I. Introduction

Since 1991 Lithuania has moved rapidly to modernise and improve civil and military communications, navigation, surveillance, and Air Traffic Management (ATM) equipment and systems. On the military side, progress has been significantly slower, constrained by limited budgets and deliberations over ATM alternatives and their impacts on cockpit equipment. An important problem is the incompatibility between civil and military systems, which restricts military operations and impacts training. Another significant problem that must be addressed is compatibility with ICAO¹, and NATO systems and procedures.

In October 2000 a new Law on Aviation was adopted in Lithuania. According to it, “the Government is responsible for efficient organisation, assignment and management of Lithuanian airspace, in order to achieve effective use of airspace by civilian aircraft considering airspace needs for national security of Lithuania.”² However, the responsibilities concerning development of communications, navigation, surveillance, and ATM equipment and systems, have to be assigned for both the Civil Aviation Administration (CAA) as a civil authority and the Ministry of Defence as a military authority as well. Such an idea brings in the requirements for interdependence and close co-operation between these two authorities in regard to airspace management in peacetime and especially in times of crisis and war.

The purpose of this article is to analyse the Lithuanian Airspace Management system in order to determine its adequacy in time of crisis and war and to recommend its further development.

The increased demand for airspace use from all airspace user groups³ is expected to continue. The existing ATM system in Lithuania is unlikely to cope with this demand. One of the main areas for change

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concerns the organization and use of airspace. A major obstacle to produce more airspace capacity is that the effective use of Lithuanian airspace has not been optimised to date. The requirements of all airspace user groups and ATM providers are the main driving forces in further development of airspace management strategy, which shall be oriented towards optimizing and simplifying the airspace structure. Furthermore, future national ATM strategies cannot realistically be developed in isolation, as each individual state is an integral element of the European ATM system.

From the ICAO approach, ATM consists of three functions:

• Air Traffic Control (ATC), which is responsible for sufficient separation between aircraft in the air and between aircraft and the ground, to avoid collisions, while ensuring a proper flow of traffic.

• Air Traffic Flow Management (ATFM), which regulates the flow of aircraft as efficiently as possible to avoid the congestion at certain control sectors.

• Airspace Management (ASM), which assigns airspace efficiently to its main users (civil and military).

Thus, in order to analyse Lithuanian Airspace Management we have to answer the question what Airspace Management System has to be developed to ensure a proper flow of traffic and national security in Lithuanian airspace in times of crisis and war.

This article does not explain the ICAO or NATO requirements, standards and procedures in detail because of limitations in size of the article. However, all necessary references to original documents are provided. Moreover, this article does not include any assessments in terms of the financial costs required, as it suggests possible solutions but not an implementation plan.

II. Legislation and responsibilities of the authorities

The objective of ASM is to achieve the most efficient use of airspace based on actual needs. A proper design of airspace structures and assignment of airspace requires close co-operation between all airspace users. From the military point of view, the efficient design, assignment and control of airspace have a decisive impact on airspace surveillance, detection of aircraft and defence of sovereignty of the country. In order to fulfil this mission, military forces require freedom of action for their assets in the air to conduct proper training in peacetime. This freedom is especially essential in time of crisis and war.

This chapter provides general information about the airspace use concept implemented by most of the European countries, including the current Lithuania’s airspace design and the ASM system. Furthermore, it provides an analysis of what authority shall have responsibility for the air traffic control in Lithuania in time of peace, crisis and war, and what are the Lithuanian Armed Forces’ demands on ATC.

Flexible use of airspace

The document “The Concept of the Flexible Use of Airspace” (the FUA Con-
cept) has been developed by the EUROCONTROL for the European Air Traffic Control Harmonisation and Integration Programme (EATCHIP Project Board and the NATO Committee for European Airspace Co-ordination (CEAC). In June 1994 the FUA document was endorsed by the 4th Meeting of the European Ministers of Transport.

The basis for the FUA Concept is that “airspace should no longer be designated as either military or civil airspace but should be considered as one continuum and used flexibly on a day-to-day basis. Consequently, any necessary airspace segregation should be only of a temporary nature...” It is of importance that the application of the FUA Concept is advantageous for both civil and military airspace users, because it will lead to an increase in ATC capacity, more efficient ways to separate Operational and General Air Traffics (OAT/GAT), improved real-time civil-military co-ordination and a significant reduction in airspace segregation needs as well as the use of Temporary Segregated Areas (TSA) being brought more closely into line with the military operational requirements.

**Airspace structure**

According to the ICAO definition, controlled airspace is divided into four different parts: Control Zone (CTR), Terminal Area (TMA), Control Area (CTA) and Temporary Segregated Area (TSA).

The FUA Concept provides that normally both the civil and military airspace users have access to CTR, TMA and CTA. In principle the ICAO standards, such as separation minima, required equipment, flight safety requirements etc., apply to all traffic. Any other national standards can be established via the Law on Aviation and published in the Aeronautical Information Publication (AIP). Furthermore, in the integrated ASM system the Regulator of military aviation can, through the Regulator of civil aviation, establish national standards for military ATC.

TSAs are established for activities of a temporary nature, which need specific protection. Normally they are used for military air combat exercises and military flight training. The military Regulator is responsible for establishing the rules and standards for military flights within a TSA. Officers in the Air Force (Fighter Controllers) normally control flights within a TSA. An important consideration has to be given to flight safety standards on separation between flights within and flights outside a TSA.

**Assigning airspace**

According to the FUA Concept, a national order for assigning airspace has to be established. This order must be in accordance with law (Law on Aviation). In order to reassess a national airspace, to establish new flexible airspace structures and to introduce the procedures for the allocation of these airspace structures on day-by-day basis, a high-level National Airspace Policy Body with representatives from the civil and military authorities should be established. The high-level civil/military national body “formulates the national ASM policy and carries out the necessary strategic planning work, taking
into account national and international airspace users requirements. Other airspace users (e.g. firing ranges) must have guaranteed influence on the airspace structure. For that purpose they shall be called as members of the national airspace policy body when issues within their field of interests are decided.

