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TESTING STATE OF THE ART RADIO COMMUNICATIONS EQUIPMENTS WITH REGARD TO THE LEGACY SYSTEMS USED IN TACTICAL ENVIRONMENT

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Abstract: *The requirements for tactical communications systems have become, in recent years, more diverse and more demanding in terms of performance. Following this idea, a modern tactical communications system must be based on the IP technology for effortless integration with information systems, must provide sufficient bandwidth, in order to support a wide range of services, and must operate continuously even if the environmental and operational conditions become more and more unsuitable, things characteristic for the tactical environment.*
The solutions adopted by the armed forces worldwide in order to achieve fast and reliable communications include high capacity multiband radio stations and radio relay equipments. The integration with the legacy communications systems, mainly based on E1 and D1 Eurocom technologies, is a must, especially if the there is a strict budget to consider.
In this paper we present an analysis of several types of equipments and technologies used in the military tactical radio networks infrastructure along with different field test results. The analysis highlights the specific advantages and disadvantages of some equipments and it is based on test results obtained by communication equipments representative for current military market. The tests were performed under ideal conditions, in order to identify the maximum performances of the equipments and to establish a benchmark, and under tactical environment or real working conditions, in order to identify the weaknesses and the strengths of each equipment especially while operating integrated in a complex system.
Keywords*: Informatics, Electrical engineering, Communications, Testing-and-evaluation*

Introduction
In the 1990s period, an extensive modernization and transformation process began in the Romanian Army. The military communications technique, based on the old russian radio stations (R 1070, R 1300, R 405, R 118) started to be updated. Also, by joining NATO in 2004, Romania assmed the implementation of a series of programs and projects (many of which related to the communication domain) and also the compliance with the NATO standards.
The most important enhancements regardind the Romanian Army communications, before and after Romania joined NATO in 2004, were: the development and implementation of the Permanent Transmission Network (RTP) and also of the RTP communications centers with local, regional and general management; the development and implementation of fixed and radio networks with different classification levels; creating the radio relay autostations with switching, management and radio access network functions; the purchase of different types of Panther and Harris hopping frequency radio stations; the purchase of portable, fixed and mobile satellite terminals; the purchase of digital and analog voice and data terminals; the purchase of fixed and mobile videoteleconference equipments.
In order to comply with the continously evolving NATO concepts, the Romanian Army communication infrastructure must continously adapt, providing new and improved solutions. Concepts such as C4ISR (Command, Control, Communications, Computers, Intelligence, Surveillance and Reconnaissance), NCW (Network Centric Warfare) and NNEC (NATO Network Enabled Capability), which require the assurance of new and bandwidth-demanding services, can only be supported by an versatile, last-generation range of communication equipments and technologies. The most common communication equipments found today in the Romanian Army are described below and include HF, VHF and UHF radio stations and radio relays that work in the GHz range.[1]
Object of the research
The object of the current paper is to analyse the current state of equipments and technologies used by the romanian military tactical radio networks infrastructure, with regard to the legacy systems used in the tactical environment. The analysis is made by highlighting the differences between the theoretical and the practical performances of typical radio communications equipments used in the military, and also by pointing out the differences between various types of equipments and technologies. The analysis is

based on the tests our team has performed under various conditions.

Communication equipments used by the Romanian Army

In order to ensure the information (data or voice) exchanged between higher and lower echalons, the tactical communications systems were designed to create, automatically and / or user-assisted, timely and flexible communication links. Therefore, according to [2], the general missions that communications systems need to address and successfully fulfill are, at least, the following:

a. Creating and maintaining the required communication links for the command and control process
b. Ensuring encrypted communication channels
c. Ensuring technical and operational compatibility with communication systems belonging to other armies
d. Ensuring the interconectivity with the communications systems belonging to the national defense system and with the civilian communications systems
e. Ensuring the continous operation of the links.

Currently, there is a high diversity regarding the communications equipments used in the military tactical environment. The romanian military tactical communication links are mainly based on the equipments listed and described below.

Panther 2000H tactical radio

Panther 2000 H tactical radio is an intelligent frequency hopping transceiver, providing coverage from 1.5 MHz to 30 MHz, in 100 Hz steps. The operating modes of the equipment are: USB, LSB, CW/ Fixed frequency/ Adaptive fixed frequency/ Intelligent frequency hopping. The hop rate for the frequency hopping mode is 10 hops/second.

The Panther 2000H tactical radio has a number of 100 programmable channels and can be deployed as a standard manpack (with peak emitted power of 5/25/50 watts) or as a transportable/ vehicle/ base station (with emmiting power varying from 5 to 400W).

