# Digital Communications – SDR Project

## Week 2 – Understanding the OFDM Sync Short Block

(Based on Section 2.2 of the article by Bloessl et al., 2013)

### 1. What does the block do?

The OFDM Sync Short block is responsible for frame detection, i.e., identifying the start of an IEEE 802.11a/g/p OFDM frame within the incoming sample stream. It detects the short training sequence (STS), which is a 16-sample pattern that repeats 10 times at the beginning of each frame.  
  
The block computes the autocorrelation of the signal with a lag of 16 samples to exploit this periodicity. When a plateau of high correlation values is detected, it indicates the presence of the short preamble and, therefore, the start of a frame.  
  
Source: Section 2.2 “Frame Detection”, paragraph 1–3 and Equation (1)

### 2. What is the meaning of the thresholds?

After computing the normalized autocorrelation coefficient, c[n] = |a[n]| / p[n], where a[n] is the autocorrelation and p[n] is the average power, the receiver determines that a frame has been detected if three consecutive samples of c[n] exceed a configurable threshold.  
  
This threshold defines how strong the correlation must be for the system to consider the pattern a valid preamble instead of noise. If the threshold is too high, the receiver may miss frames; if it is too low, it may trigger on noise.  
  
Source: Section 2.2 “Frame Detection”, paragraph 4 and Figure 2

### 3. Explore the effect of changing the thresholds

Changing the threshold directly affects the sensitivity and robustness of frame detection:  
- Lower threshold: more sensitive to weak signals, but more false detections (noise may be mistaken for a frame).  
- Higher threshold: fewer false positives, but may miss real frames in low SNR conditions.  
  
In practical terms, if you plot the normalized autocorrelation c[n], changing the threshold moves the horizontal line that determines where the receiver “sees” the plateau.  
  
Source: Section 2.2, discussion below Equation (3) and Figure 2

### 4. Understand the limitations of the approach taken

The paper explicitly mentions two main limitations of this autocorrelation-based approach:  
1. Fixed frame length – the OFDM Sync Short block pipes a fixed number of samples into the next processing stage. Therefore, if a new frame starts shortly after the previous one, the receiver might miss it.  
2. Simplified computation – autocorrelation is used instead of matched filtering for efficiency. While matched filtering would be more robust, it would also require 16 complex multiplications per input sample, making it too computationally expensive at this stage.  
  
Source: Section 2.2, last three paragraphs before Figure 2 and footnote 3

### 5. Demonstrate a case where it breaks

The system fails when frames arrive back-to-back (e.g., an RTS immediately followed by a CTS). Because the block ignores incoming samples while processing a detected frame, it does not monitor for new plateaus in the autocorrelation during that period. Hence, the second frame is not detected until the receiver resets.  
  
Source: Section 2.2, last paragraph before Section 2.3 (“Frequency Offset Correction”)