SOME ISSUES OF DATA QUALITY ANALYSIS OF AUTOMATIC SURVEILLANCE AT THE AIRPORT

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Summary

The automatic surveillance ADS - B is a low cost-monitoring system that provides periodic transmission of the aircraft parameters (identification, position) through the data link transmission mode. Information from ADS - B is transmitted, regardless of which user will receive it (another aircraft, air traffic controller), and without waiting for an answer to the user. Nevertheless, it is required that the information was made available in areas of surveillance by air traffic control. Each user, both in the sky and in the ground station can choose how to use the system: receiving, processing and displaying information.

Keywords: automatic surveillance, air traffic control

WYBRANE ZAGADNIENIA ANALIZY JAKOŚCI DANYCH SYSTEMU AUTOMATYCZNEGO DOZOROWANIA NA LOTNISKU

Streszczenie

System automatycznego dozorowania ADS – B jest nisko kosztowym systemem dozorowania, który zapewnia okresowe transmitowanie parametrów statku powietrznego (identyfikacja, położenie) poprzez tryb transmisji łącza danych. Informacja z ADS – B jest nadawana bez względu na to, który z użytkowników będzie ją odbierał (inny statek powietrzny, kontroler ruchu lotniczego) i bez oczekiwania na odpowiedź tego użytkownika. Niemniej jednak, wymagane jest, aby informacja była udostępniana na obszarach objętych dozorowaniem przez służby kontroli ruchu lotniczego. Każdy użytkownik, zarówno w przestrzeni powietrznej, jak i w stacji naziemnej może wybrać sposób użytkowania systemu: otrzymywanie, przetwarzanie lub wyświetlanie informacji.

Słowa kluczowe: automatyczne dozorowanie, kontrola ruchu lotniczego

1. INTRODUCTION

The automatic surveillance ADS - B is a low cost-monitoring system that provides periodic transmission of the aircraft parameters (identification, position) through the data link transmission mode. Information from ADS - B is transmitted, regardless of which user will receive it (another aircraft, air traffic controller), and without waiting for an answer to the user. Nevertheless, it is required that the information was made available in areas of surveillance by air traffic control. Each user, both in the sky and in the ground station can choose how to use the system: receiving, processing and displaying information. ADS - B system is automatic. Automatic, in this case, means that it act itself and does not require the flight crew or air traffic control services to share information regarding the position of the aircraft. The ADS - B system is dependent in the sense of relying on the source and method of transmitting information about the location of the aircraft (in this case the global navigation satellite system GNSS).

2. FEATURES AUTOMATIC SURVEILLANCE SYSTEM WITH THE FUNCTION OF BROADCAST (ADS - B)

In case of ADS - B surveillance services are provided in the areas of both the radar and without them. It may therefore help the radar for greater positioning accuracy of the aircraft. Currently, ADS is a system acting as a consulting mainly in the aircraft, and not operational. Future use of ADS - B tend to seek support servicesand rescue, and to monitor the aircraft by fleet operators. ADS consists of two main components, namely:

a) part of which is equipped with aircraft avionics display in the cockpit;

b) ground station (ground - based transceiver GBT).

In contrast to currently used techniques of surveillance, ADS - B installed on the aircraft - freely determine its location and other parameters and sends them to a ground station and other users. These data are determined by a global satellite

navigation system. Update them done once per second. Determining the position of the vehicle by means of satellite navigation systems depends on the adopted rules of operation of the system and the kind of measured parameter. Most principle of operation is to determine the user's location based on the measured values of the position in relation to the satellites. How to determine the position of the satellite depends on, among on the type of orbit. In the case of a geostationary satellite's position coordinates are known, and nearly constant relative to the ground segment. In the case of elliptical orbits - satellite position coordinates depend on time and are determined by various methods, for example, in the case of GPS and GLONASS - the coordinates are calculated by the receiver based on knowledge of all the elements of the orbits of satellites used. Boththe GPS and GLONASS satellites to broadcast signals at two frequencies modulated in phase information obtained from a digital memory of the satellite. Form of messages sent by the vehicle ADS is a package of information contained 56 - bit data field extended 112 - bit squitter sent at a frequency of 1090 MHz mode S. This package contains a set of defined parameters of the vehicle. Message: ADS - B has two functions: ADS - B Out (associated with the transmission of information) and ADS - B In (related of being informed).

