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ANALYSIS OF MODERN CONDITION OF MILITARY RADIOCOMMUNICATION SYSTEM

Aim of the article is to conduct an analysis of military communications systems that were used in the area of conducting antiterrorist operation in the Donetsk and Lugansk regions. The article analyzes the modern facilities of military communication, namely: military radiocommunication systems, military satellite communication systems, military systems of radio relay and tropospheric communication. The advantages and disadvantages of each type of communication are considered, the causes of their occurrence were considered, and the ways of solving these reasons in the future were substantiated. An analysis of the main technical characteristics of military communication systems, opportunities, advantages and disadvantages has been conducted. The perspectives for the development of military communication systems have been determined on the basis of the analysis of the military facilities of communication used in the article, which are used in the region of the antiterrorist operation in the Donetsk and Lugansk regions. To eliminate the problematic issues mentioned in the article, the authors of the article are proposing to launch their own military satellite for the needs of the Armed Forces of Ukraine; To develop new models of military communication; To conduct deep modernization of the existing radio stations, command-staff cars, radio relay and tropospheric stations; To integrate telecommunications equipment adopted in the last years into a single information space of the Armed Forces of Ukraine, as well as to reach agreement with representatives of leading telecommunication equipment manufacturers regarding the transfer of technologies and deployment of production in the territory of Ukraine.

Keywords: radiocommunication system, radiocommunication, radio-electronic suppression, intentional interference.

Introduction

Since beginning of armed aggression against Ukraine in beginning 2014 as Armed Forces of Ukraine in general, and forces of connection were are not ready due to effective warfare. Principles of building communication systems, laid in Soviet Union, were outdated and mostly involved using analog equipment.

Because of that, for providing effective control by anti-terrorist operation (ATO) was necessary to modernize communication systems, including radiocommunication systems [1]. Then in article to radiocommunication classified all types of communication, in which data transmission carried by using radio waves, that is actually radio (HF and UHF) and trunking, radio relay, tropospheric, satellite.

So *purpose of the article* is analysis of modern condition of systems and military radiocommunication, determination way of upgrading and perspectives of development.

Presentation of main material research

1. UHF radiocommunacation

Radio communication old park have large dimensions and weight, easy monitored and supersession by device of electronic warfare (EW) enemy. It's UHF radio stations R-159, R-105, R-111, R-123, and others. After beginning of ATO for providing communication directly on battlefield priority task was providing portable radio for forces with support digital mode and classifying (masking) language.

Domestic UHF radio stations produced by "Telecard-device", which was taken into armament (P-002, P-005, P-030, with power 2, 5 and 30 W) [2], a number of reasons absent in forces. They work in range of working frequencies 30-110 MHz, support the ability to disguise information and mode of frequency hopping spread spectrum (FHSS) at speed 312.5 h/sec (maximum number of nominal operating frequency in FHSS mode - 256), can transmit data at speeds 16 kbit/sec. Main disadvantages stations "Telecard-device" based on these characteristics: lack of cryptographic information protection; limited number of frequencies in FHSS mode, which make SRC more vulnerable to devices of radio technical intelligence (RTI) and enemy devices of electronic low warfare; data rate. Typical plan of communication organization in area of realization ATO exampled on fig. 1. Using mobile phones as it has shown and experience of carrying ATO is dangerous due to high probability of interception by enemy, determine locating forces, and potentially incoherent withdraw mobile communication systems down if it's use for command and control forces [1].

Based on lack of modern small portable radio stations, was decided to use trunking communication equipment "Mototrbro" production company "Motorola", which characterized by high quality and functionality, support digital mode and provide cryptographic information protection.

Trunking communication is major link in tactical management. It allows to provide link in motion directly on battlefield.

Main equipment "Mototrbo": DP 4800 portable radios (with screen and keyboard), DP 4400 (without screen and keyboard), car radios DM 4600, repeaters DR 3000 [4].

It should be noted that National Guard of Ukraine also uses trunking communication equipment "Mototrbo", but in the higher frequency range (403-470 MHz) [1]. Interaction organized by several radio stations commanders to units that perform tasks together or by creating a gateway with two car stations [1, 3].

