Results of Development of Tropospheric Communications System

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***Abstract* – The results of design and preliminary open path testing mobile tropospheric communication system are discussed. Practical recommendations to improve the characteristics of quality in mobile tropospheric communications systems are made.**

Keywords – tropospheric communications systems, SDR-technology, wireless interfaces and communications protocols, adaptive modulation, Solid State Power Amplifier

I. Introduction

Recently, at a special networking and commercial applications with a range of newly increased interest in tropospheric radiorelay systems (TRS). This is due to their high vitality and complexity of radio interception at large up to 100 ... 150 km length of inter-stations intervals. However, available troposphere communication stations have a number of limitations that prevent their use in transmission of telecommunications traffic with high speed and quality of transmission. Among the most critical limitations can be noted also large size and weight of the transceiver and antenna equipment that hinders the possibility of rapid deployment.

A number of authors' papers [1-4] are devoted to analysis of current level of tropospheric communication and basic directions of its development.

In this report the results of design and preliminary open path testing mobile tropospheric communication system are discussed.

II. Main Part

Substantiation of TRS performance requirements based on the analysis of energy balance in the line of tropospheric communication [5,6]. It is shown that in case of typical receiver sensitivity in the range of 6 cm for reliability communication (95-98)% with a range of 100 km and date rate up to 2Mbit/s equivalent isotropic radiated power exceeds 47-56 dB, which is provided with output of transmitter amplifier power $P_t \approx 50...100$ W and a parabolic antenna gain $G_A \approx 30...36$ dB.

Based on these requirements the laboratory sample TRS (Fig. 1) with adaptation in time, frequency, spatial polarization and speed parameters was developed. There are embedded engineering solutions aimed at providing protection from enemy intelligence and interference and ensure convergence with modern multi geographically distributed telecommunication systems with guaranteed quality of service. The means to minimize the impact multiple-pass propagation: special types of modulation, additional diversity in time and polarization, using the equalizers.

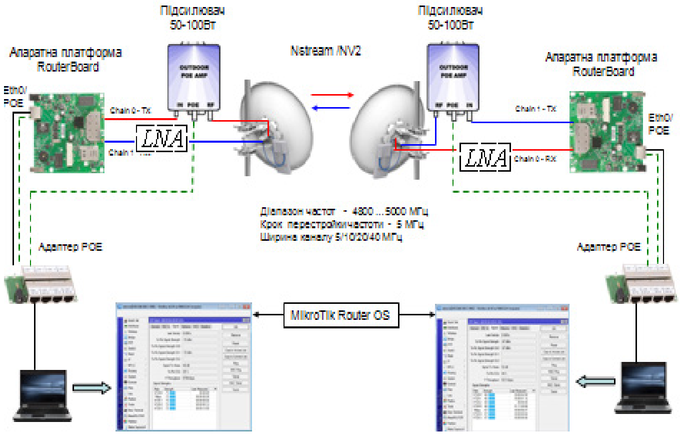
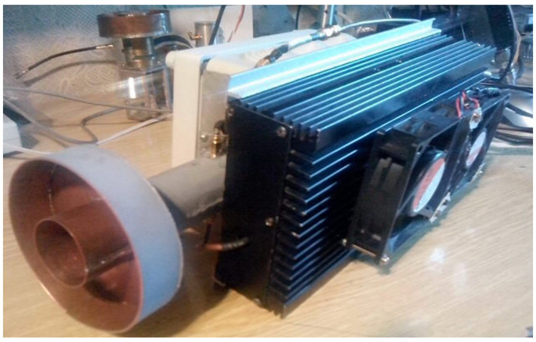


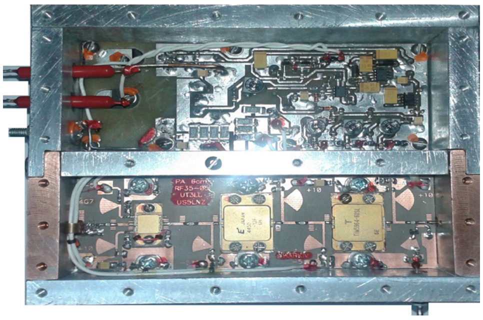
Fig. 1. Block diagram of TRS

In TRS we used communication protocol Nstream v2 (Nv2) - own protocol data transmission in wireless communication networks, developed by MikroTik based on the technology of multiple access time division TDMA. This ensures adaptation of transceiver parameters: select the operating range 2.4 GHz or 5 GHz; center frequency and channel width 2 / 5/10/20 MHz; modulation schemes; the threshold SNR; interval periodic calibration signal noise immunity; frame protection regime; type of preamble and the value of guard interval.

