SUMMARY

[6] ~~One~~A non-limiting ~~and exemplary embodiment~~example facilitates providing apparatuses for MIMO channel estimation in context of EHT WLAN.

[7] In one aspect,~~According to a first embodiment of the present disclosure,~~ there is provided a communication apparatus comprising: a circuitry, which, in operation, sets a number of Extremely High Throughput Long training field (EHT-LTF) symbols in an physical layer protocol data unit (PPDU) for multi user transmission based on an initial number of EHT-LTF symbols that is specified by a number of spatial streams (Nss) of the PPDU, wherein the number of EHT-LTF symbols is set to be equal to or larger than the initial number of EHT-LTF symbols; and a transmitter, which, in operation, transmits the PPDU, wherein the Nss is larger than 8.~~transmitter, which in operation, transmits a physical layer protocol data unit (PPDU) to one or more other communication apparatus in a multiple-input multiple-output (MIMO) wireless network, the PPDU including a long training field (LTF) that facilitates the one or more other communication apparatus to estimate respective channels for respective communications with the communication apparatus; and a controller, which in operation, establishes the number of LTF symbols (N_{LTF}) for generating the LTF in the PPDU, wherein the N_{LTF} depends on a maximum value (N_{STSMAX}) of the number of space-time streams for each resource unit (RU) in the PPDU.~~

[8] In another aspect,~~According to a second embodiment of the present disclosure~~, there is provided a communication method comprising: setting a number of Extremely High Throughput Long training field (EHT-LTF) symbols in an physical layer protocol data unit (PPDU) for multi user transmission based on an initial number of EHT-LTF symbols that is specified by a number of spatial streams (Nss) of the PPDU, wherein the number of EHT-LTF symbols is set to be equal to or larger than the initial number of EHT-LTF symbols; and transmitting the PPDU, wherein the Nss is larger than 8.~~transmitting, from a first communication apparatus to one or more second communication apparatus in a multiple-input multiple-output (MIMO) wireless network, a physical layer protocol data unit (PPDU), the PPDU including a long training field (LTF) that facilitates the one or more second communication apparatus to estimate respective~~

~~channels for respective communications with the first communication apparatus; and establishing, by the first communication apparatus, the number of LTF symbols (N_{LTF}) for generating the LTF in the PPDU, wherein the N_{LTF} depends on a maximum value (N_{STSMAX}) of the number of space-time streams for each resource unit (RU) in the PPDU.~~

[8a] In another aspect, there is provided a communication apparatus comprising: a circuitry, which, in operation, sets a number of Extremely High Throughput Long training field (EHT-LTF) symbols in a trigger based physical layer protocol data unit (TB PPDU) based on an initial number of EHT-LTF symbols that is specified by a number of spatial streams (Nss) of the TB PPDU, wherein the number of EHT-LTF symbols is set to be equal to or larger than the initial number of EHT-LTF symbols; a transmitter, which, in operation, transmits a trigger frame that solicits the TB PPDU; and a receiver, which, in operation, receives the TB PPDU, wherein the Nss is larger than 8.

[9] It should be noted that general or specific ~~embodiments~~examples may be implemented as a system, a method, an integrated circuit, a computer program, a storage medium, or any selective combination thereof.

[10] Additional benefits and advantages of ~~the disclosed embodiments~~examples in this disclosure will become apparent from the specification and drawings. The benefits and/or advantages may be individually obtained by the various ~~embodiments~~examples and features

CLAIMS

1. A communication apparatus comprising:

circuitry, which, in operation, sets a number of Extremely High Throughput Long training field (EHT-LTF) symbols in an physical layer protocol data unit (PPDU) for multi user transmission based on an initial number of EHT-LTF symbols that is specified by a number of spatial streams (Nss) of the PPDU, wherein the number of EHT-LTF symbols is set to be equal to or larger than the initial number of EHT-LTF symbols; and

a transmitter, which, in operation, transmits the PPDU,

wherein the Nss is larger than 8.

2. The communication apparatus according to claim 1, wherein the number of EHT-LTF symbols is set to be larger than the initial number of EHT-LTF symbols.

3. The communication apparatus according to claim 1, wherein the number of EHT-LTF symbols is determined from a number of EHT-LTF determination tables predetermined and stored in both the communication apparatus and a reception apparatus.

4. The communication apparatus according to claim 1, wherein the PPDU comprises a preamble that indicates the number of EHT-LTF symbols.

5. The communication apparatus according to claim 1, wherein the Nss is defined for each of resource units (RUs) allocated in the PPDU.

6. The communication apparatus according to claim 1, wherein:

in a first case that the Nss is an even number, the initial number of EHT-LTF symbols is equal to the Nss; and

in a second case that the Nss is an odd number other than one, the initial number of EHT-LTF symbols is equal to 1 plus the Nss.

7. The communication apparatus according to claim 1, wherein the number of EHT-LTF symbols is set based on a format of the PPDU.

8. A communication method comprising:

setting a number of Extremely High Throughput Long training field (EHT-LTF) symbols in an physical layer protocol data unit (PPDU) for multi user transmission based on an initial number of EHT-LTF symbols that is specified by a number of spatial streams (Nss) of the PPDU, wherein the number of EHT-LTF symbols is set to be equal to or larger than the initial number of EHT-LTF symbols; and

transmitting the PPDU,

wherein the Nss is larger than 8.