For the daily allocation and promulgation of the flexible airspace structures and for communication of the airspace status to the EUROCONTROL (a so-called Centralised Airspace Data Function (CADF)), a national Airspace Management Cell (AMC) should be established. Authorisation, responsibilities for manning and relevant instructions must be issued and described in such a manner, that the decision-making levels can be identified easily by every responsible authority, and in a manner, that can guarantee levels of influence for both the military and civil airspace users.

**Fighter control**

Not being part of the ATM system, a fighter control system normally is established for controlling military aircraft during the intercept missions and tactical training flight exercises in peacetime and for the air combat missions in wartime.

A typical scenario for a military training flight in the integrated ATM system can be described as follows: a military aircraft is departing from a military airbase for a mission and is first handled by the ATC of this particular airbase. When leaving the Terminal Area (TMA), the flight is handed over to the Area Control Centre (ACC) for the en-route phase of the flight. When the flight reaches the TSA allocated for the mission, the aircraft is handed over to a fighter controller (located in the Combined Air Operations Centre (CAOC)) who will be controlling the exercise within the TSA. During this phase of the mission there is a close cooperation between the ACC and the fighter controller in the CAOC regarding information on flight safety issues. Finally, when the exercise is completed, the aircraft is handed over to the ACC for the flight back to a base and, having reached the TMA, handed over to the ATC of that specific airbase for landing.

In air policing scenario, when a military aircraft is conducting the mission to identify and/or take other actions towards an unknown aircraft, the flight can be handed over to the fighter controller at an earlier stage in order to conduct the interception in an optimal way. By close co-operation between the ACC and/or the ATC of the airbase and the fighter controller in the CAOC, flight safety standards will be maintained during all phases of the flight.

**Current situation in Lithuania**

The present Lithuanian ASM system is designed in accordance with two main legal acts - The Law on Aviation of Lithuania from 17 October 2000 and The Decree of the Government of the Republic of Lithuania on the approval of the Air Space Structure of the Republic of Lithuania from 22 January 1997. All relevant information as well as other regulations and requirements of air navigation are
According to the Aeronautical Information Publication, the Lithuanian Airspace Structure includes Controlled Airspace, Air Traffic Services (ATS) Route, Danger Area (D), Restricted Area (R) and Prohibited Area (P). The Controlled Airspace or ATS Airspace, respectively, includes CTA, TMA and CTR. ATS airspaces are classified as Class A to G.

Airspace restrictions - D, R, and P Areas - are mainly related to various military activities in peacetime, therefore a proper design and use of them are very important. However, there are some inaccuracies and areas to be changed in the structure. For example, the military airfield in Kazlų Rūda was closed in 2001, but restricted areas (R) related to it still exist, as well as several D areas above the firing grounds, which are not in use anymore. At the same time, the main Air Force base in Šiauliai has only one small R area to conduct military flight training. These simple examples show that the Airspace Structure has to be reviewed and all necessary changes have to be done in co-operation between civil and military airspace users.

Concerning responsibilities of the authorities for ASM, which are stated in the above-mentioned legal acts as well, the Lithuanian aviation sector system is based on the conceptual structure of a Regulator, Provider and Supervisor. In such a structure the Regulator is responsible for setting standards and regulations, the Provider’s task is to serve the customer in accordance with standards and regulations set by the Regulator and the Supervisor has to monitor that the Provider applies standards and regulations set by the Regulator. According to the Law on Aviation of Lithuania, the CAA under the Ministry of Transport is the Regulator and Supervisor for civil aviation, while the governmental enterprise “Air Navigation Services” is the Provider. The Ministry of National Defence plays the role of a Regulator, Provider and Supervisor for military aviation, however the “Air Navigation Services” usually provide support for the military users in peacetime as well. The main problem to be solved is that at present time, due to the Lithuanian aviation sector’s size and available resources as well as the already established structure, the involved authorities are not able to fully carry out their responsibilities.

Regarding the above-mentioned problem, there is a need for improvements and reorganisations in the Lithuanian ASM system. It is necessary to mention here that in order to achieve the more efficient use of airspace by both the civil and military users and to increase the capacity of the air traffic, the Lithuanian ASM system is under continuous development and modernization in close co-operation between responsible civil and military authorities. The latest results of the co-
operation show that one of solutions is a development of an Integrated Civil/Military Airspace Management System in Lithuania. The integrated system shall, wherever relevant, be based on the EATCHIP “Concept of the Flexible Use of Airspace”.

**A responsible air traffic control (ATC) authority in Lithuania in peacetime, crisis and war**

Efficient Airspace Management (ASM) is essential for successful and safe tactical missions during different levels of raised alert or war situations. For that reason it is necessary to decide how the overall responsibility for providing ATC shall be distributed during various alert or war situations. It is of importance that a transfer point is defined and stated in a law similar to other laws entering into force under such circumstances. The responsibilities should be regulated via legislation and agreements through the high-level civil/military national airspace policy body. By doing so, the transfer is automatic and guarantees the uninterrupted functioning of the ASM system during all the above-mentioned phases. Preparation and planning must be made by the Airspace Management Cell (AMC) and other responsible authorities in peacetime to ensure that ASM continues during crises and can be adapted to a possible war situation. Good examples for such a preparation are military war planning, training for special war tasks and development of special equipment and procedures for military purposes. The Lithuanian Armed Forces would set the tactical demands, however the CAA shall conduct some of these preparation tasks, the remaining tasks being responsibility of the Lithuanian Air Force. A system, which ensures necessary military influence and division of responsibilities between the authorities, should be established via agreements at different levels.

**Responsibility transfer system**

In order to achieve the above-mentioned objective, a system, in which the responsibility during crisis and war is transferred to the Lithuanian Armed Forces, has to be established. This approach will ensure a strong influence by the Lithuanian Armed Forces upon ASM, thus meeting all requirements for national security. The Government should define subordination structure during raised alert or under war conditions through its decrees. Any other details of such situations should be regulated by various inter-agency agreements.