The tactical radio is designed to meet the environmental requirements of the MIL STD 810E standard.

Panther 2000 V tactical radio

The Panther 2000 V Enhanced Data Radio (EDR) tactical radio is an intelligent frequency hopping transceiver, providing coverage from 30 MHz to 108 MHz. In order to assure secure communications, the radio provides an integral high level 16kb/s digital encryption, with custom crypto solutions. Also, the Panther 2000 V tactical radio can be deployed as a 20W EPM manpack or as a vehicular transceiver, with an optional 50W amplifier.

In order to connect to a PC, the tactical radio comes with a dual 115kb/s RS232 interface, while providing a 9.6 kb/s data throughput over radio, with comprehensive FEC[3][4].

Harris 5800V tactical radio

The RF-5800V-MP is the VHF manpack member of the Falcon II tactical radio family, providing continuous coverage in the 30 to 108 MHz frequency band.

The standard 16 Kbps modem uses FSK modulation and is compatible with many legacy data communication systems while the optional highspeed modem supports rates up to 64 Kbps for added throughput and reduced on air time. ECCM protects voice and data from hostile interference with the easy-to-use Harris Quicklook 1A/II waveforms.

The embedded Harris Citadel II provides military-grade security or AES encryption for both voice and data transmissions. A customer-unique encryption algorithm is also available.[5]

Harris 5800H tactical radio

The RF-5800H-MP is part of the FALCON II family of multiband tactical radio systems. The transceiver's extended frequency range (to 60 MHz) provides secure FSK 16 kbps CVSD voice and data in the VHF band in addition to the HF capability.

High speed data rates up to 9600 bps (HF) and selectable ARQ modes reduce on-the-air transmission time and enhance secure data transmissions for improved communications reliability and throughput.

A serial-tone ECCM waveform with DSP-based excision filtering and a 600 bps vocoder are combined to provide reliable, secure HF communications in the presence of jamming. Secure digital voice, 75 to 2400 bps data, and ARQ mode are supported in the ECCM mode.

The latest third generation HF Link Automation, STANAG 4538, is included and provides high-performance ALE and data link protocols to deliver superior linking and error-free data transfer.

The Harris Citadel ASIC provides high-speed data and digital voice encryption using either a Harris-standard or a customer-unique algorithm[6].

Harris 5800M tactical radio

The RF-5800M-MP is a member of the FALCON II family of multiband tactical radio systems. This advanced multimode, multimission manpack radio supports continuous operation across the 30 MHz to 512 MHz frequency range.

The standard high speed modem uses FSK or ASK modulation and is compatible with many older data communication systems, which supports rates up to 64 Kbps for added throughput and reduced on-air time.

Electronic Protection Measures (EPM) protect communications from hostile interference using frequency hopping techniques. Multiple waveforms are supported, including Harris Quicklook 1A, and optional Havequick I/II, or Rockwell Collins TALON.

The Harris Citadel ASIC provides high-speed 128-bit digital encryption for both voice and data traffic. Customer-unique Citadel algorithms are available[7].

Harris 7800S tactical radio

The RF-7800S-TR SPR Team Radio provides secure, digitized voice and data communications to every member of a team without distracting his or her attention from the task at hand.

Full duplex, multi-group voice conferencing allows several simultaneous talkers on the net with an unlimited number of listeners—resulting in a more natural, dynamic operating environment, free from the constraints of traditional radio systems.

A priority break-in feature ensures that critical orders are heard even in the middle of a high intensity operation.

The radio is data-enabled and incorporates a built-in GPS receiver, allowing easy-to-use situational awareness, position tracking and messaging services. A standard USB data interface allows connection of Windows, Linux or Android computing devices for enhanced data applications. All transmissions are secured by the built-in Citadel II ASIC, providing FIPS certified 256- bit encryption. The Advanced Encryption Standard (AES) and Harris Citadel are selectable in the standard configuration. [8]

Harris 7800W radio relay equipment

The RF-7800W Broadband Ethernet Radio by Harris Corporation leverages proven orthogonal frequency-division multiplexing (OFDM) technology to deliver high-speed Ethernet throughput over wireless links. Under clear lineof-sight conditions, the RF-7800W can provide robust, long-range connectivity at distances beyond 50 kilometers. The all-Internet Protocol (IP) design of the RF-7800W delivers a seamless extension of Ethernet local area networks and wide area networks, at proven Ethernet data rates greater than 80 Mbps .

The RF-7800W provides unmatched spectral flexibility with support for four different channel sizes (5, 10, 20, and 40 MHz) in Point-to-Point (PTP) mode and three different channel sizes (5, 10, and 20 MHz) in Point-to-Multipoint (PMP) mode, and center frequency specification in 1 MHz increments.