9. A communication apparatus comprising:

circuitry, which, in operation, sets a number of Extremely High Throughput Long training field (EHT-LTF) symbols in a trigger based physical layer protocol data unit (TB PPDU) based on an initial number of EHT-LTF symbols that is specified by a number of spatial streams (Nss) of the TB PPDU, wherein the number of EHT-LTF symbols is set to be equal to or larger than the initial number of EHT-LTF symbols;

a transmitter, which, in operation, transmits a trigger frame that solicits the TB PPDU; and

a receiver, which, in operation, receives the TB PPDU,

wherein the Nss is larger than 8.

10. The communication apparatus according to claim 9, wherein the trigger frame indicates the number of EHT-LTF symbols.

~~1. A communication apparatus comprising:~~

~~a transmitter, which in operation, transmits a physical layer protocol data unit (PPDU) to one or more other communication apparatus in a multiple-input multiple-output (MIMO) wireless network, the PPDU including a long training field (LTF) that facilitates the one or more other communication apparatus to estimate respective channels for respective communications with the communication apparatus; and~~

~~a controller, which in operation, establishes the number of LTF symbols (N_{LTF}) for generating the LTF in the PPDU, wherein the N_{LTF} depends on a maximum value (N_{STSMAX}) of the number of space-time streams for each resource unit (RU) in the PPDU.~~

2. The communication apparatus of claim 1, wherein the controller, in operation,

establishes the N_{LTF} to be equal to the N_{STSMAX} in the PPDU when the N_{STSMAX} is an even number; and

establishes the N_{LTF} to be equal to 1 plus N_{STSMAX} in the PPDU when the N_{STSMAX} is an odd number other than 1.

3. The communication apparatus of claim 1, wherein the N_{STSMAX} in the PPDU is greater than 8.

4. The communication apparatus of claim 1, wherein the controller, in operation,

establishes the N_{LTF} to be equal to 1 plus the N_{STSMAX} in the PPDU when the N_{STSMAX} is an odd number smaller than a threshold; and

establishes the N_{LTF} to be equal to the N_{STSMAX} in the PPDU when the N_{STSMAX} is an odd number equal to or larger than the threshold.

5. The communication apparatus of claim 1, wherein the controller, in operation,

establishes the N_{LTF} according to a correspondence between the N_{LTF} and the N_{STSMAX} in the PPDU,

wherein the correspondence between the N_{LTF} and the N_{STSMAX} is determined by the communication apparatus if the PPDU is in a format of a single-user PPDU or a multiuser PPDU, and

wherein the correspondence between the N_{LTF} and the N_{STSMAX} is determined by the one or more other communication apparatus if the PPDU is in a format of a trigger-based PPDU.

6. The communication apparatus of claim 5, comprising: a transmission signal generator, which, in operation,

generates the PPDU including a signaling information field preceding the LTF, the signaling information field comprising a first signaling to indicate the N_{STSMAX} and a second signaling to indicate the correspondence between the N_{STSMAX} and the N_{LTF},

wherein the PPDU is in the format of a single user PPDU.

7. The communication apparatus of claim 5, comprising: a transmission signal generator, which, in operation, generates the PPDU including a signaling information

field preceding the LTF, the signaling information field comprising a signaling to indicate the N_{LTF}, wherein the PPDU is in a format of a multiuser PPDU.

8. The communication apparatus of claim 1, wherein the controller, in operation, determines the N_{STSMAX} in the PPDU if the PPDU is in a format of a single-user PPDU or a multiuser PPDU.

9. The communication apparatus of claim 1, comprising a transmission signal generator, which, in operation, generates the LTF in the PPDU based on a matrix (P matrix) for the LTF symbols and the N_{LTF},

wherein the controller, which in operation, generates the P matrix based on the N_{LTF}.

10. The communication apparatus of claim 1, wherein the communication apparatus is an access point (AP) and the one or more other communication apparatus is a station (STA) or vice versa if the PPDU is in a form of a single-user PPDU,

wherein the controller, when establishing the N_{LTF}, determines the N_{LTF}.

11. The communication apparatus of claim 1, wherein the communication apparatus is an access point (AP) and the one or more other communication apparatus include more than one station (STA) if the PPDU is in a form of a multiuser PPDU,

wherein the controller, when establishing the N_{LTF}, determines the N_{LTF}.

12. The communication apparatus of claim 1, wherein the one or more other communication apparatus is an access point (AP) and the communication apparatus is a station (STA) if the PPDU is in a form of a trigger-based PPDU,

wherein, the controller, when establishing the N_{LTF}, retrieves the N_{LTF} from trigger information received from the one or more other communication apparatus.

13. A communication method comprising:

transmitting, from a first communication apparatus to one or more second communication apparatus in a multiple-input multiple-output (MIMO) wireless network, a physical layer protocol data unit (PPDU), the PPDU including a long training field (LTF)

that facilitates the one or more second communication apparatus to estimate respective channels for respective communications with the first communication apparatus; and

establishing, by the first communication apparatus, the number of LTF symbols (N_{LTF}) for generating the LTF in the PPDU, wherein the N_{LTF} depends on a maximum value (N_{STSMAX}) of the number of space-time streams for each resource unit (RU) in the PPDU.