PROPOSAL FOR THE POSSIBILITY OF USING GLOBAL POSITIONING SYSTEM IN AIRPORT OPERATION

Ján Ferenc - Jakub Lech

GPS systems are a very important role in today's modern world and begin to gradually grow into other sectors. At the beginning I focused generally on airports and businesses focusing on the provision of navigation services. The intention of this work is to propose the possibility of using a global positioning system operated airports, thus akin alone GPS system in general. Next, I will describe GPS systems, using aviation. In the end, I analyzed the mapping method airports and road obstacles and airports and measurement methods for using GPS technology and then I have these methods proposed operational airports for expansion or construction of airfields or of the pathways and buildings at the airport.

Keywords: global positioning system, airport, navigation system, measurement

1 INTRODUCTION

The main object of this work is to propose the possibility of using GPS systems in operation of airports and therefore I will describe these systems in general, so I approached the functioning of the system. The most prominent is the initial navigation system NAVSTAR GPS (abbreviated - GPS), which is still the most reliable and best performing navigation system provided by the Ministry of Defense of the United States.

Briefly, I will discuss the satellite navigation system developed by the European Union and the European Space Agency called Galileo, which in the near future could be put into operation. Marginally, I will mention something about airports and GPS systems that are currently used at airports.

2 AIRPORT

The airport is an important part of the infrastructure of the air transport process . It is a place where the user of air transport (passenger , the product carrier) in the widest range of services meets the various entities involved in the process .

Advantage airports lies in their unique position in a given geographic area . The downside is only limited growth beyond its space, its capacity and demand in the catchment area.

"The airport is geographically defined and appropriately treated area , including a set of structures and facilities , permanently assigned to start and arriving aircraft and aircraft movements associated with it."

An important part of airport transport systems that connect different modes of transport . Airports often find public transport bus terminals , whether urban, suburban or remote . An increasing role in increasing the competitiveness of airports play a good connection with the airport, long-distance and regional rail [1] .

Pic. 1 Airport from the air [7]

2.1 Air navigation services

In the initial period of development of aviation was deciding on the route of flight, in-flight navigation, landing and airport movement full responsibility of the pilot. Air transport was dependent only on the ability of individual pilots and other influences (eg time of day or weather).

Initially used navigation, requiring visibility of the earth, thereby flying commercially was limited to the time of day, good visibility and flight altitudes below cloud base. Interestingly I would mention that the first years of using radio navigation was conducted by Pan Am in 1928 between Key West, Florida and Havana.

Air navigation services are now a natural part of the operation. Serve to facilitate the safe and orderly movement of aircraft since engine start (departure) to turn off the engine (arrival) [1].

2.2 Services provided by enterprises of air traffic control

Services that provide air traffic control companies , which are in accordance with the terms of the *Convention on International Civil Aviation* (Chicago Convention). Are the responsibility of individual countries, whose

governments it in its most delegated to the specialized conditions of air traffic management (Air Navigation Services Provider - ANSP). *Provide the following services:*

- Air traffic control service,
- Flight information service,
- Emergency Service [1].

3 GLOBAL POSITIONING SYSTEM

GPS systems have nowadays become almost an inseparable part of our lives and the GPS receiver now owns almost everyone , most often in the form of a mobile phone . It's an indispensible aid in today's life , which serves both for navigation when traveling or finding different points of interest, etc.

What is GPS ?

GPS is a satellite navigation system that is used to determine the exact position and provides a highly accurate time reference almost anywhere on Earth or the Earth's orbit . It uses an assembly of at least 24 satellites in earth orbit and is the basis for GPS navigation devices.

This system is capable of providing location data irrespective of the period of 24 hours a day . It is therefore a passive satellite dĺžkomerný system . The operator of this system is the U.S. Department of Defense and its original aim was to military forces to accurately determine the position, speed and time in a single reference system. It follows, therefore , that this system was developed mainly for military purposes, but ultimately the U.S. Congress approved the use of GPS and the civilian sector but with some limitations [8].

Basic navigation systems:

- *Galileo,*
- *The NAVSTAR GPS.*

3.1 Building the GPS NAVSTAR

This system began to develop in 1973, the United States for use for military purposes. The work on the NAVSTAR GPS (GPS) have been divided into three phases.

The first phase took place in the years 1973 - 1979 and during this time was discharged 10 satellites into space . The first satellite of these ten satellites were launched in 1978 to verify the functionality and reliability of the positioning system.

