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KÁROLY KRISZTIÁN

***POSSIBILITIES FOR IMPLEMENTING AUTOMATED TRACKING
CAPACITY IN THE COMMUNICATION INFORMATION SYSTEM OF
THE HUNGARIAN DEFENSE FORCES***

The author's description and official reviews of the doctoral dissertation

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THE SCIENTIFIC PROBLEM

The important achievement of the fourth industrial revolution (information revolution) consists of the possibility of accurate geo-location at local, regional or even global scale, and due to the related network-based services it became possible to query the geographical position of the devices, vehicles possessing the proper signalling equipment or the people possessing “smart” devices (e.g. phone, tablet) through the remote supervision system as well as to display in the digital map, even in the screen of a computer or a suitable smart phone from any point of the world. Besides the possibilities residing in the service it naturally incurs serious security issues, too. In addition the technologies and procedures applied in the fleet tracking with public purpose can't be applied directly in the practice with military and defensive purposes because of the different, primarily the security requirements.

At national the tracking of our own and the allied terrestrial troops takes place primarily on paper, with marking on printed maps, and through the paper-based and electronic documentation of the data received on paper and through the telecommunication devices. Optionally it is possible to display within a certain system the geo-location information received from various telecommunication systems, for certain user groups (e.g.: Hungarian TETRA¹ system). My professional opinion is that by applying the modern IT² technologies Hungary requires to establish an automated force tracking capacity where – by further developing our already functioning telecommunication systems respectively by implementing the complementary target systems – the own teams' geo-location data can be shared, supplemented eventually with information deriving from various sensor-networks. The connection of the automated systems established in this way, and the establishing of the, interoperability might enhance the possibilities of establishing our leading superiority. Naturally besides all these I still think it is important to sustain the paper-based planning and documentation, for the eventual system failures or counter activity. But in my interpretation the focus would be shifted to the electronic, automated force tracking systems where the geo-location information on the own and the allied troops can be monitored at almost real time.

My theme selection was basically influenced by my practical experience gained in the operational areas of Afghanistan and Kosovo, related to force tracking. During my professional activity I realised that one of the critical points of the force tracking systems and the force tracking layer of the battle management systems consists of the wireless connection of the terminals, in this way I am dealing with my systemising analysis along this thread.

¹ Terrestrial Trunked Radio

² Information Technology

The international examples and recommendations can't be applied in full during the creation of a national automated force tracking capacity because of the capacity and development level of the available assets respectively because of the differing needs. Hungary has to determine and develop her own strategy of implementing such a capacity which needs to be preceded by a thorough scientific research work respectively there is need for a comprehensive and thorough terminology which extends to the determination of force tracking and the related notions.

I consider as the preliminaries of my research that in his announcement Attila Gulyás has already dealt with the force tracking systems that can be applied at the Hungarian special operational forces which is a good base to analyse the solutions based on tactical radios. In his thesis Tibor Farkas has already mentioned the possibility of the Hungarian application of the IFTS³ system established for the NATO's forces in Afghanistan. In his scientific thesis András Németh has also mentioned the necessity of using the fleet-tracking solutions in the area of communicating the danger-situations.

RESEARCH OBJECTIVES

The modern warfare got shifted from the conventional symmetrical features to the asymmetric ones respectively their mixed format is characterising the hybrid warfare. The majority of the military operations are fourth-generation operations such as the operations against the counterinsurgencies or the migration-related crisis situations. When observing the conflicts of our present time, such as the war in Iraq, or the protests in Kiev in 2014, it can be told that the media coverage and its effect are growing factors. As a result a military error may involve strategic consequences. Realising this Charles Krulak, general of the US Marine Corps created his „Strategic corporal” concept, meaning that even a squad leader can take decisions during his activity whose consequences may have strategic impact starting from local level. Due to these events it is more important for the units situated at lower organisational level to be able to get directly connected with the headquarters of higher level. As a result they created the network centric warfare concept after the Gulf War of 1990. By applying the network-based model the spreading of information becomes easier both horizontally and vertically. In this complex warfare space one of the possibilities of assuring the geo-location information of almost real-time consists of applying the force tracking systems.

