optical receiver having a plurality of radio frequency (RF) outputs;~~

~~a plurality of LNAs, each having an input and an output, the inputs coupled to a corresponding plurality of satellite optical receiver RF outputs;~~

~~a plurality of upconverters, each having an input and an output, the inputs coupled to the outputs of corresponding LNAs;~~

~~a plurality of power amplifiers (PA), each having an input and an output, the inputs coupled to the outputs of corresponding upconverters; and~~

~~an antenna array having a plurality of antenna elements, each antenna element having an input coupled to a corresponding one of the PA outputs.~~

~~167. The system of Claim 166, wherein the beamformer applies beam weights to each beam element signal such that when the beam weight signals are demodulated by a satellite and transmitted by a antenna array, they superpose to form user spot beams.~~

~~168. The system of Claim 167, wherein the number of user spot beams formed is equal to the number of beamformer inputs.~~

~~169. The satellite of Claim 166, wherein the steerable lens can be positioned by rotation about at least two axis in response to ground commands.~~

~~170. The satellite of Claim 166, wherein the steerable lens can be positioned by rotation about at least two axis in response to on-board processing.~~

~~171. The system of Claim 166, further comprising at least a second SAN having at least one electrical input coupled to a corresponding output from the beamformer and at least one electrical input configured to receive a second timing pilot signal, wherein the first timing pilot signal and the second timing pilot signal are aligned.~~

~~172. The system of Claim 171, wherein the beamformer further comprises a timing module, and wherein the first and second timing pilot signals are generated by the timing module.~~

~~173. The system of Claim 171, wherein the second pilot timing signal is a copy of the first timing pilot signal.~~

~~174. The system of Claim 173, wherein the number of copies of the timing pilot signals is equal to the number of SANs to which the beamformer is coupled.~~

~~175. The system of Claim 171, wherein the SANs each have a SAN optical receiver configured to receive an optical signal from a satellite and to demultiplex and demodulate a timing pilot signal from the optical signal.~~

~~176. The system of Claim 175, wherein the beamformer further comprises a timing control input, and wherein the SAN further comprises a timing pilot modem coupled to the SAN optical receiver, the timing pilot modem having an output coupled to the beamformer timing control input.~~

~~177. The system of Claim 176, wherein the timing module within the beamformer generates a delay in the transmission of beam elements signals in response to signals presented to the timing control input.~~

~~178. The system of Claim 175, where the SAN further comprises a timing module coupled between the beamformer and each optical modulator, the timing module having a timing control input coupled to receive the timing pilot signal from the SAN optical receiver.~~

~~179. The system of Claim 178, wherein the timing module within the SAN generates a delay in the transmission of beam elements signals in response to signals presented to the timing control input.~~

~~180. The system of Claim 166, wherein the antenna patterns of at least some of the antenna elements overlap such that signals transmitter therefrom will be superposed upon one another and thus coherently combine to form a user spot beam.~~

181. The system of Claim 180, wherein user spot beams are directed to user beam coverage areas distributed over a satellite service coverage area that is substantially larger than user beam coverage areas.

182. The system of Claim 181, wherein the satellite optical receiver comprises an optical demultiplexer having an input and a plurality of outputs, each output associated with a corresponding optical wavelength.

183. The system of Claim 182, wherein the wavelengths associated with the outputs of the optical demultiplexer are grouped in optical bands.

184. The system of Claim 183, wherein wavelengths in the same optical band define unique optical channels.

185. The system of Claim 183, wherein optical bands that are selected have an attenuation that is not greater than bands that are not selected.

186. The system of Claim 166, wherein the satellite optical receiver comprises a plurality of satellite receiver optical detectors each having an RF output coupled to a corresponding RF output of the satellite optical receiver.

187. The system of Claim 186, wherein the RF signal output from the satellite receiver detector has an amplitude that tracks the intensity of the optical signal applied to the satellite receiver optical detector input.

188. The system of Claim 187, wherein each satellite optical receiver further comprises a steerable lens having an output coupled to the input of at least one of the plurality of satellite receiver optical detectors.

189. The satellite of Claim 188, wherein the steerable lens can be positioned by rotation about at least two axis in response to ground commands.

190. The satellite of Claim 188, wherein the steerable lens can be positioned by rotation about at least two axis in response to on-board processing.

