APPLICATION NOTE

802.11ac Transmitter Testing – A Tool That Measures Every Frame

Overview

The 802.11ac technology march is upon us, and brings with it 256-QAM and 80 MHz bandwidths. If a transmitted signal has any hope of being received at some distance, transmitters must be verified to be delivering clean EVM and reliable performance. When integrated into system designs, the demand to prove out that each and every frame transmitted is free of clock interference, noise and distortion is key to fulfilling 802.11ac's promise of blistering data rates.

If you are someone who cares about qualifying your 802.11ac transmitter, you are probably someone who has already qualified a legacy and/or 802.11n transmitter or system design. As such, you already know that a Vector Signal Analyzer (VSA) is a device that captures a single frame at a time, post-processes the captured record, then displays the associated constellation and measurement some number of microseconds later. You already know that at 802.11ac data rates, thousands of frames went by uncaptured by the VSA, and the chance of seeing the problem you are looking for is remote at best. You know that the VSA can only trigger on power level, so if the problem you are tracking is based on frequency offset, flatness across the band, EVM, or even some bit pattern, you simply can't trigger on the frame of interest, because none of those attributes are determined by the VSA until long after the frame has passed – it's all post-processed.

You're probably one of those engineers who has spent days hunting for the elusive "bad frame". You would like a test tool that shows you what you're looking for in minutes, not days.

What Is Required?

To keep pace with the introduction rate of 802.11ac, it is imperative that test equipment used for testing transmitters have the capability to make measurements on every frame your transmitter sends out, missing nothing. You need the confidence that you can walk through your test plan, generating thousands of frames at each phy rate, frame length, bandwidth, bit pattern and power level – and have definitive measurements on every one of those frames, not just a small sampling.

What is required is a departure from the traditional "capture a short record and post process" approach – what is required is measurement capability built into a real-time, line-rate, test-grade radio and baseband, so that all the crucial measurements are made on every frame, every time.

Why Doesn't the Traditional Approach Work?

The "traditional" approach is to use a vector signal analyzer (VSG) to capture a record, typically a single frame, and then use software on the VSG or a PC to demodulate the I/Q record and perform the measurements. The VSG can only trigger an acquisition on power, so it has no way to discern between a "good" frame and a "bad" frame at the time the frame is in flight, unless the problem being chased is specific to power level. Triggering on poor EVM, frequency flatness, center frequency offset, or other key characteristics is impossible, because the VSA does not recognize these attributes – only after post –processing in software do these attributes become known. Therefore, finding clock interference from digital circuitry, phase jumps from PLLs and VCO, aperiodic variation in symbol timing over long frames and other infrequent maladies become a game of "find the needle in the haystack" and can go on for days.

Furthermore, your transmitter is a MIMO transmitter, and you need to be collecting data on all transmit chains simultaneously, on every frame. Many VSA devices are single input, able to capture a single spatial stream. At most, devices support 2 spatial streams have to be stacked together and managed as separate devices to be synchronized.

How Do You Solve this Problem?

There is just one way to address this issue. Build a product that analyzes every packet of all four spatial streams. This can only be accomplished by using a purpose-built radio, backed up by a custom baseband that is designed to run at 802.11ac line rates and make the measurements in the process of decoding the frame. This takes specially-designed hardware and software, and is not achievable with general-purpose VSA approaches. The IxVeriWave architecture was designed from the ground up with this need in mind – to analyze every 802.11 frame, at line rate, without limitation. Real-time packet analysis is the key.

The Product

The IxVeriwave product family was introduced in 2004 with real-time, line-rate packet decoding capability, where each Wi-Fi WaveBlade load card receives line-rate traffic. This means that the WaveBlade has the ability to decode from RF to bits each frame before the next frame comes along. The purpose-built hardware does it.

