

JOINT TACTICAL RADIO SYSTEM – CONNECTING THE GIG TO THE TACTICAL EDGE

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ABSTRACT

The Joint Tactical Radio System (JTRS) is one of the Department of Defense's (DoD) core transformational programs. The Joint Program Executive Office (JPEO) JTRS manages the acquisition of this critical new capability. The mission of the JPEO JTRS is to develop and produce a family of interoperable, affordable software defined radios at moderate risk which provide secure, wireless networking communications capabilities for Joint forces. This paper will explain recent changes to the JTRS program and its new approach to delivering wireless networking capabilities to the warfighter.

BACKGROUND

JTRS is understood to be a Transformational Communications program; however there are two additional perspectives by which JTRS is making transformations beyond the sphere of communications capability.

JTRS was initiated in the late 1990s with a primary focus on replacing aging legacy radios with a single, versatile system. The JTRS waveform application software was procured under a Joint Program Office and radio terminals were procured under Service-led Program Offices (called "Clusters"). The first transformational aspect of JTRS was already under way – the movement from a "closed-system" radio market to a more open business model based on standards and common software. The intention being to produce a more competitive market for radio hardware yielding the cost savings associated with competition.

Two factors worked against the initial JTRS approach: 1) the loose organization between highly dependent programs and 2) the JTRS mission evolved from legacy radio replacement to

transformational wireless networking. Without strong centralized management, the growth in mission and requirements resulted in schedule and cost over-runs.

In February 2005, the collection of JTRS efforts was placed under the leadership of the Joint Program Executive Office. Subsequently, the DoD formally recognized the change in mission for radios and reduced the original requirements to concentrate on the transformational communications aspect (i.e. delivering wireless networking to the Tactical Edge) and a subset of current Force communications. The goals of the JPEO JTRS are summarized as follows:

- **MANAGE RISKS** - Understand and manage Enterprise, Domain, and Program risks
- **DEVELOP and PRODUCE** - Effectively manage program cost, schedule, and performance
- **INTEROPERABLE and SECURE** - Institute an Enterprise approach to developing a secure interoperable JTRS capability

The JPEO has also looked to reinforce the transition to a more open market by enhancing the standardization effort and assuring the reusability of the software held by the government. Specifically, the JTRS Information Repository (IR) was established to make Government Purpose Rights software, design artifacts, and Test and Evaluation results available to all JTRS product developers. The IR is the cornerstone in establishing the JPEO's new Enterprise Business Model (EBM). That model is characterized by product development that meets the following objectives:

- Enhance portability and reusability while ensuring security

- Maximize competition and hold Industry accountable

There is an additional component to the EBM, focused not on industry, but on the DoD acquisition process

- Institutionalize an Enterprise Execution and Governance model

This last element is underscored by the Under Secretary of Defense for Acquisition, Technology and Logistics decision to use JTRS as a test-bed for acquisition streamlining. Thus, JTRS is now transformational not only from a capability perspective, but also from DoD acquisition process and DoD radio market views as well.

INCREMENT 1 CAPABILITIES

The JTRS program is now being pursued in an incremental approach. Table 1 lists the fourteen form factors along with their associated waveforms determined for Increment 1 (JTRS ORD 3.2.1 dtd Aug 2006). This represents roughly a 1/3 reduction in requirements from ORD 3.2 dated April 2003. Additional waveforms, form factors, and capabilities are planned to be added to JTRS in Increment 2 and future increments.

	WNW	SRW Type 1 Secret	SRW Type 2 SBU	JAN-TE	SINC	SINC w/INC	LINK 16	EPLRS	MUOS	HF	UHF SATCOM DAMA
GROUND VEHICLE (4 ch)	X	X	X		X	X		X		X	X
MIDS-J (4 ch)				X			X				
SFF A/H (IMS/UGS 1/2 ch)			X								
SFF D (UAV 1 ch)			X								
SFF J (NLOS 2 ch)		X	X		X						
MAN PACK (2 ch)		X	X		X			X		X	X
AMF SA (2 ch)	X	X	X				X		X		
SFF B (LW 2 ch)		X	X		X			X			
SFF C (LW 1 ch)			X								
SFF I (LW 1 ch)		X	X		X			X			
AMF M (4 ch)									X		X
HANDHELD (2 ch)		X	X		X			X			

Table 1: JTRS Inc 1 Form Factors and Waveforms.