The effect of transferring responsibility is that the Air Traffic Management (ATM) elements and services would cease to exist as a part of the civil structure. Equipment and facilities would be transferred to the military structure, and civilian employees would become subordinated to the military staff. ATM would continue uninterruptedly in the same manner as before the transfer and there would be no necessity to replace either the employees or equipment. The ATC’s function at military airbases would continue providing services to both the military and civil customers under control of the Lithuanian Armed Forces, while concurrently the ATC units not located at
the military airbases would continue providing services to all aviation under subordination of the Lithuanian Armed Forces as well.

Since the system of transferring responsibility is usually prepared in advance and interacts with similar laws for war situations, the transfer would be automatic and not affecting the services provided to either military or civil aviation.

**Areas for agreements and contracts**

With the system of transferring responsibility the ATM elements, such as equipment and facilities, and service providing employees would become a part of the Lithuanian Armed Forces after the transfer and would be subordinated to the Lithuanian Air Force. In this case there are a number of areas, which need to be regulated through different agreements and contracts between the above-mentioned parties.

Examples of such areas are:

- Financial agreements between the Ministry of National Defence and the Ministry of Transport for distribution of costs for investments in training, necessary infrastructure and procurement of equipment according to the special demands set by the Lithuanian Armed Forces. Those agreements will be based on the principle that the Ministry of National Defence accepts to share or compensate costs for the special services, equipment, buildings and facilities necessary for the military purposes.

- Establishment of a system where the air traffic controllers at military facilities can fulfil specific military duties. If the air traffic controllers are to be transferred to serve in the Lithuanian Armed Forces, probably a reservists system should be established for that purpose. Additional costs for exercise and training of the reservists should be part of the financial agreements between the Ministry of National Defence and the Ministry of Transport.

- Establishment of working procedures between different relevant organisations to ensure an uninterrupted transition from peacetime to a war situation.

- Establishment of an organisation, or assigning of a part of an already existing organisation within the Lithuanian Armed Forces, to hold responsibility of preparing for the wartime ATM duties.

**Demands of the Lithuanian Armed Forces on air traffic management**

An integrated ATM system is designed to give civil and military aviation an integrated access to controlled airspace during raised alert and war. At the same time, it ensures tactical freedom for defence aviation flights during exercises, for incident readiness flights and in wartime. Different parts of the aviation sector interact with each other in accordance with the same principles in peacetime as well as during raised alert and war. To ensure an uninterrupted and well-functioning ATM system during raised alert, when the CAA is maintaining responsibility, as well as during war, when responsibility is transferred to the Lithuanian Armed Forces, a Regulation on ATM for war should be
established. This regulation should cover a number of different areas during the two different phases and include items such as readiness, airspace organization and classification, and ATM organization.

It is important that the Lithuanian Air Force should have an incident readiness at all times. Moreover, the ATM personnel at airbases have to be a part of this readiness as well. If the Government raises alert for whatever the reason, the ATM personnel shall remain employees of the CAA until the transferring point. During this phase, orders concerning ATM should be passed from the Lithuanian Armed Forces to them for execution. After the transferring point the ATM personnel will become employees of the Lithuanian Armed Forces or conscripts. The important consideration here is that the CAA has to be ready to take back the responsibility when alert level is decreased or war is terminated. If the State authorities have not declared a state of war, but there is war de facto, it should be considered as an automatic state of war. In such a situation, the responsibility for ATM

has to be immediately transferred to the Lithuanian Armed Forces, and the ATM personnel shall act in accordance with what has been planned in advance.

The airspace organisation has to ensure the priority to and safety of combat flights. In wartime, a priority to combat flights is an imperative, however it can also be given to important civil transportation flights on defence missions. Airspace classification definitions in accordance with the AIP are valid through all phases of raised alert and war, therefore any changes of airspace classification have to be planned by the Airspace Management Cell, in close co-operation between the Lithuanian Armed Forces and the CAA. The planning and implementation of changes to airspace classification has to be done taking into account the Land Force and Navy air defence assets as well.

The ATM organisation has to be able to provide professional services adapted to the requirements of the Lithuanian Armed Forces for civil and military aviation as well as a number of special tasks. Those tasks mean duties of partly or totally different nature where special skills of the ATM personnel are useful to the defence. The purpose is to ensure required quality, flexibility and continuity of command and control at fighter control units, airbases, headquarters, Area Control Centre (ACC) and Combined Air Operations Centre (CAOC). Another important task is a co-ordination with air defence units to ensure their ability to perform their duties and prevent accidental fire at friendly aircraft. Those tasks require an ATM organisation that is properly equipped and trained. At wartime all flights shall have the best possible service as long as possible. Therefore peacetime investments have to be adapted whenever possible to wartime demands as well as planning and development have to secure the ability to adapt to war. Moreover, recruitment and training of personnel have to meet the necessary military requirements and, in order to have an efficient military organisation, the ATM personnel shall be prepared to fulfil not only their professional duties but also other, defence related ones, as well.
Wartime airspace management considerations

Modern warfare is characterised by the fact that all military forces become airspace users either to a full or certain extent. This leads to a high level of complexity of ASM not only in peacetime but also especially in times of crisis and war. The examples of combat operations when aircraft are engaged by their own air defences or inadvertently damaged by friendly fire prove this fact. In order to minimise the risks of losing air assets being engaged by friendly fire on the one hand and to maximise their freedom of action in combat on the other hand, special measures have to be taken. These measures are known as Airspace Control (ASC). “The objective of ASC is to maximise the effectiveness of military operations by promoting the ability of air, land, and maritime forces to operate in efficient, integrated and flexible manner with minimum mutual interference and without undue restraint and risk to friendly forces and neutral air. ASC provides a commander with the operational flexibility to effectively employ forces...”

