1/2017
ISBN: 978-83-60617-49-6
Aeronautika XVII

The Plan for the Future Usage of Aviation Communication, Navigation and Surveillance Systems

Daniela Čekanová, Milan Džunda,
Peter Čekan, Tomáš Puškáš

Department of Air Traffic Management, Faculty of Aeronautics, Technical University of Kosice, Rampova 7, 041 21 Kosice, Slovakia

Email: daniela.cekanova@tuke.sk

The article explains the basic issues of security and financial costs for upgrading the air navigation and surveillance systems and follows to the overview of selected systems that are used abroad. It also shows the current state of the systems and their location in Slovakia. The aim of this article is to approach the intention of the dissertation thesis that is currently being prepared, and to point out the possibilities of replacing the selected navigation and surveillance systems after the analysis of the most advanced types of systems using the research methods described further in the chapter four. This chapter sets out objectives for research on the issue. The result will be a mathematical simulation of the types, quantities and financial costs of exchanging navigation and surveillance systems in Slovakia to meet the worldwide requirements for aviation safety. Finally, we emphasize the needs to explore the issue of air navigation and surveillance systems, which is also confirmed by information media.

Keywords: navigation, surveillance financial costs, safety

Introduction

Air Navigation and Surveillance Systems, which may be prospective for the Slovak aviation are needed to support future ATM in the National Airspace System (NAS). The navigation, surveillance and communication systems (CNS) are components of communication systems the last system is only marginally mentioned in this article. Requirements for future use of systems are derived from the requirements for a high level of operations and providing freedom and flexibility in flight operations. These requirements are also set out in the Integrated Plan for Research and Development of Air Traffic Management Technology (Integrated Plan, 2000).

The following basic questions, to which the Slovak Aviation needs the answers, are subjected to the research and in this article the reasons and the intentions of the research are presented in this article:

1. What navigational and tracking systems

are suitable for safe air traffic control?

2. What is the location of these systems in aviation in Slovakia?
3. What are the future options for using state-of-the-art navigation and surveillance systems in Slovakia?
4. From a safety point of view, which systems require a more modern type?
5. What are the estimated costs of purchasing these systems?
6. What are the risks of using the current navigation and surveillance systems in Slovakia in terms of safety that should be monitored?
7. What are the benefits of using the latest navigation and surveillance systems for aviation safety?

Aviation in Slovakia needs to continue to maintain and enhance the safety of air traffic in the future and to use modern equipment efficiently with the effective costs for operation. Research on the use of navigation and surveillance systems will contribute to the final discussion, review and the simulation of the prospective use of these systems in Slovakia in the dissertation thesis which is being written.

1. Current State of the Problem Solved

Flight Data Processing Systems and Navigation Systems create optimal conditions for providing high-quality air navigation services. All technical systems are operated in accordance with standards and recommendations of the International Civil Aviation Organization (ICAO) and the European Organization EUROCONTROL. Aeronautics is extremely dependent on the introduction of state-of-the-art technologies. In general, the provision of air navigation services is a result of the joint action of three equally important and indivisible basic elements: facilities, people and practices linked to quality control and security systems.

1.1. Air Navigation Services in Slovakia

In Slovakia, all important systems and facilities are continuously monitored and regularly evaluated for their reliability during all stages of their lifecycle (from designing to commissioning, operation and maintenance to decommissioning). Data collection is needed to evaluate the reliability of characteristics. Systems and equipment are subject to state professional supervision done by the Transport Office.

Navigation services have surveillance and airport radionavigation systems available. These intricate devices are located on the ground and transmit information on board the aircraft, on the basis of which the pilot determines his/her location.

The airport control tower provides airport management service, flight information and emergency service to the airport operation, on the airport's operating area and in the vicinity. The airport control towers are located at M. R. Stefánik's airports in Bratislava, Košice, Piešťany, Poprad and Žilina. The airport control towers in Piešťany, Poprad and Žilina also provide an approach control service. Surveillance services provide continuous position and speed information for aircraft using radio technologies. Surveillance systems are essential for the operation of air traffic controllers, particularly in terms of ensuring safe separation between aircraft. They are based on sources of survey information (sensors - radars) and data processing. Many of them work actively in connection with aircraft systems. The following map shows the location of some navigation systems in Slovakia.

The exact location, types and financial costs of state-of-the-art systems is the aim of the prepared dissertation, and it focuses on the use of the types of systems that serve the Slovak Aviation.