The radio relay operates over the 4.4–5.0 GHz frequency band. Transmissions can be secured via the embedded encryption capability or via external Ethernet Inline Network Encryption (INE) devices.[9]

Harris 7800H tactical radio

The RF-7800H provides continuous coverage from 1.5 to 60 MHz in a small and compact package. The radio operates from a single battery, reducing the weight while providing 20 watts HF and 10 watts VHF.

The RF-7800H incorporates the latest development in high speed wideband HF waveform technology. This advanced waveform allows data transmission in bandwidths from 3 to 24 kHz achieving data rates of up to 120 kbps. Embedded Citadel and AES encryption provides military grade security for all voice and data transmissions.

A serial-tone ECCM Hopping waveform with DSP-based excision filtering combined with robust vocoder provide reliable, secure HF communications in the presence of jamming. Embedded third generation link automation (ALE) per STANAG 4538 provides high performance link establishment and data link protocols to deliver faster and more reliable linking together with error-free data transfer under the most challenging channel conditions[10].

Harris 7800V tactical radio

The RF-7800V VHF handheld provides continuous coverage in the 30 to 108 MHz frequency band with up to 10 watts of output power. Built for battlefield voice and data networking, the RF-7800V VHF CNR provides high-speed data connectivity up to 192 kbps, making it the fastest VHF combat net radio available. Integrated Ethernet, USB, RS-232, RS-485, and RNDIS connections allow peripherals, such as digital cameras and USB storage devices, to be plugged directly into the radio for uploading data.

Harris' easy-to-use Quicklook 1A and Quicklook 2 ECCM waveforms protect voice and data from hostile interference. Built-in transmission and communications security is provided by Harris Corporation's embedded Citadel® II cryptographic technology, which provides 256-bit military grade and AES encryption, options for voice and data transmissions. Unique encryption algorithms, customer modified algorithms and customer-defined keys are also available[11].

Harris 7800M tactical radio

This single channel voice and data tactical radio covers 30 MHz to 2 GHz with 20 watts of transmit power. Capable of fixed-site, vehicular, or manportable battery-powered operation, the radio supports narrowband (25 kHz or less) waveforms from 30 to 512 MHz and wideband (greater than 25 kHz) waveforms from 225 to 2000 MHz.

Built-in AES and Citadel encryption provide high-grade security for all transmissions using a 256-bit key. Standard Quicklook ECCM protects narrowband voice and data from hostile interference, while optional TALON CUID and HaveQuick waveforms offer secure groundair communications and interoperability with fielded airborne platforms.[12]

MH 300 radio relay series

The MH300 radio relay series includes radio terminals designed according to Eurocom D/1 and EES recommendations, working in NATO RF Bands I, II, III, III+ and IV and providing an overall throughput in excess of 8 Mbps.

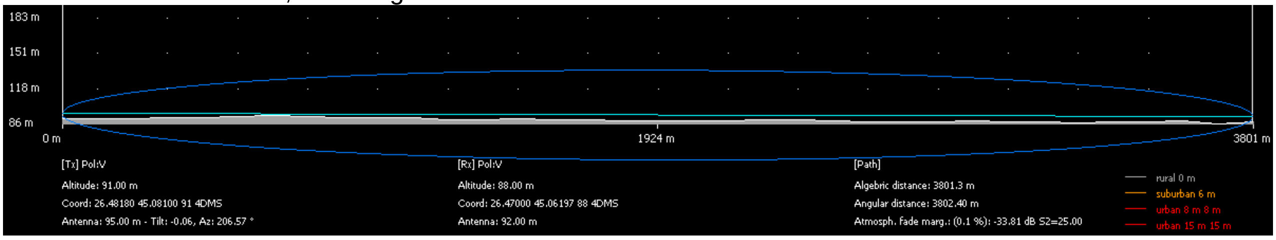


Figure 1. The terrain profile between the two radio stations under test (MBNR)

A set of radio-relay equipments forms the series:

a. MH302, operating in the 225-400 MHz NATO Band I
b. MH306, operating in the 610-960 MHz NATO Band II
c. MH313S, operating in the 1350- 1850 MHz NATO Band III
d. MH313X, operating in the 1350- 2700 MHz NATO Band IV
e. MH344, operating in the 4400- 5000 MHz NATO Band IV[13]

Two traffic capacity configurations are available:

a. 2Mb/s (for all equipment of the series) providing a single traffic channel ranging from 256 up to 2048kb/s
b. 8Mb/s (for MH313X/MH344 only) providing up to four 256-2048kb/s traffic channels (or a single 8448kb/s) plus a 16kb/s auxiliary channel.