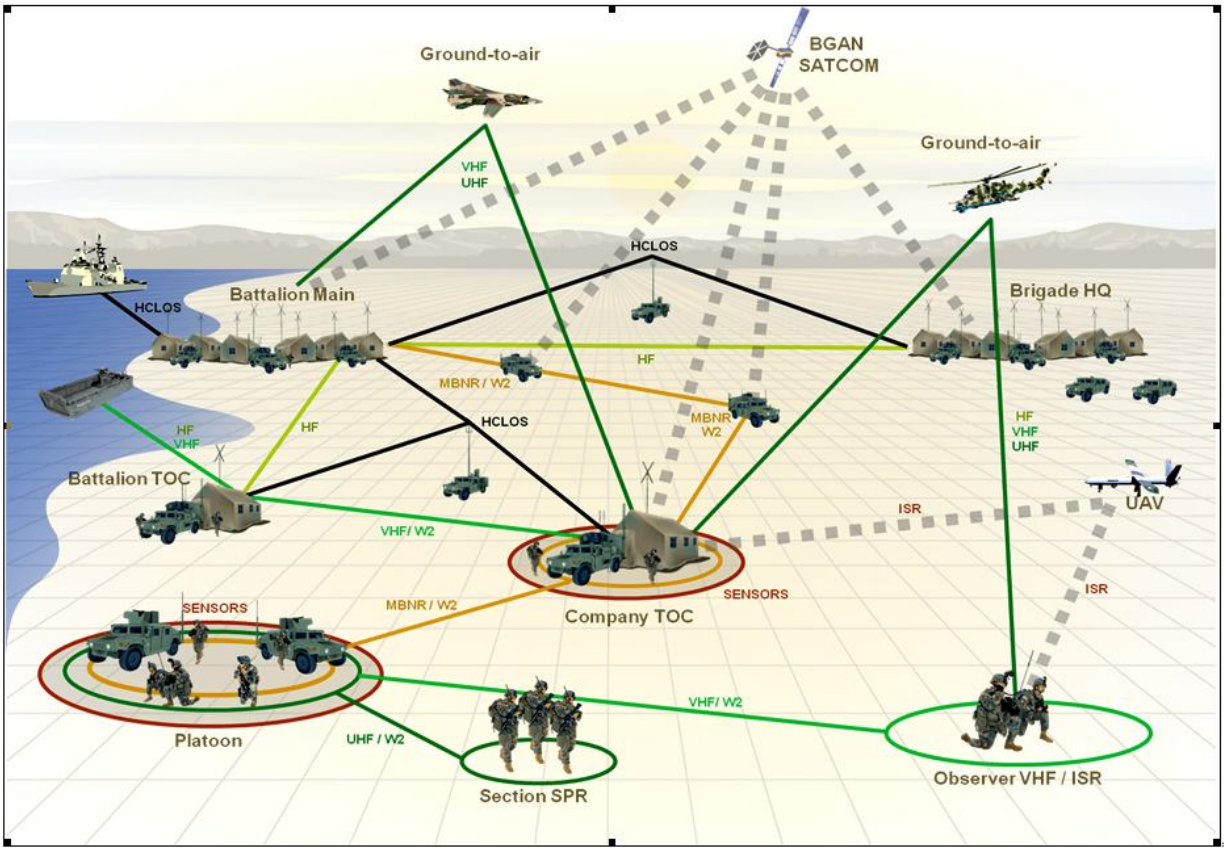

Fig. 1. Typical plan of communication organization in area of realization ATO

Radio stations, depending on configuration of the channel can work through the repeater, and directly among themselves (in the mode of direct communication). Repeater network simultaneously transmits two information channels by dividing the time of distribution channels.

Presence of transponder enables following approximate values communication range [1, 3] between portable stations 15-20 km and more, by car stations - up to 30-40 km and more. At the same time, direct communication channels for portable stations, range is usually no more than 5-7 km. It should be noted, that the communication range is determined by terrain, lifting height repeater antennas, antenna type. When repeater place site in air, such as in an airplane, communication range can be up several hundred kilometers. Well proven in planning trunking communications program that can be used to calculate coverage repeater, posted on the website of Canadian Institute of Telecommunications [4].

