Software Defined Radio Solutions for C4ISR Applications

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Application Note

Introduction

Military communications technologies are beginning to transition from single function “stove pipe" architectures to software defined radio systems (SDR) that can be dynamically reconfigured based on mission requirements. These new SDR platforms must support both legacy waveforms for voice and low-speed data, and new wideband waveforms providing high-speed data, multimedia content, and video conferencing. This shift in paradigm is being driven by interoperability requirements of various military forces, as illustrated in Figure 1. Therefore, the next generation of military radios will present a variety of challenges for the communications systems design engineer. These challenges include:

[High Data Rate Communications]

Previous generation military communications architectures supported relatively low bandwidths, with tactical communications nodes typically affording data rates below 64 Kbps and backbone communications channels at 2 Mbps or less. Support for multimedia and video teleconferencing in the new generation of military radios requires substantially higher data rates, with tactical communication channels that can sustain data rates above 500 Kbps, and backbone data rates that can exceed 40 Mbps. The signal processing devices utilized in current generation military radio products do not have the processing capabilities to support these higher data rates, and so a new generation of signal processing devices must be identified for the next generation platforms.

[Dynamic Radio Configuration]

Military communications networks are often considered a “system of systems", with subscriber nodes entering and leaving a network in an ad-hoc manner. Next generation radios need to be “reconfigured on-the-fly", often many times per second, to allow radios to interoperate in multiple networks simultaneously. This includes providing support for switching between wide and narrowband radio networks, which requires significant flexibility in partitioning the waveform across the processing elements within the software defined radio device.

[Channel Count]

Tactical communications nodes typically support a maximum of 10 RF channels, with only a single user per channel. Integrating multiple single channel radios into a common chassis can readily accommodate this channel density. However, tactical and strategic gateway systems, such as those specified in the Airborne Communication Node (ACN) and Warfighter Information Network-Tactical (WIN-T) programs, must often support channel densities upwards of 20 channels per system. The use of multiple single channel radios for these types of applications is inefficient, since higher performance processing elements capable of supporting the digital

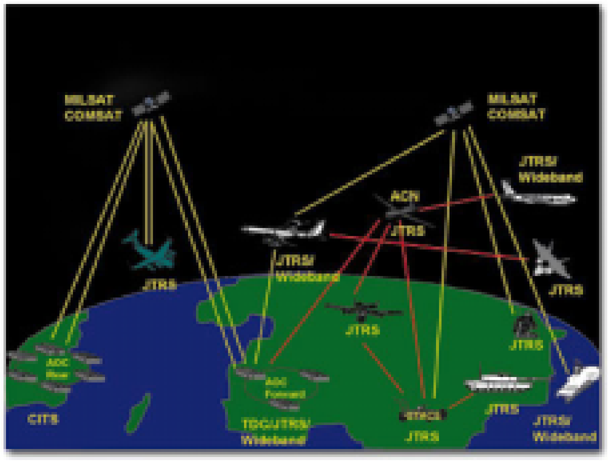

Figure 1: Interoperability Requirements in Military Communications
(Air Force Migration Briefing. JTRS Industry Day, June 28, 1999 pg.13)

radio functions for multiple channels simultaneously can be utilized for these higher density applications to significantly reduce the overall size and weight of the software defined radio. Further, these types of systems may implement some type of multiple access scheme, such as CDMA or TDMA, which allow many users per channel, and typically require a higher level of processing performance.

[Scalability]

Scalability goes hand-in-hand with channel count. If a mission requires 20 channels, 7 of which are wideband, then providing a system that only provides 10 narrowband channels is not sufficient, and providing a system that supports 150 wideband channels will probably exceed the size, weight, and power requirements for that operation. The ability to scale the radio to the specific mission requirements is a must in this new paradigm.

[Immunity to Jamming]

Immunity to hostile jammers is a key requirement for tactical communications systems. This immunity is typically achieved by utilizing a spread spectrum technology, such as frequency hopping. Historically, software-based spread spectrum processing has been impractical in these types of systems, primarily because the analog to digital converter technology has had insufficient Spurious Free Dynamic Range (SFDR) performance over the spreading bandwidth to mitigate the impact of the jammer. As a result, the spread/despread functions are typically performed in the RF transceiver subsystem, limiting the transceiver to a single user per channel. As bandwidth and channel densities increase in the new generation of military radios, however, the cost of implementing the spread spectrum processing in the RF subsystem becomes prohibitive. As such, new technologies, including multi-band channelization and smart antennas, must be employed to allow software-based spread spectrum processing while maintaining jamming immunity.

[Protection of Development Investment]

Finally, 80% of the development cost of any new radio application is in the software, and insuring that this software is portable from platform to platform is a key requirement for the next generation of radios. To meet this goal, military software defined radios must support a standards-based communications infrastructure with standards-based hardware interfaces.

Spectrum's SDR-3000 digital transceiver subsystem was architected specifically to meet these design challenges. By utilizing the latest in signal processing technology, SDR-3000 can support up to hundreds of simultaneous independent wide and narrowband channels. Each channel can be dynamically reconfigured to support the waveforms required by programs such as Joint Tactical Radio System (JTRS), Warfighter Information Network (WIN-T), Future Combat Systems and Adaptive Joint C4ISR Node. The SDR-3000 is fully compliant with the Software Communications Architecture (SCA) as released by the JTRS Joint Program Office. SDR-3000 also supports multiple technologies that are key to providing immunity to hostile jamming, including cross band synchronization and equalization so that a single wide RF band can be partitioned, through the use of pre-selectors, into a number of smaller overlapping bands that are optimized for dynamic range. Finally, SDR-3000 is entirely standards-based, allowing easy integration with other CompactPCI-based products and maximizing the portability of the developed software.

Wireless Systems

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