Photo radio frequency block, SSPA and semi-kit of TRS are shown on Fig.2 and Fig.3.



a)



b)

Fig. 2. Photo radio frequency block a) and SSPA are developed by authors

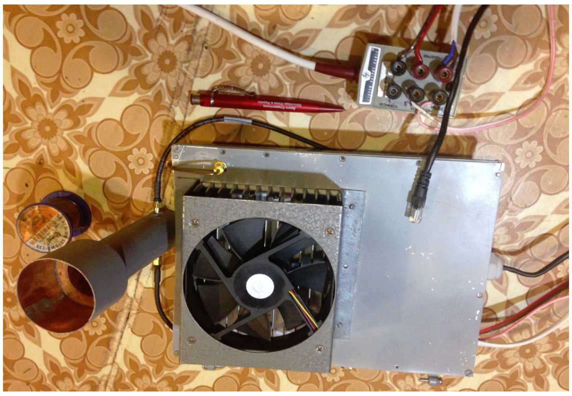


Fig. 3. Photo semi-kit of TRS

Preliminary open path testing of mobile tropo-spheric communication system. Tests have been providing in process of communication between two Kharkiv and Pavlograd amateur stations in 6 cm band (Figure 4). Distance was approximately 180 km.

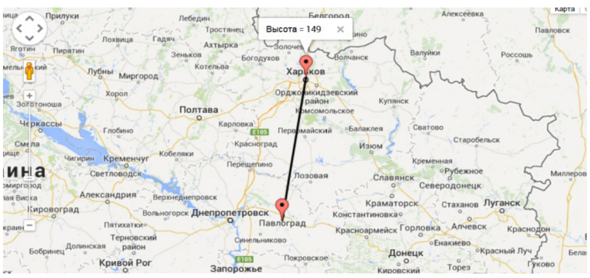


Fig. 4. Positions of stations

The route, as shown in Figure 5, is closed and communication is provided mainly by scattering signals to inhomogeneities of troposphere.

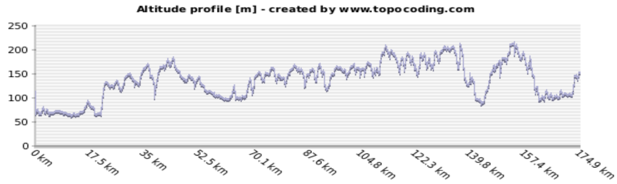


Fig. 5. Real route profile Earth surface between Kharkiv and Pavlohrad

Figure 6 shows a screenshot of the spectrum signal received in Kharkiv. S/N ratio was near 10 dB. Special methods against fading and noise-immune coding were not used.

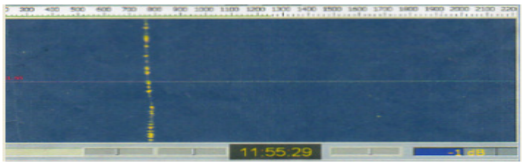


Fig. 6. Screenshot of received signal

Results of throughput measurement of TRS between point 1 in Kharkiv near KNURE and point 2 in 12 km to East from Lyubotin (distance near 38km) are shown in Figure 7. The measuring was provided with program IxChariot by the way of emulation multimedia digital stream. The maximum throughput of channel was 13Mb/s.

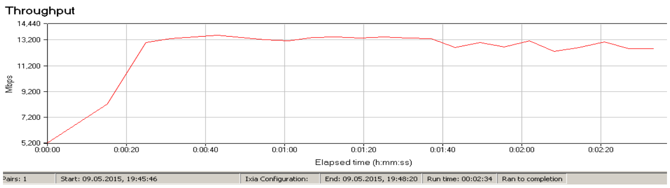


Fig. 7. Channel throughput

Using Team Talk communications software checks the quality of videocommunication. Image, received at point 2, is shown in Fig.8.

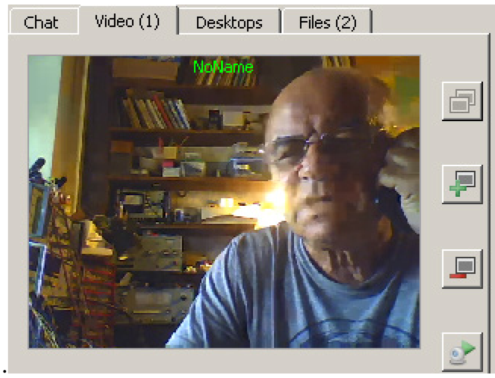


Fig. 8. Received image at point 2

III. CONCLUSION

The possibility of practical implementation of mobile tropospheric communications system, in which we implemented modern technological telecommunication networks solutions , is experimentally confirmed. Results of trace testing showed that the characteristics of quality and reliability of communications, mobility and speed the deployment of the developed TRS does not concede known designs but have a significantly lower cost of equipment.

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