We focus on the use of ADS - B in the radar environment. Integrating data from ADS - B radar data can provide the following improvements to surveillance:

• the possibility of using data from ADS - B in case where the radar can not impose themselves and garbling phenomenon occurs;
• ability to use data from ADS - B in the management of movements on the ground, especially when there were problems with the operation of the transponder;
• provide surveillance services in areas not covered by radar coverage;
• the possibility of reducing the number of surveillance radars needed for a specific area and fill gaps in the observation by the ADS - B;
• providing dual independent of each other surveillance methods of the area;
• improve the accuracy of location of aircraft.

For support system ADS - B surveillance in areas not covered by it must meet a number of additional functions such as the ability to integrate with other automated systems, display warnings including conflict detection for panels of air traffic controllers and pilots, and provide satisfactory accuracy. ADS - B is very popular in the United States, for what it's worth special attention, namely, inter alia, there were isolated two data link suitable for ADS - B: 1090 MHz extender squitter (1090 ES) and relay Universal Access (Universal Access Transceiver UAT). 1090 ES is a link dedicated to aviation and military communications, while UAT is designed for general aviation. For air traffic controller interface type in the sense of displaying data - it does not matter, because the data are displayed in the same way. In addition, these links outside ADS - B also support services in support of the system, that is, TIS - B (Traffic Information Service - Broadcast) and FIS - B (Flight Information Services - Broadcast).

TIS - B is a service which is to broadcast information on air traffic. The data source is radar surveillance systems. The advantage of this application is to increase pilot situational awareness. FIS - B, in turn, is engaged in broadcasting meteorological information (eg METAR, SPECI, TAF) and other additional aeronautical information (NOTAM). The advantage of FIS - B is to allow the pilot to obtain information about the current weather situation in the air and at airports. In the case of airports main purpose of the implementation of ADS - B is to support air traffic control services in the field of safe operations and increase productivity and, in some cases, the capacity of the movement area. Currently, the airport surface management by control tower is done by visual observation by inspectors. There is no specifically defined separation minima (distance or time) for aircraft, in addition to those carried out on the runway. In case of maneuvering commands are issued only like "Taxi behind" or "Hold short of" the controllers to the aircraft. There are also priorities, such as: departing aircraft has priority over an aircraft taxiing after landing on board. Such surveillance methods are often flawed, especially in low visibility conditions. The term environment functioning ADS - B is associated with carrying out risk analysis of system implementation. For the purpose of the document "Guidance for the Provision of Air Traffic Services using ADS - B for Airport Surface Surveillance" this analysis is carried out. There have been identified within the parameters of the best environment for the ADS. Described types of parameters airport can be found for example in the "Advanced Surface Movement Guidance and Control Systems (A - SMGCS) Manual" published by the ICAO.

There are a number of tasks that ADS - B in cooperation with the SMR must meet at airport surface surveillance, such as:

• tracking of vehicles on the maneuvering area of an airport;
• checking the busy runways;
• providing information about the traffic in a given area;
• the provision of terrestrial navigation aircraft (after generating the query by the pilot or controller);
• ensuring security and emergency vehicles to allocate routes and others.

Detailed tasks ADS - B are contained in ICAO Doc. 4444. Currently, ADS - B is an essential component of a complex system of Surface Movement Guidance A - SMGCS gradually implemented at airports worldwide. A - SMGCS as defined by ICAO is a system to ensure that the

allocation of route guidance and supervision in the field of traffic control aircraft and other vehicles, in order to maintain the declared capacity of the movement area considering all the weather conditions at the operational level of visibility at the airport (AVOL). This system has four levels of implementation, advanced, depending on the individual needs of the airport. Suitability for use ADS - In allows the receiver, the data processing system and HMI - Human Machine Interface, often called the CDU - Cockpit Display Unit. This interface has lead to a reduction in the workload of controllers, pilots and other vehicle drivers. This uses the computer systems and leads to the environment while keeping the total automation of manual ability to control the situation. The general principle of the interface is shown in Figure 1.