Interfaces are according to Eurocom D/1 and ITU-T G.703/V.11. A 16kb/s Eurocom EOW for service communications is also available.

The series provides anti-jamming capability in terms of:

a. Automatic frequency evasion for interference/jammer avoidance
b. Automatic interference and jamming detection
c. Automatic/continuous tuning high-selectivity RF cavity filters
d. Anti-pulse saturated IF amplifiers
e. Robust power-efficient modulation technique

Anti-ESM capability is provided in terms of automatic power control.

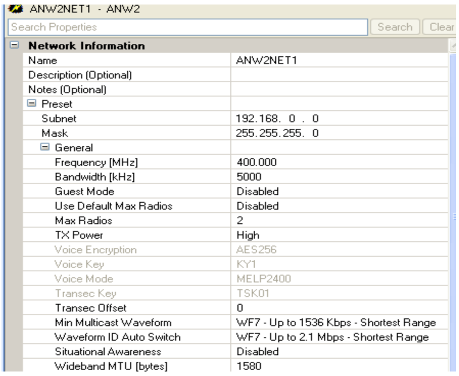
Conducted tests

Tests performed with Harris RF 7800M (MBNR – Multiband Networking Radio)

Reference test

The tests were conducted deploying the radio stations at a distance of 4 km from each other. The communication path was flat-shaped, without major obstacles, and the antennas were positioned at a height of 3.5 m. The terrain profile between the two devices under test is shown in Figure 1.

The radio stations were each connected to a laptop, one acting as a FTP server and the other as a FTP client, in order to measure the radio link parameters. The tests consisted in the transfer of a file to / from the FTP server. The interconnection mode of the equipments (the network topography) and the radio network parameters that have been set are shown in figure 2:


ANW2NET1 - ANW2

Search Properties | Search | Clear

Network Information	
Name	ANW2NET1
Description (Optional)	
Notes (Optional)	
Preset	
Subnet	192.168. 0 . 0
Mask	255.255.255. 0
General	
Frequency [MHz]	400.000
Bandwidth [kHz]	5000
Guest Mode	Disabled
Use Default Max Radios	Disabled
Max Radios	2
TX Power	High
Voice Encryption	AES256
Voice Key	KY1
Voice Mode	MELP2400
Transec Key	TSK01
Transec Offset	0
Min Multicast Waveform	WF7 - Up to 1536 Kbps - Shortest Range
Waveform ID Auto Switch	WF7 - Up to 2.1 Mbps - Shortest Range
Situational Awareness	Disabled
Wideband MTU [bytes]	1580

Figure 2. The set-up configuration of the equipments that were tested (MBNR)

The download speed from server (transfer speed is represented in kB/s) is illustrated in Figure 3.

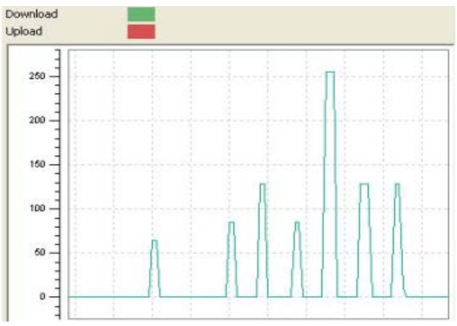


Figure 3. The download speed from the server for the reference test (MBNR)

The upload speed to server (transfer speed is represented in kB / s) is illustrated in Figure 4.

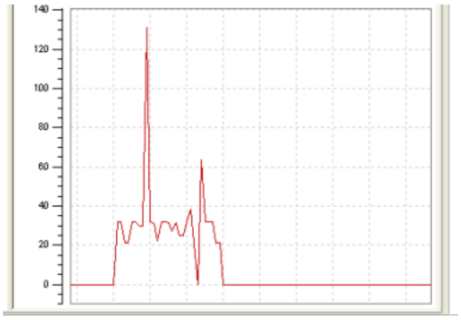


Figure 4. The upload speed to the server for the reference test (MBNR)

The goal of these tests was to determine the maximum data speed between these radio stations, under ideal conditions. The conclusions drawn based on this particular test are:

a. The maximum data speed guaranteed in a MBNR link is 1 Mbps. Though there were bursts of 2 Mbps, we cannot consider this value as a guaranteed one.
b. The data transfer has a fragmented characteristic – the communication is not continous, is made in bursts;
c. Voice calls can be made without degrading the performance of the data link;
d. The ANW2 waveform (that must be used for high capacity bandwith) can be performed only in crypto mode (the radio station has a built in crypto module).