³ ISAF (International and Assistance Forces) Force Tracking System

My scientific basic objective aims to reveal the domestic and international possibilities of establishing the automated force tracking based on the Hungarian and NATO regulators and system descriptions deriving from the open sources, and my professional experience, the performed research work, my experiments and measurements, as well as the defining of the possible Hungarian development and improving directions.

- KC 1. The first step of my objective consists of clarifying the earlier definitions of force tracking and the related notions, as well as creating new definitions.
- KC 2. I aim to determine whether the force and vehicle tracking is legitimate, whether it is against the law, and whether the geo-location and tracking systems with civil purpose of the national economy can be involved for military purposes?
- KC 3. The Hungarian Defense Forces – keeping pace with the modern challenges – also tries to establish its own network centric warfare capacity. These need to be built on information technologies and purposefully established management system. However during the creation of the system one should examine the operating human network and during the realisation steps it is required to review from time to time the efficiency, and a so-called network-analysis needs to be performed. Is it possible to create a system that can accelerate the realisation of the leading superiority? In my opinion the dependency and informal connection system of the infantry battalion needs to be examined with the most up-to-date network-analysing methods to establish a communication system that can efficiently support the commanders, their staff and the executors during their tasks. Therefore my research objective consists of revealing the connection system of the infantry battalion through network-scientific means.
- KC 4. My objective consists of revealing the possibilities of applying the global navigational satellite systems in the fleet- and force tracking of public service, paying attention - among others - to the factors that negatively influence the functioning of these systems. As a result of my research work I intend to make suggestions on solutions based on global navigational satellite systems that are capable to assure the geo-location information for the fleet- and force tracking systems that support the public service, either during the special legal system or in another situation that endangers the navigational infrastructure.
- KC 5. I also aim to reveal the possibilities of forwarding the data of the force tracking systems, through the digital tactical radios, TETRA terminals operating through the

HF⁴, VHF⁵, UHF⁶ bands operating in the Hungarian Defense Forces. By analysing the issue of interoperability in a multinational environment it is possible to connect our networks with the allied systems.

- KC 6. Based on my experience the availability indicators of the force tracking systems that possess satellite-based data-communication route are more advantageous than the force tracking systems supported by other data-transmission solutions. However due to our country's limited economic and space-industrial capacities it is reasonable to examine technologies that approach the satellite-based coverage. My research objective consists of elaborating a proposal on applying balloons as data-communication relays.
- KC 7. The mentioned modern communication devices – besides the geo-location data – may forward other information, too. The analysis of the data gained from the sensorially monitorable systems (e.g.: material replenishment, health-related data) may supply important supplementary information in establishing the accurate geo-location. I aim to reveal the integration possibilities of the information supplied by the soldier's individual health-condition checking and reporting.

HYPOTHESES OF THE RESEARCH

Based on the statements made so far, I set up the following hypotheses:

- H 1. Nowadays the automated force tracking capacity is much more an integrated module of a battle management, command and control system, it can be defined as its layer, being its required and indispensable element, and the source of the near real-time information obtained about the blue and allied troops (supported primarily with geo-local situational awareness information, perspectively gained through sensor networks). The application of the automated force tracking capacity assists the commanders and their staff in preparing their decisions based on objective information, in order to establish our own information superiority. (KC 1)
- H 2. The force- and vehicle-tracking with the purpose of national defence is lawful, it does not breach any law in force. (KC 2)

