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Joint tactical radio – aspects of standardization

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This paper presents the Joint Tactical Radio System (JTRS). The intention was to introduce the organization of and requirements for the system. Also, it reviews a new generation of the Joint Tactical Radios (JTRs), realized on the basis of the Software Defined Radio (SDR), and a brief survey of typical standards that define the JTRS. The organization of a new tactical flexible network, developed under standards for period after 2000, where the JTR should find its application, is presented.

Key words: **military communications, tactical radio system, joint tactical radio, software defined radio.**

Used abbreviations

AALs – ATM Adaptive Layer
API – Application Program Interfaces
ASPEN – Adaptive Signal Processing & Networking
ATM – Asyncrhonous Transfer Mode
C41 – Command, Control, Communications, Computing and Intelligence
CNR – Combat Net Radio
COBRA – Common Object Request Broker Architecture
DEQPSK – Differentially Encoded Quadrature Phase Shift Keying
DQDB – Distributed Queue Dual Bus
EHF – Extremely High Frequency
FEC – Forward Error Correction
GEO – Geostationary Earth Orbit
GPS – Global Positioning System
IFF – Identification of friends or foes
INFOSEC – Information Security
ISDN – Integrated Services Digital Network
ISO OSI – International Standards Organization Open Systems Interconnections
ITU- T – International Telecommunication Union –the Telecommunications services sector
JTIDS – Joint Tactical Information Distribution System
JTR – Joint Tactical Radio
JTRS – Joint Tactical Radio System
LAS – Local Area Subsystem
LEO – Low Earth Orbit
MIDS – Multifunctional Distribution System
MSRC – Modular Software-programmable Radio Consortium
MRR – Multi-role Radio
MS – Mobile Subsystem
MT – Mobile Telephone
PR – Packet Radio
RAP – Radio Access Point
RF – Radio Frequency
SBPSK – Shaped Binary Phase Shift Keying
SCA – Software Communications Architecture
SDR – Software Defined Radio
SHF – Super High Frequency
SMCS – System Management and Control Subsystem
SOQPSK – Shaped Offset Quadrate Phase Shift Keying
TMN – Telecommunications Management Network
WAS – Wide Area Subsystem
WLAN – Wireless Local Area Network
WNW – Wideband Networking Waveform
WWAN – Wireless Wide Area Network

Introduction

THE Joint Tactical Radio System is a family of modular, software programmable, multi-band, multi-mode tactical radios, having a possibility to create a signal of different legacy waveforms. They have to enable interoperability among diverse legacy radios and JTRs. JTRS will provide a reliable multi-channel voice, data, imagery, and video transmission and enable the communication between different terrestrial and satellite tactical communications networks. The JTRS appears to exceed the problems of using different radio equipment in telecommunications networks and connecting different types of networks. The described problems are the consequence of creating different communications and production standards forced by leading producers of tactical equipment and by military structures.

The need for that kind of radio is especially expressed in military communications. The technical limiting factors of existing communications systems is their incompatibility with commercial communications systems and their mutual incompatibility. A lot of programs with great investments were started by the most contemporary equipped world's armies. The international industrial association Modular Multifunctional Information Transfer System (MMITS) was founded. That forum consists of leading world tactical communications equipment producers and other scientific institutions. The objective of the forum is to define the con-

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cept of a new radio in order to solve the mentioned problems. The solution based on the Software Defined Radio (SDR) technology with a new Software Communications Architecture (SCA) was suggested. Basic standards for the Radio Frequency (RF), user and network interfaces were also adopted.

Tactical communications network

Basic principles of the tactical communications network

A future tactical communications network should be the base of the contemporary command system C^4I (Command, Control, Communications, Computing and Intelligence). The goal is to reach the level of universal attainability and interconnection of multimedia information networks, and intensive information traffic in order to achieve the unity of action and combat operation control.

The structure of the presented tactical communications network is based on the standards and recommendations of the Project Group 6 (PG/6), established by NATO for the Tactical Communications Systems POST-2000 in the land combat zone. The tactical communications network includes the communication up to the corps level, associated headquarters and support units. The network interconnects the combat forces capable of frequent movement throughout the area of operations, supplied with reliable, portable and mutually compatible communications equipment. Besides, it is necessary to provide an interconnection with civil and strategic networks. The system is to be based on commercial standards, as much as possible.

The network is expected to provide different communications and information services within different sub-systems and transmission media during joint operations with international allies. The services include: voice, half-duplex telephony, data transmission, file transfer, real-time data transmission, data processing and distribution, system management, security management, graphics, still and motion picture transmission at low and high transmission rates, and so on. The bearer service includes circuit switching network or a packet switching network. The maximum continual transmission rate is 64 kb/s in the circuit switching mode.

A strong hierarchical structure is maintained in the communication between combat units and weapons systems. The command level has a possibility of interconnection with other communications systems. Interconnecting with other military, civil, satellite, and ground-to-air systems can be direct or through networks (radio systems are the access points or interfaces).