The keystone document for ASC is NATO ATP-40(B) “Doctrine for Airspace Control in Times of Crisis and War”. The doctrine is designed for all NATO forces as well as PfP nation’s forces. Therefore, the suggested Lithuanian regulation on wartime ATM, which was discussed in the previous chapter, should be designed in accordance with the requirements of this doctrine. The following is not a detailed description of the doctrine, but a summary of the main principles and areas covered by the document.

Airspace control authority

The doctrine provides a command structure for all kind of military operations, chain of command as well as clear responsibilities of each commander. The most important principle for command and control is that one commander - Airspace Control Authority (ACA) should be designated for each area of operations and should assume overall responsibility for ASC in the area. The ACA is to plan, coordinate and organise the Airspace Control System (ACS) and to be responsible for its operation in order to support the higher commander’s campaign objectives. All other commanders are to integrate all their weapon systems within the Airspace Control Plan (ACP), which has to be approved by ACA.

Planning of the airspace control system

In order to reach the effective ASC during the military operations the requirements of all commanders should be considered during the ASC planning process. Therefore, “each commander who operates aerial vehicles, weapons systems or electronic means to perform his assigned mission within the ASC-Area, must participate in planning the use of that airspace...” Furthermore, the requirements for civilian aircraft flights and any other host nation military and civil aviation impacts must be taken into account. The results of the ASC planning must be implemented into ACP. The ACP will list
the responsibilities of the authorities, rules of engagement (ROE), instructions and any specified procedures for ASC, and will detail the boundaries of the ASC-Area and any sub-areas. Finally, the ACA will implement the ACP by issuing the Airspace Control Orders (ACO), which by their character may be standing or based on the threat, operations tempo or other planning factors.

Structure and methods of the airspace control

All airspace users and their controlling elements should possess interoperable communications, information systems and equipment to fulfil their duties in the ACS. The whole of airspace control facilities, communications and automation capabilities, surveillance and identification resources, and procedures is known as Airspace Control Means (ACM). The ACA is responsible to select, in coordination with subordinate commanders, those ACM, which are most suitable for the ASC-Area and accomplishment of the mission. He may, where necessary, identify additional means as well.

As mentioned before, in order to maximise operational effectiveness, friendly air assets must be able to operate with a minimum risk of engagement by own air defences. Furthermore, those air defences must be able to identify friendly air assets in order to engage the hostile ones. To achieve these aims, the operational commander must ensure that an appropriate system of ASC exists. Two main methods are used for exercising ASC - positive ASC and procedural ASC. The positive method relies on positive identification and control of an aircraft by electronic means, while procedural relies on a combination of previously agreed orders and procedures. Operational situations, however, in general could demand a mixture of those two methods. It is of importance that, when the control of an aircraft is transferred between two control authorities in combat, the responsibility assuming authority must positively identify the aircraft as friendly.

Conclusion

As it is mentioned in this chapter there are some indicators that the present Lithuanian ASM system has to be modernised and developed in order to achieve more efficient use of airspace by both civilian and military users. The most adequate solution is to develop an integrated civil/military ASM system. This system shall, wherever relevant, be based on the EATCHIP “Concept of the Flexible Use of Airspace”.

In accordance with the FUA Concept, entire airspace is considered to be one continuum and is designated as both military and civil airspace. This approach is advantageous for both types of users, because the airspace is used flexibly on a day-by-day basis with necessary airspace segregation being of temporary nature only. Establishment of the TSAs, which should replace or modify, wherever possible, the D, P and R areas currently used in Lithuania, would bring the ASM system more closely into line with the mili-
Military operational requirements. Therefore a high-level national airspace policy body with representatives from the civil and military airspace authorities needs to be established. Furthermore, a National Airspace Management Cell needs to be set up to serve all users in the daily allocation of the airspace structures.

The main principle of an integrated ASM system is that the provider’s responsibility is given to one authority. This has to be regulated through the high-level civil/military national airspace policy body at different levels of raised alert and in war situations. Because responsible authorities are different in peacetime and wartime, it is of importance to establish a system of transferring the responsibility of ATM, which guarantees the uninterrupted provision of services during crisis and war. A transfer point has to be clearly defined by the Government and stated in a law coming into force under such a situation. The successful transfer requires close co-operation between civil and military authorities through agreements and contracts in legal, financial areas, areas of personnel training, establishment of facilities, procurement of systems and equipment, establishment of common regulations and procedures. Therefore, a regulation on wartime ATM, which shall cover readiness, airspace and ATM organization and other military demands, has to be produced.

In wartime, Lithuania must combine defence resources and means from various levels - national, regional, and multinational. That requires a close co-operation between all the participants. Thus the Lithuanian ASM system in times of crisis and war has to be developed in accordance with the NATO requirements for ASC, which are prescribed in NATO ATP-40 (B) “Doctrine for Airspace Control in Times of Crisis and War”.

III. Air surveillance

One of the top priorities for the Lithuanian Air Force is exercising control over Lithuanian airspace. Efficient air surveillance above all territory, territorial waters and at all altitudes of flights as well as military defence of the airspace have to be developed to fulfil this mission. The Air Surveillance is purely a military function and, as such, is not part of ATM. This function normally does not imply controlling air traffic but rather deals with identification and tracking of aircraft within the Area of Operations (AOO). The air surveillance in crisis or wartime is a mission for detection and identification of the aircraft, particularly the Identification of Friend or Foe (IFF).

The following chapter provides a general description of the requirements for the identification systems, which are used by the ICAO and NATO countries, as well as interrelations between them. The proper development of the identification capabilities of air defence assets and air surveillance systems is a crucial issue in terms of risk to friendly forces and neutral aircraft being engaged by own air defences or damaged by friendly fire.

Furthermore, this chapter provides a description of capabilities of the current Lithuanian Air Surveillance System and introduces a so far quite well developed
and still ongoing co-operation between all three Baltic countries in regional airspace surveillance – the BALTNET\textsuperscript{10}. The areas for improvement of the Air Surveillance System and the BALTNET are discussed in this chapter as well.