The second phase was conducted in 1979 - 1985. During these years have been edited more satellites so that they , in July 1995, it was in orbit 24 and were thus built the foundations of the first global positioning system . Since 1995 shall operate always at least 24 satellites , but generally there are more. The satellites are positioned so that at any place on Earth to be visible for at least 4 satellites. During these years, has gradually built up a five ground control stations and started the development of new types of satellites called. Block II satellites.

The third phase took place in the years 1985 - 1994 which took place gradually refilling and replacement satellites Block I, Block II satellites. On March 3, 1994 are in operation 24 Block II satellites and thus to qualify for full operational status [2].

Pic. 2 disposition of the GPS satellites in space [9]

3.2 Building GALILEO

Galileo is a global navigation satellite system developed by the European Union , which will be an alternative to the U.S. NAVSTAR GPS system and the Russian GLONASS. GALILEO will be operational in 2010, but due to technical and other reasons , the term shifted to 2014. GALILEO system was named after the Italian scientist Galileo Galilei . The main objective of this system is , inter alia, meet citizens needs, serve other EU policies, to concentrate on space applications and to improve European competitiveness.

The first plans to build a European navigation system was presented by the Commission 10. February 1999. Estimated project development was four phases of a mixed form of financing. The system was opposed to the American and Russian system designed specifically for civilian and commercial purposes and will provide very accurate 3D positioning and timing services worldwide for civil applications but especially for surface transport.

On December 28, 2005 was sent into space the first satellite navigation technology to test the interoperability of the system called GIOVE -A . This satellite weighed 600 kg and was sent into orbit distant from Earth 23,222 km. 27 April 2008 was launched into space to orbit the Earth second satellite named GIOVE - B.

GALILEO struggled during the execution of the same delays as compared with its design . As I said the system should be operational in 2010, but because of these delays this deadline will be for 2014. One reason for the delay was the dispute about funding for this expensive project.

GALILEO is compatible with the NAVSTAR, allowing combined use of the two systems [3].

Pic. 3 Galileo satellites, GIOVE-A [9]

4 GLOBAL POSITIONING SYSTEM AVIATION

Pilots around the world use global positioning system to improve the safety and efficiency of flight. GPS offers seamless satellite navigation services that can satisfy the most demanding requirements for air transport users, but especially for pilots and people involved in the transportation. To display three-dimensional position determination and for all three phases of flight from departure through the flight to landing . Procedures for aircraft navigation have been gradually extended to all phases of flight especially in areas which are not suitable navigational aids or tracking devices [10].

Developed systems relating to systems that use GPS for *ground handling* of *aircraft systems and assisting in flight and upon landing*.

4.1 Systems for ground handling of aircraft using global positioning system

The development of GPS systems on the trip surfaces for aircraft, raises a number of systems to increase the efficiency and safety of aircraft ground handling equipment , but also the efficiency of the staff and especially to reduce the cost of operation. One of these systems with these issues are *Airport Visualiser* and Advanced Surface Movement Guidance and Control System (*A- SMGCS*).

Airport Visualiser

- It is a comprehensive software and hardware solutions for ground handling of aircraft at the airport , which provides management and planning of all mobile mechanization at the airport in real time . This system locates and record every means of ramp and allows the operator more flights with fewer resources. Airport Visualiser simultaneously reduces the risks of flight delays and thus increases customer satisfaction and also leads to increased productivity and safety. This is done with the assistance of integrated modules that help solve business requirements.

Airport Visualiser GPS modules are divided into:

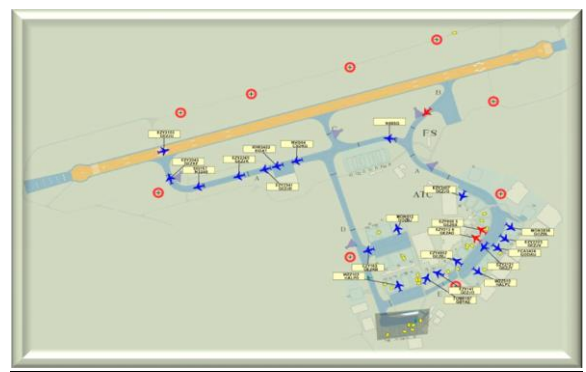
- ProFacts ,
- ProView ,
- ProOperations ,
- PROSAFETY ,
- ProMaintenance [4].