The architecture of networks is based on four principles:

1. 1.**Interoperability** – Means the ability of a system or equipment to interact with other systems or equipment without additional interventions by users. In a military organization, interoperability means the possibility of the multinational Allied Forces, as well as the coalition partners' forces to train, exercise and effectively execute assigned missions and tasks, under all tactical conditions, during the peacetime or combat. This means the possibility of simple equipment and subsystems exchange, simple and flexible interconnection with tactical and strategic networks, and connection to national and commercial networks. The definition of interoperability standards means the development and implementation of concepts, doctrines, procedures and designs in order to achieve and maintain the required levels of compatibility, interchangeability and unity in operational, procedural, material, technical and administrative fields.
2. **Transitionability** – Each nation should use its own technologies and systems and conform them to the requirements of a new architecture according to its possibilities. The architecture of networks has stressed features independent from technology.
3. **Flexibility** – Means the network is modularly designed in order to quickly change its configuration and deployment in the battlefield.
4. **Military Features** – The architecture is to be defined by commercial technologies. Specific military communications systems features, such as the confidential data and traffic security, identification, authentication, persistence and resistance of the network, access control and service denial protection, identification of friends or foes, electronic warfare support and ECCM, forward error correction coding, directed antennas and adaptive routing, must be adopted during the network design.

The communication with public networks is provided by the ISO OSI (*International Standards Organization Open Systems Interconnections*) model. The network management (*Telecommunications Management Network*, TMN) is defined by ITU-T (*International Telecommunication Union - the Telecommunication services sector*, ITU-T) M3010.

The tactical communications architecture is shown in Figure 1.

The tactical communications network structure

The network consists of four subsystems: Local Area Subsystem (LAS), Wide Area Subsystem (WAS), Mobile Subsystem (MS) and System Management and Control Subsystem (SMCS).

Local Area Subsystem (LAS) supports local communications in geographically restricted area. It provides users with the access to WAS, strategic and commercial networks. It is modularly designed and can be configured for various types of networks. The basic principle of transmission is ATM (Asynchronous Transfer Mode). Fiber-optic cables are used as a transmission medium where the throughput is in Gb/s. At lower levels there is very often a requirement for mobility. Therefore, the wireless LAS up to 60 GHz is defined.

Wide Area Subsystem (WAS) is a network that supports the transit and switching of LAS users to external networks. It is also modularly designed and allows connecting several local subsystems together within a larger network.

Mobile Subsystem (MS) is an independent network for mobile users, which may operate independently as a part of the tactical system. The mobile subsystem supports all three communications modes of operation: Mobile Telephone (MT), Packet Radio, (PR) and Combat Net Radio, (CNR). MS consists of Radio Access Points (RAPs) and the system of Multi–role Radios, (MRRs). MRR should be lightweight, compact, multifunctional, multi-mode radio with high quality. MRR should integrate user services (voice, data and imagery transmission), the positioning (Global Positioning System, GPS) and navigation system, as well as the identification of friends or foes (IFF) into the three communications modes (CNR, MT and PR). RAP contains the interfaces for the three communications modes, ATM switch and LAS radio. RAP can exist as a stand-alone unit or be connected to other MS, LAS, or WAS nodes. With an appropriate gateway, RAP interconnects with external radio networks.

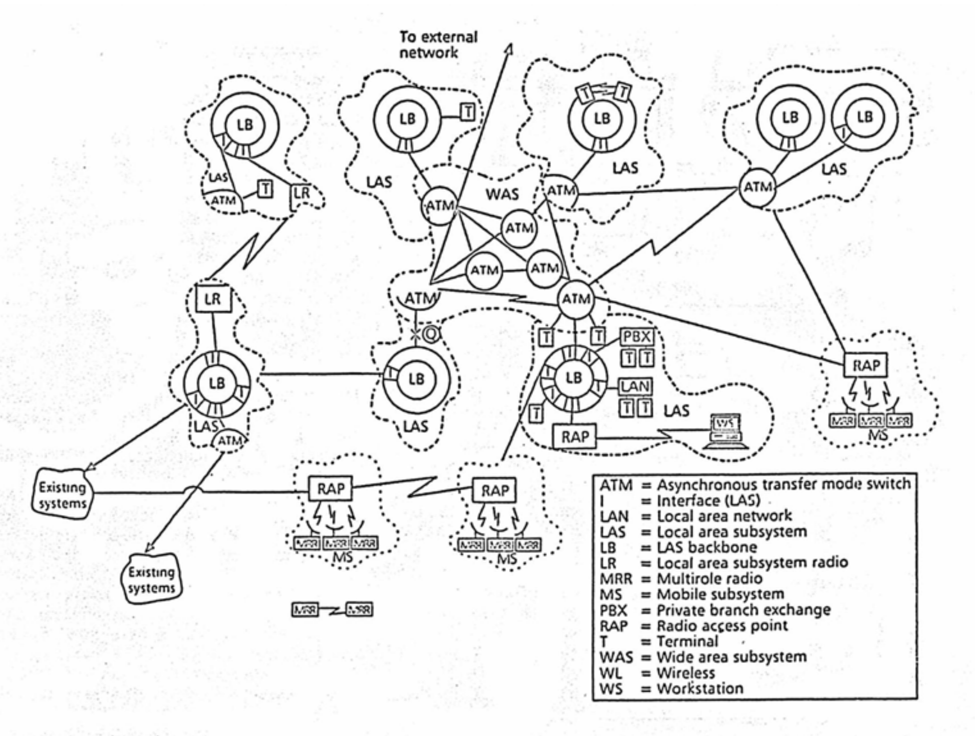

Figure 1. Tactical communications architecture

System Management and Control Subsystem (SMCS) System Management functions, according to ITU standards, are incorporated at an application level in authorized Network Management (NM) terminals. The Network Management functions are: Performance management, Fault management, Account management, Security management and Configuration management. These functions and network planning functions should use artificial intelligence techniques and be fully automated in the system.

