

WHAT IS CLAIMED IS:

1. A method comprising:
selecting, at a transmitter, a frame format for use in communicating a packet via
a sub-one gigahertz wireless network operating at a particular bandwidth,
wherein the frame format is selected based at least in part on the
particular bandwidth;
determining one or more timing parameters based on the selected frame format
and the particular bandwidth;
generating the packet in accordance with the selected frame format and the one
or more timing parameters; and
sending the packet from the transmitter to a receiver,
wherein the selected frame format is a short frame format when the particular
bandwidth is one megahertz, and
wherein the selected frame format is the short frame format or a long frame
format when the particular bandwidth is greater than one megahertz.
2. The method of claim 1, wherein the sub-one gigahertz wireless network
operates in accordance with an Institute of Electrical and Electronics Engineers (IEEE)
802.11ah protocol.
3. The method of claim 1, wherein the short frame format comprises a short
training field (STF), a long training field (LTF), a signal field (SIG), and a data portion.
4. The method of claim 3, wherein when more than one spatial stream is in use,
the short frame format further comprises one or more additional LTFs.

5. The method of claim 1, wherein:
the long frame format comprises a first portion without precoding and a second portion with precoding;
the first portion comprises a short training field (STF), a first long training field (LTF), and a signal A field (SIG-A); and
the second portion comprises a second STF, one or more signal B fields (SIG-Bs), and a data portion.
6. The method of claim 5, wherein when more than one spatial stream is in use, the long frame format further comprises one or more additional LTFs.
7. The method of claim 1, wherein the particular bandwidth comprises 1 megahertz (MHz), 2 MHz, 4 MHz, 8 MHz, or 16 MHz.

8. The method of claim 1, wherein the one or more timing parameters include:

- a number of complex data subcarriers;
- a number of pilot subcarriers;
- a number of total subcarriers excluding guards;
- a highest data subcarrier index;
- a subcarrier frequency spacing;
- a discrete Fourier transform (DFT) period;
- an inverse DFT (IDFT) period;
- a guard interval duration;
- a double guard interval duration;
- a short guard interval duration;
- an orthogonal frequency-division multiplexing (OFDM) symbol duration with long guard intervals;
- an OFDM symbol duration with short guard intervals;
- an OFDM symbol duration;
- a number of bits in a SERVICE field;
- a number of tail bits per binary convolution code encoder;
- a short training field (STF) duration;
- a long training field (LTF) duration;
- a signal field (SIG) duration;
- a signal A field (SIG-A) duration;
- a multiple-input multiple-output LTF (MIMO-LTF) duration;
- a long format STF duration;
- a signal B field (SIG-B) duration;
- or any combination thereof.

9. The method of claim 8, wherein the STF duration, the LTF duration, and one of the SIG duration and the SIG-A duration are each longer when the particular bandwidth is one megahertz than when the particular bandwidth is greater than one megahertz.

10. The method of claim 8, wherein:

the subcarrier frequency spacing is 31.25 kilohertz (KHz);

the DFT period is 32 microseconds (μ s);

the IDFT period is 32 μ s;

the guard interval duration is 8 μ s;

a double guard interval duration is 16 μ s;

a short guard interval duration is 4 μ s;

the OFDM symbol duration with long guard intervals is 40 μ s;

an OFDM symbol duration with short guard intervals is 36 μ s;

the OFDM symbol duration is 40 μ s or 36 μ s;

the number of bits in the SERVICE field is 16;

the number of tail bits per binary convolution code encoder is 6; and

the MIMO-LTF duration is 40 μ s.

11. The method of claim 8, wherein when the particular bandwidth is 1 megahertz (MHz):

the number of complex data subcarriers is 24;

the number of pilot subcarriers is 2;

the number of total subcarriers excluding guards is 26;

the highest data subcarrier index is 13;

the STF duration is 160 microseconds (μ s);

the LTF duration is 160 μ s; and

the SIG duration is 240 μ s or 200 μ s.

12. The method of claim 8, wherein when the particular bandwidth is greater than 1 megahertz (MHz):

the STF duration is 80 microseconds (μ s);

the LTF duration is 8 μ s;

the SIG duration is 80 μ s;

the SIG-A duration is 80 μ s;

the long format STF duration is 40 μ s; and

the SIG-B duration is 40 μ s.