⁴ High Frequency – Short wave 3 – 30 MHz

⁵ Very High Frequency – Ultra-short wave 30 – 300 MHz

⁶ Ultra High Frequency – Decimeter wave 300 MHz – 3 GHz

- H 3. During the special law and order system the geo-locating and tracking systems of civil purpose can be involved from the national economy to meet military needs (KC 2).
- H 4. The dependency and information connection system of the infantry battalion going to be examined is a modular scale-free network. (KC 3)
- H 5. In the future one should switch from the use of GPS⁷-based receiver equipment used for the production of the geo-location data to the use of the GNSS⁸-based devices that is able to process the data of several global navigational satellite systems. In case of military applications it is a basic requirement to use the devices that are suitable to receive the encrypted signals of the GPS and GALILEO⁹ systems. (KC 4)
- H 6. Besides the sound and data-supplying services the modern digital tactical radio systems used during the military operations, even if in a limited way, but they are able to provide force tracking data, and share these data organised in networks, even with networks that are beyond their radio-traffic systems. Therefore this service could form one of the pillars of the Hungarian automated force tracking capacity. (KC 5)
- H 7. The automatic vehicle and person-tracking service (TETRA AVL¹⁰ and APL¹¹) of the Hungarian TETRA system (EDR¹²) used in several public service segments could form the second pillar of the Hungarian automated force tracking capacity which – during the peaceful periods and during the operations below threshold – is able to meet the governmental organs' critical communication and information need as well as situational awareness. (KC 5)
- H 8. In order to establish a national automated force tracking capacity that integrates well into the NATO's alliance system it is indispensable to implement the interoperability recommendations, standards, de facto procedures established in the international regulators, standards, cooperation systems, by taking into consideration the Hungarian needs at the highest possible level. (KC 5)
- H 9. For Hungary it may mean an alternative to implement the tethered balloons in order to carry communication relays. The relays of the balloons would be able to

⁷ Global Positioning System

⁸ Global Navigation Satellite System

⁹ The European Union's global navigational satellite system, named after Galileo Galilei, famous astronomer

¹⁰ Terrestrial Trunked Radio Automatic Vehicle Location

¹¹ Automatic Personal Location (TETRA)

¹² Egységes Digitális Rádiórendszer

efficiently support the wireless communication channels of the force tracking systems at terminal – network level. (KC 6)

H 10. In order to establish our own information superiority it is indispensable to enlarge the geo-location information deriving from force tracking with the replenishment data gained from the sensor networks and the health-related data of the troops. (KC 7)

The following items were not subject of my research:

The analysis, researching of the interoperability of the standardised geo-location information that support the connectivity of the force tracking systems of the NATO-allied countries with a programming and database-handling operator's approach.

The revelation of the HR and economic areas of the recommended solutions. The law-related issues of the implementation of the various systems and tools.

In regards of my recommended solutions I dealt in a limited way with their information-protection and security characteristics.

The complex analysis of the warfare systems does not form the subject of my research directly, I deal with them at the required level only. In my thesis I am focussing at the force tracking capacities of the discussed warfare systems.

Although it is strongly related to the topic of force tracking, but because of the extent-related considerations I did not study the area of Combat Identification (CID¹³) respectively the Identification Friend or Foe solutions (IFF¹⁴).

METHODS OF RESEARCH

I performed literature studying and analysis in regards of the domestic and NATO regulators, standards, system documentations that can be reached from open source. **I studied** at large the scientific literature available in Hungarian, English and German.

In regards of the tracking of people and vehicles **I examined** the legal issues related to data protection, personal data, special personal data, and based on the obtained results **I drew conclusions**, then based on these conclusions **I made suggestions** for the possible application procedures.

With mathematical and modern **network-analysis methods** I examined the dependency and information connection system of the infantry battalion. With **inductive**

¹³ Combat Identification

¹⁴ Identification Friend or Foe

(Csermely induction) and **deductive** (proving the modular scale-free according to the Barabási-Albert criteria) proving procedures, measurements, and **mathematical methods** I proved that the infantry battalion's dependency and information connection network shows scale-free features. For solving the problem I used mathematical methods such as discrete mathematics, theory of graphs, fractals, mathematical labelling.