For a successful SMCS functioning, a very good configuration of management and control network, service channels and signaling is necessary. The architecture of NATO communications uses commercial ITU NM protocols for SMCS with a special adaptation to military requirements when necessary.

Switching, Transmission and Interfaces

The switching function in LAS can be performed at three points: the ATM node, distributed in LAN, or within a community of interest (e.g. access exchange of community of interest). The switching functions of OSI layer 2 physical media are similar for both LAS technologies: Distributed Queue Dual Bus (DQDB) and ATM. Both use the same type of cell structure (48 bytes with five-byte header), but they have different header functionality and protocol structure. Functions of layer 3, network switching and signaling, can be performed centrally in the ATM switch or distributed among the DQDB interface units. The ATM switching in the LAS nodes provides the switching function for routing the traffic to external subsystems.

WAS will use standards of ATM layers 1 and 2 for physical medium switching and access in the same way as in LAS and MS. The packet switching of standard 53-byte cells will be implemented hierarchically. Addressed cells containing voice, data and imagery will be switched via the LAS interface unit to the ATM local switch and routed through the WAS ATM nodes. Signaling and routing at network level will be switched by WAS ATM functional components. Since the ATM functions were adapted for this tactical architecture, different AALs (ATM Adapting Layers) also may be required when interfacing with external systems. Switching in the MS was carried out via the ATM switch in the radio access point (RAP). Each RAP has the capability to switch calls among its local subscribers and to provide and support them with appropriate protocols. Subscribers affiliated with RAP, when accessing to other subsystems, are switched by the ATM switched network formed by RAP, LAS and WAS.

Radio LAS, i.e. wireless LAS, was designed to support rapid deployment of units in terrain, unsuitable for cable installations. Cable LAS will use fiber-optical cables supporting throughputs epressed in Gb/s. Layer-one protocols are ITU standards such as G.703/E3, G.703/DS3, G.703/E4 and G.77/9 (STM-1), depending on bit rates. The nature of the tactical system and the expected distance between WAS nodes suggests radio links. Radio links include terrestrial radio links, satellite radio links GEO (Geostationary Earth Orbit) and LEO (Low Earth Orbit), and links with airborne platforms. The closeness between the WAS node and the LAS/RAP node allows the radio transmission by radio links or fiber-optic lines. Fiber-optical cables can be used for connection with external systems, because most strategic and commercial networks are cable-based. Due to the performance of radio links between WAS nodes, throughput of 2 Mb/s was selected as the maximum rate. The frequencies between 1 GHz and 10 GHz are recommended for the maximum distance of 40 km between WAS nodes, but the frequencies up to 60 GHz are used for distances up to 1 km. For distances greater then 40 km, satellite links are suitable. Average distance between the WAS and LAS link will be less then 10 km and suitable frequency band is 1-10GHz. Short distance between the RAP and WAS/LAS ATM node (less than 1 km) can use higher frequencies. EHFs (Extremely High Frequencies) are recommended for that kind of link.

MS is a radio system that uses the full spectrum. Optimal MS frequencies are in the VHF to UHF range. SHF (Super High Frequency) ranges is used for special applications. High UHF frequencies are recommended for the mobile network based on cellular designs.

Three kinds of interconnection are realized in LAS: user access, subsystem interconnection, and external access. Local users are supported with terminal providing multimedia services or integrated services similar to commercial terminals adapted to military requirements. These networks use three types of interfaces:

- ISDN (Integrated Services Digital Network) narrowband interface, adapted to military requirements for connecting LAN and WAN
- Broadband interface (150 and 600 Mb/s)
- Narrowband interface for interfacing with the mobile subsystem

The joint tactical radio based on SDR could operate as the multifunctional radio (MRR) in the suggested architecture.

Joint tactical radio system

The Joint Tactical Radio System (JTRS) is a family of universal multi-mode, multi-standard, multi-band digital radios, with a capability of rapid adaptation to conditions of transmission and types of networks. It is modularly designed and provides the ability of quick upgrade and addition of capabilities and features. It contains network interfaces and protocols allowing dynamic in-network and inter-network routing. In the future, it is to replace many existing tactical radio systems.

The JTRS will enable a protocol conversion between communications networks operating with different protocols. The objective is to achieve coordination and integration of military communications systems into a cohesive tactical radio network, as well as to connect military and civil networks with legacy radio equipment. The JTRS military and civil users are typically classified into five general domains: airborne, ground mobile, fixed stations, maritime, and personal communications, united in one tactical network. The idea is that the type of network, valid waveforms, protocols and interfaces are to be determined by the network management. It requires the setting of appropriate standards for JTRS, programmed during the development of JTRS and sets the radio into appropriate mode, compatible with the network [2].

