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WAVEFORM USE IN TACTICAL RADIO NETWORKS

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Abstract:
A series of software-defined multiband programmable radios and waveforms designed to transfer voice, data and video with the goal of connecting small tactical units with larger battlefield networks is developing in this time. By drawing on available spectrum, waveforms provide secure wireless networking services for mobile and stationary forces to transmit and receive information, including voice, data, images and video. While there are many waveforms, three in particular—Soldier Radio Waveform (SRW), Wideband Networking Waveform (WNW) and Mobile User Objective System (MUOS)—are playing critical roles in tactical radio operation and performance.

Keywords: *Soldier Radio Waveform (SRW), Wideband Networking Waveform (WNW) and Mobile User Objective System (MUOS), ANW2, SDR.*

1. Introduction

Military forces' transition to wideband communications has led to an increased use of collaborative wireless applications such as video feeds, imagery, tactical chat, and file transfer. Wideband systems provide enhanced command and control and situational awareness through the utilization of ad-hoc networking technologies, which enable voice and data to travel around geographical obstructions via automatic relay. When operating over a wideband network, deployed forces are able to communicate in new and different ways to stay connected and retain the upper hand on the enemy. For military personnel looking to implement new wideband technologies, the benefits exceed the challenges. However, the latter do exist, including a lack of infrastructure, security, and channel conditions. That's why companies at the forefront of wideband development like Harris Corporation continue to dedicate resources to help meet the growing networking needs of soldiers.

For years, networking has been deployed on the battlefield at the division, brigade, and battalion levels. However, networking at the battalion level and below has proven more difficult due to the mobile nature of those forces and to the limited data capabilities of traditional narrowband tactical radios, such as the inability to support voice and data on a single channel.

Starting in the late 1990s, first-generation wideband networking solutions overcame some of these issues by integrating the data network inside the radio and providing increased channel bandwidth. These single-purpose data radios provided improved performance but were not yet a "perfect" solution, with shortcomings that included lack of integrated security and integrated voice, limited frequency support, and a pre-configured hierarchy**[1].**

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2.Adaptive Networking Wideband Waveform (ANW2)

The latest wideband waveforms, such as the Adaptive Networking Wideband Waveform (ANW2) from Harris Corporation, are providing effective and field-tested solutions to the challenges of wireless tactical networking. ANW2 is operating on the Harris Falcon III® AN/PRC-117G and is widely fielded by RO forces in Afghanistan, providing transformational communication capabilities. The waveform is also be operating on the Harris Falcon III AN/PRC-152(C) handheld radio, allowing deployed forces greater and more portable options for wireless tactical communications**[1]**.

2.1 The role of ANW2

Harris' development of ANW2 was driven by the need to deliver many different types of information across an often asymmetric, non-linear battlespace in which enemy engagements take on varying forms. At the time, the military had not yet completed its planned standard waveforms for mobile, flexible, and secure networked voice and wideband data communications at the battalion level and below. ANW2 uses robust and adaptive modem technology to provide connectivity in challenging combat scenarios. Mobile ad-hoc networking seamlessly provides soldiers with a common operational picture of the battlespace. This includes voice and data connectivity around geographical obstructions such as buildings or mountains. This capability is enabled by automatic relay, which, in essence, means that all radios in an ANW2 network act as relay stations, delivering signals to all other members on a network.

Harris' AN/PRC-117G (PRC-117G) provides legacy narrowband interoperability and mobile wideband networking in a radio platform that is significantly smaller and lighter than previous units. The radio provides up to 20 watts of output power as a dismount system and 50 watts when connected to a vehicular amplifier, which further extends its reach across the battlefield.

The radio covers an extended frequency range from 30 MHz to 2 GHz, with narrowband interoperability with manpack radios in the 30-512 MHz band and wideband waveform support from 225-2000 MHz**[2]**.

The radio's SCA V2.2 operating environment is certified SCA compliant by the Joint Tactical Radio System (JTRS) Joint Test and Evaluation Laboratories (JTEL). The radio includes the Sierra II™ programmable crypto system, which is a reprogrammable cryptographic device that protects information up to the TOP SECRET level, and supports cryptographic requirements of the JTRS and NSA's Crypto Modernization program, including the requirement for programmability**[3]**.

