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WLAN-802.11n PHY Layer

Introduction:

This paper describes WLAN-802.11n wireless networking standard, introduced by IEEE. It covers various frames transmitted by 11n compliant device and physical layer. It is the successor to previous standards i.e. 802.11a and 802.11g. It supports the features supported by these legacy standards. The main idea for 11n is to increase the data rate. This done by increasing the Bandwidth to 40 MHz from legacy systems of 20 MHz and supporting multiple streams. Maximum 4 streams are supported by the standard.

Frame Structure:

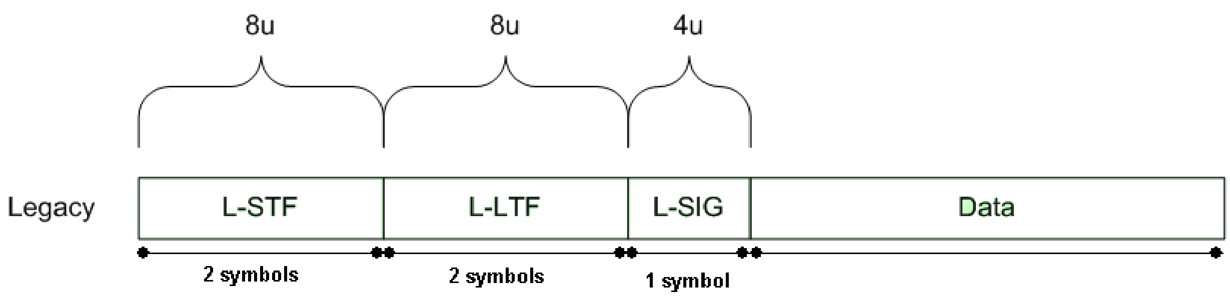
In 802.11n system, WLAN OFDM system supports three physical layer models. They are Legacy mode, Mixed Mode and Green Field Mode.

In legacy mode bandwidth supported is 20MHz and 64 point IFFT is used. It supports legacy 11a and 11g systems. L-SIG is as per SIGNAL field structure defined in the IEEE 802.11a standard.

HT mode is supported in both green field and mixed modes. 40MHz bandwidth and 128 point IFFT is employed here. HT-SIG field is described in IEEE 802.11n-2009 standard.

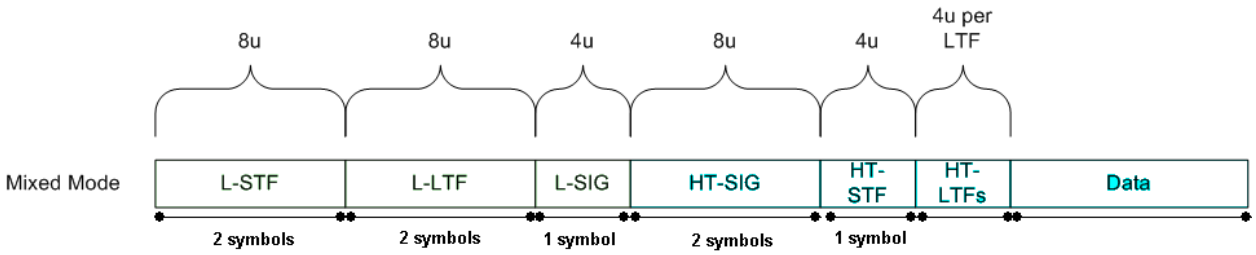
- **Legacy Mode**

In the legacy mode, frames are transmitted in the legacy IEEE 802.11a or 11g OFDM format.



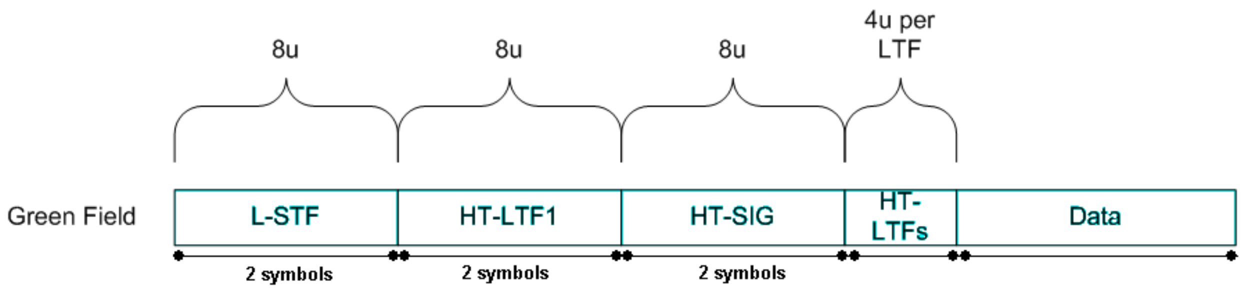
- **Mixed Mode**

In the Mixed Mode, frame is composed of both legacy preambles/header as well as 11n compatible preambles/ header (HT) as shown below. This is done so that such frame is decoded by legacy 11a/g devices.