1.2. Air safety

Each air space has a certain capacity which is centrally controlled in the whole of Europe. This is a sophisticated flight plan submission system which, using complex programs, calculates how many aircraft will be at the same time in each sector of the airspace. By doing so, it is ensured that not more aircraft would take off than the airspace is able to accommodate, and also takes into account the capacities of individual airports. This system is called ATM, an abbreviation for Air Traffic Management, whose data are processed by highly secured computers in Brussels, Belgium and Bretigny, France to take into account the safe horizontal and vertical distances of each aircraft on each route every second. In addition to the ATC, there are several other security and communication channels, so control and flight safety is secured several times. Of course, during summer holidays the airspace of Europe is busy. The individual aerodromes and the regional air traffic control centres therefore increase the number of tower controllers accordingly, so that each aircraft can be reliably controlled in individual air sectors and routes. This prevents the individual controllers from supervising a larger number of aircraft than they can monitor. However, flight safety also depends on how individual companies maintain their equipment and crew training. Therefore, aviation authorities strictly respect the level the fleet and company personnel take care about that, and unless the required quality of pilot technology and pilot training is met, such an airline will get a so-called blacklist and will not be allowed to land in EU countries. However, they are mostly low cost Asian or African airlines.

1.3. Airspace management

We divide the airspace into a controlled and unmanned airspace. Controlled airspace is located within a few dozen kilometers around airports and above 2 450 m / nm. Below this level only small aircraft can fly, gliders, helicopters without announcing their flight plan to the nearest control tower unless they are in the controlled airspace around the airport. In practice, for example, everyone flying around Bratislava, Kosice, Piestany, Sliac, Tatry and Zilina must know when to enter the airspace of the airports and must give reports to controllers so that they inform them of the details of the flight. Outside these areas and below the flight altitude level, these small aircraft can land and take off, or to fly without further reporting duties, with the minimum flight height of 150 m - of course, except landing and take-off. However, pilots must strictly respect the rule that, in this case, it is possible to fly only in good visibility, not in foggy, dark, cloudy weather.

At present, the technique of flight management, communication, navigation, technical control, aircraft equipment, pilot training and staffing at a highly sophisticated level, and we must state that most of the causes of air accidents result in the failure of the human factor. However, the number of these misfortunes and casualties is considerably lower than for example in road transport, and it is still true that the journey by air is now safer than car transport (Veda na dosah, 2017).

2. New Trends in the Use of Air Navigation and Surveillance Systems

The Single European Initiative or aims are to increase the efficiency of air traffic control and air navigation services by reducing the fragmentation of European airspace. This ongoing initiative has a pan-European character and is open to neighboring countries.

The Single European Initiative began in 1999 to improve the performance of ATM and ANS through better integration of European airspace. The presented benefits of the Single European Sky are considerable: compared with 2004, this initiative (after the completion of 2030-2035) could triple airspace capacity, reduce ATM costs, increase security, and reduce the environmental impact of aviation by 10 %.

The first set of common requirements setting up the Single European Act was adopted in 2004 (Single European or I); covered Regulation (EC) No. (EC) No 549/2004 laying down the framework for the creation of the single European sky, 550/2004 on the provision of air navigation services, Regulation (EC) (EC) No 551/2004 on the organization and use of the airspace in the single European sky and Regulation (EC) 552/2004 on the interoperability of the air traffic management network. This framework was amended in 2009 (Single European or II) to include performance-based mechanisms (Regulation (EC) No 1070/2009). It has also been complemented by the EU Aviation Safety Rules (and related competencies of the European Aviation Safety Agency), whose scope has been extended to ATM, ANS and airport operations. At the same time, several implementing regulations and technical standards were adopted, either by the Commission through, or less frequently, by the legislators (Európske noviny, 2017).

2.1. Gallileo

Satellite radio navigation is currently a leading technology that allows anyone who has a receiver to accurately determine their current geographic location. Determination works on the evaluation of signals coming from multiple satellites located outside Earth's atmosphere. The US is especially technological power that has built a Global Localization System known as GPS. However, Russia is not left behind with its GLONASS system. Both of these systems are funded and controlled by military. The Commission presented for the first time its plans for the construction of the European satellite navigation system Galileo on 10 February 1999.

It is a more powerful, more accurate and compatible than the US GPS system. Fully functional should be in 2020 when all 30 satellites are on their orbits. For the time being, they are 18.

Both the US and the Russian systems are funded and controlled by the military, and the data provided for them may be distorted or totally blocked for civilian or political reasons at any time. This is highlighted by the European Space Agency (ESA), which, together with the European Commission, covers the Galileo system. In addition to independence, the European system will provide more precision. Its advantage is also the connectivity with the US GPS, which increases accuracy.

The construction of Galileo is expected to reach about seven billion euros. Run-time operating costs are estimated at € 800 million per year. It was originally assumed that the consortium of major European companies will contribute to the construction. This has resigned due to concerns about the profitability of the project, so the EU decided in 2007 to fund the project from EU funds. Satellite

maintenance is handled by the British company Astrium and the Galileo administrative center is in Prague.

3. Methods and Objectives of the planned research

For the planned research to find answers to the questions mentioned in the introduction, we propose to set research methods that aim at analyzing the current status of the quantity and types of navigation and surveillance systems in Slovakia, the economic costs of exchanging selected types, assessing safety and creating a computer simulation for the use of new systems.

