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APPLICATION NOTE

802.11ac Receiver Testing – Why the Tools You Own Today Fail You

Overview

The next big thing in the world of Wi-Fi is coming, and quickly. The 802.11ac technology march has already begun, with early products hitting the market in the Spring of 2012, and a steady stream of client and access point devices headed for the market. This technology advance promises the next quantum leap in transport rates, simultaneous downstream transmission to multiple client devices, closed-loop transmit beam forming for better sustained performance. 802.11ac adds 9 new phy rates at 4 different bandwidth settings to the 802.11 definition, and requires backwards compatibility.

If you are someone who cares about qualifying your 802.11ac receiver, you have a huge mountain of testing to get done, and less time and money to accomplish the task than you had for 802.11n. If you are even considering approaching this task with traditional test tools like you did for 802.11 a/b/g/n, you're already dead in the water.

What is required is a test product that is designed for the job as defined today. Lucky for you, someone is taking this problem seriously – Ixia.

What Is Required?

Wi-Fi has crossed over from being a "best effort" technology, to "mission critical". This means that the testing rigor needs to look very much like what made the Ethernet world become plug-and-play. In the Ethernet world, no stones were left unturned: interfaces and devices were (and are) tested for every physical transport rate, every frame length, each stressful combination of packet conditions that represent worst-case scenario in real-world deployments. Equipment that stands up to such levels of stress can be counted on to work under every condition in the field.

The same must happen for 802.11 interfaces and devices, but hasn't been the case up to now. Specifically, receiver testing by chip designers and device manufacturers has been using techniques that are not able to subject receivers to the worst-case conditions of diversity devices see in the real world – not even close. The equipment that has been available up to now simply didn't support the need.

To support mission-critical performance levels, 802.11ac receivers must be tested against every conceivable combination of frames, including legacy, HT and VHT, at multiple power levels, at various frame lengths, through various channel models. To get this done efficiently, a quantum leap in equipment is required, where configuration of the equipment becomes point-and-click, and the equipment is able to produce any conceivable combination of frame conditions, without limitation. This takes a new class of equipment.

Why Doesn't the Traditional Approach Work?

The "traditional" approach is to use a vector signal generator (VSG) to play out pre-created I/Q files. These VSG's come in two basic flavors: general purpose, single output units from the familiar suppliers of RF test equipment; and multiple output units that have been designed to address the Wi-Fi marketplace. At the heart of these products is a chunk of memory, a pair of digital-to-analog converters, and a radio system to create digitally-modulated waveforms. A closer look at the sequence of events required to get a frame generated reveals why this approach is to slow and cumbersome to meet the need.

First, the user employs a software program to create an I/Q file. This would be something like MatLab or Signal Studio from Agilent, and requires an engineer with DSP training to use. The user specifies the characteristics of the frame desired, such as modulation rate, bandwidth, guard interval, etc. and the program then generates an output file of sequential sample points to be downloaded to the vector signal generator's memory.

Next, the user downloads this I/Q file to the VSG, and configures additional characteristics, such as power level and channel. Finally, the user then directs the VSG to play out the I/Q file.

What this gives the user is one frame definition playing out at a time, in a single-shot or endless-loop fashion. What's wrong with this?

- To add a second frame definition to the sequence, so that first one frame type is being sent to the receiver then another, such as a legacy frame followed by an 802.11ac frame, this entire process of creating the I/Q file from the software, then downloading and configuring, must be repeated. In most cases, an interim step of "stitching" two I/Q files together from the two frame definitions are involved. This is slow, and time-consuming, and there are a limited number of frames you can put together before the I/Q file is too big to fit into the memory of the VSG.
- To create a situation where one frame comes in at one power level and the next frame comes in at a different power level, well – VSG's cannot change output power at a per-frame rate. So, this simply cannot be done.
- To create a frame of maximum length (1518 byte frame, aggregated to 43 MSDU's, 40 MHz bandwidth) requires more memory than is available in either the Agilent or LitePoint VSG. So, testing receivers with even one worst-case frame with regards to frame length isn't even possible.

The net effect is that with VSG approaches, the tester simply cannot create the complex combinations of frames necessary to perform rigorous testing, and what they can create is cumbersome and slow to use, and requires highly trained engineers to create the I/Q files and configure the equipment.

How Do You Solve this Problem?

There is just one way to address this issue. Build a product that generates any given frame in real-time, at line rate. This takes specially-designed hardware and software, and is not achievable with general-purpose VSG approaches. The IxVeriWave architecture was designed from the ground up with this need in mind – to produce any conceivable 802.11 frame, in any conceivable combination, at line rate, without limitation, and with a simple user interface that eliminates the need for creation of I/Q files by DSP engineers. Real-time packet generation is the key.