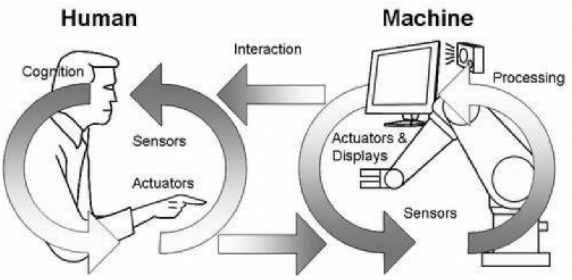

Fig. 1. General aim of use of HMI interface

CDU unit has been designed to monitor the tasks performed by the pilot of the aircraft. The quality of his work can be verified by simulator. This project monitors EUROCONTROL through the PHARE program.

3. ASSUMPTIONS AND REQUIREMENTS FOR THE IMPLEMENTATION OF ADS - B ON THE SELECTED AIRPORT

ADS - B for each utility system is regulated by specific standards. In case of aviation proper legal framework is extremely important. Guidelines for the implementation of this system can be found, inter alia, Commission Implementing Regulation (EU) No. 1207/2011 of 22 November 2011 laying down the requirements for the performance and interoperability of surveillance systems in the single European sky. A functional model systems using signal ES (Extended squitter) operating in S supports ADS-B and / or TIS-B is shown in Figure 2 Onboard give messages ADS-B (ADS-B OUT), but they can also receive ADS-B and TIS-B (ADS-B IN and TIS-B IN). Ground-based systems (ground stations) are suitable TIS-B messages and receive messages ADS-B. Although not shown explicitly in the functional diagram, the signal ES systems installed on the airport ground vehicles and fixed obstacles may also transmit ADS-B message (ADS-B OUT).

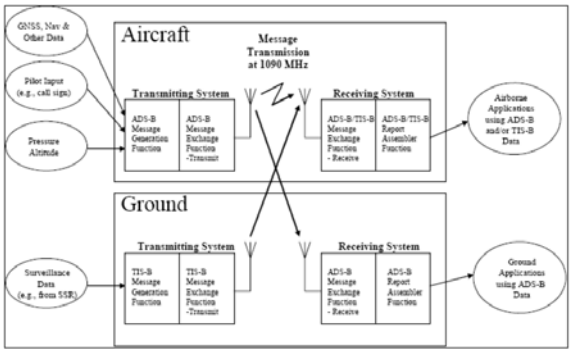

Fig. 2. Functional model of systems using ADS – B with ES mode S or TIS – B

ES signal transmission apparatus will be classified in accordance with the scope of the capabilities of the device and a set of parameters that are capable of transmitting:

• Class A - includes on-board signal ES that support both functions broadcasting (ADS-B OUT) and the complementary functions of signal reception (eg. ADS-B IN) included in the on-board ADS-B;

• Class B includes the ES signal systems that provide only broadcasting (ADS-B OUT), without being able to pick for use on aircraft, ground vehicles and fixed obstacles;

• Class C includes the ES signal systems that have the ability to only receive and therefore do not apply to them requirements for transmission.

Ground stations serving TIS-B using the signal transmission functions. The characteristics of the transmitter power, antenna gain, transmission speed can be adjusted to the desired level of service TIS-B ground stations, assuming that users are provided with a deck receiving systems at least Class A. The maximum baud rate and the effective radiated power should be controlled, to avoid unacceptable levels of radio interference of other systems operating at a frequency of 1090 MH (such as SSR and ACAS systems).