JTR is modularly designed. The JTR set consists of the radio hardware, associated operating environment and software applications. The JTR hardware, with the associated SCA operating environment, includes: Radio Frequency (RF) hardware components, antenna, receiver, amplifier, modem, Information Security (INFOSEC) devices, hardware-specific interfaces, Operating System (real-time, POSIX compliant), CORBA (Common Object Request Broker Architecture), Core Framework software, associated adapters/drivers used for interfaces between the software and hardware.

Software includes waveform applications, encrypted algorithms, protocols, routers.

A typical block scheme of the JTR hardware is shown in Figure 2, where one can see the way of signal processing [3]. User Interfaces were defined according to valid standards (RS232, IEEE-1394...). INFOSEC represents the demarcation between the "Black" and "Red" information for JTRS applications that require communications security protection. In some applications, the information will be

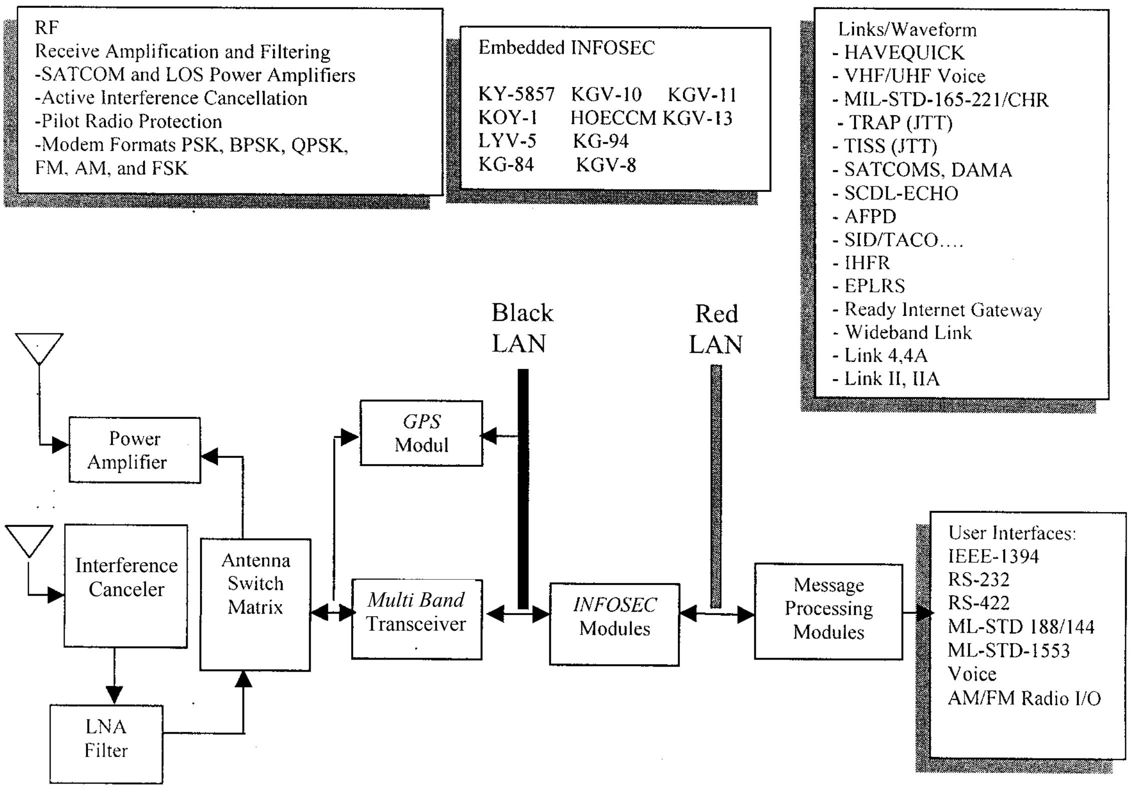

Figure 2. JTRS block scheme

protected (encrypted) at its source of generation and will not require additional transmission protection (encryption). In other applications, e.g., civil aviation, communications must remain unencrypted all the time. In the broader information–centred understanding of INFOSEC, the system has a possibility to choose one or more INFOSEC channels. JTRS incorporates Global Positioning System (GPS) receivers. The signal goes to the matrix antenna switch, LNA filter, power amplifier, Interference Canceller and antenna. Different standards for waveforms, INFOSEC, user interfaces and RF functions are reviewed in Figure 2. They present possible options for JTR, indicated by SCA according to the requirements.

JTRS is expected to operate in a bandwidth from 2 MHz to 2 GHz. Interoperability within the JTRS will be supported by use of software-based waveforms. The waveform software developed for the JTRS includes not only the actual radio frequency (RF) signal in space, but the entire set of radio functions that occur from the user input to the RF output and vice versa. The waveform software will control the receipt of data (either analog or digital) from the input device and will manage the encoding. The encoded data are carried to the encryption engine. The resultant encoded/encrypted data stream is modulated into an intermediate frequency (IF) signal. Finally, the IF signal is converted into a RF signal and transmitted to the antenna. The JTRS program implements software versions of legacy waveforms and defines new waveforms (such as the Wideband Networking Waveform or WNW) in order to fulfill emerging requirements for higher capacity, highly networked, secure communications. Waveform software applications will be common in all implementations.