**The ICAO and NATO requirements for identification**

**ICAO Mode S**

The latest development and the ICAO requirement for identification systems is a Mode S capability. Mode S is a beacon system used for aircraft surveillance in terminal areas as well as for en-route traffic. It has several features that represent significant capability improvements (e.g. azimuth accuracy, separation of responses from two very close aircraft) over the current system. As it is a beacon system, there is a ground sensor transmitting interrogations to a special transponder, carried on an aircraft. The transponders formulate replies that are transmitted to the ground sensor. The Mode S system is compatible with the current Air Traffic Control Radar Beacon System (ATCRBS). The Mode S ground sensors periodically transmit ATCRBS Mode A identity and Mode C altitude interrogations and, vice versa, the Mode S transponders will respond to interrogations from the ATCRBS ground sensors. Mode C is a common civil/military mode that allows an aircraft to report its altimeter-reported altitude.

In previous years NATO saw no military requirement for Mode S procurement as a military IFF system. This view was taken, because Mode S is a civil ATS system that would not meet the military operational requirement for a question and answer component of the NATO Identification System. Specifically, Mode S is neither secure nor jam-resistant.

Nevertheless, NATO recognises that military aircraft and authorities will have to make use of Mode S for the following reasons: to enable the military to access/penetrate the civilian route structure or terminal control areas; to facilitate the safe coordination of military/civilian air traffic; to facilitate the use of civil airfields by military aircraft; to provide information to NATO Air Defence authorities that will aid compilation of the Recognised Air Picture (RAP); to be able to assume management and control of the civil ATM system in times of crisis.

NATO Mode S requirements are defined by STANAG\textsuperscript{11} 4193 “Technical Characteristics of IFF Mk XA and Mk XII Interrogators and Transponders” Part IV – Technical Characteristics of Mode S in Military Interrogators and Transponders. NATO recommendations can be summarised as follows:

- Tactical fixed and rotary wing aircraft that do not make regular use of controlled airspace are to be fitted to Mode S level 2 (Basic Surveillance functionality).
- Fixed and rotary wing aircraft that are regular users of the civil route structure are to be fitted to meet the requirements of ICAO Europe; these have yet to be finalized.
- Aircraft addresses should be easily changeable by ground crews prior to flight.
- Mode S transponders must be at least on-off selectable from the cockpit or ap-
appropriately aircrew station while in flight. Where technically feasible, aircrew should be able to control the Level of Mode S being transmitted from their aircraft to Level 2 Basic Surveillance functionality.

**NATO IFF**

NATO requires the use of compatible IFF systems in support of ATC and NATO Integrated Air Defence (NATINADS) operations. All aircraft participating in NATO operations and/or flying in NATO member airspace must be equipped with NATO-compatible IFF equipment. National air defence elements of NATINADS and military ATC systems must be equipped with appropriate IFF interrogator sets to interact with the airborne elements.

NATO requires IFF systems to support operations in modes 1, 2, 3 and 4. Technical characteristics of these modes are defined in STANAG 4193, Part I - General Description of the System. Modes 1 and 2 provide a non-encrypted, military-only identification of aircraft. Mode 3 corresponds to the civilian Mode A and is used in support of both military and civil ATC. Mode 4 is a crypto-secure mode of Mk XII IFF that is used to provide a high confidence, beyond visual range, identification of friendly aircraft to avoid misidentification. IFF systems may also support Mode C operations.

Mode 4 transponders can provide a valid reply only if they and the interrogator are properly keyed. Interrogator systems interface with a KIR-1C cryptographic computer. Transponder systems interface with a KIT-1C cryptographic computer. To insure the security of the encryption, the variables (keys) that are used in the encryption and decryption processes are changed daily.

For ATC purposes, the non-secure aircraft identification codes (modes 1, 2 and/or 3) should be included in the flight plan information (route, height, speed, time of arrival, etc.) provided to military and/or civilian ATC centres located across flight information region (FIR) boundaries. All ATC centres that will have responsibility for the flight need to know the relevant identity code. As the aircraft progresses along its journey, this information will allow the ATC centres to follow its flight through the FIR for which they are responsible and to hand it over to its neighbouring FIR.

NATO is developing a new IFF system, known as IFF Mode 5. All Mode 4 avionics will be updated when IFF Mode 5 is fielded. STANAG 4193 Mk XIIIA Parts V and VI define Mode 5 and the document has been released for ratification so far.

**Lithuanian air surveillance system and the BALTNET**

**Lithuanian air surveillance system**

Together with the development of the airborne part of identification capabilities, the ground-based part of the system has to be taken into account as well. The first step of such development is to reach the proper and efficient coverage of area by air surveillance sensors (radars). Currently, the military radars used are the radar types P-18, P-37, P-40, “Jawor” and “Korenj” as well as altimeters PRV-11 and PRV-16. These radars are deployed
throughout the country. The P-18 and P-37 medium range radars are used for medium and high altitude air surveillance. The P-18 radars have an extractor fitted that digitises the signal, while the P-37 radars have major system upgrades planned. As a result their digitised signals can be used within the BALTNET.

Against low (300 m above the ground level, AGL) flying aircraft the military radar sites in Lithuania provide good coverage over the western half of the country, but limited coverage in the east.

Lithuania has 3 primary civilian radars that are integrated with the military radars. At higher altitudes the radars provide continuous radar coverage over the entire country, but have limited radar coverage beyond the south-eastern border.

Information from the radars flows into the Airspace Control Centre (ACC) of the Lithuanian Airspace Surveillance and Control Command (ASCC) and the Regional Air Surveillance Coordination Centre (RASCC) of the BALTNET through a microwave communication and information network in real time.

**BALTNET**

The BALTNET project was conceived from the U.S. sponsored Regional Airspace Initiative (RAI) to the Central European countries. Officially, the RASCC was inaugurated on June 1, 2000. Since then, it has been serving the airspace surveillance for 24 hours per day. The BALTNET objective is to produce a Recognized Air Picture (RAP) over the Baltic states and their approaches and to communicate it to the national air surveillance centres in Estonia, Latvia and Lithuania, and, if needed, also to other states as may be agreed. It will allow the Baltic states to survey effectively and co-ordinate their sovereign air space and to ensure safety of the air traffic.