Test with one fixed radio station and one radio station in motion

The tests were conducted deploying one of the radio stations on a moving vehicle and the other acting as a fixed station. The antennas used were omnidirectional and were positioned at a height of 3.5 m. The communication path between the radios was clear in the majority of the time, but was also disrupted at times by different obstacles (trees, buildings). The distance between the radio stations didn't exceed 1 kilometer.

The radio stations were each connected to a laptop, one acting as a FTP server and the other as a FTP client, in order to measure the radio link parameters. The tests consisted in the transfer of a file to / from the FTP server. The interconnection mode of the equipments (the network topography) and the radio network parameters that have been set were similar to the ones used in the reference test.

In Figure 5 we present the graphical results of the test. The download traffic is represented in red and the upload traffic is represented in yellow. The traffic is instantaneous and it is updated at the second.

The goal of this test was to monitor the effects introduced by continuously changing the position of one equipment under test on the performance of the data link.

The conclusions drawn based on this particular test are:

a. The maximum instantaneous data speed was below 300 kbps;
b. The average data speed was about 50 kbps;
c. The data transfer has the specific fragmented characteristic, but it is not significantly affected by the obstacles encountered;

Tests performed with Harris RF 7800W (HCLOS – High Capacity Line Of Sight)

Reference test

The test was conducted deploying the radio relays at a distance of 700 meters from each other. The communication path was flat, without major obstacles, and the directional antennas used (Harris PN RF-7800W-AT001) were positioned at a height of 3.5 m.

The radio relays equipments were each connected to a laptop, one acting as a FTP server and the other as a FTP client, in order to measure the radio link parameters. The tests consisted in the transfer of several different-sized files to / from the FTP server.

Next we present the results obtained by setting up the equipments with the following parameters (parameters that maximize the channel capacity):

a. Channel bandwidth - 40 MHz;
b. UBR - 108 Mbps;
c. Transmit power - 20 dBm;
d. Frequency: 4720 MHz.

The download speed from server (represented above) and the upload speed to server (represented below) are illustrated in Figure 6 (transfer speed is represented in kB / s).

The goal of this test was to determine the maximum data speed between two HCLOS radio relays, under ideal conditions. The conclusions drawn based on this particular test are:

a. The maximum data speed guaranteed in a HCLOS link is 50 Mbps;
b. The data transfer is continous and stable;
c. The equipment is IP-only, without other interfaces;
d. The radio relay has a built in crypto module that can be activated or deactivated.

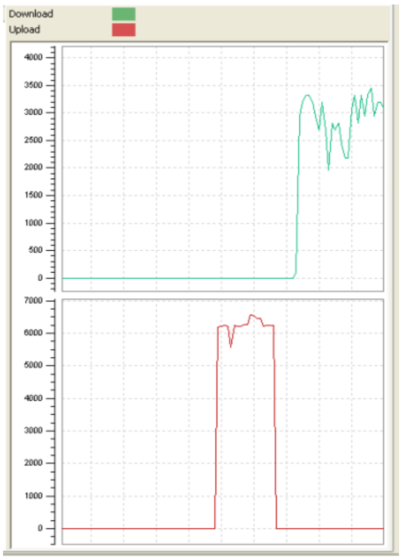


Figure 5. The download and the upload speed from/ to the server for the reference test (HCLOS)

Long-range test

The test was conducted deploying the radio relays at a distance of 60 kilometers from each other. The free communication path free, without obstacles, is represented in Figure 7.

The antennas used were the same directional antenna used in the reference test. The major difference to the reference test was (besides the distance) the alignment of the antennas. Because we lack an automatic alignment system, the alignment was made based on the buzzer the equipments are equipped with. However, because the distance between the devices under test was significant, the alignment wasn't perfect.

The radio relays equipments were each connected to a laptop, one acting as a FTP server and the other as a FTP client, in order to measure the radio link parameters. The tests consisted in the transfer of several different-sized files to / from the FTP server.

