SDR and Cognitive Radios

The armed forces are constantly looking for ways in which they can communicate in a smarter way. The lack of available spectrum has been a constant headache for the military but the development of intelligent radios that can actually seek out empty spectrum to exploit is pushing the envelope further. GMC discovers the benefits of Software Defined Radio and Cognitive Radio.

Software Defined Radio (SDR) and its successor, Cognitive Radio, are taking radio to places that we would never have expected. Radio, for many decades, has played a crucial role in the communications capabilities of militaries the world over, but the future of radio holds some truly incredible capabilities. SDR and Cognitive Radio offer an impressive level of flexibility which is so vital on the battlefields of today, allowing troops to communicate at a high level.

SDR is a radio communications system where the components have been actually been implemented into the radio by means of software in an embedded system meaning that they are very easy to upgrade and allow the radio to use a variety of different waveforms offering true flexibility in the field. The concept of SDR was that a common platform could be used across a number of different areas and the software within the radio could be used to change the configuration to different functions at any given time. SDR also may be re-configured to allow upgrades and to meet another role if necessary.

Cognitive Radio takes this concept even further. These radios can autonomously detect and exploit empty spectrum. It is an intelligent radio that can be programmed and configured dynamically. Once the radio has detected an available channel, it can then change its transmission or reception parameters to its spectrum band, thus allowing a form of dynamic spectrum management. Cognitive Radios are able to monitor their own performance on a constant basis so that they are able to deliver a high quality of service. It recognises its operational environment and adjusts itself accordingly so that it delivers a consistent high quality of transmission, essential to military radio communications. So really, what you have is a radio that is situationally aware and that can use its intelligent processing to deliver the best standard of service available to it. Cognitive Radios can acquire, classify and organise information, can retain information, can apply logic and analysis to information and can make and implement choices. They can also hide and avoid interference.

The development and use of Cognitive Radios will help to address the challenge of lack of spectrum available to the military as they are able to seek out and use available spectrum that would otherwise be going unused. It is now the task of the military to better understand the cognitive radio and to make clear to manufacturers their needs and requirements so that the equipment that is developed is tailored to their specific needs.

The development and eventual fielding of Cognitive Radios has the potential to transform military radio communications. It has the potential to access new frequency bands, to protect high priority users from harmful interference and can enable mobile troops to communicate and share critical information more effectively. By enabling cost-effective use of bandwidth and being very easy to upgrade through its software, the cognitive radio is also much more cost effective and flexible. There are huge possibilities for Cognitive Radio, some of which we have not yet even come to realise. Communications technology enables the military to be more situationally aware, but imagine how much this can be improved if the technology itself becomes situationally aware.

The military has very exact requirements when it comes to radio, especially in terms of hardware being able to withstand harsh conditions and also to cope with the mission critical needs of the military. Radios also have to be highly resistant to jamming and interference and the whole radio network must be resilient and robust. It is for these reasons that Cognitive Radio is being tested and explored by militaries across the world. They meet the stringent requirements of the military and the technology is available today.

Per Vices' Crimson SDR
In 2014, Per Vices launched its robust wideband RF front end and powerful digital back end of Crimson, the company's latest Software Defined Radio.

Crimson features a high stability internal reference clock with stability of ± 5ppb. "The successful incorporation of our ultra-low phase noise and low-jitter performance oscillators in the Per Vices Crimson software defined radio means that the Crimson software defined radio is capable of supporting the most demanding radio applications," said Anthony Mastropole, President of Crystek Corporation.

Crimson's accuracy and stability rival specifications found in other test equipment in a single device featuring lower cost and greater flexibility. Crimson can perform the duties of a 100KHz to 6GHz radio receiver/transmitter, spectrum analyser, data recorder, and internet communications hub. Crimson is equipped with four independent receivers and transmitters, allowing it to perform multiple duties simultaneously. Its functions are software defined and can be controlled and reconfigured in real time from anywhere in the world.

xG demonstrates cognitive SDR jamming resistance capabilities
xG Technology successfully demonstrated its interference mitigation capabilities against sustained jamming at the US Special Operations Command's (USSOCOM) Technical Experimentation Event, conducted June 14-18 at the Muscatatuck Urban Training Centre in Indiana.

