Joint Tactical Radio System (JTRS)

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Introduction - The Joint Tactical Radio System (JTRS) program is a key technology and acquisition program for the Army and other services. Its objective is to provide the US military with a common family of software programmable tactical radio systems that can function in different roles and operate in different modes and frequency bands. Basically, the JTRS will consist of a set of hardware platforms that will take on different operational characteristics based on the software application package loaded on them. This concept is similar to the philosophy behind the personal computer (PC). A PC is also a hardware platform on which different software application packages are loaded thus making it function in different roles – as a word processor, a spreadsheet generator, an Internet interface, etc. Also, as with today’s PCs that are manufactured by different vendors like IBM, Dell or Hewlett-Packard, the JTRS hardware platforms will also be produced by different vendors. Each vendor will adhere to a basic set of ground rules like system architecture, physical characteristics, environmental requirements, etc. But, as in the case of the PC, each vendor will be free to introduce its own hardware enhancements to the radio. The basic requirement is that each of these platforms will support the JTRS software waveforms just as each of today’s PCs supports Microsoft Office software.

Synopsis - This article covers some of the important aspects of the JTRS program. It describes the background of the concept, the goals of the program, the organizations charged with achieving these goals and the status of the program today. Information used to generate the article was obtained from available literature and open documentation and from discussions with personnel from the Program Manager (PM) Tactical Radio Communications Systems (TRCS) project office located at Fort Monmouth. This included Colonel John R. Grobmeier, TRCS Project Manager, LTC Peter N. Fuller, Product Manager, Acting PM JTRS-Army (Ground and Airborne), Ms. Patricia C. Allocca, Deputy PM JTRS-Army, and Mr. Leo Emery, JTRS-Army Step 2C/Block I System Engineer.

Background - Since the introduction of wireless communications to the warfighting environment, different radios have been used for different applications. Today’s military has approximately 750,000 service unique radios
divided into approximately 20 families. These are mostly “hardware intensive” systems that are single-mode, single-band radios mostly with no networking capabilities. The Army, for example, uses the Single Channel Ground and Airborne Radio System (SINCGARS) in the role of a voice and data Combat Net Radio (CNR) in the Very High Frequency (VHF) band. Concurrently it uses the Enhanced Position Location Radio System (EPLRS) in the role of a network data radio in the Ultra High frequency (UHF) band. Additionally, in the role of a line-of-sight (LOS) radio, the Army uses the AN/GRC-226 radio operating in the UHF band.

Inefficiencies inherent in using different radios and the lack of interoperability between the services have prompted military leaders and scientist to search for a new approach. This, combined with the advances made in processing technology, resulted in the initiation of the Speakeasy program by the Air Force’s Rome Laboratory in 1989. The Army (CECOM) and Navy (NRaD) joined soon after. The objective of Speakeasy was to develop a common radio system to support multiband operation, simultaneous transmission and reception in multiple channels (four channels as a goal) and networked operation. The Speakeasy was to be based on an open architecture (see definition below) and be programmable so that it could be flexible and support re-configuration locally or through over-the-air transmission. Phase I of the program, the development of a Speakeasy modem, was awarded to Hazeltine Corporation as a prime contractor and TRW as waveform software subcontractor in 1990. Concurrently a multiband antenna program was started at CECOM with contracts awarded to Georgia Tech, Ball Aerospace and Southwest Research. Phase I covered five waveforms including non-hopping SINCGARS, Have Quick I&II and MIL-STD-188-110. Seven other waveforms were considered but not funded. Speakeasy Phase II was the next step which called for the development of a fieldable Multiband Multimode Radio (MBMMR). This radio was to emulate more than 15 existing military radios in bands from 2MHz to 2GHz. Its waveforms included wideband and narrowband as well as networks and bridges. A contract was awarded to Motorola in 1995 to insert narrowband waveforms with options for wideband waveforms. The program was terminated when the cost to add the wideband waveforms exceeded what was in the program budget.