These JTRS waveforms have to be "portable" between hardware platforms. Portability means the basic waveform software was developed in such a way that it may run in different hardware platforms and operating systems. Each waveform is developed only once.

The JTRS Operational Requirements Document identifies 33 waveforms that are to be developed as a standard for JTRS users. The survey of legacy waveforms and suggestions for a new waveform with the defined frequency band, bandwidth, data rates and military standards are indicated in Table 1. [4] [5].

Some waveforms (SINGARS, EPLR, and Have Quick) were defined on the basis of legacy radios. Some waveforms were defined for the JTRS, e.g. Wideband Networking Waveform (WNW). Some standards are still in the procedure. Very good commercial standards for WLAN (Wireless Local Area Network) and WWAN (Wireless Wide Area Network), e.g. GSM, are candidates for the JTRS waveforms. NATO communications standard STANAG was developed by the International Project Office (IPO), which was established in 1999. The standard will be adopted in 2003/2004.

Table 1

1. SINCGARS Enhanced improvement Program (ESIP) operates in the 30-88 MHz frequency band. It will operate in the analog and 16 kb/s digital voice as well as at data rates of 75 b/s and 16 kb/s, with the bandwidth of 25 kHz. SINCGARS will be compliant with MIL-STD-188-220 and 241-1/2.
2. HAVE QUICK II (UHF/AM/FM/PSK) operates in the 225-400 MHz frequency band. It will operate in the analog and 16 kb/s digital voice as well as at data rates from 75 b/s to 16 kb/s, with the bandwidth of 25 kHz. HQ II will be compliant with MIL-STD-188-220 and 243 and JIEO-9120A.
3. EPLRS operates in the 420-450 MHz frequency range. EPLRS will operate in the data mode at 57 kb/s VHSIC SIP and 228 kb/s VECP, with the bandwidth of 3MHz. EPLRS will be compliant with CDRL-4002W-001A.
4. UHF DAMA SATCOM operates in the 225-400 MHz frequency range with the 5-25 kHz bandwidth and will be complaint with MIL-STD-188-184
5. WIDEBAND NETWORKING WAVEFORM Exact frequency operating range and modes of operation are being developed by the government. It is expected the waveform will operate in the 2 MHz to 2 GHz frequency range at up to 5 Mb/s networked throughputs. Standards for the WNW waveform are currently under development.
6. LINK 16 will operate in the 960 to 1215 MHz frequency range. LINK 16 will support voice mode of operation at 2.4 and 16 kb/s and data with FEC at rates of 28.8 kb/s to 1.137 Mb/s. Link 16 will be compliant with MIL-STD 6016 and STANAG 5516.
7. LINK 11/TADIL will operate in the 2-30 MHz and 225-400 MHz frequency ranges. Link 11 will operate in a data mode 1364 and 2250 b/s, with the bandwidth of 3 kHz and 25 kHz. Link 11 will be compliant with MIL-STD 188-203-1A and STANAG 5511.
8. VHF FM operates in the 30-88 MHz frequency range. VHF FM supports analog voice and digital voice at 16 kb/s. VHF FM will be compliant with MIL-STD-188-242.
9. VHF ATC Data Link will operate in the 2-30 MHz frequency range. VHF ATC Data Link will support analog voice and data at 300, 600, 1200 and 1800 b/s. VHF ATC Data Link will be compliant with RTCA DO-265, ARNIC 635-3 and 735-3, FAA TSO C31d. and C32d.
10. VHF AM ATC operates in the 118-137 MHz frequency range. VHF AM ATC supports analog voice communications. VHF AM ATC will be compliant with RTCA DO-186a and ARINC 716.
11. VHF AM ATC (Extended) will operate in the 108-156 MHz frequency range. VHF AN Extended will support analog voice communications. VHF AM Extended will be compliant with QSTAG-706, RTCA DO-186a, DO-195, DO-196, and ARINC 716.
12. VHF/UHF FM LMR operates in the 136-174 MHz, 380-512MHz, and 764-869 MHz frequency ranges. VHF/UHF FM LMR will support analog voice and 16 kb/s digital voice and data rates up to 16 kb/s. VHF/UHF FM LMR will be compliant with APCO 25 Common Air Interface (CAI).
13. SOLDIER RADIO and WLAN will operate in the 1.755-1.850 GHz frequency range. The Soldier Radio and WLAN will support digital 16 kb/s voice and data at 1 Mb/s, with the bandwidth of 125 kHz. The WLAN will be compliant with IEEE 802.11b, 802.11e and 802.11g.
14. COBRA communications modes and data rates will be determined by the government and issued to authorized users only.
15. MUOS will operate in the 240-320 MHz frequency range. MUOS will support data at rates of 2.4, 9.6, 16, 32 and 64 kb/s, with the bandwidth of 5-25 MHz. MUOS will support the Common Air Interface. Sta-

ndards for MOUS are being developed.