ANW2 provides transformational capabilities, optimizing network performance across several, often conflicting, parameters, including rate (capacity), robustness, range, and network reach (routing). Optimizing these parameters requires deliberate and flexible trade-offs that vary depending on how and where the network is deployed. Some of the key considerations include:

- No Infrastructure. Unlike broadband technologies in established strategic locations such as Wi-Fi, networked tactical radios are without the benefit of any existing network infrastructure—no cell towers, no fiber optics, no cable companies. ANW2 requires no pre-configured head or cluster nodes. This allows ANW2 to form multiple networks and adapt constantly to changing channel conditions.
- High Security. ANW2 data in the 117G is secured using the High Assurance Internet Protocol Encryption (HAIPE™) standard. Using this interoperable networking standard, the 117G is NSA certified to pass TOP SECRET data. Voice traffic is also Type-1 encrypted.

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- Varying Channel Conditions. The channel conditions between any two stations in a network undergo constant change as nodes—individual warfighters—move on the battlefield. At times, nodes may not always have direct line-of-sight communication to all other notes. The nodes in an ANW2 network measure and communicate these changes and automatically adapt by selecting appropriate modulations. The modulation is chosen on a station-by-station basis so that the entire network is not penalized by the lowest performing connection.
- Fast Forming and Healing Times. Military environments where warfighters are on the move require networks that can form, break apart, and heal very quickly. ANW2 employs a time-division multiple-access (TDMA) data protocol, which provides predictable performance and fast forming and healing times—typically less than 10 seconds. The TDMA structure also allows all radios to transmit at maximum power. Other common mechanisms require adaptive power schemes.
- Voice Connectivity. Even in the networked environment, voice remains a key capability for critical and last-ditch communications. ANW2 includes a dedicated all-informed combat net radio (CNR) voice channel that operates simultaneously, yet independently, from the data operation. This dedicated voice channel improves voice reliability and performance in combat environments while at the same time leveraging the network capability of the waveform, providing a unique multi-hop voice capability. This voice-flooding technique allows stations without direct line-of-sight to communicate using voice.
- Scalability. ANW2 sub-networks support one to 30 full-member nodes and up to 250 guest-member nodes. Full-member nodes have access to transmit and receive voice and data, while guest-member nodes can transmit and receive voice as well as receive multicast data. This allows up to 280 nodes within a single sub-network or radio channel. ANW2 also uses standard network protocols and interfaces**[2].**

The main objective of wideband waveforms is to improve efficiency and aid force protection through increased information sharing. Using ANW2, the 117G provides increased data connectivity to the battalion and below levels, including secure reachback capability into secure networks. This capability is also being further extended through the use of high capacity line of sight (HCLOS) radios, satellite terminals, or direct connection to a secure network.

For example, a 117G combined with a Broadband Global Area Network (BGAN) satellite terminal enables mobile and dismounted command and control in rugged terrain. The 117G network stack determines the link to use based on the network connectivity. If an address cannot be reached using ANW2, it falls over to use the beyond line-of-sight (BLOS) BGAN links. Conversely, when line-of sight connectivity is re-established, the BGAN link is dropped.

Once in place, these networks enable the use of existing collaborative applications. For example, the Tactical Ground Reporting Network (TiGRNet) application allows posting of text and imagery to a map, while the Biometrics Automated Toolset (BAT) allows collection and querying of biometric. Since the PRC-117G follows network standards, little integration is required to support these applications**[1].**

Further applying its know-how in tactical networking, Harris continues to port waveforms from the JTRS Information Repository to provide warfighters with greater flexibility and capabilities. This includes the Soldier Radio Waveform (SRW), the Wideband Networking Waveform (WNW), and the Mobile User Objective System (MUOS). ANW2 is a complementary technology to these waveforms, providing a mobile on-the-move link between SRW at the soldier level and WNW at the battalion level and above.

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The architecture of battlefield whit all this waveform work together is shows in the next picture. In this picture is represented also the hole networks that make part of JTRS. For us important is SRW, WNW, MUOS.