191. The system of Claim 187, wherein the satellite receiver optical detector is a photo diode.

192. The system of Claim 166, further comprising at least one frequency converter coupled between a corresponding beamformer output and a corresponding antenna element input.

193. The system of Claim 192, further comprising a power amplifier coupled between an output of a frequency converter and a corresponding antenna element input.

194. The satellite of Claim 166, further comprising a plurality of satellite optical receivers, each having a plurality of optical receiver outputs, each optical receiver output being coupled to a beamformer input.

195. The system of Claim 166, 180, 181, 182, 183, 184, 185, 186, 187, 188, 191, 192, 193, or 194, the SANs further comprising a timing module having inputs configured to receive the beam element signals and the timing pilot signal and a plurality of outputs configured to output appropriately delayed beam element signals and timing pilot signal, the output coupled to the electrical inputs of the plurality of optical modulators.

196. The system of Claim 195, each of the plurality of optical modulators comprise at least one light source operating at an optical wavelength within one of four optical bands.

197. The system of Claim 196, wherein the four optical bands are centered at approximately 1100nm, 1300nm, 1550nm and 2100nm.

198. The system of Claim 196, wherein the wavelength of each light source within the same optical band is spaced apart by approximately 100 GHz.

199. The system of Claim 196, wherein the electrical input to the plurality of optical modulators is further configured to receive a signal having a bandwidth of approximately 3.5 GHz.

200. The system of Claim 166, 180, 181, 182, 183, 184, 185, 186, 187, 188, 191, 192, 193, or 194, the SANs further comprising a plurality of baseband to IF converters, each having:

an output;

a plurality of frequency converters having outputs; and

a summing circuit having a plurality of inputs and an output, each input coupled to a corresponding one of the plurality of frequency converter outputs;

wherein the output of each of the plurality of baseband to IF converters is coupled to the electrical input of a corresponding one of the plurality of optical modulators.

201. The system of Claim 200, wherein the plurality of frequency converters have inputs configured to receive beam element signals.

~~202. The system of Claim 200, wherein at least one of the frequency converters is configured to receive a timing pilot signal.~~

~~203. The system of Claim 166, 180, 181, 182, 183, 184, 185, 186, 187, 188, 191, 192, 193, or 194, the SANs further comprising a SAN optical receiver configured to receive an optical signal and to output a plurality of beam element signals.~~

~~204. The system of Claim 203, wherein the SAN optical receiver is further configured to output at least one timing pilot signal.~~

~~205. A method of transmitting information through a satellite of a satellite communications system, comprising:~~

~~receiving an optical signal within the satellite;~~

~~demultiplexing the optical signal and outputting a plurality of optical signals, each of the plurality of demultiplexed optical signals having a wavelength in a unique optical channel;~~

~~generating a plurality of digital electrical signals, each having a logical state determined in response to the optical intensity of one of the demultiplexed optical signals;~~

~~generating an analog signal based on the digital signals; and~~

~~selecting at least one of the analog signals to be transmitted in a user spot beam.~~

~~206. The method of Claim 205, wherein generating the analog signal comprises generating a binary phase shift keying (BPSK) analog signal.~~

~~207. The method of Claim 205, wherein generating the analog signal comprises modulating a carrier with symbols representing more than two logic states on the analog signal.~~

~~208. The method of Claims 206 or 207, further comprising amplifying the at least one analog signal.~~

~~209. The method of Claim 208, further comprising receiving at least a second optical signal and wherein selecting which analog signals to transmit in each user spot beam is made based upon the quality of optical links between the satellite and SANs over which the received optical signals have been transmitted to the satellite.~~

~~210. The method of Claim 209, wherein selecting which analog signals to be transmitted in each user spot beam comprises time multiplexing analog signals between more than one user spot beams.~~

~~211. The method of Claim 210, further comprising receiving at least a second optical signal and wherein time multiplexing analog signals is performed in response to the quality of at least one of the received optical signals being below a threshold.~~

~~212. The method of Claim 210, wherein receiving an optical signal further comprises directing an optical receiver to receive optical signals from SANs for which there is an optical link to the satellite that is above a quality threshold.~~

~~213. The method of Claim 205, 206, 207 or 210, wherein receiving optical signals further comprises redirecting at least one optical receiver away from a SAN from which there is an optical link that is below a first quality threshold and to a SAN from which there is an optical link for which the quality is above a second quality threshold.~~