"In 2014, Per Vices launched its robust wideband RF front end and powerful digital back end of Crimson, the company's latest Software Defined Radio."

Photo courtesy of Per Vices

During a three day exercise, a tactical xMax network was deployed to provide real-time video, position location and integrated tactical radio communications from vehicles operating in diverse terrain throughout the MUTC. Sustained electronic attacks from military-grade jammers were introduced but were unable to disrupt the performance of the xMax network.

xG was selected to participate as a technology developer at the event because of the unique capabilities that the xMax cognitive software-defined radio platform brings to tactical and expeditionary operations. xMax was the only communication system on display at the event that met the USSOCOM requirement for innovative and advanced software-defined radio technologies that will enable secure and interference-resistant communications for Special Operations Forces.

USSOCOM provides command, control and training for all Special Operations Forces in the US. It conducts Technical

Cognitive Radios vs. Conventional Radios

Conventional Radio View of Unlicensed Spectrum
Sees Radio Spectrum as a
"Wall of Interference"

This spectrum analyzer reading shows how conventional radios see congested radio spectrum with heavy interference, and essentially unusable.

Cognitive Radio View of Unlicensed Spectrum
Sees Radio Spectrum as a
"Windows of Opportunity"
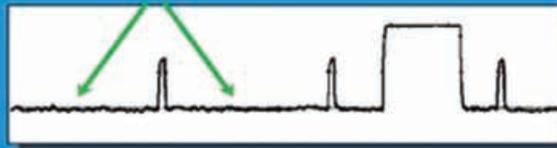
Cognitive radios can view the same radio spectrum in deeper detail, allowing them to identify unused gaps to transmit signals.

Image courtesy of Xg

Experimentation events throughout the US with participation from government, academia, and private industry. The events provide a unique opportunity for technology developers to interact with the Special Operations Forces community in a collaborative environment.

Brian Lasagna, Vice President of Business Development at xG Technology, said, "This represented an excellent opportunity to display how the advanced interference mitigation capabilities of the xMax system meet current USSOCOM requirements. We had significant engagement at the event with USSOCOM program planners and officials, and we look forward to working closely with them to tailor xMax form factor, frequency support and other features to suit specific SOF missions. Our success at this event reflects the increasing interest in the ability of our technology to assure high-capacity, high-availability wireless services, regardless of external conditions."

ASELSAN SDR for land, sea and naval platforms

Turkish company, ASELSAN, provides a family of multi-service HF SDRs that offer secure and reliable radio communication solutions for land, air and naval platforms. These radios enable beyond line of sight communications by employing the latest HF technology and conform to various NATO STANAG's and military standards. Software configurable architecture provides reliable secure voice and data communications by supporting various HF radio waveforms and EPM techniques. The versatility of waveforms and modes enable communication even in the most challenging HF channel conditions. With the use of modern technologies such as 3rd Generation Automatic Link Establishment (ALE) and Automatic Channel Selection (ACS), these radios provide ease of use, reducing the need for well-trained and experienced HF radio operators.

The family operates within ground, naval and airborne configurations and operates in within the 1.6-29.999MHz band and to STANAG 4203.

The family features:

- CW ,USB, LSB, ISB, AM and AME Modulations;
- Supports 10 Hz Channel Spacing;
- Digital voice (S4591 MELPe) and Data (Synch/Asynch/IP);
- Built-In Digital Modem - STANAG 4539;
- Automatic Channel Selection (ACS);
- Automatic Link Establishment (ALE) - STANAG 4538;
- Built in Encryption for both Voice and Data Services;
- Frequency Hopping Capability;
- Easy to Use Man Machine Interface;
- Built-in-Test (BITE);
- Built-in GPS;
- Remote Control Capability; and
- Complete Line of System Accessories.

Rockwell Collins' FlexNet-Four

The FlexNet™- Four H/V/UHF vehicular multichannel Software Defined Radio (SDR) offers enhanced capacities to significantly improve the connectivity, mobility, versatility, interoperability and exchange of information on the battlefield. The FlexNet products are joint developments of Rockwell Collins and Thales.

