

## Monthly Seminar



**Dr. Robert C. Qiu**

TTU Professor of Electrical and Computer Engineering, Center for Manufacturing Research



The international honor society of scientific and engineering research

### **Reinventing "Made in the USA" Technology: A Convergence Story of Cognitive Radio, Cognitive Radar and Anti-Jamming**

Wall Street crashed; Millions of jobs lost; Trillion dollars of deficit budget; Unprepared work force. Now what? What US still has: first-class university researchers and No. 1 defense spending in the world. These two factors can be exploited to reinvent US by looking forward for new "made in USA" technology---and create new jobs and keep them within US in the future.

When interviewed by Thomson Reuters (Science Watch) in 2006---for my paper that was selected as monthly "fast breaking paper" in computer science, I made the following comments on ultra-wideband (UWB) technology:

UWB technology is a pure "Made in the USA" technology. UWB radars have been used to detect stealth airplanes and mines. The technology matured during the 1960s-1970s. UWB technology is a classical example for how a military technology turns into a commercial breakthrough---often through some small startups.

This example vividly illustrates the strength and enormous potential of American technology accumulation. Most DoD (Department of Defense) research projects charge the researchers with potential commercial applications. The technology transition to commercial applications can be accelerated through some early seed investment from DoD and then by venture capital.

These comments make perfect sense for today's crisis situation. There is no way out, unless US is committed again to innovation, invention and entrepreneurship, and greatly increases investment in (still) leading technology sectors. I want to make my point using another example: cognitive radio and cognitive radar---currently the hottest technology in wireless and radar industry. This is a game changer for US---the "cannot afford to lose" opportunity. US has a clear leadership since this cognitive system is critical to both commercial and military applications. For example, Air Force needs technology for "spectrum dominance" in its "air dominance" vision. Army needs cognitive radio networks for broadband access and security (anti-jamming). Navy has special needs that are different. Fortunately, these needs fit into the commercial picture for wireless broadband access. The most amazing thing is that, for the first time, the wireless industry and the radar industry must work together to address the pressing DoD needs that are commercially promising.

The merging has created a new leadership of US researchers, since US is good at both sectors. This high entry barrier provides essential protection for US jobs.

The technological story begins with the radio spectrum---the real estate for wireless industry. The spectrum scarcity is the most severe problem for US for wireless services, partially due to the fact that US has most dense spectrum usage. Also, US does not reserve spectrum for the ever-growing wireless service. I deeply understood this significance to US industry: Cognitive radio provides an alternative (a new paradigm) to systems such as the third generation (3G) and the fourth generation (4G), where US has no clear leadership. Recently (Nov. 2008) FCC ruled over unlicensed cognitive sharing of TV spectrum.

With the rapid development of wireless communications, the ever increasing demand for limited spectrum resources will eventually cause spectrum scarcity problem. However, a recent study conducted by Shared Spectrum shows that average spectrum occupancy in the frequency band from 300 MHz to 3000MHz over multiple locations is merely 5.2%. The maximum occupancy is about 13% in New York City. It can be found that the spectrum scarcity is mostly caused by the fixed assignment to the wireless service operators, and there exist spectrum opportunities both in spatially and temporally. Therefore, the interest in allowing access to unutilized spectrum by unlicensed user (second user) has been growing in several regulatory bodies and standardization groups, e.g. FCC and IEEE 802.22.

Dynamic spectrum access is a must-have ingredient for future systems that are ideally cognitive. One focus of this talk is to address the multi-GHz front end that is the challenge for the next-generation cognitive systems. This unifying theme of this research is to spell out the convergence for cognitive radio, radar, (anti-)jamming and geo-location. Moore's law drives the major system functions into digital part. From a system view, this talk gives the first comprehensive treatment for the functions and the challenges of this multi-function (wideband) system. This talk brings together the interdisciplinary knowledge. Currently, TTU is working with DoD to address the defensive needs by improving the technology that is commercially promising. Our sponsors include ONR, ARO, NSF, and industry.

For details, visit <http://iweb.tntech.edu/rqiu/index.htm>

**12:00 noon, Thursday, January 29, 2009**  
**New Location! ECE Conference Room, Brown Hall 208**