Using Adaptive Beam Forming in Real-Life Tactical Situations

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Military command, control and computer communications often consist of multiple ad-hoc tactical networks that interface to each other, as well as backbone communications networks connected through a variety of wireless communications gateways. Within this "system of systems", the military currently supports hundreds of legacy waveforms—each with its own unique air interface specification and independent link/network layer protocols. At any given time, the specific waveforms required by warfighters operating in this communications environment are dependent upon both the situational environment and the availability of the various tactical, strategic and coalition communications networks.

To address these new requirements, military communications technologies are beginning to transition from single function "stove pipe" devices to software defined radio (SDR) architectures that can be dynamically reconfigured to meet mission requirements by using programmable devices in lieu of ASICs. These programmable devices allow each channel within the radio to be dynamically reconfigured "on-the-fly" with disparate waveforms, both at the time of deployment and during operation. Thus, each radio is able to dynamically support both legacy waveforms for voice and low-speed data, and new wideband waveforms with sufficient bandwidth for multimedia data and video conferencing.

When adaptive beam forming is incorporated into SDR, this paradigm extends directly to the beam forming subsystem. Fundamental to the use of adaptive beam forming in a dynamic waveform environment is the ability to modify the algorithms used in calculating the weighting vector in the beam-forming subsystem. This provides an optimized algorithm for each supported waveform. By utilizing programmable devices in the calculation of the weighting vector, a new weighting algorithm can be loaded each time a waveform is changed.

Figure

Illustrating how beam forming could be used in a battlefield situation. With a soldier behind enemy lines, imagery that contains critical positional information is relayed from a satellite and an Airborne Warning and Control System (AWACS) aircraft via an ad hoc network. The use of beam forming ensures the enemy tanks cannot intercept the lines of communication to the soldier and also enables the extended range required by the tank to communicate with the High Mobility Multipurpose Wheeled Vehicle (HMMWV).

In this manner, all tactical and strategic SDRs can use beam forming when communicating to each other or sending messages to legacy radios. Beam forming would be advantageous for:

- Reduced probability of intercept: the more precisely one can focus the beam the less likely an enemy could be in the communications path and intercept the signal.
- Extended range: focusing the energy of the transmitter enables the reception of signals that may be beyond the range of a comparable omni-directional antenna.
- Increased signal-to-noise ratio (SNR): by canceling out interfering signals, the SNR can be dramatically improved.

As a result, adaptive beam forming is becoming increasingly integrated into high-performance software defined radios.