The BALTNET system consists of national air surveillance centres in Estonia, Latvia and Lithuania, an internationally staffed RASCC (the core of the system) in Karmėlava, near Kaunas, Lithuania as well as communication lines and air surveillance radars.

The BALTNET has been designed as a NATO-interoperable system. In the future it should be connected to the NATINADS as well as other early warning systems. The USA, Denmark, Norway and Poland have been actively supporting the project.

**Conclusion**

In order to reach control over Lithuanian airspace, an efficient air surveillance and defence systems have to be developed. ICAO and NATO requirements clearly outline the common civil/military interest in this area. NATO requires the use of compatible IFF systems in support of ATC and NATINADS operations. All aircraft participating in NATO-led operations must be equipped with NATO-compatible IFF equipment while air defence elements and military ATC systems must be equipped with appropriate IFF interrogators to interact with the airborne elements. The goal of taking such measures is to minimise the risks to the air assets from friendly fire while at the same time maximising freedom of action.

The current Lithuanian Air Surveillance and Control System provides a complete
coverage over Lithuania against aircraft flying at high altitudes, however significant parts of eastern Lithuania are left without coverage against aircraft at low-level altitude. Therefore further development of the system is required. An efficient system might be reached through modernisation of existing assets, procurement of new ones, as well as through enhanced cooperation with the civil ATM and the Navy by using their air surveillance assets as well.

Regional cooperation between the three Baltic states in order to improve air surveillance capability is extremely important to Lithuania. The BALTNET is a tool for developing regional security and national defence capability. The project is an example of a successful implementation of foreign military assistance and cooperation between the Baltic states, between the civil and military ASM, and between the Baltic states and NATO.

**IV. Air defence**

Air defence (AD) is defined by NATO as “all measures designed to nullify or reduce the effectiveness of hostile air action”\(^{12}\). As it was already mentioned, all military forces in modern warfare become airspace users either to a full or certain extent, which leads to high level of complexity of above-mentioned measures. Development and implementation of more sophisticated AD weapons is aimed at increasing defence effectiveness on the one hand, but, on the other hand, has raised the risk to neutral or friendly forces being engaged by their own air defences. Furthermore, air assets, both fixed and rotary wing, manned and unmanned, are not only at risk from the AD weapons aimed at them, but also from inadvertent contact with rounds from surface-to-surface weapons. Therefore, these systems should be regarded as additional users of airspace and should also be considered during airspace planning. It is essential that all users of the airspace are aware of these problems. As for the Lithuanian Armed Forces, which are at the very beginning of the development of its AD capability, it is of importance to consider proper design and management of the AD system.

The following chapter provides a description of active and passive AD methods as well as NATO requirements for the AD planning, employment of the AD assets, co-ordination and control of the AD missions in times of crisis and war. This chapter also covers several issues, which should be taken into consideration by the Lithuanian Armed Forces’ authorities, in order to develop the appropriate regulations for integrating current and planned air, naval and land AD assets.

**Air defence methods**

There are two main methods of air defence: active AD and passive AD. Active AD operations are conducted to detect, identify, intercept and destroy hostile airborne vehicles, which threaten friendly forces or installations. Passive AD includes all measures, other than active AD, taken to minimise the effectiveness of hostile air action.

**Active air defence**

Active AD is direct defensive action taken to nullify or reduce the effective-
ness of hostile air action. It is conducted using aircraft, AD weapons and missile systems, electronic warfare, ground-based or airborne surveillance systems, supported by secure and highly responsive communications. In peacetime, active AD involves continuous surveillance of country’s airspace and its approaches, lines of sea communications and hostile forces in order to provide early warning of attack and to deny enemy’s freedom to conduct reconnaissance and harassment missions over the sovereign territory. In wartime, active AD operations are conducted, together with offensive counter air operations, to achieve air superiority.

**Passive air defence**

During the war it is seldom possible to stop hostile air actions completely, but passive defence measures taken by all military forces will lessen the impact of such actions. These measures include dispersal, the use of protective constructions for personnel and material, Airfield Damage Repair (ADR) capability, tone-down and camouflage, physical and electronic deception, mobility of forces, emission control, monitoring for nuclear, biological, chemical (NBC) contamination and decontamination. All above-mentioned and any other possible measures are taken to provide the maximum protection for friendly assets and to complicate the enemy’s targeting process.

**Air defence planning, co-ordination and control**

It is of importance for all commanders of all forces to understand the complexity of the AD operations. “Air defence is conducted through the whole depth of airspace, within which other types of aircraft operate and missiles and guns are fired”\(^\text{13}\). Thus, in order to maximise efficiency and safety, the various AD weapon systems must not only be integrated with each other, but must also be fully co-ordinated with all other airspace users. The main principles and procedures are prescribed at NATO ATP-40(B) “Doctrine for Airspace Control in Times of Crisis and War”. The following is a general summary of NATO requirements for the AD operational considerations.

**Air defence planning**

Although the AD planning process is conducted in accordance with standard planning procedures at all levels of command, there are several specific areas to be taken into consideration. On the basis of air threat analysis, the adversary’s offensive capabilities as well as own resources and the geographical characteristics of the area, a commander should decide the structure and the type (area, point or self-defence) of AD. Here an early warning capability plays a vital role, because it defines reaction time available for own forces. The enemy should be detected as early as possible and engaged as far forward as possible. Therefore characteristics of the own AD weapons have to be taken into account. Hostile air targets may be engaged by aircraft or surface-to-air weapons (missiles or guns).