~~214. The method of Claim 213, wherein the first quality threshold is the same as the second quality threshold.~~

~~215. The method of Claims 206 or 207, further comprising selecting a plurality of analog signals, each selected analog signal to be transmitted to a unique user spot beam.~~

~~216. The method of Claims 206 or 207, further comprising amplifying the analog signals before selecting the analog signal for transmission to a user spot beam.~~

~~217. The method of Claims 206 or 207, further comprising amplifying the selected analog signals after selection for transmission in a user spot beam.~~

~~218. The method of Claim 205, further comprising:~~

~~providing at least one power amplifier, wherein the number of power amplifiers in the satellite is less than the number of analog signals;~~

~~selecting a first analog signal to be amplified by a first power amplifier within the satellite during a first time period;~~

~~selecting a first user spot beam over which to transmit the analog signal during the first time period;~~

selecting a second analog signal to be amplified by a first power amplifier within the satellite during a second time period; and

selecting a second user spot beam over which to transmit the second analog signal during the second time period.

219. A method of transmitting information through a satellite of a satellite communications system, comprising:

receiving an optical signal within the satellite;

demultiplexing the optical signal and outputting a plurality of optical signals, each of the plurality of demultiplexed optical signals having a wavelength in a unique optical channel;

generating a plurality of analog electrical signals, each having an amplitude determined in response to the optical intensity of one of the demultiplexed optical signals; and

selecting at least one of the analog signals to be transmitted in a user spot beam.

220. The method of Claim 219, further comprising amplifying the at least one analog signal before selection.

221. The method of Claim 219, further comprising amplifying the at least one analog signal after selection.

222. The method of Claim 219, wherein selection of at least one analog signal includes coupling the analog signal to a particular one of a plurality of switch matrix inputs, connecting the particular input to a selected one of a plurality of switch matrix outputs and connecting the selected switch matrix output to a particular one of a plurality of antenna inputs and wherein signals coupled to the particular antenna input are transmitted by the antenna in the user spot beam.

223. The method of Claim 222, further including receiving commands within the satellite to connect particular switch matrix inputs to particular switch matrix outputs based on the quality of the optical links between satellite access nodes (SANs) and the satellite.

224. The method of Claim 223, wherein the received commands include commands that connect a particular switch matrix input to a first switch matrix output for during a first period of time and to a second switch matrix output during a second period of time.

225. The method of Claim 219, wherein the analog signal is an IF composite signal having a plurality of sub-channels combined thereon.

226. The method of Claim 225 wherein the IF composite signal has a bandwidth of 3.5 GHz.

227. The method of Claim 226, wherein 16 IF composite signals are demultiplex from the optical signal.

228. The method of Claim 226, wherein demultiplexing includes separating a plurality of IF composite signals that are intensity modulated onto the optical carrier, each spaced approximately 0.8 nm apart over the optical spectrum.

229. The method of Claim 225, wherein the sub-channels have a bandwidth of 500 MHz.

230. A method of transmitting information through a satellite of a satellite communications system, comprising:

receiving an optical signal within a satellite;

demultiplexing the optical signal and outputting a plurality of optical signals, each of the plurality of demultiplexed optical signals having a wavelength in a unique optical channel

generating a plurality of analog electrical signals, each having an amplitude determined in response to the optical intensity of one of the demultiplexed optical signals;

applying the plurality of analog electrical signals to a beamformer aboard the satellite;

receiving from the beamformer beam element signals; and

transmitting the beam element signals from an antenna array such that when the beam element signals are superpose with one another, they form a user spot beam.

231. The method of Claim 230, further including receiving commands within the beamformer to generate beam element signals, each of the beam element signal beam weighted to form user spot beams directed to a first user beam coverage area particular based on the quality of the optical links between satellite access nodes (SANs) and the satellite.

232. The method of Claim 231, wherein the received commands include commands to generate beam element signals, each of the beam element signal beam weighted to form user spot beams directed to a first user beam coverage area during a first period of time and to a user spot beams directed to a second user beam coverage area during a second period of time.

233. The method of Claim 230, further comprising amplifying the beam element signals before transmission.

234. A method for transmitting signals to a satellite comprising:

receiving a plurality of beam element signals with a satellite access node (SAN);

receiving at least one timing pilot signal within the SAN;

modulating the received beam element signals and the received timing pilot signal onto an optical carrier;

transmitting the modulated optical carrier to the satellite.