Mode of working system "Mototrbo", which used in Armed Forces: direct communication; because of one independent relay (conventional mode);

IP site connect, which provides up to 15 repeaters combined into single network using IP network. Communication range is determined by topology of IP network can theoretically be arbitrarily large.

Also it used in some cases, in single situation, mode Capacity Plus, which provides for increasing channel capacity convertive mode through using multiple (up to 8 voice) repeaters placed along and interconnected through the switcher (switch). As one repeater provides 2 channels, the 8 transponders – 16 channels. Now state of field-communication center in mechanized battalion includes following equipment: Repeater DR 3000 - 1; DM 4600 - 7; DP 4800 - 10; DP 4400 - 70.

Repeater can work on 2 antennas (spaced antenna reception and transmission) or one antenna (via duplexer connected to relay). For the first option should be to provide spatial diversity antennas (primarily vertically - at least 2 meters, with the reception antenna is located above and horizontally - as far as conditions permit areas, existing poles and feeder length). Disadvantage of scheme with duplexer is reducing cover (10%) due to additional losses in the filters of the duplexer. In addition, duplexer filters are narrowband (bandwidth about 50 kHz), so change frequency transmission and reception transponder can only be within ± 18.75 kHz the central frequency. Generally, duplexer filters can recustomize in the frequency range with of about 5 MHz, but in the field, this procedure is quite problematic. It need using HF-signal generator and digital spectrum analyzer. These operations are usually carried out before delivery to the troops. Antennas that can be used for repeaters: probe various modifications (usual pin, J-shaped, collinear etc.). And directed type "wave channel". When more larger antenna gain, the narrower working bandwidth which it overlaps.

To deploy antenna masts used hardware from old park storage (P-409, P-419, P-414, P-142N, R-161A-2M et al.) or existing local infrastructure. In addition, to increase communication range of recovery options repeater (or antennas) balloon on unmanned

aerial vehicles, aircraft. The last option is planned for using after leaving district. Debaltseve [1] for communication while moving units and parts, when standard antenna-mast devices are repeaters in collapsed state.

To create appropriate usually use company radio channels of direct communication, battalion and brigade radio network should be created to channel repeater. Brigadier network can be created in several ways:

in IP site connection mode;

through repeater MP brigade in case of radio visibility with car radio stations COP battalions;

organization radio direction separate car radio with highly elevated directional antennas type "wave channel" on battalions repeaters, each time slot which is used for organization radio crews;

Combination of two or even three above mentioned methods, it is possible without increasing the number of radio stations by scanning mode channels.

Repeater in battalion is peer system IP-site connect teams (provided its creation). 1st battalion channel repeater is released under the radio network brigade in IP-site connect, on the 2nd channel organized radio network battalion commander.

Radio Network a lower level as radio interactions, it is advisable to organize channels of direct communication.

Based on the experience of combat employment system "Mototrbo" its benefits to provide radio communication in the background are the following: digital mode;

built-standard encryption key length of 40 bits and possibility of replacing (at extra cost) to 256 bits. Standards ARC-4 and AES-256 can not be used for transmission of confidential information is disadvantage, and at the same time advantage due to lack of strict requirements for using equipment, key documents, in particular, such as for equipment classification;

transponder availability; scan mode channels (radio station can control up to 16 radio while in another mode of reception);

high enough mechanical (impact resistance), moisture and dust (protection class IP 57, portable stations allow immersion in water to depth of 1 m); high speed connection (less than 300 ms).

Main disadvantages equipment "Mototrbo":

obstacle security lack of modes, including FHSS mode. Because of that channels "Mototrbo" can easily be suppressed by instruments of electronic warfare opponent.

Measures that increase the resistance slightly REW are: maximum dispersal of the various radio channels all over range of operating frequencies, creating a "false" radio work using directional antennas;

hardware configuration is only possible using PC, keyboard user station can modify channels;

low speed of transmission data (less 2 kbit/s).

Perspectives UHF radio. Task of providing communications on move, directly on battlefield, generally resolved by trunking communication system "Mototrbo", which has potential to remain in service as backup device of communication and/or at level of junior officers and soldiers. Main device of UHF radio communication must be professional military radio. Examples of such stations is devices of production "Harris", including: RF-7800S in link-division squad, RF-7800V-HH or RF-7850M-HH link platoon-mouth; link battalion, brigade stations should complement external power amplifier and install on the car (armored) basis [5] (applicable, that it will be special command post vehicles (CSV), or retrofitted, modernized CSV of old park).