Signal receiving system receives messages ES ADS-B and TIS - B and it reports application users. The required parameters for the implementation of functional and receiving systems will be different depending on the application users of ADS-B and TIS-B, which will operate and use the system operationally. Receivers-board signal ES Mode S are consistent with the classes receiving systems. Receiver parameters associated with the class should properly secure the required level of operational capacity. class of equipment A is used for Mode S airborne equipment that have features of transmitting Mode S ES (ADS-OUT) and receive functions (ADS-B IN). Class B equipment are used for Mode S equipment to transmit only functions (ADS-B OUT) and include classes of on-board equipment, ground vehicles and fixed obstacles. Class C equipment used ground-based signal receiver ES Mode S. The level of consistency of the system further protocol transponders ADS - B signal ES, including avionics, coupled with a transponder,

is equal to or less than 10-5 per flight hour. Total time waiting for data on the horizontal position should be equal to or below 1.5 seconds in the 95% rate. If the transponder is set to use a Mode A, provide information on the Mode A code by using either the ADS - B ES signal is blocked. Surveillance systems should be subjected to the assessment of conformity or suitability. For this purpose, you can take steps to verify the compliance of the system with the relevant requirements in the test environment. The verification of the technical documentation produced, including a description of the implementation of the system and report on inspections and tests carried out before putting the system into operation.

4. ANALYSIS OF THE QUALITY OF THE DATA USED BY THE ADS – B

By definition, a GNSS is a global system for determining time and space, comprising one or more satellite constellations, receivers and on-board system integrity monitoring devices, if necessary, extended to support the navigation requirements for the intended operation. Each satellite system should act as:
• accuracy (accuracy);
• the ability to immediately alert the user to a disfunctioning (integrity);
• uninterrupted operation (continuity of service);
• availability (availability).
One of the major limitations of satellite systems is susceptible to various types of interference. Can be divided into several categories, namely:
• noise propagation (ionospheric, tropospheric);
• unintentional interference signals at radio frequencies: the noise emissions in the band
- other devices can transmit without permission GPS band; the issue at close ranges
- some waves propagated in similar frequencies may cause interference of harmonic waves
- some identified cases involve devices that emit waves at very different frequencies;
• intentional interference of jamming.

The solution to the problems in Europe, the positioning accuracy is to be implemented EGNOS system. Its mission is to support the GNSS systems by improving the positioning accuracy in real time. However, a particularly important aspect of the aviation operation is to provide information the reliability of the data transmitted to the user.

Supervision of the proper operation of the system fully, inter alia, the ESA (European Space Agency). EGNOS achieves its action by sending differential corrections and information the inadequacies of the system to users by three geostationary satellites positioned over Europe. The EGNOS system consists of:
• the space segment, which consists of three geostationary satellites moving at about 36 000 km above the Earth's surface;
• ground segment made up of about 40 measurement and observation stations RIMS located in Europe;
• user segment.

The analysis of the quality of the data used by ADS - B, including GNSS data presented in the report tests the system to Heathrow Airport. It was the EUROCONTROL project initiated by the EEC (Eurocontrol Experimental Centre). Trial was to compare the quality of the data from the three above-ground surveillance sources:
• ADS - B using the Mode S (ES);
• ADS - B with UAT;
• ADS - B using VHF Datalink Mode 4 (VDL - 4).

Studies have been conducted in real time and in real flight operations. It should be noted that in no way changed airport environment, and so I was left with its complete infrastructure, which made it possible to assess the impact of obstacles to possible interference. Base station project was specially prepared vehicle, previously used to assess the MLS. Transponder installed in the working in S (Fig. 3), the relay UAT and VDL - 4 And the ground station was previously installed at Heathrow Airport and is shown in Figure 4.