Aircraft, because of their flexibility and high mobility, can be used to protect very large areas or they can be concentrated
rapidly for point defence if required. On the other hand, aircraft may have limited employment since they cannot be re-armed, re-crewed or serviced in the air, except of an air-to-air refuelling (AAR) possibility. However, “no single weapons system can fulfil effectively all the requirements of air defence. Therefore, to meet the full range of the enemy air threat a balance of weapon types must be deployed”\(^\text{14}\).

Consequently, the commander makes a decision on AD and integrates it into the Airspace Control Plan (ACP), which has to be approved by a higher authority – the Airspace Control Authority (ACA) in the airspace control area.

**Air defence assets employment**

It is obvious, that different AD assets can be employed in different ways. Normally, an air defence weapon system will consist of two components: fighter aircraft and surface-to-air defences. AD fighters basically can be employed from ground or deck alert as well as for the Combat Air Patrol (CAP) missions. Ground/deck alert is “that status in which aircraft on the ground/deck are fully serviced and armed, with combat crews in readiness to take off within a specified short period of time (usually 15 minutes) after receipt of a mission order”\(^\text{15}\). CAP is “an aircraft patrol provided over an objective area, over the force protected, over the critical area of a combat zone, or over an air defence area, for the purpose of intercepting and destroying hostile aircraft before they reach their target”\(^\text{16}\). CAP may be the best way of using fighters when there is no early warning.

Another task for interceptors can be an air escort for offensive air missions, air reconnaissance, evacuation, and combat search and rescue (CSAR).

Surface-to-air defences consist of surface-to-air missiles (SAM) and anti-aircraft artillery (AAA) and may be used for the AD missions as the assets at a very high state of readiness with a quick response capability to the whole spectrum of the air threat. However, in comparison with fighter aircraft, they have limited range and often low mobility, therefore the best way of using them is point air defence.

In wartime, in order to exploit the capabilities of ground-based air defence systems to the maximum possible extent, the decisions about their employment and command and control should normally be delegated to the levels as close as possible to the commanders of fire units.

**Control and co-ordination**

In order to ensure the optimum use of resources available against the air threat, all the various elements of the weapons and detection systems should be integrated into a co-ordinated entity by a proper control and co-ordination system. Usually, the Joint Force Commander (JFC) designates one commander - the Air Defence Commander (ADC) - responsible for integrating all available assets. If the area for defence is large, a number of defence sectors can be established. In this case a Sector Commander may be designated for each sector. He is responsible for sector AD and reports to the ADC. Where applicable, co-ordination with the NATINADS and the Regional Air Defence
Commander (RADC) may be required as well.

All levels of commanders should be provided with suitable command and control systems to enable them to exercise the AD. Normally the composition of the system includes control agencies and components with appropriate staff. It will include communications and information processing equipment as well as situation display facilities. If it is required functionally, it may also include active and passive sensors for identification, air surveillance and weapons control. The number and size of the systems may be different for different areas and depends on the nature of the task and number of force components involved in the AD.

In times of crisis or war, in order to provide control of the weapon systems, the Weapons Control Order (WCO) has to be issued. The WCO promulgates the Weapons Control Status (WCS). The following WCS' are used to communicate the criteria an AD unit must use to engage a target: “Weapons Hold” – weapon systems may only be fired in self defence or in response to a formal order; “Weapons Tight” – weapon systems may be fired only at targets recognised as hostile; and “Weapons Free” – weapon systems may be fired at any target not positively recognised as friendly. It is of importance to exercise WCS between every air, land and maritime user of airspace.

**Air defence development considerations for Lithuania**

Although in accordance with the target force structure the Lithuanian Armed Forces possess a quite well developed AD capability, it is necessary here to discuss several practical issues, which the Lithuanian Armed Forces are facing in reality at present time.

The air surveillance and identification requirements and functions were already discussed in the previous chapter. Moreover, the Lithuanian Air Force currently is carrying two missions related to AD – a limited air policing function using light attack aircraft and a function of point defence of strategically important object by using AAA guns. The Lithuanian Navy has ships with the AD capability (SAM and AAA) as well.

Certainly, all the necessary regulations for airspace management, Rules of Engagement (ROE), command and control relations regarding these missions are made and approved by respective authorities. However, so far there is no common policy or doctrine covering the principles, requirements and regulations for the AD missions when several forces are involved. That becomes a vital issue in times of crisis or war as soon as, on the one hand, several services employ the AD assets and, on the other hand, the international forces are involved.

Development of the AD capability of the Reaction Brigade of the Lithuanian Land Forces, which is a top priority at present time, definitely requires an establishment of appropriate regulations for employment of the procured AD assets. Therefore, the regulations on wartime ATM should cover all demands on integrating the air, naval and land AD assets,
air surveillance as well as command and control systems into a co-ordinated entity.

Conclusion

Air defence consists of important measures taken by all forces to certain extent, in order to protect themselves or others against any kind of an air threat. The aim of developing more efficient AD weapon systems is to increase the effectiveness of this protection. Such development, however, has raised the risk for own air assets being engaged by friendly air defences. This ambivalent situation requires proper planning, employment, co-ordination and control of the AD assets.

NATO has issued publications, which define basic characteristics, principles, requirements and procedures for the AD operations conducted by NATO forces. Every commander who is involved in an AD operation should be familiar with the requirements of these documents and to follow them when integrating the AD assets of his unit into the Airspace Control Plan (ACP) of a higher authority.

Complexity of the AD operations requires efficient allocation of the AD weapon systems, which normally consist of two complementary components - fighter aircraft and surface-to-air defences. The designated ADC is responsible for prioritising and integrating all of the assets available for a particular AD operation as well as co-ordinating them within the ACP.

Since the Lithuanian Armed Forces have moved rapidly to develop their AD capability, it is of great importance that all units involved in the AD operations are aware of the requirements and regulations for these operations. Therefore, the regulations on wartime ATM should be developed as well as respective education and training should be done prior to procuring any modern AD weapon systems.