I performed **experiments, measurements** with the global satellite-based navigational receiving equipment, simulation software from the results of which I drew conclusions.

I analysed the components of the global satellite-based navigational systems and by synthesising this information I made suggestions for the receiving equipment that assures geo-location data of the automated force tracking that are able to cover the wide spectrum of the governmental utilisation needs.

I consulted, carried out in-depth interviews with the Hungarian and international representatives of the telecommunication, IT, communication, legal, medical and mathematical areas that concern the partitions of my research.

Based on my knowledge gained in an international environment **I analysed** the force tracking partial elements of the warfare systems and I processed the practical experience.

SHORT DISCRPTION OF THE COMPLETED EXAMINATION

Based on the international literature in the **first** chapter I performed the terminology related to the force tracking then based on the related results I organised it. Although I proved my (H1) hypothesis but this can't be considered a new scientific achievement since the related information can be obtained easily by evaluating the related literature. But the work of organising the terminology was indispensable to establish a solid notion background for the thesis. With my researching colleagues I defined the notion of force tracking which in this format means a novel approach, and I don't consider it as a stand-alone scientific achievement.

Hungary possesses partly the legal background that is required to implement a force tracking system with defence objectives. I achieved my set research goals, I proved that the military person- and vehicle tracking is a legitimate act, but in regards of handling the data obtained during the force tracking (mostly the personal and special data) the law needs to be clarified. During the research I proved that during the elaboration of the technical requirements of the force tracking systems it is worth establishing them in such a way that the soldier's special data don't get corrupted and they are available for the proper staff only (in our case meaning the health professionals), in this way complying with the strict legal

environment. I made suggestions on erecting a work-group that encompasses several professional areas which performs the further examinations according to a complex system of criteria (legal – technical – IT) and based on this it elaborates solutions for the law-makers.

I found also that if there are not sufficient available devices, the missing sources could be involved from the national economy according to the law in force. It is worth mentioning that this requires serious preliminary coordination because the accurate legal background is not sufficient, the records referred therein need to be filled with the required information then they should be updated.

I used mathematical methods to analyse the dependency connection system of an infantry battalion. As a result of the performed measurements-calculations I found that the network has modular scale-free characteristics. After studying the literature I summarised the characteristics of the scale-free networks and showed the vulnerability of the examined network. During my research I found similar elements in the dependency system that are fractal-like formations. These research results are easing the possibility of computerised modelling and the understanding of the robustness and vulnerability of the network in the network centric and entropy-based warfare space.

I used mathematical methods to analyse the information connection system of an infantry battalion and I was looking for scale-free networks and fractal characteristics. I found that the examined network is modular and scale-free, and based on the dynamism presented by me the real network becomes scale-free. In the information connection system of the infantry battalion I found Granovetter groups which refers to the signs of modern work scheduling.

Analysing the communications systems that can be used by the infantry battalion, as well as the mathematics-based reasons of their success, I made suggestions for solutions that improve the possibility of information exchange.

Although I did not set as a research objective, and did not treat it as a hypothesis, but as the result of my analysing and synthesising work and originating from my basic research objective I interpreted the interdisciplinary environment of force tracking, I identified the influencing factors. I showed how the change of warfare, the renewal of the information technologies of exponential dynamism, the regulating environment, our alliance system, the economic and political opportunities, respectively the leadership-control approaches can influence the requirements set toward the force tracking systems.

In the **second chapter** – among others – I presented the force tracking possibilities based on the communication channels of the modern digital tactical radio devices and operational modes found at certain units respectively complexes of the Hungarian Defense Forces as well as their practical realisation. Integrated into a network these devices are able to share situational awareness (primarily geo-location data) with each other and they can integrate them into systems of higher level.

I analysed the structure of the geo-location (position-reporting) messages based on the NATO standards, I found that because of the permitting feature of the regulatory environment the connectivity of the various systems has been causing and is still causing serious problems.