16. CELLULAR RADIO will operate in the 824-894 MHz, 890-960 MHz and 1850-1990 MHz frequency ranges. Cellular radio will support voice and data at 10 kb/s nominal rates and 3G data at rates up to 144/384 kb/s and 2 Mb/s. Cellular Radio will be compliant with TR-45.1 AMPS, IS-54 TDMA, IS-95b CDMA, IS-136HS TDMA and GSM and 3GSM, 2.5 G, 3G, WCDMA and CDMA-2000.
17. LINK-22 will operate in the 3-30 MHz and 225-400 MHz frequency ranges. Link 22 will support data at rates that will be determined by the government in the future. Link 11 will be compliant with STANAG 5522 and STANAG 4539, Annex D.
18. MOBILE SATELLITE SERVICE (MSS) will operate in the 1.61-2 GHz frequency range. MSS will support digital voice at 2.4 to 9.6 kb/s. MSS will be compliant with emerging LEOSAT and MEOSAT standards.
19. INTEGRATED BROADCAST SERVICE-MODULE (IBS-M) will operate in the 225-400 MHz frequency range. IBS-M will support data at 2.4, 4.8, 9.6 and 19.2 kb/s. Compliance standards for IBS-M will be developed by the government in the future.
20. VHF ATC Data Link (NEXCOM) will operate in the 118-137 MHz frequency range. VHF ATC Data Link (NEXCOM) will support digital voice at 4.8 kb/s and data at 31.5 kb/s. VHF ATC Data Link (NEXCOM) will be compliant with RTCA DO-186a and DO-224a.
21. UHF AM/FM PSK will operate in the 225-400MHz and 225-450 MHz frequency ranges. UHF AM/FM PSK will support analog and 16 kb/s digital voice and data at rates up to 16 kb/s. UHF AM/FM PSK will be compliant with MIL-std-188-181B and MIL-STD-188-243.
22. LINK 4A will operate in the 225-400 MHz frequency range. Link 4A will support data at 5 kb/s, with the bandwidth of 25 kHz. Link 4A will be compliant with MIL-STD-188-203-3.
23. Link 11B will operate in the 225-400 MHz frequency range. Link 11B will support data at 600, 1200, and 2400 b/s, with the bandwidth of 25 kHz. Link 11B will be compliant with MIL-STD-188-212 and STANAG 5511.
24. SATURN will operate in the 225-400 MHz frequency range. SATURN will support digital voice and data rates that will be determined by the government in the future. SATURN will be compliant with STANAG-4372 and JIEO-9120A.
25. IFF/ADS/TCAS will operate at 1030 and 1090 MHz. IFF/ADS/TCAS will support data at 689.7 bps. IFF/ADS/TCAS will be compliant with STANAG 4193.
26. DWTS will operate in the 1350-1850 MHz frequency range. DWTS will support analog and digital voice and data at rates of 144, 256, 288, 512, 576, 1024, 1152, 1544, 2048 and 2304 kb/s. DWTS will be compliant with Army MSE equipment.
27. BOWMAN will operate in the HF/VHF/UHF frequency ranges. BOWMAN will support analog and 16 kb/s digital voice and data at rates to be determined by the government. The government will determine standards for interoperability also.

The new software communications architecture (SCA) was defined by the JTRS Joint Program Office (JPO) and the Modular Software-programmable Radio Consortium (MSRC), and introduced new software platform which could meet the requirements for JTRS. The SCA defines the framework for JTRS implementations and provides communications interoperability, portability of application programs, embedded INFOSEC, scalability of applications and the ability of commercial development products.

The SCA is an open architecture framework that tells designers how elements of hardware and software connect in order to operate in harmony within the JTRS. It governs the structure and operation of the JTRS, enabling programmable radios to load waveforms, run applications, and be networked within an integrated system. Key features of the SCA are the core software framework interfaces defined in a standard interface definition language (IDL), communication waveform application program interfaces (APIs) and API building blocks, and requirements for embedded INFOSEC and for INFOSEC APIs.