Today station type RF-7850M-HH in service in limited quantities and using mainly for benefit of Special Operations units and highly mobile airborne troops (AF) [1]. Because of high cost of Harris radios acceptable solution can be procured radios from other manufacturers optimal criterion of "price-quality" such as radio production company "Aselsan" (Turkey) [6].

Watching on high cost of foreign professional military UHF and need of UHF radio in TC, and obviously, in the long term is necessary to establish domestic production VHF radio.

2. UHF radiocommunication

Radiocommunication in range of short waves (HF) has special place in military communication. Main advantage of HF communication is ability to provide radio communication for hundreds and thousands of kilometers without relay signal. This is possible due to ability of radio waves in this range distributed by reflection from the ionosphere towards Earth and vice versa.

Main feature of HF radio line, regardless of the distance between correspondents is that the conditions of propagation of radio waves of certain frequency band by reflection from ionosphere, determined by time of day, season and solar activity.

Disadvantages of HF radio communication are, firstly, low bandwidth communication channels is caused by transience Ionosphere and low frequency HF range capacity, second, dependence on reliability of radio communications on the correct choice of operating frequencies.

Using analog HF radio stations that were and are represented on arms (P-130, P-134, P-140, P-161A-2M) provide reliable, obstacle security and communication closed considerably difficult.

Because HF radio in ATU organized using radio production "Harris": RF-7800H capacity of 20, 150 or 400 watts (Falcon III) and MPR-9600 (Falcon II) power of 20 W and 125 [7, 8].

Backpack (20 watts) radio station replaced P-130m from command post storage (CSV) Soviet production station with external power amplifiers - medium power radio station R-161A or R-140-2M (P-140-0,5). Usually CSV and medium power stations upgraded by installing radio "Harris".

HF radio stations "Harris" brought to battalion (division) inclusive. Because of this, the lowest level of HF radio - radio crews.

Main tasks of HF radio communication: operational organization of communication channels

with senior staff, communication with units that operate in isolation from main forces, relationship with deep intelligence units, backup key information areas on which channels formed lines snap (wired or radio relay) to transport networks or satellite stations.

Analysis of operating HF radio Harris conducted in [9], which systematically issues and suggests possible ways to solve them. One of major shortcomings that complicates HF radio communications is lack of frequency control service.

3. Perspectives of HF radio

Given large number of HF radios Falcon-III and Falcon-II, it is clear that system of military HF radio communication Armed Forces of Ukraine should be built precisely based on equipment.

If decision will take on adoption of HF radio other (including domestic) manufacturers, they should be compatible with existing radio stations “Harris”.

Stations with an external amplifier, and in many cases stations capacity of 20 watts, should be installed as part of CSV upgraded or new CSV own production.

4. Satellite communications

Satellite communications at start of anti-terrorist operation (ATO) was used to limited extent, mostly to link with peacekeeping contingents through leased lines of business, including "Iridium", "Inmarsat". Experience of communication during ATO showed special significance of satellite communications where is no ability to deploy fully functional field communication system. Equipment used in satellite communications link from GS AF of Ukraine to separate (unit block post) including [1].

Detailed full subsystem of satellite communications connected (Fig. 1) ensures stable connection between control point (CP) of all levels of management of Armed Forces of Ukraine and brought to some of company tactical groups and block posts. In absence of own telecommunications satellite subsystems on existing satellite stations make satellite communication terminals and portable satellite communications for commercial purpose (“Tooway”).

Satellite Internet “Tooway” - service provided by Eutelsat throughout Europe via satellite Ka-Sat, positioned in geostationary orbit at position 9 ° SD (83 Ka-band transponders, amount of resource - 20 000 MHz), operating in the Ka-band (20/30 GHz). Ka-Sat satellite is unique because it is designed solely to provide satellite internet “Tooway” satellite using small diameter antennas.

Provider of service “two-way satellite Internet Tooway” SkyLogic company, which provides VSAT Internet access in 26 European countries, including Ukraine. Headquarters is located SkyLogic operator in Italy in Turin. The owner of satellite Ka-Sat 9E is company Eutelsat, France.