13. The method of claim 8, wherein when the particular bandwidth is 2 megahertz (MHz):

the number of complex data subcarriers is 52;
the number of pilot subcarriers is 4;
the number of total subcarriers excluding guards is 56; and
the highest data subcarrier index is 28.

14. The method of claim 8, wherein when the particular bandwidth is 4 megahertz (MHz):

the number of complex data subcarriers is 108;
the number of pilot subcarriers is 6;
the number of total subcarriers excluding guards is 114; and
the highest data subcarrier index is 58.

15. The method of claim 8, wherein when the particular bandwidth is 8 megahertz (MHz):

the number of complex data subcarriers is 234;
the number of pilot subcarriers is 8;
the number of total subcarriers excluding guards is 242; and
the highest data subcarrier index is 122.

16. The method of claim 8, wherein when the particular bandwidth is 16 megahertz (MHz):

the number of complex data subcarriers is 468;
the number of pilot subcarriers is 16;
the number of total subcarriers excluding guards is 484; and
the highest data subcarrier index is 250.

17. A non-transitory processor-readable medium storing:
one or more data structures, the one or more data structures indicating timing parameters for a short frame format and a long frame format of a sub-one gigahertz wireless network for each of a plurality of operating bandwidths of the sub-one gigahertz wireless network,
wherein the timing parameters include:
- a number of complex data subcarriers;
 - a number of pilot subcarriers;
 - a number of total subcarriers excluding guards;
 - a highest data subcarrier index;
 - a subcarrier frequency spacing;
 - an inverse discrete Fourier transform period;
 - a discrete Fourier transform period;
 - a guard interval duration;
 - a double guard interval duration;
 - a short guard interval duration;
 - an orthogonal frequency-division multiplexing (OFDM) symbol duration with long guard intervals;
 - an OFDM symbol duration with short guard intervals;
 - an OFDM symbol duration;
 - a number of bits in a SERVICE field;
 - a number of tail bits per binary convolution code encoder;
 - a short training field (STF) duration;
 - a long training field (LTF) duration;
 - a signal field (SIG) duration;
 - a signal A field (SIG-A) duration;
 - a multiple-input multiple-output LTF (MIMO-LTF) duration;
 - a long format STF duration;
 - a signal B field (SIG-B) duration;
 - or any combination thereof.

18. An apparatus comprising:

a memory storing one or more data structures, the one or more data structures indicating timing parameters for a plurality of frame formats and a plurality of bandwidths of a sub-one gigahertz wireless network; and a processor coupled to the memory, the processor configured to:

select a frame format for use in communicating a packet via the sub-one gigahertz wireless network operating at a particular bandwidth, wherein the frame format is selected based at least in part on the particular bandwidth;

determine one or more timing parameters based on the selected frame format and the particular bandwidth; and

generate the packet in accordance with the selected frame format and the one or more timing parameters,

wherein the selected frame format is a short frame format when the particular bandwidth is one megahertz, and

wherein the selected frame format is the short frame format or a long frame format when the particular bandwidth is greater than one megahertz.

19. The apparatus of claim 18, wherein the sub-one gigahertz wireless network operates in accordance with an Institute of Electrical and Electronics Engineers (IEEE) 802.11ah protocol.

20. An apparatus comprising:

means for storing one or more data structures, the one or more data structures indicating timing parameters for a plurality of frame formats and a plurality of bandwidths of a sub-one gigahertz wireless network;

means for selecting a frame format for use in communicating a packet via the sub-one gigahertz wireless network operating at a particular bandwidth, wherein the frame format is selected based at least in part on the particular bandwidth;

means for determining one or more timing parameters based on the selected frame format and the particular bandwidth; and

means for generating the packet in accordance with the selected frame format and the one or more timing parameters.

CLAIMS

1. A method comprising:
 - selecting, at a transmitter, a frame format for use in communicating a packet via a sub-one gigahertz wireless network operating at a particular bandwidth, wherein the frame format is selected based at least in part on the particular bandwidth;
 - determining one or more timing parameters based on the selected frame format and the particular bandwidth;
 - generating the packet in accordance with the selected frame format and the one or more timing parameters;
 - and
 - sending the packet from the transmitter to a receiver, wherein the selected frame format is a first frame format when the particular bandwidth is one megahertz, wherein the selected frame format is the first frame format or a second frame format when the particular bandwidth is greater than one megahertz, wherein the second frame format comprises a first portion and a second portion, wherein the first portion comprises an omni portion comprising a short training field (STF), a first long training field (LTF), and a signal A field (SIG-A), and wherein the second portion comprises a data portion comprising a second STF, one or more signal B fields (SIG-Bs), and a data field.
2. The method of claim 1, wherein the sub-one gigahertz wireless network operates in accordance with an Institute of Electrical and Electronics Engineers (IEEE) 802.11ah protocol.