With connectivity and mobility at the top of the list of military customers, integrating FlexNet-Waveform, FlexNet-Four V/UHF SDR equipment offers transverse communications, high data rate transmission on the move, and mobility management that greatly improve the connection between the users from HQ to small action units. FlexNet-Four brings to the users an increased level of service such as voice (digital or VoIP), data (short messages, formatted messages, file transfer), image and video transmission.

With a scalable capacity of four simultaneous channels and embedded routing capability, FlexNet-Four acts as a communication node making it highly versatile. Each channel can be configured and programmed independently according to a majority of missions dedicated to mobile battlefield platforms. In addition to the services provided by each channel, FlexNet-Four provides networking and cross-banding functions that enable connecting users on the field even if they are not on the same frequency range radio networks.

Based on an open architecture, compliant with Software Communications Architecture (SCA 2.2) international standard, and a powerful programmable hardware platform, FlexNet-Four ensures enhanced functionality, expandability and waveform portability accommodating future technology or requirement upgrades with ease. This flexibility is improved due to the modular hardware architecture of FlexNet-Four.

In terms of interoperability, the radio can be immediately reconfigured to provide interoperability with the PR4G standard and is open to host other standard waveforms (MIL-STD, STANAG) and national waveforms with their national specific requirements.

SDR and Cognitive Radios are the future

Building on the solid foundation laid down by developments in Software Defined Radio, Cognitive Radio is where the future lies in terms of military radio communications. SDR is fielded and proven and has already proved its worth in theatre. Though still in the demonstration phase, Cognitive Radio is set to change the game in terms of radio capability. We have seen here how forces such as USSOCOM, have been won over by its capabilities.

For the military, especially, Cognitive Radio and its resistance to jamming and ability to solve bandwidth challenges, provides an excellent fit for battlefield communications. Both SDR and Cognitive Radio enable the military to overcome communications on the battlefield.

The communications are only going to be as effective as the equipment used, and SDR and later, Cognitive Radio can provide flexibility, interoperability, versatility and anti-jamming capability that will offer tactical and strategic advantage over adversaries and enable the fighting forces to carry on communicating regardless of the situation they are in. **GMC**
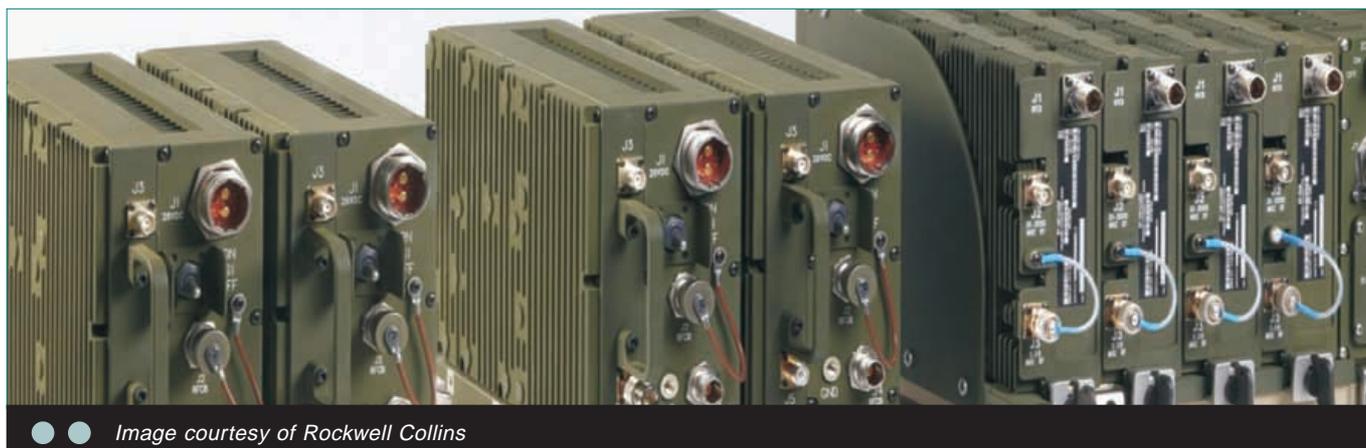

Image courtesy of Rockwell Collins