According characteristics maximum speed while ensuring access to the Internet on line “up” can be up to 5 Mbit/s on line “down” - up to 20 Mbit/s. Speed that can be achieved in one terminal for military purposes can be up to 5 Mbit/s.

Terminals “Tooway” installed in headquarters machine P-142, P-145 connection and integrated hardware P-258-60K (P-238TK) and used separately. Satellite channels of communication, in first queue created with using modern equipment IP-encryption of domestic production, as well as open, enabled single information environment for benefit of units that carry out tasks in area of ATO [10].

Main advantages of using system Tooway in system of military communications are:

cost of satellite channels in range Ka significantly lower than in lower ranges, in particular, Ku;

comfortable to use and customize terminals, much smaller than in Ku.

Main disadvantages of terminal are:

dependence on communication quality (bit rate) on weather conditions. In Ku band that would not be virtually;

difficult scheme of signal routing (all calls go through main station in Italy and Ukraine get fiber optic lines). Calls from terminal to terminal twojumps because signal delay between subscribers only through propagation of more than 0.5 seconds, which reduces reliability of communication by increasing likelihood of failures in different parts of channel;

inability to use equipment in field (especially low - satellite modem, routers, gateways, telephones, cables and connectors, etc.).

Last disadvantage to some extent remedied by making sets of Mobile Satellite Communications (MSC 1.1), more adapted to using in field, providing reliable operation at temperatures from -10 °C to + 30 °C [11]. Modem, router, VoIP-penstock gateways and battery as backup power source installed in special container with high mechanical and vibration resistance.

Total weight of 24.5 kg kit. 1.1 MSC transported personnel serving his knapsack with two backpacks. In addition, antenna gain MSC both transmission higher by about 1 dB.

Perspectives of satellite communications. Towards development of satellite communications include:

deployment HUB station “Tooway” in Ukraine, which will provide connection simplify and reduce likelihood of failures (increasing reliability of communication);

launch their own satellites and development their own satellite terminals military purposes.

5. Radiorelay and tropospheric communication

Main purpose and tropospheric radio relay stations in system of military communications - creating lines binding to stationary communication centers telephone network, creating line of communication between control points. Number of local digital radio-relay stations (RRS) R-450 produced by “Telecard-device” in service, with capacity of up to 8 Mbit/s is extremely limited. Given high cost and relatively low bandwidth and their subsequent manufacture and supply troops unnecessary.

Recently was adopted by radio relay station R-425S3 (code "Mars") production Ltd. “JSC Olympus’s” (Svetlovodks) which provides transfer rates up to 155 Mbit/s in range of 6,4-7,1 MHz. With using of RRS built backbone communication line along contact line, which is under commissioning. In addition, upgraded hardware of P-414 (P-414MU), which has also entered service includes RRS R-425 with two-way radio equipment 6,4-7,1 MHz band to build transmission lines and 14,4 -15,4 MHz (throughput up to 50 Mbit/s) for construction of transmission lines linking.

Widely spread way to build lines linking using modern equipment wireless (access point Wi-Fi) [1] with directional antennas, such as production of “Ubiquity Networks” with capacity of up to 300 Mbit/s.

At armed forces of communication have also analog PPS type R-409, R-419, R-414, R-410, R-412, in addition, digital TRS P-417MU and P-423-2.

One of the modernization and TRS analog RRS old park is using modems M-Eth-2DSLbis domestic production of "Crocus" [12], which form Ethernet-flow as possible for given width and channel speed. Modem replaces analog hardware interconnect stations and includes inlet tract intermediate frequency (for modulator / demodulator station). Using such modems allow to turn in radio highway bypassing analog to digital equipment channel formation reach speeds of up to several (5-8) Mbit/s.

6. Perspectives of relay and tropospheric communication

Perspectives areas of troposphere communication are:

development of modern RRS and TRS on experience of leading countries, including establishment of small radio relay, tropospheric stations [1, 13] at speed at least 2 Mbit/s over distance of 100 km (with possibility of creating retranslators), analogues of which are armed with advanced countries [14];

modernization analog RRS, TRS by installing digital modems as SHDSL, and specially designed.