3. The method of claim 1, wherein the first frame format comprises a short training field (STF), a long training field (LTF), a signal field (SIG), and a data portion.

4. The method of claim 3, wherein when more than one spatial stream is in use, the first frame format further comprises one or more additional LTFs.

5. The method of claim 1, wherein when more than one spatial stream is in use, the second frame format further comprises one or more additional LTFs.

6. The method of claim 1, wherein the particular bandwidth comprises 1 megahertz (MHz), 2 MHz, 4 MHz, 8 MHz, or 16 MHz.

7. The method of claim 1, wherein the one or more timing parameters include:

- a number of complex data subcarriers;
- a number of pilot subcarriers;
- a number of total subcarriers excluding guards;
- a highest data subcarrier index;
- a subcarrier frequency spacing;
- a discrete Fourier transform (DFT) period;
- an inverse DFT (IDFT) period;
- a guard interval duration;
- a double guard interval duration;
- a short guard interval duration;
- an orthogonal frequency-division multiplexing (OFDM)
 - symbol duration with long guard intervals;
- an OFDM symbol duration with short guard intervals;
- an OFDM symbol duration;

a number of bits in a SERVICE field;
a number of tail bits per binary convolution code encoder;
a short training field (STF) duration;
a long training field (LTF) duration;
a signal field (SIG) duration;
a signal A field (SIG-A) duration;
a multiple-input multiple-output LTF (MIMO-LTF) duration;
a long format STF duration;
a signal B field (SIG-B) duration;
or any combination thereof.

8. The method of claim 7, wherein the STF duration, the LTF duration, and one of the SIG duration and the SIG-A duration are each longer when the particular bandwidth is one megahertz than when the particular bandwidth is greater than one megahertz.

9. The method of claim 7, wherein:
the subcarrier frequency spacing is 31.25 kilohertz (KHz);
the DFT period is 32 microseconds (μ s);
the IDFT period is 32 μ s;
the guard interval duration is 8 μ s;
a double guard interval duration is 16 μ s;
a short guard interval duration is 4 μ s;
the OFDM symbol duration with long guard intervals is 40 μ s;
an OFDM symbol duration with short guard intervals is 36 μ s;
the OFDM symbol duration is 40 μ s or 36 μ s;
the number of bits in the SERVICE field is 16;
the number of tail bits per binary convolution code encoder is 6; and
the MIMO-LTF duration is 40 μ s.

10. The method of claim 7, wherein when the particular bandwidth is 1 megahertz (MHz):

- the number of complex data subcarriers is 24;
- the number of pilot subcarriers is 2;
- the number of total subcarriers excluding guards is 26;
- the highest data subcarrier index is 13;
- the STF duration is 160 microseconds (μs);
- the LTF duration is 160 μs ; and
- the SIG duration is 240 μs or 200 μs .

11. The method of claim 7, wherein when the particular bandwidth is greater than 1 megahertz (MHz):

- the STF duration is 80 microseconds (μs);
- the LTF duration is 8 μs ;
- the SIG duration is 80 μs ;
- the SIG-A duration is 80 μs ;
- the long format STF duration is 40 μs ; and
- the SIG-B duration is 40 μs .

12. The method of claim 7, wherein when the particular bandwidth is 2 megahertz (MHz):

- the number of complex data subcarriers is 52;
- the number of pilot subcarriers is 4;
- the number of total subcarriers excluding guards is 56; and
- the highest data subcarrier index is 28.

13. The method of claim 7, wherein when the particular bandwidth is 4 megahertz (MHz):

- the number of complex data subcarriers is 108;
- the number of pilot subcarriers is 6;
- the number of total subcarriers excluding guards is 114;
- and
- the highest data subcarrier index is 58.