In 1996 the Army, faced with near term needs for a digital networked programmable radio, had CECOM award a contract (potentially worth $23.4M) to a team headed by ITT Aerospace /Communications Division for the Near Term Digital Radio System (NTDRS). This system is basically a wireless data network transport system similar to the EPLRS system. As the system was developed, its mission was to provide Tactical Operations Center (TOC) to TOC networked, mobile data communications for data terminals and Local Area Networks primarily at echelons Brigade and Below. The NTDRS is capable of supporting up to 40 Km range and operating in a moving vehicle at speeds up to 50 mph. It provides throughput of better than 288 Kbps. According to Mr. Emery, 174 radios were purchased by the Army and will be “hand-receipted” to the 4 Infantry
Division and 3rd Brigade Combat Team. In general, development and acquisition of any tactical radio other than JTRS by any service were banned in 1998 by Mr. Arthur Money, Assistant Secretary of Defense (ASD). Waivers justifying the need for an exemption have to be submitted to ASD/C3I and are reviewed by the JTRS JPO.

**Objective** - The goal of the JTRS program is to develop a radio system that satisfies the requirements stated in the Operational Requirements Document (ORD) approved by the Joint Requirements Oversight Council (JROC) in March 1998. This document calls for the radio system to be “software-reprogrammable, multi-band/multi-mode capable, networkable, and provide simultaneous voice, data and video communications with low probability of intercept.” Satisfying these requirements the JTRS will “provide increased interoperability, flexibility, and adaptability to support the varied mission requirements of the warfighters.” The ORD further states that the JTRS will “use existing and advance waveform capabilities, will operate with legacy waveforms currently used by military and civilian agencies, and incorporate new waveforms as they are developed.” These requirements will ensure that the radio system will be able to interoperate with legacy radios using their existing waveforms, a concept known as backward compatibility. For example, it will be able to interoperate with the SINCGARS radio using the SINCGARS’ waveform consisting of FM modulation in the VHF band with frequency hopping. So far 33 legacy waveforms have been identified as potential candidate for the JTRS. The JTRS will also be capable of supporting new waveforms that are developed in the future in response to specific communications needs that will emerge as technology advances and as the military identifies new operational requirements.

The ORD imposes specific structural requirements on the JTRS such as the need for scalability, growth capability, and an open architecture. Open architecture is a critical requirement. A system’s architecture, in general, is defined as a set of hardware elements or software elements of a system and a specified a set of rules that govern how these elements interact with one another. Open architecture is a type of architecture that allows system elements to be easily replaced without impacting system operation. For example, the open architecture of the JTRS will allow substituting one waveform – a software element – for another waveform thus changing the operational characteristics of the radio. Since the architecture of the JTRS will be known, different vendors would be able to develop different waveforms and “plug” them into the radio. Note that scalability and growth potential are an integral part of the open architecture concept.

The JTRS will consist of a family of radios designed to operate in three basic operational missions and environments known as “domains.” They are Airborne, Maritime/Fixed and Ground. The Ground domain can be further broken down into Handheld, Dismounted and Vehicular sub-domains.
The Program - The JTRS program is a Joint program with centralized management and de-centralized execution. To support this concept, the Department of Defense (DoD) set up a Joint Program Office (JPO) at the Pentagon headed currently by an Air Force Colonel. The JPO consists of representatives from the Army, Air Force and the Navy and liaison officers from the National Security Agency (NSA) and the Federal Aviation Administration (FAA). The primary responsibilities of the JTRS JPO are to provide the JTRS system architecture, called the Software Communications Architecture (SCA); and to provide the JTRS SCA waveforms to the hardware developers. The Army is the first service to develop hardware to meet the warfighters needs. The Army’s PM TRCS with its considerable experience in developing and fielding tactical radios, was selected as the program office within the Army to develop the first JTRS radios. The Army today is the service most committed to this program as the JTRS is included in its Program Objective Memorandum (POM) funding cycle. The Army organized its effort into three distinct yet interdependent phases or Blocks. Block I includes the development of a two channel ruggedized prototype to validate networking Tactics, Techniques and Procedures. Block II includes the development of a three-channel ground vehicular and aviation platform system, that can host or support the operation of the software of many legacy radio systems. Block III includes the development of systems to meet the Army’s manpack, handheld and dismounted requirements. The JTRS management approach has been the subject of some discussion. Some feel that in order to produce the most efficient and timely system with these revolutionary technologies, it would be best to have a single entity develop and integrate both hardware and software. Time will tell.