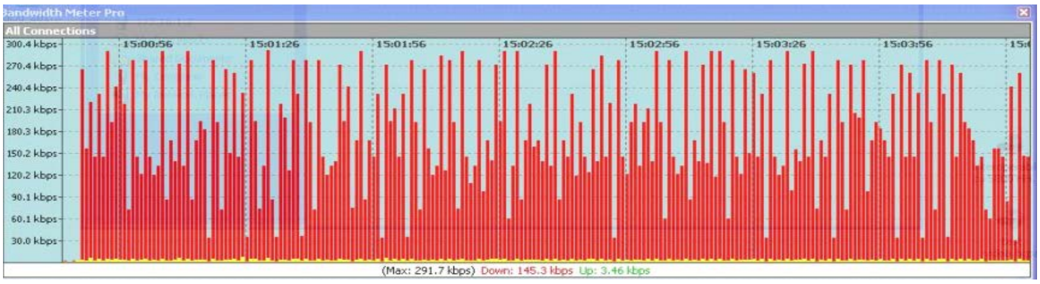


Figure 6. The representation of the traffic for the test made in motion (MBNR)

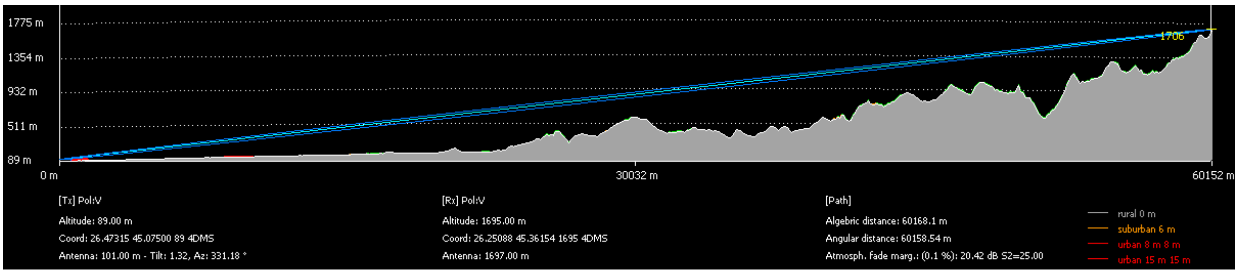


Figure 7. The terrain profile between the two radio relays under test (HCLOS)

In order to perform the test, the radio relays were configured with the following parameters (as it can be noticed, the channel parameters were reduced to minimal values):

a. Channel bandwidth - 10 MHz;
b. UBR - 9 Mbps;
c. Transmit power - 20 dBm;
d. Frequency: 4920 MHz.

The download speed from server (represented above) and the upload speed to server (represented below) are illustrated in Fugire 8 (transfer speed is represented in kB / s).

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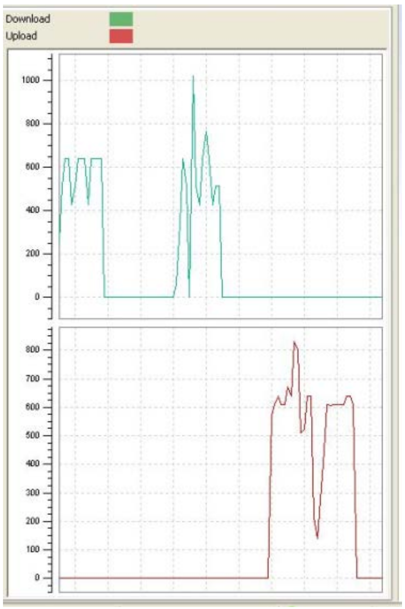

Figure 8. The download and the upload speed from/ to the server for the long-range test (HCLOS)

The goal of this test was to determine the maximum distance and data speed for a HCLOS-based communication link. The conclusions drawn based on this particular test are:

a. The communication link can have at least 60 km;
b. The data speed obtained for the 60 km link distance was 5 Mbps;
c. The data transfer is continous and stable – only affected by the alignment of the antennas;

Test with one fixed radio relay and one radio relay in motion

The test was conducted deploying one of the radio stations on a moving vehicle and the other acting as a fixed station. The antennas used were omnidirectional and were positioned at a height of 3.5 m. The communication path between the radios was clear in the majority of the time, but was also disrupted at times by different obstacles (trees, buildings). The distance between the radio relays didn't exceed 1 kilometer.

The radio relays were each connected to a laptop, one acting as a FTP server and the other as a FTP client, in order to measure the radio link parameters. The test consisted in the transfer of a 155 MB file from the FTP server. In order to perform the test, the radio relays were configured with the following parameters:

a. Channel bandwidth - 20 MHz;
b. UBR - 36 Mbps;
c. Transmit power - 20 dBm;
d. Frequency: 4720 MHz

Next we present the graphical results of the test. The traffic is instantaneous and it is updated at the second.

Even though the radio relays equipments are not, usually, used in motion, the goal of this test was to monitor the effects introduced by continuously changing the position of one equipment under test on the performance of the data link.

The conclusions drawn based on this particular test are:

a. The maximum instantaneous data speed was approximately 13 Mbps;
b. The average data speed was around 2 Mbps;
c. The data transfer has a fragmented characteristic.

Analysis of the results

The results are summed up in Table 1.