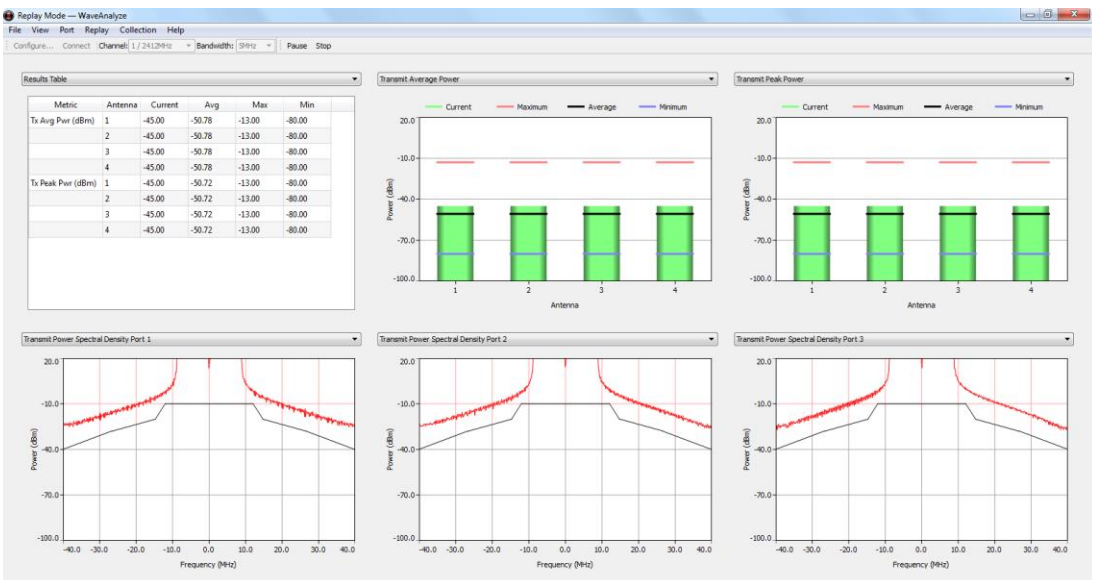

Figure 1: WaveAnalyze 802.11ac GUI

This same capability has been imported into the RF36014, which brings to market the WaveBlade that will decode any 802.11 a/b/g/n/ac frames, in real time, without additional software, and deliver the minimum/ maximum/ average measurement values of all key RF attributes needed. The WaveAnalyze application becomes the viewer for results, a familiar interface to observe constellations and measurement, however with an important improvement over traditional views – you see the results of all frames your transmitter sent, not just the results of the one sample out of 10,000 captured. What's more the RF36014 is:

- 4 spatial streams in one blade, rather than managing multiple single-stream VSG's
- A line-rate, real-time frame generator (See Application Note on receiver testing/WaveGen)
- A line-rate, real-time traffic generator/analyzer, supporting full system testing through L7.

Conclusion

Traditional I/Q based signal analysis of 802.11 signals on general purpose VSA's does not give you the answers you need fast enough keep pace with the requirements for performance, quality and time-to-market that drive the Wi-Fi market.

Ixia is delivering the 802.11ac line of IxVeriWave Wi-Fi WaveBlades, designed from the ground up to be the fastest, most accurate, most cost-effective, and flexible solution to 802.11ac transmitter testing, receiver testing, and full system test. Using the WaveAnalyze application, seeing the performance of your transmitter at a glance with confidence that measurements are on all frames, not just a select few, mean you can prove out your designs faster, and find problems in record time.

For the first time, Wi-Fi transmitters can be tested as thoroughly as they must be to earn the status of meeting "mission critical" performance. Move beyond the limits of traditional testing and set some records of your own.

Table 1: Key 802.11ac RF Transmitter Tests

Area	Measurement
Power	Average, peak, power spectral density, power peak excursion, power-on / power-down
Frequency	Center freq tolerance, Symbol clock freq tolerance, preamble freq error, RF carrier suppression
Spectral	Tx spectrum mask, Spectral flatness, Tx center frequency leakage, CCDF, Occupied Bandwidth
Modulation	Constellation error, EVM, Transmitter modulation accuracy
I/Q	Gain mismatch, Phase mismatch