The SCA Specification is comprised of four major areas

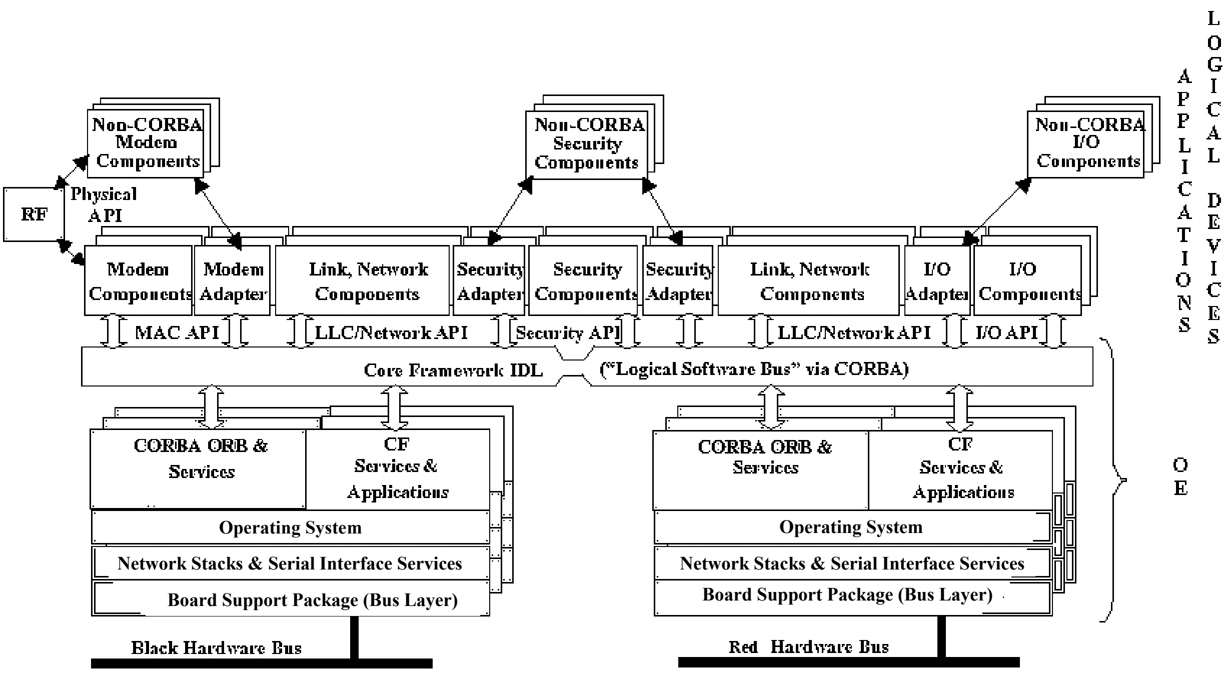

Figure 3. SCA Software Structure

of requirements: Software Architecture Definition, Hardware Architecture Definition, Security Architecture Definition, and Application Program Interfaces [6].

The SCA Software Structure is shown in figure 3. It was defined as open, commercial infrastructure software for managing and interconnecting application resources in embedded distributed computing environment. The architecture is defined by an Operating Environment (OE), applications, and logical devices. The OE consists of a Real Time Operating System (RTOS), CORBA layer, service and core framework (CF). OE provides the control of system, applications and other software interfaces.

Application is a part of the SCA that determines general requirements or limitations for applications. A logical device is proxy software for an actual hardware device and is used to define the CF interfaces between applications and devices

Hardware architecture presents the support platform for software and security architectures. Hardware critical interfaces are required to be in accordance with the established standards. Security requirements are an integral part of the architecture and system design. The SCA separates security validation, commercial and military. Specification separates security requirements into those that affect the software architecture CF by putting them in the main body of the specification, and those that are specific to a military security solution by putting them into the Security Supplement. The Application program interfaces provide requirements for the development of APIs, i.e. specification operations the application of which must run if communicates through network.

The International forums dealing with standards work on adoption of SCA as an international commercial standard for the software communications architecture.

Validation

The whole system JTRS is still in validation process. The MSRC provided four unique prototypes for validation, produced by four vendors. Those are BAE, ITT, Raytheon and Rockwell-Collins with their JTRS. They work as multiband, based on SCA, and have possibility of applying two or more waveform applications.

Other significant vendors of tactical radio equipment have also taken part in development of this new generation sistem.

The radio for network ASPEN [7,8]- Adaptive Signal Processing & Networking by Raytheon [4] for 2000 was defined by the following characteristics:

Frequency Range	225.5 MHz to 1000 MHz
Waveform Description	Direct Sequence
Chip Rate	20 Mb/s
Data Modulation	DPSK
Variable Proc. Gain	7 types
Packet Size	68, 212, 500 Bytes
Data Rates	Up to 830 kb/s
Data interface	Ethernet or RS-232
Output Power	0.1 –20W

Harris realized JTRS AN/PRC-117 in 2003 [9] with next features

Frequency Range

VHF LOW:	30.000 to 89.999 MHz
VHF HIGH:	90.000 to 224.999 MHz
UHF:	225.000 to 512.000 MHz
UHF SATCOM:	243.000 to 270.000 and 292.000 to 318.000 MHz

Channel Bandwidth

VHF LOW:	25 kHz
VHF HIGH:	8.33 kHz,12.5 kHz, 25 kHz
UHF:	5 kHz, 8.33 kHz,12.5 kHz, 25 kHz

Preset Channels

100 Fixed/Hopping presets
10 DAMA presets

Modulatiron

VHF LOW:	FM (5, 6.5, or 8 kHz), FSK
VHF HIGH:	FM (5, 6.5, or 8 kHz); AM (90%), FSK, ASK
UHF:	FM (5, 6.5, or 8 kHz); AM (90%), FSK, ASK
UHF SATCOM:	BP/K, SBP/K (Shaped BP/K), SOQPSK (Shaped OQPSK), DEQPSK (Differentially Encoded QPSK), CPM