As a result of my research it can be stated that for the environmental impacts experienced in the short wave range the third-generation Automatic Link Establishment (ALE 3G) operational mode still offers a satisfactory solution by being able to assure in parallel the digital data-communication and speech connection. Through the small formal messages available in the system one can automate the distribution of the position, and through this providing significant time windows for the users to share other information, too. By integrating the data collected from the member states into systems of higher level it is easier to establish the common operational picture whose existence is definitely required to apply the modern warfare methods – either in case of national or international operations. Thus the forming of these functions requires special attention when developing the technical subsystem of the leadership system of the Hungarian Defense Forces.

I presented the general structure of the Global Navigational Satellite Systems from among which I detailed the American NAVSTAR GPS system. In my analysis I dealt with the satellite constellation, the signal-structure emitted by the satellites with navigational purpose and the reception possibilities of the open and encrypted channels, and with the various sources available in the Internet (with the tracking systems and emulation software) I performed experiments and I modelled the GNSS services available above my standpoint.

It can be stated that for meeting the navigational needs of the fleet- and force tracking systems – instead of using the purely GPS-based system – the suitable solution would be a GNSS receiver that provides several services in an integrated way, and I am detailing this in the subsequent chapter.

I presented the technical bases of the TETRA AVL, its operational environment and through successful foreign examples I drafted a possible development direction and the aspects of the military applicability.

I summarised and evaluated the knowledge and application experience available about the force tracking systems (FBCB2 BFT, IFTS, KFTS) used also by me in the NATO operations.

Based on my research performed in the **third** chapter it is reasonable to pay more attention to the collection of the geo-location data and situational awareness during the current development of the communication systems of the Hungarian Defense Forces and it is required to establish the possibility of forwarding these into the Hungarian military respectively NATO's data-fusion systems. I have set up two acting options to establish this capacity.

Through the pattern networks I presented the steps of collecting the geo-location information and I stressed the significance of using the MIP standards in the area of publishing the information into external systems.

In my research work I comprehensively presented the global satellite-based navigational systems and the possible risks that endanger their use. I performed simulations and primer measurements with my own reception equipment in order to study the GNSS services. I found that in regards of the GNSS systems that support the Hungarian fleet- and force tracking systems of public purpose it is reasonable to establish and use the NMEA 0183 protocol in order to make use of the wide interoperability possibilities.

Based on my research I made suggestions on the development an application of multilevel navigational GNSS reception equipment. These development ideas could be good examples for the allied countries that have similar economic-military potential.

I made suggestions in regards of the utilisation of the balloons of low and mid-altitude within the Hungarian Defense Forces CIS system.

I presented one possibility of perspective developing the EDR (Hungarian TETRA) system.

I made suggestion regarding the possibilities of using the WBAN networks in connection with the sharing of the force tracking data, with special regard to the possibility of integration of the data supplied by the individual health-status checking and reporting system.

Based on the revealed connections, partial conclusions, the results of the experiments and measurements and my empirical experience I organised my knowledge then – by taking into consideration the national characteristics – I made suggestions about the implementation of the automated force tracking capacity in the national military CIS system.

SUMMARY OF THE CONCLUSIONS

Based on my research work I performed a comprehensive clarification of the terminology. In my analysis **I showed** that nowadays the automated force tracking capacity can be defined more as an integrated module of a command and control, battle management system, as its layer, and simultaneously it is its necessary and indispensable element, and it is used exclusively less as a fleet- or force tracking system. Although I proved my H1 hypothesis, I do not consider this result as a stand-alone new scientific result.