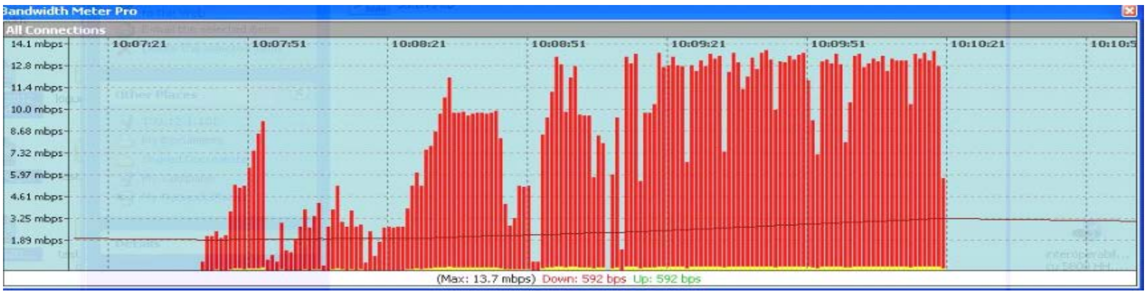

Figure 9. The representation of the traffic for the test made in motion (HCLOS)

Tests \ Results	RF 7800W (HCLOS)	RF 7800M (MBNR)
Reference test	Maximum data speed of 50 Mbps Data transfer continous and stable Only data (IP), no voice	Maximum data speed of 2 Mbps Guaranteed data speed of 1 Mbps Communication made in bursts Voice and data communications
Long-distance test	Communication link of at least 60 km Maximum data speed of 2 Mbps Data transfer continous and stable – the alignment of the antennas is very important	N/A
Test in motion	Maximum instantaneous data speed of 13 Mbps Average data speed of 2 Mbps Data transfer has a fragmented characteristic – the equipments must be in LOS	Maximum instantaneous data speed below 300 kbps Average data speed of 50 kbps Data transfer has a fragmented characteristic – the equipments must be in LOS

Table 1. Tests results

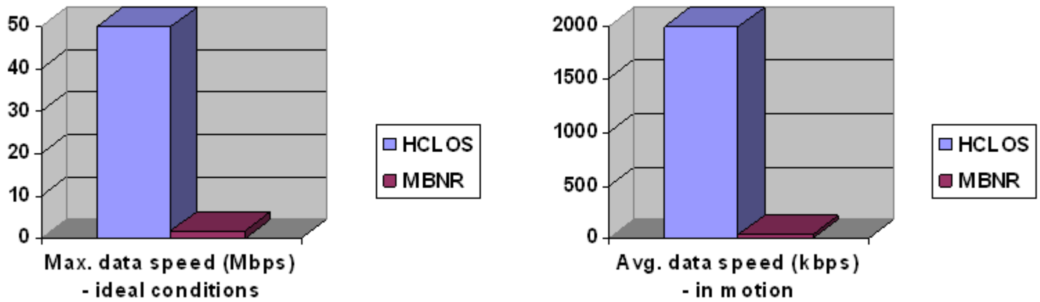

Figure 10. The representation of the data speeds obtained for the reference and for the "in motion" tests (HCLOS and MBNR)

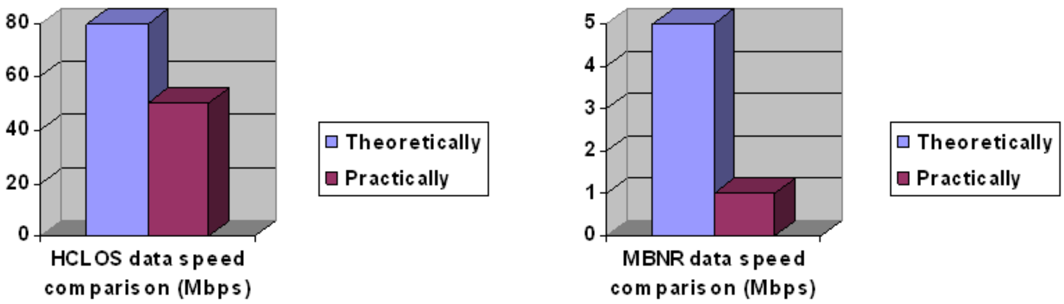

Figure 11. The representation of the theoretical and the practical data speeds obtained (HCLOS and MBNR)

Regarding the performance of the two tested equipments, it can be seen that the radio relay offers higher data throughput capacity, and also longer communication links. The performance of the radio relay is superior to the one of the radio station because of the missions they both must meet: while the radio relay is built to interconnect Command Posts / Tactical Operation Centers / Operating Bases or to connect them to the mobile patrols (all links demanding high capacity data), the MBNR is a wideband tactical radio, built to fulfill the missions of individual soldiers.

