Exploring Modern ART

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Spectrum is a scarce national resource whose allocation is controlled by governing agencies. Scarcity of spectrum has driven the technologists to think out of the box for addressing this problem. Charles Darvin said “It's not the strongest of the species that survives, or the most intelligent.

It is the one most adaptable to change." “Spectrum holes” represent the potential opportunities for non-interfering use of spectrum. This opportunity has led to the concept of “Adaptive Radio Technology” (ART), more commonly known as “Cognitive Radio Technology”.

One desirable attribute of anAdaptive Radio is frequency configurability and agility, for several reasons: First the radio may need to transmit at different frequencies to communicate with different existing radios. Second, choosing the frequency to transmit and receive at may be necessary on the battle field to avoid interference. Third, military radio waveforms are often hopped rapidly to avoid detection and for countermeasures. A fourth reason is that frequency agility is a necessary capability to enable Cognitive Radio technology.

The CognitiveRadio represents a significant leap in the field of radio design. The premise is that one day a radio will be able to sense “white space” in the RF spectrum and then configure itself to use that frequency for communication. There is currently an extensive amount of work being applied to making this technology a reality and some preliminary demonstrations have been shown.

Cognitive radio is very dependent on fast processing and the further development of software PHY layer architecture. To realize this technology it is obvious that the receiver will require a wide bandwidth and/or a flexible front end to move operating frequency. This would require a wideband IF with a high sampling ADC and/or a variable oscillator. Understandably this introduces new issues for the RF engineer which we will touch on in this presentation.

With Adaptive Radio architectures, designers encounter a myriad of unique challenges, many of which emanate from the change in signal formats. Signal amplitudes once represented by an analog voltage or potential between two points are now a series of digital word sample points on a signal bus of many different voltage potentials. Often, the signal is represented on time sampled dual I–Q signal busses complicating test matters further.

Diagnosing digital issues thus requires a different test interface to different hardware. Probing I–Q busses with many test connections becomes essential. Probing is often complicated when using FPGAs, as many of the desired test points may not be readily accessible outside of the chip.

To add to all these challenges, cross format analysis is often a crucial troubleshooting need. Since most ART designs ultimately get converted back to analog signals, it is frequently necessary to compare the analog signal with the digital signal that initially created it. This requires cross format analysis capability to compare modulation parameters between a digital signal and an analog signal. Comparative analysis can extend well beyond baseband I–Q measurements, ranging through IF and RF frequencies.

This paper starts with the challenges of radio resource management. Introduction to Cognitive Radio is covered and further the cognitive cycle and adaptive radio resource management is described in this paper. Latest advances in this area of technology are discussed. Advancement in technology has also lead to new test challenges. This adjustable hardware may need more and faster tests. Also, in such software defined hardware, testing radio components also implies testing soft components. The paper also discusses new methods for design and verification of such new architectures.

About the speaker:

Vishal Gupta is the Technical Expert in Microwave and mm-wave technologies at Agilent Technologies in India. He has over 12 years of techno-commercial experience mainly in the field of RF/Microwave, Millimeter wave Electronics and Surveillance testing. Together with his technical acumen and business skills, Vishal has a very strong consultancy, hardware design, project management and system engineering back ground. Apart from providing technical support to wide customer base in aerospace and defense, wireless and manufacturing industries in India, Vishal has provided support to customers in Australia, Sri Lanka and Singapore. Prior to joining Agilent – Vishal Gupta had experience in telecom, RF & Microwave system and subsystem design and VSAT technology, with positions at HFCL R&D and HFCL Satellite Communications Ltd. Vishal has done his Masters of Technology (Microwave Electronics) from University of Delhi. Along with technical education Vishal is also a post graduate in Business Management with specialization in Marketing and Strategy from Management Development Institute, Gurgaon. Vishal is an active member of IEEE-MTT-S.