A - SMGCS

- It is a system that provides direction , guidance and supervision of the management of aircraft and vehicles on the movement area of an aerodrome to maintain a specified rate of movement in any weather or time of day or night within the aerodrome visibility operational level while maintaining the required level of safety. It is a modular system, which consists of various functions to promote a safe , controlled and rapid movement of aircraft and vehicles on the movement area of an aerodrome, under all circumstances with respect to the traffic density and complexity of aerodrome with respect to the required specifications under all visibility conditions [11].

Tasks and objectives of A-SMGCS system in the future:

- safety,
- ensuring growth opportunities service,
- customer orientation and service,
- environment [5].



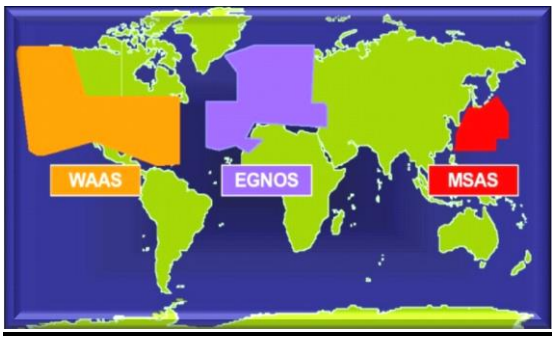
Pic. 4 scheme guidance system for aircraft ground support A-SMGCS system [11]

4.2 Systems using a global positioning system in flight and upon landing

GPS systems are used in aviation long, but despite its short time in operation is fairly widely spread. But do not forget that GPS can also be used in the operation of airports in the actual flight of the aircraft or the landing. There are several such systems. The following systems are very accurate and are now at several airports to the necessary equipment for pilots.

The pair of the WAAS and EGNOS are basically the same principle systems , one of which is used in America and the other in Europe. These systems are used for the flight itself. Other systems based on GPS and LAAS system is essentially a system using the precision approach and landing aircraft itself airport. There is also a system for flight

guidance titled MSAS, which is used in Asia but it will not be specified.



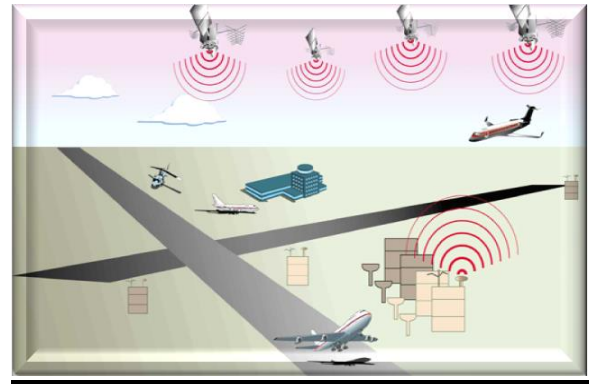
Pic. 5 cover WAAS, EGNOS and MSAS [12]

WAAS

- A system that has been developed since 1994 by the Federal Aviation Administration for aid to air navigation to improve accuracy, integrity and availability of GPS in aviation. The system is basically designed in order to enable aircraft to rely on GPS for all phases of flight (departure, the flight and landing), including precision approach at each airport within its coverage area. This system is used for North America [13].

LAAS

- The system is operating in all weather conditions and is used for landing aircraft -based and real-time differential GPS correction signal. Current accuracy for precision approaches is 16 m at the sides and 4 m vertically. Reference receivers of this system are located around the airport and send data to the central location of the airport. Data are used to formulate corrective messages that are then transmitted to the user via the so-called . VHF Data Link (this is a way of sending information between aircraft and ground stations). Receiver on board the aircraft uses this information to repair the GPS signal, which then provides ILS display when flying . ICAO this type of system is called Ground Based Augmentation System (GBAS) [14].



Pic. 6 LAAS system [12]

EGNOS

- It is actually a WAAS , which is used in North America, but this is used for the needs of Europe. As I have already indicated , EGNOS is a satellite- based system SBAS (WAAS naming ICAO) developed by the European Space Agency, the European Commission and EUROCONTROL. As GPS and Galileo systems that report on the reliability and accuracy of data location. The official launch of the system that was announced by the European Commission on 1 October 2009.

More than 40 ground stations, which are connected together and to form a network of EGNOS, which consists of:

- 34 Rims: receiving signals from GPS satellites,
- 4 MCC : processing,
- 6 NLEs : accuracy and reliability of data [15] .