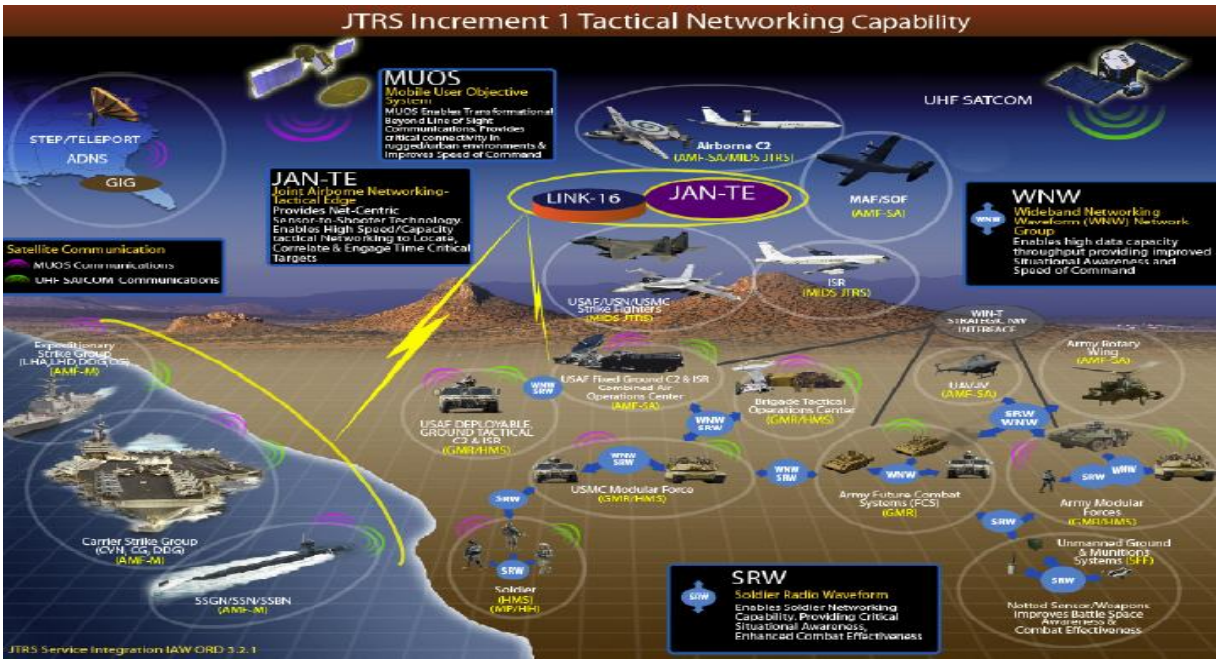

Fig.1. JTRS increment 1 tactical networking capability**[4].**

3. Soldier Radio Waveform (SRW)

SRW is an open-standard voice and data waveform that's used to extend wideband battlefield networks to the tactical edge. Designed as a mobile ad hoc waveform, SRW functions as a node or router within a wireless network to transmit vital information across long distances and over elevated terrain, including mountains and other natural or manmade obstructions.

SRW is used by individual soldiers, small units and very small sensors such as unattended ground or air vehicles. The waveform allow communication without a fixed infrastructure, such a cell tower or satellite network. SRW has been fielded as part of the Army's Capability Set (CS) 13 in the Rifleman and Manpack Radios. Both radios use SRW to transmit real-time information that was previously only available in vehicles or command posts down to the dismounted soldier**[5].**

4. Wideband Networking Waveform (WNW)

WNW is designed to provide network connectivity between aircraft and ground vehicles. The waveform re-routes and re-transmits communications whenever terrain or structures challenge users attempting to communicate beyond line-of-sight. Moran noted that compared to SRW, WNW "is a little bit of a heftier waveform, a little bit more capable waveform." He added that the "waveform is used to provide connectivity to command posts at the platoon, company and battalion level."**[5]**

With its mobile ad-hoc networking capabilities, WNW is designed to work well in an urban landscape or a terrain-constrained environment, since it can locate specific network nodes and determine the best path for transmitting information.

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As part of the Army's new Mid-tier Networking Vehicular Radios (MNVRs), WNW is on track for fielding with Capability Set 17. The waveform's most recent version increases the throughput and number of nodes supported simultaneously in a single network. Soldiers will also be able to send and receive Internet Protocol information from any source while on the move.

5. Mobile User Objective System (MUOS)

Harris's Falcon III AN/PRC-117G multiband manpack radio, hosting the Mobile User Objective System (MUOS) waveform, has successfully completed initial interoperability testing, but now is not available for Ro Army. In this paper we discussed about MUOS because in a efficient waveform for tactical networks.

The test, conducted at the Joint Tactical Networking Center MUOS Reference Implementation Laboratory in San Diego, California, US, demonstrated interoperability with the addition of MUOS software to AN/PRC-117G radios, without modification from their standard hardware configurations. The US Navy's MUOS is a next-generation narrowband tactical satellite communications system capable of enhancing ground communications for US forces on the move. In addition to providing cellular-based service through tactical radios, the MUOS offers more communications capability for military users over existing systems, including simultaneous voice, video and data - similar to the capabilities experienced today with smart phones**[6].**

6. Conclusion

The benefits of wideband tactical communications are vast, benefitting the warfighter with a more extensive information environment. In this paper we are discussed about the ultimate wideband waveforms that existing. These waveforms are the foundation for designing future tactical radio networks capable of fighting against both traditional threats and especially those hybrid.

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