7. Other perspectives of radio communication systems

In [15] proposed variant of communication system in background with wide application in conjunction with professional military hardware tools for civil use (such as Wi-Fi, Wi-MAX, etc.).

Main idea of proposed scheme - construction of telecommunication network with ability to transfer and processing of heterogeneous traffic with providing many routes passing information of individual users on basis of purely civilian network equipment and communication facilities existing Armed Forces, with gradual build-up of professional military component equipment.

Conclusion

Because of this, modern Armed Forces radio communication system used in area of anti-terrorist operations, generally provides tasks of communication for benefit of command.

Main directions of development of systems and radio communications are:

launch own satellite telecommunications Ukraine of resources allocated for using by Armed Forces of Ukraine;

development and production own military devices digital radio (satellite terminals HF and UHF radios, microwave and tropospheric stations, command post vehicles);

modernization old hardware park (command post vehicles, tropospheric and radio relay stations);

integration new domestic and foreign devices of radio communications in communication system of Armed Forces of Ukraine.

Future research directed to develop methods of selecting options means military radio.

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Аналіз сучасного стану та перспектив розвитку воєнних систем радіозв’язку

І.О. Романенко, А.В. Шишацький

Метою статті є проведення аналізу військових систем зв’язку, які використовуються в районі проведення антитерористичної операції на території Донецької та Луганської областей. У статті проведений аналіз сучасних засобів військовому зв’язку, а саме: військових систем радіозв’язку, військових систем супутниковому зв’язку, військових систем радіорелейного та тропосферного зв’язку. Розглянуті переваги та недоліки кожного з видів зв’язку, розглянуті причини їх виникнення, а також обґрунтовані шляхи їх вирішення надалі. Проведений аналіз основних технічних характеристик військових систем зв’язку, їх можливостей, переваг та недоліків. На основі проведеного в статті аналізу військових засобів зв’язку, які використовуються в районі проведення антитерористичної операції на території Донецької та Луганської областей визначені перспективи розвитку систем військовому зв'язку. Для усунення зазначених у статті проблемних питань, авторами статті пропонується запустити власний військовий супутник для потреб Збройних Сил України; провести розробку нових зразків військового зв’язку; провести глибоку модернізацію наявних на озброєнні радіостанцій, командно-штабних машин, радіорелейних і тропосферних станцій; провести інтеграцію прийнятого на озброєння за останні роки телекомунікаційного встаткування в єдиний інформаційний простір Збройних Сил України, а також досягти угод із представниками провідних виробників телекомунікаційного устаткування щодо трансферу технологій і розгортання виробництва на території України.

Ключові слова: система радіозв'язку, радіозв'язок, радіоелектронне подавлення, навмисні завади.

Анализ современного состояния и перспектив развития военных систем радиосвязи

И.О. Романенко, А.В. Шишацкий

Целью статьи есть проведение анализа военных систем связи, которые используются в районе проведения антитеррористической операции на территории Донецкой и Луганской областей. В статье проведён анализ современных средств военной связи, а именно: военных систем радиосвязи, военных систем спутниковой связи, военных систем радиорелейной и тропосферной связи. Рассмотрены преимущества и недостатки каждого из видов связи, рассмотрены причины их возникновения, а также обоснованы пути решения указанных причин в дальнейшем. Проведен анализ основных технических характеристик военных систем связи, возможностей, преимуществ и их недостатков. На основе проведённого в статье анализа военных средств связи, которые используются в районе проведения антитеррористической операции на территории Донецкой и Луганской областей определены перспективы развития систем военной связи. Для устранения указанных в статье проблемных вопросов, авторами статьи предлагается запустить собственный военный спутник для нужд Вооруженных Сил Украины; провести разработку новых образцов военной связи; провести глубокую модернизацию имеющихся на вооружении радиостанций, командно-штабных машин, радиорелейных и тропосферных станций; провести интеграцию принятого на вооружение за последние годы телекоммуникационного оборудования в единое информационное пространство Вооруженных Сил Украины, а также достичь соглашений с представителями ведущих производителей телекоммуникационного оборудование относительно трансфера технологий и развёртывания производства на территории Украины.

Ключевые слова: система радиосвязи, радиосвязь, радиоэлектронное подавление, преднамеренные помехи.