5 SURVEY , ANALYSIS AND DESIGN OPTIONS USING GLOBAL POSITIONING SYSTEM OPERATED AIRPORTS

Provides data on terrain and obstacles at the airport. Approximate methods and ways of mapping airports and measurement methods using GPS systems, which would then also could be combined to measure, construction or expansion of airports, airfields and buildings at the airport.

5.1 Information on terrain and obstacles at the airport

The purpose of these data are just sets of electronic terrain data and obstacles at the airport used in combination with data on aviation. These data should be appropriate to the needs of users to support these applications in air navigation:

- system for ground proximity warning with search function to avoid terrain,
- warning system for minimum safe altitudes - MSAW,
- theme fallback procedure in case of emergency during the failed approach to runway or take,
- analysis of restrictions on the operation of aircraft,
- theme instrumental procedures,
- establishing procedures for the descent of the transit route,
- enhanced navigation system for managing the movement of aircraft on the ground (A - SMGCS),
- creation of on-board databases,
- creation of aeronautical charts,
- flight simulator,
- restrictions on airport or heliport , which are caused by obstacles and their removal [6].

5.2 Methods for mapping the airport

Any processed data must be consistent with known quality and implementation of procedures and processes. Data quality requirements shall be meeting the strictest requirements in applications. To retrieve data from mapping airports are acceptable number of methods , such as air or *digital photogrammetry* , *satellite photogrammetry*, *remote sensing* and *digitizing existing maps of airports*.

5.3 Methods of measurement using GPS technology and the subsequent proposal in operation and under construction airport

Measurement methods using GPS technology are many , and so I decided to describe the most used and those that are best suited just for construction use at airports or in the vicinity.

Static method

- Measurement method I would recommend to use in the construction of airports in the first place, due to its quirements and high accuracy. Mainly I would but emphasized the use of this measurement method using GPS at major airports, due to its vastness measurements. Surveying the help of GPS technology to smaller airports, I would recommend a measuring method called pseudokinematická or rapid static method (this method would be suitable but also the larger airports preferably focusing his short time).

Kinematic method

- The method is usually applied only to a small radius of 10 km . Therefore, this surveying using GPS technology also suitable for focus , expansion and construction in aviation , but I would rather prefer static measurements using GPS, and because of the range of measurement. If it were not typical of airport or some different terrain. the airport with smaller dimensions is possible to consider the suitability of use of this measurement [3].

DGPS for large areas - WADGPS

- This is a method of measuring in real time , so the preceding methods differ mainly in the speed of processing of measured data, which significantly saves time.

The quality of differential correction does not decrease with distance from the base station, but is evenly distributed throughout the territory. Therefore, it is appropriate to use this method for the measurement of large areas, where the airport is definitely. This method of measurement in real time is most suitable for use for targeting airports and airport construction.

WADGPS for best results are obtained by calculating the differential correction for virtual reference station. It is a place where they

may be located no real reference station, but is independent of the chosen location , which is also currently in the receiver , which is in motion [2].

6 CONCLUSION

GPS systems are very extensive and can be used in almost every field of industry. Over the last twenty years, their development moved forward significantly, and if this trend will continue in the future we can look forward to utilizing this system, what style you have to know even imagine. It is in aviation, these GPS systems represent a significant change for the better, especially in the field of security, which is probably the most important indicator for transport.

Surveying and surveyors also started using GPS systems for targeting objects and obstacles in the field, mainly because of the simplicity and accuracy of these measurements and these measurements can easily be spread to targeting airports. With the use of GPS systems in operation at the airport surveying areas for the construction of the airport or expansion of existing space at the airport I have yet to meet. I have therefore decided in this work to describe methods of measurement using GPS and then these methods propose to build the airport but also to extend existing areas at airports.

LITERATURE

[1]. PRUŠA, Jiři a kol.: Svet leteckej dopravy, Praha: Galileo, 2008. ISBN 978-80- 8073-938-6.

[2]. PISCA, Peter: Globálne navigačné systémy. Stavebná fakulta Žilinskej univerzity, Žilina 2005.

[3]. SEDLAK, Vladimír - LOŠONCZI, Peter – PODLESNÁ, Ivana: Družicové navigačné systémy, Vysoká škola bezpečnostného manažmentu, Košice 2009, ISBN 978-80-89282- 31-9.

[4]. STRAKOVÁ, Eva – FERENC, Ján: Prostriedky pre pozemnú obsluhu lietadiel, Košice 2011, ISBN 978-80- 553-0706-0.