I found that the personal and vehicle tracking is lawful, but the law needs clarification, and the geo-location and reporting systems of civil purpose can be involved for military purposes from the national economy during special legal periods. (H2; H3)

I used network-analysing methods to **analyse** the dependency and information connection system of an infantry battalion, looking for scale-free network and fractal characteristics. **I found** that the analysed networks are modular scale-free and based on a dynamism presented by me the actual network becomes scale-free. In the information connection system of the infantry battalion **I found** Granovetter groups which is hinting to the modern work scheduling. During my research I **analysed** similar elements in the dependency system that show fractal-like characteristics. (H4)

In my analysis I showed that instead of the GPS-based reception systems used to obtain the geo-local data it is recommended to use the GNSS systems that use the data of the multi-global satellite-based navigational system. **I made suggestions** for the solutions based on global satellite-based navigational systems that are capable to assure the geo-local information for the fleet- and force tracking systems that support the public service. For the practical realisation I made suggestions for the realisation of the geo-location devices that are able to receive and process the encrypted signals of the GPS and GALILEO systems that are adjusted to certain user needs of certain levels. (H5)

In my summarising analysis **I showed** that one of the bottlenecks of sharing the force tracking data consists of the transmission capacity of the wireless interface between the terminals and the reception points of the carrying networks. By the simultaneous application of several systems and by using the possibilities offered by the solutions with various architectures this problem can be remedied partly. (H6)

Based on the results of my scientific research **I made suggestions** for the TETRA AVL and APL frame system of the Hungarian TETRA system (after the required enhancements) to become one of the pillars of the Hungarian automated force tracking capacity which in peaceful periods and during the operations below the threshold can assure

the governmental organs' critical communication and information needs up to the destruction of the infrastructure. Respectively **I showed** why the Hungarian TETRA system should be improved for a more modern TETRA LTE system. (H7).

This would be supplemented – as a second pillar – by the force tracking services that can aim to share the situational awareness – besides the already existing sound and data supplying services – that can be established along the special operational modes of the modern digital tactical radio systems that are used in the Hungarian Defense Forces and organised into a perspective applicable network. In addition the international examples and recommendations can't be transposed in full during the realisation of a national automated force tracking capacity, it needs to be adjusted to the Hungarian needs. (H6)

I found that for Hungary the utilisation of the tethered balloons of a low altitude (30-300 m) and medium altitude (300 m – 5 km) would mean a possible alternative for Hungary which would simultaneously have ISR platforms and communication relay points. The relays of the tethered balloons of low and medium altitude could serve as an alternative (reserve) solution for the wireless communication needs of the force tracking systems' terminal – network relationship. (H9)

I made suggestions in connection with the perspective utilisation of the WBAN networks in regards of the sharing of the force tracking data with special regard to the possibility of integration (fusion) of the data supplied by the individual health and status-checking system. (H10)

By examining the issue of interoperability I revealed the technical possibilities of cooperation with the NATO alliance systems and I processed the related standards, international regulators and de facto procedures. In addition I made suggestion for getting connected to the MIP community, and simultaneously to implement the recommendations drafted in the MIP interoperability program. (H8)

In my scientific thesis I showed that Hungary needs to establish an automated force tracking capacity. **I specified** a possible method of the perspectival national development.

NEW SCIENTIFIC RESULTS

T 1. **I defined** the group of interdisciplinary factors that directly influence the force tracking's environment through which – by evaluating and handling them in a complex way – it is possible to establish the efficient Hungarian force tracking capacity. Within this I explored the group of legal anomalies whose untying is indispensable to establish