JTRS Increment 1 includes a mix of current force capabilities along with modern mobile ad hoc networking capabilities based on the Internet Protocol. These new networking waveforms cover a wide range of needs in the tactical domain and include the following: Wideband Networking Waveform (WNW); Soldier Radio Waveform (SRW); Joint Airborne Network – Tactical Edge

(JAN-TE) and Mobile User Objective System (MUOS). Each of these waveforms fills a particular operational niche in the tactical environment yet each provides a common transport function for IP-based traffic.

WNW supports the ground vehicular environment and provides mobile transit routing capabilities. SRW operates as a stub network for battery-powered platforms including dismounted soldiers and unmanned systems. The JAN-TE waveform supports the tactical airborne domain of weapons platforms that require very low-latency traffic. Finally, the MUOS Common Air Interface (CAI) waveform provides beyond-line-of-sight communications. Figure 1 illustrates how JTRS provides the transport to extend the Global Information Grid (GIG) to the tactical edge.

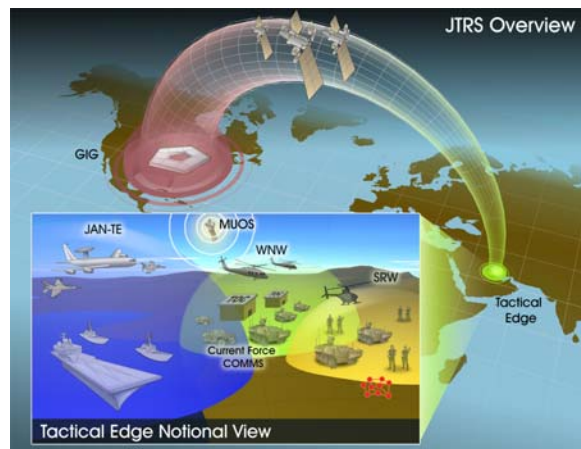


Figure 1: JTRS Support of Tactical Edge.

Each JTRS product is designed with a basic networking architecture to enable it to support specific tactical operations. Some installations will require interfaces to Service and Coalition Networks. For JTRS Increment 1, direct connections to the GIG will be through service networks to adequately address security concerns. In addition, some routing and retransmission functions will be accomplished in external gateway devices to reduce the complexity and cost of the radio design. Figure 2 depicts the use of a JTRS Gateway Device external to the Joint Tactical Radio (JTR) to provide this function. The external gateway device is only required for those platforms performing gateway missions. JTRS is pursuing designs that can be integrated

into existing Service gateway programs where applicable.

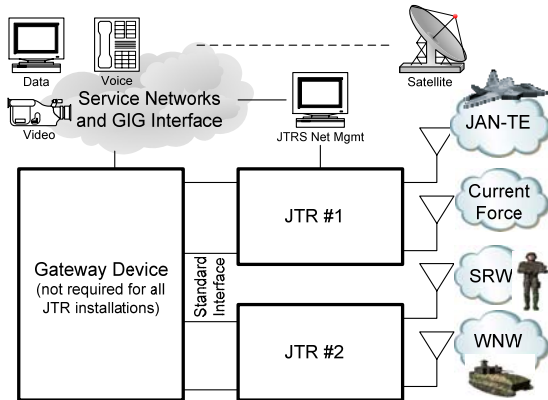


Figure 2: JTR Connection to Service Networks, GIG, and Gateway Devices.

Interoperability is enforced within JTRS using multiple approaches. First, all products are built on a set of DoD and commercial standards, as depicted in Figure 3, to enforce interoperability. Second, all products reuse the same waveform software with their associated JTRS Infrastructure Standards. And third, JTRS products must pass the Joint Interoperability Test Center’s (JITC) waveform conformance and interoperability tests.