[5]. PŘIBIL, Dávid: Projekt systémy zabezpečení a řízení letového provozu. ČVUT, Fakulta Dopravní, Katedra Letecké Dopravy, Praha 2006.

[6]. L15 – Letecká informačná služba, apríl 1998. Publikácia Leteckej informačnej služby Slovenskej republiky. [online]. [cit. 2014-04-28]. Dostupné na internete: http: //www.fabryatc.net/civilnepredpisy/L15_ D5_01AUG2008.pdf

[7]. Reuters, Centrair - nové medzinárodné letisko v Japonsku. Aktualizované 7.máj 2013 [cit. 2014- 04-28]. Dostupné na internete:http://aero.sme.sk/1933939/centrair-nove-medzinarodne-letisko-v-japonsku.html

[8]. IVANIČ, Jozef: Optimalizácia metód harmonizácie a integrácie priestorovýc údajov o území. Komunitný GEO portál pre používateľov geografických informácií, systémov a technológií. Aktualizované 14. marec 2013 [cit. 2014- 04-28]. Dostupné na internete:<http: //www.geoinformatika.sk/>.

[9]. Jak zvýšit přesnost GPS- aktualizované 7.oktobra 2013 [cit. 2014-04-28]. Dostupné na internete: http: // navigovat.mobilmania.cz/clanky/jak-zvysit-presnost-gps/sc-265-a1313205/default.aspx

[10]. Aviation, Official U.S. Government information about the Global Positioning System (GPS) and related topics. Aktualizované 27.septembra 2013 [cit. 2014-04- 28]. Dostupné na internete: <http://www.gps.gov/applications/aviation>.[11]. Skybrary, Advanced Surface Movement Guidance and Control System (A-SMGCS). Aktualizované 1.apríla 2012 [cit. 2014-04-28]. Dostupné na internete: <http: //www.skybrary.aero/index.php/Advanced_Surface_Movement_Guidance_and_C ontrol_System>

[12]. Starty kosmických raket a těles v roce 2005- aktualizované 7.január 2013 [cit. 2014-04-28]. Dostupné na internete: <http://mek.kosmo.cz/novinky/starty/2005mek.htm>

[13]. Medzinárodné letisko Atlantic City, New Jersey: FAA / William J. Hughes.

Aktualizované 27.máj 2013 [cit. 2014-04-28]. Dostupné na internete:<http:// www.nstb.tc.faa.gov/rep orts/waa span26.pdf>

[14]. Local Area Augmentation System, Aktualizované 7.máj 2012 [cit. 2014-04-28]. Dostupné na internete: <http: //en.wikipedia.org/wiki/Local_Area _Augme ntation_System>

[15]. EGNOS, Safety of Life Service Definition Document. Aktualizované 27.máj 2013 [cit.2014-04-28].Dostupné na internete: <http: //www.esspsas.eu /downloa ds /pjqefsq/ egnos_sol_sdd_in_force.pdf>

RESUME

V tejto práci bolo hlavným cieľom navrhnúť možnosti globálneho polohovacieho systému v prevádzke letísk. Pre správne pochopenie tejto práce, sme tu zakomponovail stručný popis letiska a sluzieb riadenia, ktoré poskytujú podniky riadenia letovej prevádzky. V ďalšom pokračovaní spomíname všeobecné využitie GPS systémov a popis tohto systému. Sú tu objasnené aj systémy používajúce GPS v samotnej prevádzke letísk, či už na pozenú obsluhu lietadiel alebo na navigáciu pri samotnom lete, alebo pri presnom priblížení a pristání lietadiel.Systémov, ktoré využívajú GPS v prevádze letísk je mnoho, a preto sme nevideli opodstatnenie navrhovať dalšie z takýchto systémov.

Zujímavá sféra je meranie pomocou GPS techniky, hlavne kvôli jej presnosti. S používanim takýchto meraní sa dnes môžeme stretnúť v geodézii bežne. Nikde som sa ale nedočítali o používaní meraní pomocou GPS, v zameriavaní letísk a letiskových prekážok, a preto nám prišlo vhoné aplikovať metódy meraní pomocou GPS do prevádzky letísk resp. na ich výstavbu. V závere práce opisujeme jednotlivé metódy meraní a následne ich odporúčam pre daný typ letiska.

Jakub Lech, Bc., Raketová 17, Košice
Ján Ferenc, Ing. PhD., Letecká fakulta, Technickej univerzity Košice, ul. Rampova 7, 040 11 Košice
Jan.Ferenc@tuke.sk