V. Summary and Way Ahead

The purpose of this article is to analyse Lithuanian ASM system in order to determine its conformability for times of crisis and war and to recommend further development of the system. Therefore, the number of relevant factors such as legislation and responsibility of authorities for airspace management, potential threats for Lithuania’s sovereignty, air surveillance and air defence were analysed. The following is a summary and final conclusion of this analysis as well as recommendations for development of ASM system for Lithuania in times of crisis and war.

Summary

Analysis of the present Lithuanian ASM system shows that there is a need to establish a more efficient and flexible ASM system in the country. The principal recommendations for a design of such a system can be summarised as follows:

• Establish an integrated civil/military ASM system with divided areas of responsibilities according to the conceptual principles of “Regulator, Provider and Supervisor”. One authority (the CAA of the Republic of Lithuania) shall fulfil the mission of providing ATM for all the
users in peacetime. Responsibility for providing ATM during crisis or war, however, shall be transferred from the CAA to the Lithuanian Armed Forces (Air Force) at a specific time point defined by the Government.

- The organisation and use of airspace shall, wherever relevant, be based on the European Air Traffic Control Harmonisation and Integration Programme (EATCHIP) “Concept of Flexible Use of Airspace” (FUA Concept), which has been supported by the EUROCONTROL and NATO Committee for European Airspace Co-ordination and implemented in European countries. The implementation of the FUA Concept should start with the establishment of a national high-level airspace policy body. This body should be tasked with the reassessment of national airspace, the progressive establishment of new flexible airspace structures and the introduction of procedures for the allocation of these airspace structures on a day-by-day basis. Furthermore, for the daily allocation of the airspace structures and real-time civil/military co-ordination, a national Airspace Management Cell should be established.

- Develop a regulation on ATM for war, which would cover legal aspects of the airspace organisation, ASM, readiness, air surveillance and defence, command and control, co-ordination between the defence forces’ components, and co-operation with international forces.

- The Airspace Control (ASC) shall be based on NATO ATP-40 (B) “Doctrine for Airspace Control in Times of Crisis and War”. Development of the Lithuanian Airspace Control Means (ACM) in accordance with above-mentioned document is a keystone of success on the way of developing NATO compatible and interoperable communications, information systems and equipment for ASM in times of crisis and war, especially when defence of country’s sovereignty requires involvement of international forces.

- Improve surveillance of Lithuanian airspace, especially the low-level coverage. The Air Surveillance System shall continue developing through modernisation of air surveillance assets, procurement and integration of new ones, and co-operation with the Navy and civil ATC.

- Develop the Identification Friend or Foe (IFF) capability of both ground sensors and flying assets in order to fulfil an air surveillance mission in times of crisis and war. The IFF system should be compatible with the ICAO standards and interoperable with NATO to be able to interact with ATC and the NATINADS.

- Improve regional security and national air defence capability through cooperation with the Baltic states and internationally. The BALTNET should remain the chief tool for this development, and it should be integrated into the NATINADS and other early warning systems in the future.

- Establish a common AD policy and relevant doctrines. These regulations should meet the requirements for ASM, AD planning, employment of the AD assets, co-ordination and control of air defence set by NATO air doctrines. All defence forces’ components should integrate their weapons and detection systems into a co-ordinated entity. Therefore, a proper
command and control system should be developed.

**Recommendations for implementation**

The suggested Lithuanian ASM system development covers quite wide areas of influence and responsibility of different authorities within the Lithuanian Armed Forces and outside them domestically and even internationally. This fact makes the system implementation relatively complex. Therefore, during the implementation process different levels of authority and means of their execution should be applied. Certainly, all levels are coherent and shall interact with each other.

The highest authority of the State, the Seimas of Lithuania, legislates internally and ratifies international agreements if required. The Government sets regulations following from laws, approves State authorities, delegates power or responsibility to States authorities, and approves their decisions and agreements between them.

The main players in the implementation process, however, are the governmental agencies, particularly the Ministry of National Defence and the Ministry of Transport, and the appropriate Departments of under these authorities. Their responsibility should be the development of requirements and implementation plans, agreements between different authorities, and internal regulations and instructions within the areas of their responsibilities. Therefore, in order to achieve the above-mentioned objectives, the suitable committees and working groups, consisting of representatives of the parties concerned as well as independent experts, should be established.

Furthermore, NATO membership will have a huge, if not a decisive, impact on the implementation process. As soon as Lithuania becomes a member of NATO, new tasks or responsibilities may emerge, consequently necessitating a review of priorities and development plans. On the other hand, the membership will certainly simplify many areas for decisions, actions and developments to be implemented.

In order to start and effectively run the implementation process, the first immediate step should be an assignment of personnel from the concerned state authorities for the establishment of a national high-level airspace policy body. This organisation should investigate what decisions to take in the main areas of the implementation process as well as what resources to allocate. The following is a suggested summary of the areas for the short-term actions:

- Reassessment of national airspace and the design of the Airspace Structure.
- Review of both military and civil aviation structures concerning ASM.
- Review of laws and regulations related to ASM and development of necessary changes.
- Development of international co-operation plans in the ASM area.
- Assignment of responsibilities and areas to be developed by state authorities and their departments.
- Preparation of agreements between the state authorities.
- Development of an implementation plan.
Actions recommended in a long-term perspective should cover identification of long-term political decisions, areas related to international co-operation, and long term plans and financial agreements between the governmental agencies on modernisation and procurement of efficient airspace control means.

1 ICAO – International Civil Aviation Organisation
2 Law on Aviation of Lithuania, No VII-2066, 17 Oct, 2000
3 “Airspace user group” is used to denote ALL users of airspace, including military air, sea and ground forces, airlines, civil aviation organisations and sport aviation.

EUROCONTROL – European Organization for the Safety of Air Navigation
5 EACHIP ASM Handbook. 1996. EUROCONTROL. Page 2-1
9 Ibid. Page 3-1.
10 BALTNET - Baltic Air Surveillance Network.
11 STANAG – NATO Standardization Agreement
14 Ibid. Page 4-7.
17 Target force structure of the Lithuanian Armed Forces is not presented in this article.