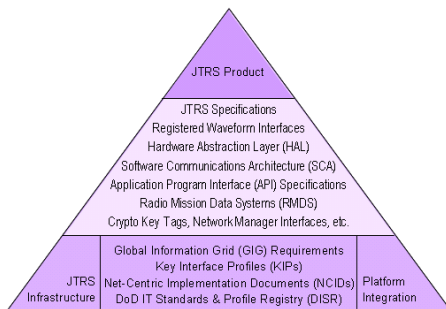


Figure 3: JTRS Products are built on a set of Common Standards and Specifications.

NETWORKING

Wireless tactical networking is one of the most critical capabilities the JTRS program will deliver. Today’s forces employ a variety of unique voice and datalink waveforms that are not interoperable with each other nor with modern Internet Protocol (IP) networks. The new JTRS networking waveforms are based on IP standards that permit tactical edge users to connect to the DoD’s GIG, as illustrated in Figure 4. For the initial JTRS

capability increment, IPv4 standards will be used along with High Assurance Internet Protocol Encryption (HAIPE) for secure networking. Future capability increments will accommodate IPv6 as those standards mature for tactical networking.

The employment of IP networking at the tactical edge is challenging because most commercial IP networks are static and operate over very high bandwidth links. In JTRS, quite the opposite is true. Network nodes often move and the bandwidth of the links is very limited. Mobile ad-hoc networking (MANET) protocols are designed to handle these wireless environments. Each JTRS networking waveform employs a MANET protocol tuned to its peculiar environment. These protocols interact with the IP layers in the radios to hide the network mobility and dynamics from the external commercial-based networking equipment to facilitate interoperability.

The JTRS networking architecture provides for a black core routing infrastructure. The black core routing permits encrypted IP packets from one radio frequency (RF) subnet to be directly routed to another RF subnet without an intermediate encryption and decryption process. The transit networking capability of WNW uses black core routing between its RF subnets to form a common heterogeneous network. The black core network can be extended to other external networks or the encrypted packets can be sent through a HAIPE to red-side networks that carry user traffic. User traffic at different security levels will be cryptographically separated by the HAIPE and the radio platform’s security architecture.

The JAN-TE network and SRW network architectures are still being finalized. However, these networks are intended to serve as stub networks for their end-user applications. As stub networks, these networks will have minimal inherent routing capability and will connect to transit networks via external gateway devices. JTRS Enterprise Network Services (ENS) are being defined to provide a Common Network Service (CNS) across all these JTRS networking waveforms and to identify Gateway solutions.

SOFTWARE DEFINED RADIO TECHNOLOGY

JTRS products are all based on Software Defined Radio (SDR) technology to enable a more scaleable and extensible radio system in comparison to a system composed of dedicated hardware. Each channel of a JTR is capable (in general) of executing a different waveform (e.g. WNW, EPLRS, ...) depending on the mission requirements determined by the operator. A multi-channel JTR may execute several different waveforms, or multiple instances of the same waveform, simultaneously. This flexibility of JTRS enables transformational change from earlier DoD communications systems.

Software for JTRS systems is designed around an Open Systems modular architecture, developed and managed in an open source-like environment for JTRS developers. The JTR Infrastructure Standards include the Software Communications Architecture (SCA), Application Program Interfaces (APIs), software coding standards, Modem Hardware Abstraction Level (MHAL) standards, and others as shown in Figure 5. The SCA is a framework for the deployment and interaction of all software components in the JTR [Ref SCA 2.2.2 dated May 2006]. Further, JTRS software and artifacts are available (under

Government Purpose Rights) for reuse through the JTRS Information Repository.

Establishing the JTRS Infrastructure of Figure 5 enhances code reusability and portability. JTR application developers are guaranteed that a radio will provide a known set of interfaces and behaviors. Waveforms and other applications can thus be developed for a specific JTR form factor/mission and then deployed to other JTR form factors as the needs of the warfighter or deployment change. These same key interfaces allow for tech insertion and refresh of older radios in addition to early fielding of future increment JTRS capabilities.

SUMMARY

This paper has described how JTRS has been restructured to deliver the DoD's next generation of interoperable and secure tactical radios while effectively managing risks. JTRS is employing a new Enterprise Business Model that includes a new Joint governance process, enhancing portability and reusability while ensuring security, and maximizing competition and holding Industry accountable. In summary, the program is now aligned to deliver a truly transformational communications capability to the warfighter.