235. The method of Claim 234 further comprising:

receiving a timing control signal;

delaying the received beam element signals in response to the received timing control signal.

236. A method for transmitting signals to a satellite comprising;

generating the timing pilot signal within a beamformer;

receiving a plurality of binary data streams within the beamformer, the binary data streams for transmission to a plurality of user beam coverage areas;

generating a plurality of beam element signals, each beam element signal generated such that when transmitted from an antenna array in the satellite the beam element signals superpose with one another to form at least one user spot beam; and

providing the beam element signals from the beamformer to the SAN together with the timing pilot signal.

237. A method of transmitting information through a satellite of a satellite communications system, comprising:

receiving within a SAN, at least one digital data stream;

intensity modulating the at least one digital data stream on an optical channel signal;

multiplexing the optical channel signals onto an optical feeder link signal;

transmitting the modulated optical feeder link signal to the satellite;

receiving the optical signal within the satellite;

demultiplexing the optical channels signals from the optical feeder link signal;

generating a plurality of digital electrical signals, each having a logical state determined in response to the optical intensity of one of the demultiplexed optical signals;

generating an analog signal based on the digital signals; and

selecting at least one of the analog signals to be transmitted in a user spot beam.

238. The method of Claim 237, wherein generating the analog signal comprises generating a binary phase shift keying (BPSK) analog signal.

239. The method of Claim 237, wherein generating the analog signal comprises modulating a carrier with symbols representing more than two logic states on the analog signal.

240. The method of Claims 238 or 239, further comprising receiving at least a second optical signal and wherein selecting which analog signals to be transmitted in each user spot beam is made based upon the quality of optical links between the satellite and SANs over which the received optical signals have been transmitted to the satellite.

241. The method of Claim 240, wherein selecting which analog signals to be transmitted in each user spot beam comprises time multiplexing analog signals between more than one user spot beam.

242. The method of Claim 241, further comprising receiving at least a second optical signal and wherein time multiplexing analog signals is performed in response to the quality of at least one of the received optical signals being below a threshold.

243. The method of Claim 241, wherein receiving an optical signal further comprises directing an optical receiver to receive optical signals from SANs for which there is an optical link to the satellite that is above a quality threshold.

244. The method of Claim 237, 238, 239 or 241, wherein receiving optical signals further comprises redirecting at least one optical receiver away from a SAN from which there is an optical link that is below a first quality threshold and to a SAN from which there is an optical link for which the quality is above a second quality threshold.

245. The method of Claim 244, wherein the first quality threshold is the same as the second quality threshold.

246. The method of Claims 238 or 239, further comprising selecting a plurality of analog signals, each selected analog signal to be transmitted to a unique user spot beam.

247. The method of Claim 237, further comprising:

providing at least one power amplifier in the satellite, wherein the number of power amplifiers is less than the number of analog signals;

selecting a first analog signal to be amplified by a first power amplifier within the satellite during a first time period;

selecting a first user spot beam over which to transmit the analog signal during the first time period;

selecting a second analog signal to be amplified by a first power amplifier within the satellite during a second time period; and

selecting a second user spot beam over which to transmit the second analog signal during the second time period.

248. A method of transmitting information through a satellite of a satellite communications system, comprising:

receiving within a SAN, at least one digital data stream;

intensity modulating the at least one digital data stream on an optical channel signal;

multiplexing the optical channel signals onto an optical feeder link signal;

transmitting the modulated optical feeder link signal to the satellite;

receiving an optical signal within the satellite;

demultiplexing the optical signal and outputting a plurality of optical signals, each of the plurality of demultiplexed optical signals having a wavelength in a unique optical channel;

generating a plurality of analog electrical signals, each having an amplitude determined in response to the optical intensity of one of the demultiplexed optical signals; and

selecting at least one of the analog signals to be transmitted in a user spot beam.

249. The method of Claim 248, wherein selection of at least one analog signal includes coupling the analog signal to a particular one of a plurality of switch matrix inputs, connecting the particular input to a selected one of a plurality of switch matrix outputs and connecting the selected switch matrix output to a particular one of a plurality of antenna inputs and wherein signals coupled to the particular antenna input are transmitted by the antenna in the user spot beam.