The JTRS program is being executed in three steps as shown in the accompanying figure. Step 1 was the definition of potential architectures. It was executed in a three-month period starting February 1999 by three consortia of companies headed by Boeing, Motorola and Raytheon Company. Each consortium received $1.5M and matched it with their own $1.5M investment. At the end of the three-month period three architectural approaches were submitted to the JPO for technical evaluation.

In Step 2, the actual architecture of the JTRS was developed and validated. Due to the complexity involved in the process, Step 2 was divided into three parts - Step 2A, Step 2B and Step 2C. Step 2A involves the development and validation of the baseline architecture known as the Software Communications Architecture (SCA). The SCA is central to the JTRS and is expected to become the basis for all future DoD tactical radio acquisitions as well as an industry accepted commercial and international standard. It will be placed in the public domain so that it can be used by potential bidders for Step 3 of the program. Step 2A also includes the development of prototype hardware that will be used for validating the architecture.
Step 2A is a 12 to 15 month effort that was awarded to a consortium headed by the Raytheon Company. The consortium also includes ITT Industries, BAE Systems, Qualcomm, Racal Communications Inc., Rockwell-Collins, Rooftop Communications, Software Technology Inc., Sun Microsystems and Xetron. The consortium received a $21.7M contract from the JPO.

Step 2B provides further validation of the SCA by third parties. Some specific activities include assessing SCA impact on scalability with regard to man-pack and hand-held radios, assessing SCA impact on complex waveforms, Core Framework (CF) implementations and third party waveform development. To date six agreements have been signed with third parties.

Step 2C is also referred within the Army as Block I. The objective of this 24-month effort is to produce a number of JTRS radios. As part of this step the JPO, with contract support from US Army CECOM, signed an Other Transaction Agreement (OTA) with BAE Systems Aerospace Inc. valued at approximately $14.5M. In accordance with this agreement, the company will perform a research, development, and production effort to assist in validating the emerging SCA open standard being developed as part of JTRS Step 2A activities. Step 2C effort will provide 40 engineering development models of 2-channel systems, and 220 ruggedized 2-channel prototype radios, to help validate the networking portion of the SCA. BAE Systems will use their AN/VRC-99 2-channel radio as the basis for their 2C JTRS. That radio can operate as a Time Division Multiple Access (TDMA) radio and as a Code Division Multiple Access (CDMA) radio. It operates in the UHF band and provides a bandwidth of 288 Kbps in each channel. Deliveries of the 2C radios will start in November 2001 and the radios will be delivered primarily to 1st Cavalry and the third Brigade Combat Team (BCT).

The OTA contractual vehicle used here is under the authority of 10 U.S.C. section 2371 and Section 845 of the 1994 National Defense Authorization Act, as amended. According to Col. Grobmeier "The OTA was selected because it allows the kind of flexibility we need on this project." It is used to reduce the traditional administrative and oversight burden of Government contracts and is not subject to the normal Federal procurement laws and regulations.

In Step 3, the JPO will procure waveforms for all the services. These will be used in future Service hardware procurement programs which have been designated as "clusters". The Army block 2 program is the initial service hardware acquisition program (cluster 1, if you will) that will use the waveform software procured by the JPO under their step 2 program. The JTRS will support secure and non-secure voice, data and video communications using wideband and narrow-band waveforms. Seven waveforms will be implemented and the radio will operate in the 2 MHZ – 2 GHz frequency range. JTRS will be managed as a family of programs and acquisition will be the responsibility of several organizations. Software waveforms will be acquired by the JPO which will also
be responsible for maintaining and evolving the system architecture. Hardware platforms in their particular domains will be acquired by the services in accordance with their requirements. Key to the JTRS procurement is the service-developed migration plans that have to be approved by DoD. Current activities in the program involve generation of key requirements document such as the Joint Concept of Operations (CONOPS) and the service-specific CONOPS. An ORD for the JTRS (Revision 1-Version a) has been released and is in the review cycle. The schedule for the program is still not firm at this time. Estimates are that Initial Operational Test and Evaluation (IOT&E) will take place in the FY 06 time frame with First Unit Equipped (FUE) in the FY 07 time frame.