3.1. Assumptions for working with the financial costs of air navigation and surveillance systems

LPS SR š. p. performs the basic mission of providing comprehensive air traffic services, providing air traffic services, aeronautical information services, search and rescue services and other activities related to the fulfilment of the basic purpose and subject matter of the enterprise in order to ensure a safe and efficient flight flow operation, in designated airspace and at designated airports in the Slovak Republic.

The Annual Report 2016 of Air Traffic Services of the SR shows that there are a number of technical air traffic services, technical air traffic management activities in the framework of technical development and methodology focusing on the following key projects resulting from the relevant European legislation, the need for renewal systems and equipment, and operational requirements:

- ADS - B receivers/MLAT upgrade system - system operational verification, preparation of specification for data integration into LETVIS system;
- AFTN / AMHS system upgrade - system operational verification, commissioning;
- DME ZNA - project implementation - system operational verification, RCMS communication troubleshooting and preparation for commissioning;
- VOR JAN - preparation of the project, preparation of project documentation for building and structural modifications;
- ATIS / VOLMET - HW system renewal and call for submission of documents from GNSS monitoring - test operation of the monitoring receiver;

The Annual plan of LPS SR contains provisions regarding the level and quality of the service, such as the expected level of capacity, safety, the environment and cost-effectiveness. The company's financial position is based on long-term management intents, which are specified in the individual financial cost and income plan items.

The research in the prepared thesis will focus on the financial cost of operation and the possible exchange of navigation systems based on available and permitted data (Výročná správa, 2016).

3.2. The Future of NASA's Global Positioning System Application

Worldwide government and commercial spacecraft will launch projections over the next two decades, showing that approximately 60% of future missions will operate on a low orbit and 95% of missions will operate on or under the geosynchronous orbit. Many of these space users could, thanks to GPS, meet their navigation needs in real time, thereby reducing the burden on NASA surveillance stations.

3.3. Missions using BlackJack receivers

As most future missions use GPS satellite signals, NASA is developing dedicated GPS receivers for space applications, many of which are already in use:

The NASA Goddard Space Flight Centre (GSFC) navigation receiver uses the L1 C / A signal. This receiver was in service mission No. 4 - The Hubble Space Telescope in May 2009 and proved to be very successful. Many future missions in HEO, GEO, and MEO are being planned to work with this receiver with their highly sensitive receivers for signal acquisition and surveillance.

The Jet Propulsion Laboratory (JPL) BlackJack GPS uses L1 and L2 frequencies with eighteen receivers already in orbit tracked by GPS. The newly created Triple GNSS receiver (TriG) is in the development phase with the ability to track multiple GPS signals and other GNSS signals to include Russian GLONASS and the European Galileo constellations.

Conclusion

Obviously, air traffic safety is a priority for the airline operator. This is also true for aviation in Slovakia. Aeronautical technologies are becoming more complex and safer. Their replacement is nowadays a necessary part of modernization despite the need to rely on the financial costs on their replacement and maintenance. This also applies to the aeronautical navigation and surveillance systems that are the source of transmission of information to pilots and air traffic control. The analysis of the current state of these systems, their quantity, types and locations, with the possibility of replacing some of the system types, has not yet been implemented. Indeed, Slovakia needs to pay attention to this area, as evidenced by the statement of the current Minister of Education Lubyova, who in January 2018 held a speech on education in Slovakia at the summit, said Slovakia needed an entry fee of EUR 1.4 million so it could keep steps with technological development in Europe and integrate as soon as possible with the European Space Agency (ESA).

References

1. Ciećko, A. et al.: Examination of Egnos Safety-of-live Service in Eastern Slovakia, In: Annual of Navigation. Vol. 22, no. 1 (2015), p. 65-78., ISSN 2300-6633.
2. Európske noviny. [online]. https://europskenoviny.sk/2015/11/21/brusel-chce-satelitne-sledovanie-lietadiel-ma-priniest-vacsiu-bezpecnost/
3. Integrated Plan for Air Traffic Management Research and Technology Development. Version 4.0. January 2000. Federal Aviation Administration (AAR-230), 800 Independence Avenue, S.W. Washington D.C. and National Aeronautics and Space Administration. Ames Research Center. Moffett Field, CA.
4. Kraus, J. - Plos, V. – Szabo. S.: Sensor Networks for CBRNE Detection / MAD Special. Vol. 2, no. 1 (2015), p. 26-29., ISSN 2336-2677.
5. Veda na dosah. [online]. http://vedanadosah.cvtisr.sk/bezpecnost-leteckej-dopravy-vysetrovanie-havarie-lietadla-je-ako-detektivka
6. Výročná správa 2016. [online]. http://www.lps.sk/images/vs/vyrsprava2016sk.pdf