250. The method of Claim 249, further including receiving commands within the satellite to connect particular switch matrix inputs to particular switch matrix outputs based on the quality of the optical links between satellite access nodes (SANs) and the satellite.

251. The method of Claim 250, wherein the received commands include commands that connect a particular switch matrix input to a first switch matrix output for during a first period of time and to a second switch matrix output during a second period of time.

252. The method of Claim 248, wherein the analog signal is an IF composite signal having a plurality of sub-channels combined thereon.

253. The method of Claim 252, wherein the IF composite signal has a bandwidth of 3.5 GHz.

254. The method of Claim 253, wherein 16 IF composite signals are demultiplex from the optical signal.

255. The method of Claim 253, wherein demultiplexing includes separating a plurality of IF composite signals that are intensity modulated onto the optical carrier, each spaced approximately 0.8 nm apart over the optical spectrum.

256. The method of Claim 252, wherein the sub-channels have a bandwidth of 500 MHz.

257. A method of transmitting information through a satellite of a satellite communications system, comprising:

receiving a plurality of binary data streams within the beamformer, the binary data streams for transmission to a plurality of user beam coverage areas;

generating a plurality of beam element signals, each beam element signal generated such that when transmitted from an antenna array in the satellite the beam element signals superpose with one another to form at least one user spot beam; and

~~transmitting the beam element signals from the beamformer to at least one SAN;~~

~~receiving a plurality of beam element signals with the at least one SAN;~~

~~modulating the received beam element signals onto an optical carrier;~~

~~transmitting the modulated optical carrier from the at least one SAN to the satellite;~~

~~receiving an optical signal within a satellite;~~

~~demultiplexing the optical signal and outputting a plurality of optical signals, each of the plurality of demultiplexed optical signals having a wavelength in a unique optical channel;~~

~~generating a plurality of analog electrical signals, each having an amplitude determined in response to the optical intensity of one of the demultiplexed optical signals;~~

~~applying the plurality of analog electrical signals to elements of an antenna array such that when the beam element signals are superpose with one another, they form at least one user spot beam.~~

~~258. The method of Claim 257, further including:~~

~~generating at least one timing pilot signal within the beamformer;~~

~~transmitting the timing pilot signal together with the beam element signals to at least two SANs;~~

~~receiving timing pilot signals within the at least two SANs;~~

~~modulating the received timing pilot signals onto the optical carrier in the at least two SANs;~~

~~transmitting the timing pilot signals from each of the at least two SANs;~~

~~receiving in the satellite the timing pilot signals from the at least two SANs;~~

~~demodulating the timing pilot signal in the satellite;~~

~~determining the time difference between the two timing pilot signals and generating a timing correction signals based on the time difference; and~~

~~transmitting the timing correction signal to the at least two SANs.~~

~~259. The method of Claim 258, further including delaying the transmission of the beam element signals from at least one of the SANs to reduce the time difference.~~

~~260. The method of Claim 257, further including generating the plurality of beam element signals based on the quality of the optical links between the satellite and the at least one SAN.~~

~~261. The method of Claim 257, wherein each of the at least one SANs receives a subset of the plurality of beam element signals.~~

~~262. The method of Claim 257, further comprising positioning lenses within the satellite to receive optical signals from a subset of SANs, wherein SANs are included in the subset based on the attenuation of optical signals transmitted over the optical link between each SAN and the satellite.~~

~~263. The method of Claim 262, wherein positioning the lenses further comprises redirecting a lens away from a first SAN and pointing the lens at a second SAN if the satellite is not currently receiving an optical signal from the second SAN and the optical link between the satellite and the second SAN has less attenuation than the optical link between the satellite and the first SAN.~~

~~264. A satellite comprising:~~

~~an antenna having a plurality of antenna outputs;~~

~~a plurality of frequency converters, each coupled to a corresponding one of the plurality of antenna outputs;~~

~~a switch matrix having a plurality of switch matrix inputs and switch matrix outputs, each switch matrix input coupled to a corresponding one of the frequency converters; and~~

~~a plurality of RF demodulators, each having an input configured to receive an RF signal from a corresponding switch matrix output and each having an RF demodulator output configured to output a digital data stream;~~

~~an optical transmitter having a plurality of digital inputs, each digital input coupled to a corresponding RF demodulator output, and having an optical output port configured to output an optical signal having multiplexed optical channels upon which the digital data stream has been modulated.~~

~~265. The satellite of Claim 264, wherein at least one of the RF demodulators is a binary demodulator.~~

~~266. The satellite of Claim 264, wherein at least one of the RF demodulators is a QAM demodulator.~~

~~267. A satellite comprising:~~

an antenna having a plurality of antenna outputs;

a switch matrix having a plurality of switch matrix inputs and switch matrix outputs, each of the switch matrix inputs coupled to a corresponding one of the plurality of antenna outputs; and

an optical transmitter having a plurality of RF inputs and an optical output, the optical output configured to output an optical signal having multiplexed optical channels modulated by signals coupled to the RF inputs.