14. The method of claim 7, wherein when the particular bandwidth is 8 megahertz (MHz):
the number of complex data subcarriers is 234;
the number of pilot subcarriers is 8;
the number of total subcarriers excluding guards is 242;
and
the highest data subcarrier index is 122.
15. The method of claim 7, wherein when the particular bandwidth is 16 megahertz (MHz):
the number of complex data subcarriers is 468;
the number of pilot subcarriers is 16;
the number of total subcarriers excluding guards is 484;
and
the highest data subcarrier index is 250.
16. A non-transitory processor-readable medium storing:
one or more data structures, the one or more data structures indicating timing parameters for a first frame format and a second frame format of a sub-one gigahertz wireless network for each of a plurality of operating bandwidths of the sub-one gigahertz wireless network, wherein a first operating bandwidth of one megahertz is associated with the first frame format, wherein a second operating bandwidth that is greater than one megahertz is associated with the first frame format or the second frame format, wherein the second frame format comprises a first portion and a second portion, wherein the first portion comprises an omni portion comprising a short training field (STF), a first long training field (LTF), and a signal A field (SIG-A), and wherein the second portion comprises a data portion comprising a second STF, one or more signal B fields (SIG-Bs), and a data field;

wherein the timing parameters include:

- a number of complex data subcarriers;
- a number of pilot subcarriers;
- a number of total subcarriers excluding guards;
- a highest data subcarrier index;
- a subcarrier frequency spacing;
- an inverse discrete Fourier transform period;
- a discrete Fourier transform period;
- a guard interval duration;
- a double guard interval duration;
- a short guard interval duration;
- an orthogonal frequency-division multiplexing (OFDM) symbol duration with long guard intervals;
- an OFDM symbol duration with short guard intervals;
- an OFDM symbol duration;
- a number of bits in a SERVICE field;
- a number of tail bits per binary convolution code encoder;
- a short training field (STF) duration;
- a long training field (LTF) duration;
- a signal field (SIG) duration;
- a signal A field (SIG-A) duration;
- a multiple-input multiple-output LTF (MIMO-LTF) duration;
- a long format STF duration;
- a signal B field (SIG-B) duration;
- or any combination thereof.

17. An apparatus comprising:

- a memory storing one or more data structures, the one or more data structures indicating timing parameters for a plurality of frame formats and a plurality of bandwidths of a sub-one gigahertz wireless network; and
- a processor coupled to the memory, the processor configured to:

select a frame format for use in communicating a packet via the sub-one gigahertz wireless network operating at a particular bandwidth, wherein the frame format is selected based at least in part on the particular bandwidth;

determine one or more timing parameters based on the selected frame format and the particular bandwidth; and

generate the packet in accordance with the selected frame format and the one or more timing parameters, wherein the selected frame format is a first frame format when the particular bandwidth is one megahertz, and wherein the selected frame format is the first frame format or a second frame format when the particular bandwidth is greater than one megahertz, wherein the second frame format comprises a first portion and a second portion, wherein the first portion comprises an omni portion comprising a short training field (STF), a first long training field (LTF), and a signal A field (SIG-A), and wherein the second portion comprises a data portion comprising a second STF, one or more signal B fields (SIG-Bs), and a data field.

18. The apparatus of claim 17, wherein the sub-one gigahertz wireless network operates in accordance with an Institute of Electrical and Electronics Engineers (IEEE) 802.11ah protocol.

19. An apparatus comprising:

means for storing one or more data structures, the one or more data structures indicating timing parameters for a plurality of frame formats and a plurality of bandwidths of a sub-one gigahertz wireless network;

means for selecting a frame format for use in communicating a packet via the sub-one gigahertz wireless network

operating at a particular bandwidth, wherein the frame format is selected based at least in part on the particular bandwidth;

means for determining one or more timing parameters based on the selected frame format and the particular bandwidth; and

means for generating the packet in accordance with the selected frame format and the one or more timing parameters,

wherein the selected frame format is a first frame format when the particular bandwidth is one megahertz,

wherein the selected frame format is the first frame format or a second frame format when the particular bandwidth is greater than one megahertz, wherein the second frame format comprises a first portion and a second portion, wherein the first portion comprises an omni portion comprising a short training field (STF), a first long training field (LTF), and a signal A field (SIG-A), and wherein the second portion comprises a data portion comprising a second STF, one or more signal B fields (SIG-Bs), and a data field.