- the legal environment of the contraction-free Hungarian automated force tracking. (H2; H3)
- T 2. **I have proved** that the dependency and information connection system of the infantry battalion is modular scale-free network, and based on the dynamism presented by me the actual network becomes scale-free. In the information connection system of the infantry battalion I identified Granovetter groups, and in the dependency system I analysed self-similar elements that show fractal-like characteristics. These new results make it possible to design telecommunication networks and systems that are efficiently capable to serve the Hungarian Defense Forces' command and control system and force tracking needs. (H4)
- T 3. **I elaborated** the concept of a group of devices based on geo-locating services supplied by the various global navigational satellite systems which – by being adjusted to the needs of the public service organisations – can safely and with high availability assure the accurate geo-location information for the fleet- and force tracking systems. (H5)
- T 4. **I proved** that – mostly in the periods related to the managing of the disaster situations or in other situations falling under the special legal system – it is an alternative for Hungary to use the tethered balloons of low and medium altitude. These – besides the reconnaissance-supporting platforms – are suitable to carry relays which – in case of the damaging of the terrestrial infrastructure – are able to assure the required communications channels for the operating organisations respectively the connections required for the operation of their fleet- and force tracking systems. (H9)
- T 5. **I elaborated** the complex system of the national automated force tracking capacity lying on three pillars – as Hungarian TETRA system, the various tactical radio systems and the communication platforms assured by the satellite-based systems – which besides the geo-location information supports the headquarters decisions in order to establish the leadership superiority with the possibility of the automated and structured sharing of the status information related to the people's and assets' warfare value and readiness to fight. (H6; H7; H8; H10)
- T 6. **I defined** the group of the parameters related to the troops' momentary health condition that can be monitored with non-invasive methods through the sensor-systems integrated into the personal equipment. Then **I elaborated** the logical structure of the Zigbee-based WBAN sensor-network system which is able to serve the communication needs of the elements of a health condition checking and reporting system and assures

the possibility of forwarding the provided information into the data-transmission channels of the force tracking systems. (H10)

APPLICABILITY OF THE RESEARCH RESULTS

I suggest processing my thesis and research results at the various commanding levels of the Ministry of Defence and the Hungarian Defense Forces for the professionals dealing with the realisation of the battle management and force tracking systems, the realisation of the national force tracking capacity system and for the elaboration groups.

Based on the conclusions drawn in the various chapters my thesis may be the base of further scientific examinations and research.

Some areas of my scientific research may serve as source for the national defence industry's pre-competitive research.

I suggest reviewing my summarising work in regards of force tracking at the National University of Public Services Faculty of Military Sciences and Army Officers.

My thesis can be used for the Bsc, Msc, PhD courses of the National University of Public Services Faculty of Military Sciences and Army Officers, as source for the researches and as the recommended literature for the related subjects.

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SCIENTIFIC CURRICULUM VITAE OF THE DOCTORAL CANDIDATE

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Work experiences:

- From 2009 various IT positions in Hungarian Defense Forces
- 2011-2012 HUN PRT Afghanistan (NATO - ISAF), IT officer
- 2015 HUN KFOR Kosovo (NATO - KFOR), Chief of HUN CIS section

Studies:

- 2013-National University of Public Service- Doctoral School of Military Engineering
- 2010-2013 National University of Public Service, Safety Engineer (Master Degree)
- 2009 Miklós Zrínyi Defense University, electrical engineer (Bachelor Degree)
- 2005-2009 Miklós Zrínyi Defense University, military and safety engineer, signal specialization (Bachelor Degree)

Language proficiency:

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Academic activity:

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- Scholarships:
 - National Talent Program, Nation's Young Talent Scholarship 2016
 - National Talent Program, Nation's Young Talent Scholarship 2017
 - New National Excellence Program of the Ministry of Human Capacities 2018 - Scholarship
- 2014-2015 Secretary of Science Section, HDF 25/88. Light Mixed Battalion
- Alliance of Hungarian PhD Aspirants, Military Sciences Section, member
- Hungarian Academic Society of Military Sciences, Electronic, IT, and Robotic Section, member
- 2008-2013 Student Association of Modern Military Communication Information Systems, member
- 2008-2009 Miklós Zrínyi National Defense University, János Bolyai Military Technical Faculty, Scientific Student Council, member
- Conferences:
 - Szolnok Conference on Aviation Science 2017
 - Kommunikáció 2018, international scientific conference
 - A Tudomány Kapujában poster conference 2014,2017,2018
 - A Haza Szolgálatában, PhD aspirant conference NUPS, 2014, 2018
 - Tavaszi Szél 2019, PhD aspirant conference
 - A biztonság és védelem kultúrája 2013. conference Gödöllő