268. A satellite comprising:

an antenna having a plurality of antenna outputs;

a plurality of frequency converters, each coupled to a corresponding one of the plurality of antenna outputs;

a beamformer having a plurality of beamformer inputs and beamformer outputs, each beamformer input coupled to a corresponding one of the frequency converters;

a plurality of RF demodulators, each having an RF demodulator input configured to receive an RF signal from a corresponding beamformer output and configured to output a digital data stream; and

an optical transmitter having a plurality of digital inputs, each coupled to an output of a corresponding one of the RF demodulators and having an optical output configured to output an optical signal having multiplexed optical channels upon which the digital data stream has been modulated.

269. The satellite of Claim 267, wherein the RF demodulator is a binary demodulator.

270. The satellite of Claim 267, wherein the RF demodulator is a QAM demodulator.

271. A satellite comprising:

an antenna having a plurality of antenna outputs;

a plurality of frequency converters, each having a converter input coupled to a corresponding one of the antenna outputs and having a converter output;

a beamformer having a plurality of beamformer inputs and beamformer outputs, each of the beamformer inputs coupled to a corresponding output of one of the plurality of frequency converters; and

an optical transmitter having a plurality of RF inputs, each coupled to a corresponding beamformer output and having an optical output, the optical output configured to output an optical signal having multiplexed optical channels modulated by signals coupled to the RF inputs.

272. A satellite comprising:

an antenna having a plurality of antenna outputs; and

an optical transmitter having a plurality of transmitter inputs, each transmitter input coupled to a corresponding one of the antenna outputs and the optical transmitter having an optical output configured to output a multiplexed optical signals having a plurality of channels each modulated by a signal applied to the transmitter input.

273. A SAN comprising:

an steerable optical lens configured to receive an optical signal from a satellite;

an optical demultiplexer having a demux input coupled to receive the optical signal from the optical lens and a plurality of demux outputs configured to output optical channels demultiplexed from the optical signal;

a plurality of optical detectors, each optical detector coupled to a corresponding one of the demux outputs, the optical detectors having a detector output.

274. The SAN of Claim 273, wherein the detector output is configured to output a digital data stream.

275. The SAN of Claim 273, wherein the detector output is configured to output an RF signal, the amplitude of which is proportional to the intensity of a signal coupled to the detector from the corresponding one of the demux outputs.

276. The SAN of Claim 275, wherein the detector outputs are configured to output beam element signals to a beamformer.

277. A ground network of a satellite communication system, comprising:

a SAN comprising:

an steerable optical lens configured to receive an optical signal from a satellite;

an optical demultiplexer having a demux input coupled to receive the optical signal from the optical lens and a plurality of demux outputs configured to output optical channels demultiplexed from the optical signal; and

a plurality of optical detectors, each optical detector coupled to a corresponding one of the demux outputs, the optical detectors having a detector output configured to output an RF signal, the amplitude of which is proportional to the intensity of a signal coupled to the detector from the corresponding one of the demux outputs;

a beamformer having a plurality of beamformer inputs, each configured to receive an RF output signal from a corresponding one of the plurality of optical detectors.

278. A satellite communication system comprising:

a satellite comprising:

an antenna having a plurality of antenna outputs;

a switch matrix having a plurality of switch matrix inputs and switch matrix outputs, each of the switch matrix inputs coupled to a corresponding one of the plurality of antenna outputs; and

an optical transmitter having a plurality of RF inputs and an optical output, the optical output configured to output an optical signal having multiplexed optical channels modulated by signals coupled to the RF inputs; and

a SAN comprising:

an steerable optical lens configured to receive an optical signal from the satellite;

an optical demultiplexer having a demux input coupled to receive the optical signal from the optical lens and a plurality of demux outputs configured to output optical channels demultiplexed from the optical signal; and

a plurality of optical detectors, each optical detector coupled to a corresponding one of the demux outputs, the optical detectors having a detector output.