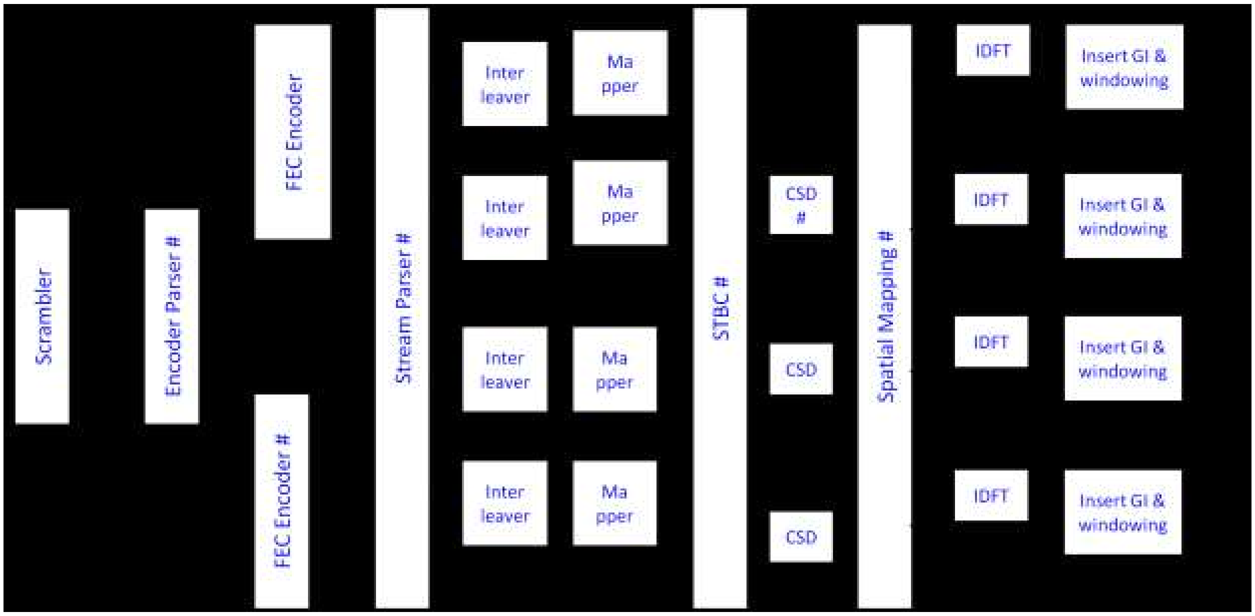
- **Green Field Mode**

In the Green Field mode, legacy preamble, HT preamble and Header are incorporated as shown below.



802.11n Transmitter:

The transmitter is composed of the following blocks:



a) **Scrambler:** scrambles the data to prevent long sequences of zeros or ones. For more information refer standard section 20.3.10.2

b) **Encoder parser:** It de-multiplexes the scrambled bits among NES (number of FEC encoders) FEC encoders, in a round robin manner.

c) **FEC encoders:** It encodes the data to enable error correction—an FEC encoder may include a binary convolution encoder followed by a puncturing device, or an LDPC encoder.

d) **Stream parser:** It divides the outputs of the encoders into blocks that are sent to different interleaver and mapping devices. The sequences of the bits sent to the interleavers are called spatial streams.

e) **Interleaver:** If BCC encoding is to be used, this module interleaves the bits of each spatial stream (changes order of bits) to prevent long sequences of adjacent noisy bits from entering the BCC decoder.

f) **Constellation mapper:** maps the sequence of bits in each spatial stream to constellation points (complex numbers).

g) **Space time block encoder:** constellation points from Nss spatial streams are spread into Nsts (space time streams) using a space time block code, whereby Nss<Nsts. Refer section 20.3.10.8.1 (Space Time Block Coding-STBC).

h) **Spatial mapper:** maps space time streams to transmit chains. This may include one of the following:

1) **Direct mapping:** constellation points from each space time stream are mapped directly onto the transmit chains (one-to-one mapping).

2) **Spatial expansion:** vectors of constellation points from all the space time streams are expanded via matrix multiplication to produce the input to all the transmit chains.

3) **Beam forming:** similar to spatial expansion. Each vector of constellation points from all the space time streams is multiplied by a matrix of steering vectors to produce the input to the transmit chains.

i) **Inverse discrete Fourier transform (IDFT):** converts a block of constellation points to a time domain block.

j) **Cyclic shift (CSD) insertion:** insertion of the cyclic shifts prevents unintentional beam forming. There are three cyclic shift types as follows:

1) A cyclic shift specified per transmitter chain with the values defined in Table n61 (Cyclic shift for non-HT portion of the packet) (possible implementation is shown in Figure n63 (Transmitter block diagram for the non-HT portion and the HT signal field of the HT mixed format packet).

2) A cyclic shift specified per space time stream with the values defined in Table n62 (Cyclic shift values of HT portion of the packet) (possible implementation is shown in Figure n64 (Transmitter block diagram for the green field format packet and HT portion of the mixed format packet except HT signal field)).

3) A cyclic shift Mcsd (K) may be applied as a part of the spatial mapper, see 20.3.10.10.1 (Spatial mapping). When beam forming is not used it is sometimes possible to implement the cyclic shifts in the time domain.

k) **Guard interval insertion:** This module extracts last few samples of the OFDM symbol and appends at the beginning.

l) **Windowing:** It smoothes the edges of each symbol to increase spectral decay.

m) **Packet formation:** packet is formed as per the frame structure defined in the section above.

REFERENCES:

1. IEEE 802.11n-2009 Standard