The Product

The IxVeriwave product family was introduced in 2004 with real-time, line-rate packet generation capability, where each Wi-Fi WaveBlade load card can emulate **500 unique clients**. This mean that the entire WaveBlade has the ability to change the personality of packets at the front panel on a per-packet basis, so if the need was for 10 frames at 64 bytes, 54 Mbit phy rate at -47 dBm followed by 15 frames at 1000-byte at MCS15 at -10 dBm No problem. The purpose-built hardware does it.

In 2009, we introduced WaveGen, a simple GUI application which allows designers to use IxVeriwave MIMO WaveBlades to access this capability of creating any desired sequence of frames using a simple GUI approach. WaveGen has been updated to encompass 802.11ac.

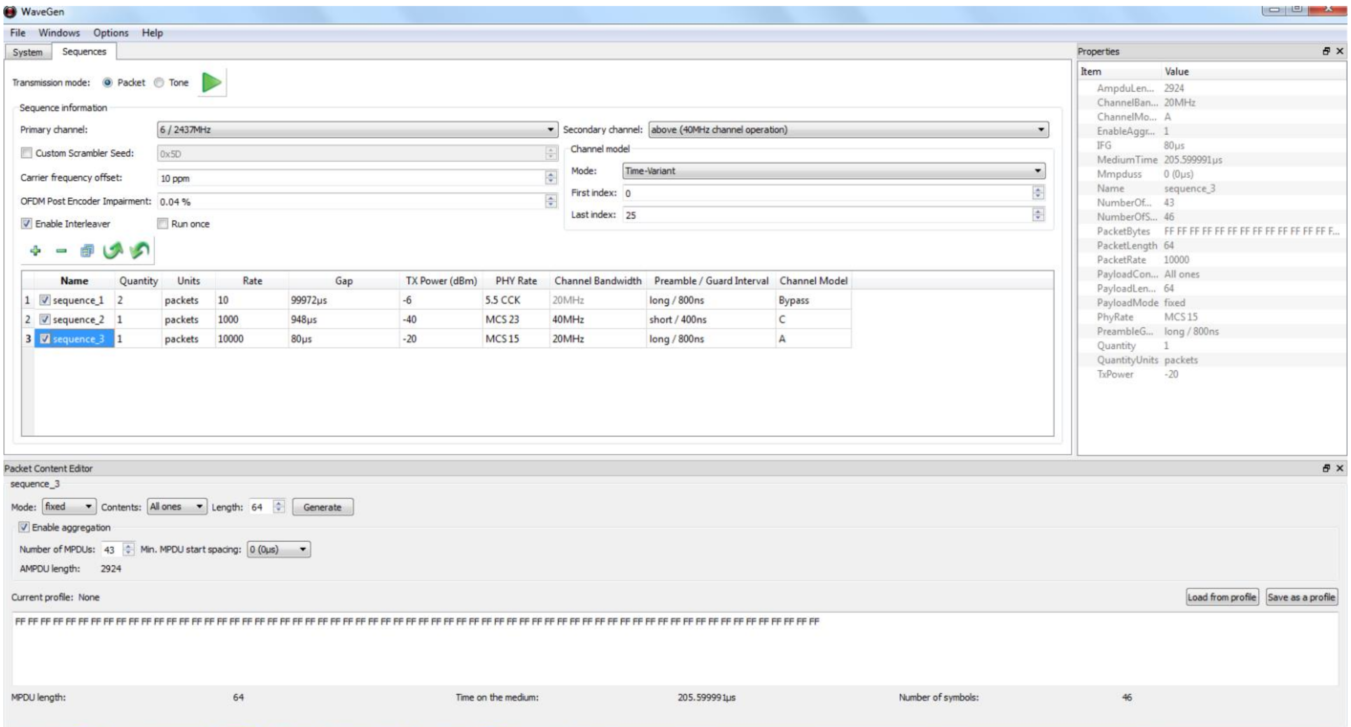

Figure 1: WaveGen 802.11ac GUI

This same capability has been imported into the RF36014, which brings to market the WaveBlade that will produce any combination of 802.11 a/b/g/n/ac frames, without DSP programming, I/Q downloads, and without memory limitations and power ramp constraints. And, as with all IxVeriWave MIMO WaveBlades, channel emulation is built in and selectable on a per-client basis, the only tool in the market able to change IEEE channel models on a per-packet, per-client rate.

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 analyzer (See Application Note on transmitter testing/WaveAnalyze)
- A line-rate, real-time traffic generator/analyzer, supporting full system testing through L7.

Conclusion

Traditional I/Q based signal generation of 802.11 signals on general purpose VSG's does not 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 receiver testing, transmitter testing, and full system test. Using the WaveGen application, creating any sequence of frames to meet your testing needs becomes a point-and-click affair, without DSP knowledge.

For the first time, Wi-Fi receivers 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.