Voice Modes

Simplex or Half-duplex
SINCGARS ECCM (VHF low band only) Plain Text Analog Voice
Wideband Cipher Text Digital Voice (16 kb/s; CVSD; KY-57), 12 kb/s Fascinator)
Narrowband Cipher Text Digital Voice (2.4 kb/s; LPC-10, ANDVT/KYV-5)
Have Quick I/II ECCM (UHF band only)

Data Modes

Simplex or Half-duplex Asynchronous data (75 b/s, 150 b/s, 300 b/s, 600 b/s, 1200 b/s, 2400 b/s, 4800 b/s, 9600 b/s, 19.2 kb/s, 38.4 kb/s, 57.6 kb/s, 115.2 kb/s)
Synchronous data (300 b/s, 600 b/s, 1200 b/s, 2400 b/s, 12 kb/s, 16 kb/s)
SINCGARS ECCM (VHF LOW band/1200 b/s, 2400 b/s, 4800 b/s, 9600 b/s, 16 kb/s& TACFIRE[1])
Wideband Cipher Teyt Digital Data (16 kbps; KY-57)
Narrowband Cipher Text Digital Data (2.4 kb/s; ANDVT/-/KYV-5)
KG-84C
Have Quick I/II ECCM (16 kb/s; KY-57 UHF band only)

Data Capability

High Performance Waveform (HPW) SATCOM
48/64 kb/s LOS secure data
MIL-STD-188-181B – Dedicated Channels
MIL-STD-188-182 – 5 kHz DAMA
MIL-STD-188-183 – 25 kHz DAMA
Full order wire capability

[1]SYNOPSIS: TACFIRE AUTOMATES SELECTED FIELD ARTLLERY COMMAND AND CONTROL FUNCTIONS TO PROVIDE EFFICIENT MANAGEMENT OF FIRE SUPPORT RESOURCES

COMSEC Interoperability

KY-57 VINSON, ANDVT/KYV-5 (Mode 3),
KG-84C (Modes 1, 2, 3, 4), Fascinator

TRANSEC Interoperability

SINCGARS ESIP (ICOM, SDM and EDM)
Have Quick I/II
DAMA Order wire

External Data Interfaces

RS-232E, MIL-STD-188-114A, RS-422 balanced

Remote Control Capability

Full remote control — RS-232E or RS-422 balanced interface
Removable Keypad/Display Unit (up to 250 feet)

Interoperable Radios

AN/PRC-117D(V)2; AN/VRC-94D(V)2; AN/PRC-119A CNR,
AN/PRC-113; AN/PRC-77, PSC-5, LST-5 B/D/E

JTRS as a whole software radio is still in the phase of technical and technological research. The reason is that until 2000 unique world communications standard in this field, and digital signal processor consumption and power which could fulfill all technical requirements for tactical radios, for an integrated military network, did not exist.

The appearance of a large number of new radio devices based on SDR and new communications standard SCA is expected between 2000 and 2010, e.g. Digital Modular Radio - Motorola, Boing, Rockwell-Collins etc. The MITRE Corporation offers the JTIDS (Joint Tactical Information Distribution System (JTIDS) and the Multifunctional Distribution System (MIDS).

Conclusion

Contemporary tactical military radio networks converge to commercial technologies and civil communications. There is a tendency of bringing military and civil communications and technological standards together because of direct interconnections. JTRS is a project for solving interoperability in tactical networks of contemporary equipped armies. JTRS is a base for accomplishing compatibility with legacy systems and gives a possibility for further development. JTRS was realized as the software defined radio. It gives a possibility for development of new services and actions in signal processing in order to realize next tactical and commercial requirements.

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Mrežni taktički radio

U radu je prikazan mrežni taktički radio-sistem - MTRS (engl. Joint Tactical Radio System, JTRS). Data je kraća analiza organizacije sistema kao i zahteva koje sistem treba da zadovolji. Prikazana je nova generacija mrežnih taktičkih radija - MTR (Joint Tactical Radio, JTR), realizovanih po konceptu softverski definisanog radija (Software Defined Radio, SDR). Takođe je dat i kraći pregled karakterističnih standarda koji definišu MTR. Prikazana je i organizacija jedne nove fleksibilne taktičke mreže, projektovane po standardima za vreme posle 2000. godine u okviru koje MTR treba da nađe primenu.

Ključne reči: **vojne komunikacije, taktički radio sistemi, mrežni taktički radio, softverski radio.**

Systèmes radio combinés

Cet article présente le système radio tactique combiné (Joint Tactical Radio System, JTRS). L'organisation du système est analysée brièvement aussi bien que les demandes auxquelles le système doit satisfaire. Une nouvelle génération des radios tactiques combinés (Joint Tactical Radio, JTR), réalisée selon la conception du radio défini par logiciel (Software Defined Radio,SDR), est aussi présentée. Après un répertoire bref des standards caractéristiques définissant le radio tactique combiné, on a donné une organisation d'un nouveau réseau tactique flexible, conçu selon les standards adoptés après l'an 2000 et dans lequel le radio tactique combiné doit trouver sa propre place.

Mots-clés: **communications militaires, radio systèmes tactiques, radio tactique combiné, radio défini par logiciel.**