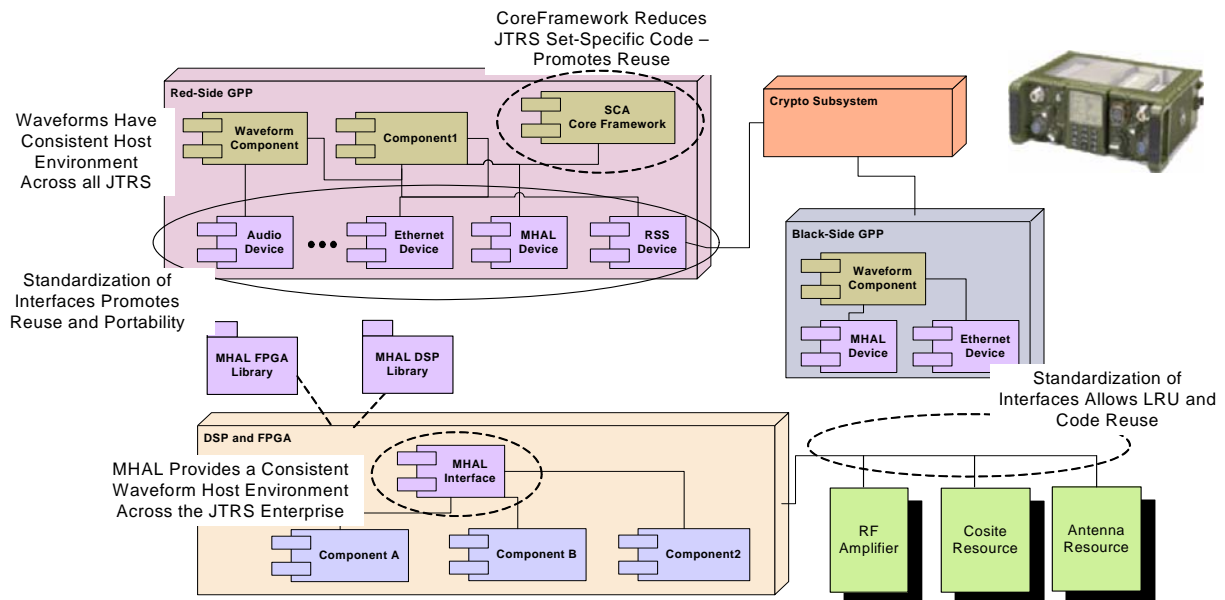


Figure 5: Standardization of JTR Infrastructure.

BIOGRAPHIES

Dr. Rich North is a US Government Navy civil servant at the Space and Naval Warfare Systems Center (SPAWAR SSC) in San Diego and serves as the Technical Director for the JPEO JTRS. Dr. North attended the University of California, Davis where he received his B.S. in Electrical and Computer Engineering (ECE), and earned his M.S. in EE at Cornell University in Ithaca, NY. Dr. North received his Ph.D in ECE from the University of California in San Diego. He has been with the Navy for over 14 years leading a variety of R&D and procurement activities in military communications systems.

Len Schiavone is a Senior Principal Engineer at The MITRE Corporation, a not-for-profit R&D firm supporting the United States Government, in San Diego, CA, USA. His current assignment is to serve as the Systems Engineering lead for the JPEO JTRS and as the MITRE Project Director for JTRS activities. He completed undergraduate studies at Worcester Polytechnic Institute ('84, BSEE) and graduate studies at Northeastern University ('87, MSEE). He has been employed at the MITRE Corporation for over 20 years working on the development of various communications systems.

Norm Browne is a Senior Member of the Professional Staff with SRA International, Inc. He is currently assigned to the JPEO JTRS working risk management, technical analysis and oversight support for the Technical Director. He completed undergraduate studies at the California State University, San Bernardino ('81, BA) and graduate studies at the Claremont Graduate University ('89, MS). He has over 20 years of software development and management experience in the commercial and public sectors.