Another advantage of the radio relay is the automatic and transparent adjustment of the link parameters, in order to provide the best performance for the link. There are a number of key parameters that are continously monitored and adjusted during a data transfer. The most important ones are the Tx power and the modulation of the data.

But the MBNR has its own set of advantages. Voice and data communications can be made simultaneously, without degrading the data throughput capacity. Also, this particular radio station can form ad-hoc networks, which allows automatic and transparent relay through any available station, and also heals the network if any station leaves the network.
The results obtained in the reference tests were satisfactory from a performance point of view. While there were differences from the data speeds provided in their respective datasheets, we consider that the speeds reached by the HCLOS and by the MBNR (50 Mbps and 2 Mbps) cover all the communication needs of a modern army, at the tactical level.
But both tested equipments underperformed when used in motion, mostly because they need Line-of-Sight visibility with their respective correspondents, as shown in Figure 10. That being said, the radio relay still managed to provide an average speed for the data of 2 Mbps, with the omnidirectional antennas. These antennas have a smaller gain than the omnidirectional ones, but have the advantage of no longer needing to align them. Considering that we do not have an automatic alignment system for the omnidirectional antennas, the trade-off of a smaller data speed for a totally mobile system seems acceptable.
Another point observed during the tests was the fact that both equipments automatically managed to retrieve the connections when back in sight, after losing it.
The alignment of the HCLOS directional antennas was again a problem during the long distance test. Considering that the environmental conditions were adverse (it was windy) and the fact that we have set up the channel parameters to their minimal values, the results that we have obtained were very good – 5 Mbps with bursts of 6.5 Mbps for an UBR of 9 Mbps.
Regarding the comparison between the theoretical and the practical data speeds of the tested equipments, it can be noticed that there is a difference of 37.5% between the theoretical and the practical data speeds of the HCLOS and 80% for the MBNR, as shown in Figure 11. The difference can be explained by the fact that we didn't use specialized software application to test the equipments and, in the case of the MBNR, the theoretical value of 5 Mbps is for the air data rate. As we didn't measure the data rate at the air interface, it was only normal that the Ethernet data rate to be smaller.

CONCLUSIONS

Both equipments tested can succesfully fulfill any of the missions they are intended to accomplish. The radio relay is suitable for fixed and mobile deployments where large amount of data are being transferred. The MBNR is a wideband tactical radio suitable for fixed-site, vehicular, or manportable operation. The MBNR's most important capability is, however, its networking ability. The radio station uses innovative, intelligent routing protocols that do not require a designated network control station—each radio automatically discovers and joins an authorized network. Also, its ad-hoc capability is another factor that increases its networking abilities.
The results of the tests reflect just the different utility of the two equipments. The HCLOS offers speeds in the range of Megabytes for a various range of possible deployments. If the link conditions are good, the performance offered by the HCLOS competes with the one offered by a wired link. Also, HCLOS' ability to automatically adapt to the changing conditions of the transmission channel makes it a reliable partner for the armed forces.
The difference between the theoretical and the practical data speeds of the HCLOS is very small and we consider it to be acceptable, but the difference between the data speed obtained in motion and the data speed obtained under ideal conditions was considerably large. The possible explanations could be that we used different software application to measure the data speed in the two circumstances, we used diminished set up parameters for the link when in motion (an obvious reason for the weaker result) and also we used omnidirectional antennas with lower gain (another obvious reason for the weaker result). Also, considering that the peak value of the data speed for the test made in motion was 13 Mbps (value that was obtained in a consistent way, for an UBR of 36 Mbps), we are confident that the performance of such a link can be higher.
The MBNR offers support for all the services required by an soldier on the field. It can provide sufficient throughput for live video streaming, but to do that it needs line of sight visibility. This condition decreases a little bit its tactical capabilities, but its performances are much more decreased by operating in motion. Again, similar to the HCLOS case, the difference between the data speed obtained in motion and the data speed obtained under ideal conditions is considerable. But in this case, considering that the data transfer was very unstable (ranging from a couple of kilobytes to hundreds of kbps), we can consider that the MBNR represents a poor solution for mobile wideband communications, definetly weaker than the HCLOS.
Also, the difference between the theoretical and the practical data speeds of the MBNR is much higher than in the case of the HCLOS. Again, it can be seen that the MBNR is not a dedicated data communication device, like the HCLOS, but a tactical radio. And, for a tactical radio, it is offering some of the best data transmission capabilies in the market.

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