279. The satellite communication system of Claim 278, wherein the detector output is configured to output a digital data stream.

280. The satellite communication system of Claim 278, wherein the detector output is configured to output an RF signal, the amplitude of which is proportional to the intensity of a signal coupled to the detector from the corresponding one of the demux outputs.

281. A satellite communication system comprising:

a satellite comprising:

an antenna having a plurality of antenna outputs;

a switch matrix having a plurality of switch matrix inputs and switch matrix outputs, each of the switch matrix inputs coupled to a corresponding one of the plurality of antenna outputs; and

an optical transmitter having a plurality of RF inputs and an optical output, the optical output configured to output an optical signal having multiplexed optical channels modulated by signals coupled to the RF inputs; and

a SAN comprising:

an steerable optical lens configured to receive an optical signal from the satellite;

an optical demultiplexer having a demux input coupled to receive the optical signal from the optical lens and a plurality of demux outputs configured to output optical channels demultiplexed from the optical signal; and

a plurality of optical detectors, each optical detector coupled to a corresponding one of the demux outputs, the optical detectors having a detector output.

282. A satellite communication system comprising:

satellite comprising:

an antenna having a plurality of antenna outputs;

a plurality of frequency converters, each coupled to a corresponding one of the plurality of antenna outputs;

a beamformer having a plurality of beamformer inputs and beamformer outputs, each beamformer input coupled to a corresponding one of the frequency converters;

a plurality of RF demodulators, each having an RF demodulator input configured to receive an RF signal from a corresponding beamformer output and configured to output a digital data stream; and

an optical transmitter having a plurality of digital inputs, each coupled to an output of a corresponding one of the RF demodulators and having an optical output configured to output an optical signal having multiplexed optical channels upon which the digital data stream has been modulated; and

a SAN comprising:

an steerable optical lens configured to receive an optical signal from the satellite;

an optical demultiplexer having a demux input coupled to receive the optical signal from the optical lens and a plurality of demux outputs configured to output optical channels demultiplexed from the optical signal; and

a plurality of optical detectors, each optical detector coupled to a corresponding one of the demux outputs, the optical detectors having a detector output.

283. The satellite communication system of Claim 282, wherein the detector output is configured to output a digital data stream.

284. The satellite communication system of Claim 282, wherein the detector output is configured to output an RF signal, the amplitude of which is proportional to the intensity of a signal coupled to the detector from the corresponding one of the demux outputs.

285. A satellite communication system comprising:

satellite comprising:

an antenna having a plurality of antenna outputs;

a plurality of frequency converters, each having a converter input coupled to a corresponding one of the antenna outputs and having a converter output;

a beamformer having a plurality of beamformer inputs and beamformer outputs, each of the beamformer inputs coupled to a corresponding output of one of the plurality of frequency converters; and

an optical transmitter having a plurality of RF inputs, each coupled to a corresponding beamformer output and having an optical output, the optical output configured to output an optical signal having multiplexed optical channels modulated by signals coupled to the RF inputs; and

a SAN comprising:

an steerable optical lens configured to receive an optical signal from the satellite;

an optical demultiplexer having a demux input coupled to receive the optical signal from the optical lens and a plurality of demux outputs configured to output optical channels demultiplexed from the optical signal; and

a plurality of optical detectors, each optical detector coupled to a corresponding one of the demux outputs, the optical detectors having a detector output.

286. A satellite communication system comprising:

satellite comprising:

an antenna having a plurality of antenna outputs; and

an optical transmitter having a plurality of transmitter inputs, each transmitter input coupled to a corresponding one of the antenna outputs and the optical transmitter having an optical output configured to output a multiplexed optical signals having a plurality of channels each modulated by a signal applied to the transmitter input; and

a SAN comprising:

an steerable optical lens configured to receive an optical signal from a satellite;

an optical demultiplexer having a demux input coupled to receive the optical signal from the optical lens and a plurality of demux outputs configured to output optical channels demultiplexed from the optical signal;

a plurality of optical detectors, each optical detector coupled to a corresponding one of the demux outputs, the optical detectors having a detector output

a beamformer having a plurality of beamformer inputs, each configured to receive an RF output signal from a corresponding one of the plurality of optical detectors.