Future Cognitive Radio Technologies for Dismounted Soldier Communications

Rob Garth, Product Director, Domo Tactical Communications (DTC) talks to Soldier Modernisation

Q: What is cognitive radio?
A: Cognitive radio networks gather information about the local RF spectrum environment and use it to drive decisions around the radios operation to mitigate interference and optimise throughput. They can be invaluable in combatting accidental "blue on blue" interference - or "spectrum fratricide" as it is sometimes described - as well as playing a critical role against deliberate jamming when operating in a contested battlefield RF environment. Cognitive radio systems can also play a key role in managing electromagnetic signature to optimise Low Probability of Intercept/Low Probability of Detection (LPI/LPD) performance and to drive directional Mesh Networking capabilities.

Q: What are the potential benefits of cognitive radio systems for the warfighter and what challenges do you see?
A: Warfighter tactical radio systems have advanced immeasurably from the days when all the user had was a channel switch and a Push-to-talk (PTT) button and the only traffic was voice. Today's Software Defined soldier radios employ MANET Mesh algorithms and advanced waveforms and can operate on a variety of frequencies with a wide range of channel bandwidths. They can support multiple services including Position Location Information (PLI), UxV control, imagery and messaging as well as traditional voice applications. Cognitive techniques can ensure that a radio network is optimally configured without user intervention and continues to self-optimise to deal with a dynamically changing RF environment. This allows the warfighter to concentrate on the mission at hand and supports the deployment of advanced capabilities at a pace without the need for forward deployment of specialist technical resources.

But to make the most of the promise of Cognitive Technology, it is important to think not just at the level of the radio network but at a wider system level. As a cognitive radio adjusts the various parameters available to it to maintain connectivity, the data capacity available for user services will inevitably vary – in some cases bit rates from tens of Mb/s right down to a few Kb/s. To make the most of the available capacity it is necessary for the various data generators within the system to be aware of the bandwidth available to them and if necessary to flex the amount of data generated in response to this. Surveillance cameras might be instructed to move to a lower frame rate or resolution, voice codecs to a lower data rate mode, PLI generators to a lower update rate etc. DTC's open JSON API allows for real-time interaction between the radio network and connected systems to support this flexing.

It is also important to ensure that cognitive radio systems are easy to interact with and configure, again by non-specialist users, and can present information in an easily understood and mission-relevant format - less talk of megahertz, watts and decibels and more of mission duration, operating range and number of users. Cognitive radios systems also have the potential to deliver relevant data on the battlefield RF environment – for example localising an adversary's jamming attack – but again this is only useful if delivered in an actionable format such as a heat map displayed on an ATAK End-User Device. DTC's open API again provides an excellent foundation for the delivery of these soldier-friendly systems.

Q: What cognitive radio features does DTC offer today?
A: DTC MANET Mesh Networks have long offered an "auto-adaptive modulation" (AAM) capability in which modulation mode is adjusted based on the signal to noise ratio (SNR) measured on a link. Transmissions adjust from high throughput 64QAM at high signal to noise ratios through 16QAM and QPSK right down to an immensely robust BPSK modulation which requires only 5dB SNR and is capable of successful communication at the extremes of range or in the most hostile of raised noise floor jammed environments.

DTC's flagship MeshUltra™ and MeshUltra-X™ waveforms go much further by adding "Interference Avoidance System" (IAS) which is an "every radio a sensor" cognitive radio capability. Every radio in the network contributes information about the noise floor on many alternative

operating frequencies and this information is shared around the network. Should one of the alternative frequencies show a significantly lower noise floor than the current frequency – as reported by the network as a whole, not just at a single monitoring point – then IAS will coordinate a seamless switch to the new operating frequency. It is important to understand that this capability uses the existing radio hardware so has no impact on Size, Weight and Power (SWaP) – and also that it is implemented without any effect on network performance. IAS also does not introduce a single point of failure into the network, as the interference avoidance decisions are made cooperatively.

Q: What is DTC's cognitive radio roadmap?

A: For today's users, AAM and IAS offer significant benefits in terms of spectrum deconfliction and the ability to operate – without user intervention – in a congested RF environment, but for DTC they are only the start. Future Cognitive systems will not only adjust operating frequency and modulation mode but other waveform characteristics such as channel bandwidth and power level – or even switch to a completely different waveform better optimised for the operating environment and data throughput requirements.

DTC also sees Machine Learning (ML) playing an increasing role in future cognitive radio systems. Decisions on the frequency and operating mode will be made not only on the situation now but also from the experience of what happened on previous occasions that a particular frequency or operating mode was chosen. ML is particularly important when countering responsive Jamming Systems which can lie dormant ready to pounce when activity is seen on a particular frequency or when a specific waveform signature is detected.

Cognitive radio systems also offer the potential to optimise LPI/LPD performance and to detect and counter advanced jamming techniques. Directional Mesh Networking is an important tool here – minimising unnecessary emissions and protecting from interference. DTC has demonstrated a Mesh "SuperNode" made up of Multiple radios - each with a directional antenna – which can ensure RF is only transmitted in the desired direction. The SuperNode can be deployed as a fixed or "at the halt" base station, a vehicle fit or even as a bodyworn solution based on DTC's tiny SOL8SDR-M single-board Software Defined radio platform. ■

Rob Garth is Product Director at Domo Tactical Communications (DTC). With a background in RF engineering, Rob has more than twenty years in the development and delivery of robust tactical and fixed wireless systems for both military and civil applications, from simple FM links to multi-Megabit COFDM MESH systems and data pipes on the ground, in the air and at sea. He is Chartered Engineer and Eur.Ing with a Masters Degree in Electronic Engineering from the University of Warwick.