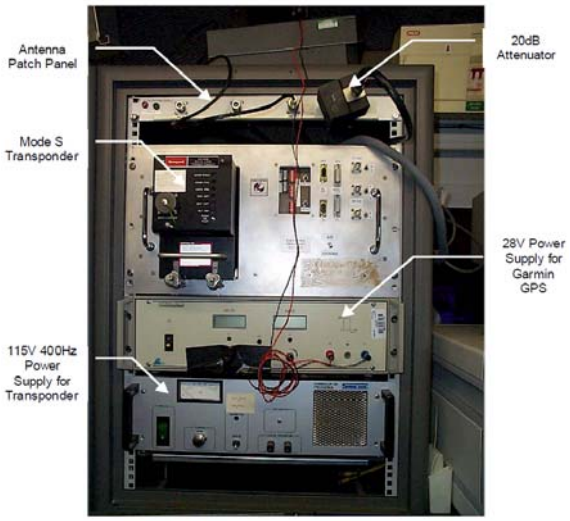

Fig. 3. Mode S transponder installation

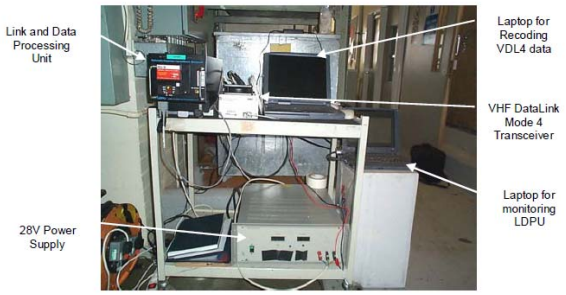

Fig. 4. Ground station at Heathrow Airport

The following figures (5, 6, 7) are shown as Position aircraft from various sources.

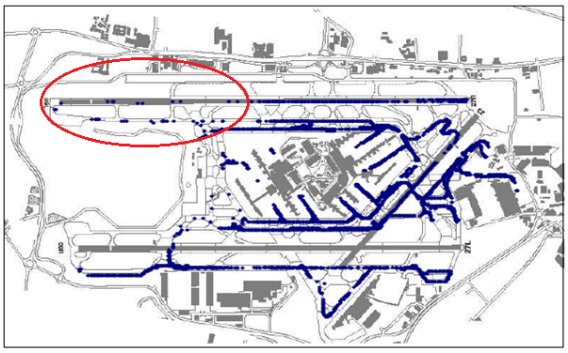

Fig. 5. Aircraft position reports from Mode S (ES)

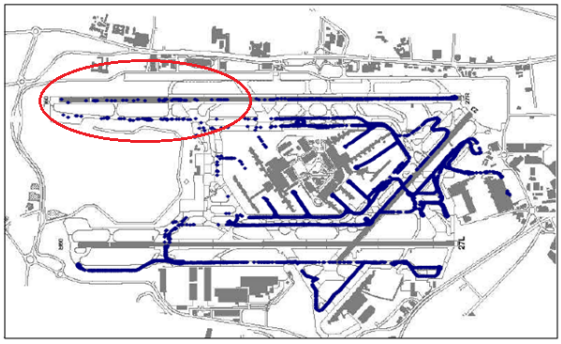

Fig. 6. Aircraft position reports from UAT

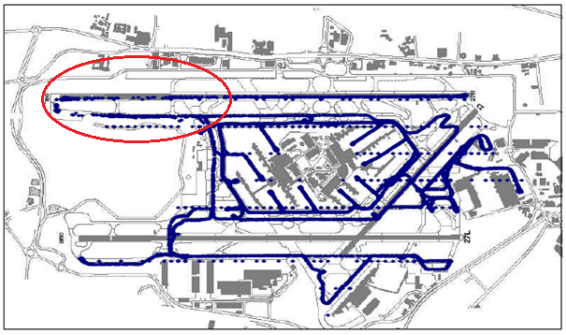

Fig. 7. Aircraft position reports from VDL – 4

Looking at these graphs it can be observed that:
• in the case of Mode S arisen difficulty detecting aircraft operating in the area obscured by the airport control tower, it turned out that the problem caused any emerging obstacles, such as when the car is moving and passing the buildings;
• in the case of UAT - the results were better than for Mode S, but also measurements suffered by the obstacles that obstruct the north - western part of the airport;
• in the case of VDL - 4 - measurement results were most gratifying, cause may be characteristic VHF.

5. CONCLUSION

In conclusion the study at Heathrow should pay attention to the benefits to collect large amounts of data that can be used for further analysis. In addition, there was some disturbing reactions Mod S car passing by aircraft. UAT relay did not react in any way, which would indicate with a Mode S signal interference from the vehicle with the signal from the Mode S aircraft. UAT in fact working on a similar frequency as the Mod S. Moreover, the impact of technology registered ADS - B navigational aids, including DME. In addition, the Mode S and UAT proved to be very sensitive to obstructions between the base station a ground station, which prevented their work. VDL - 4 did not have this problem. It should be noted that research in the area, the home airport operations should be subject to extra scrutiny. In the case of ADS - B, it would be worthwhile to try to choose a place of research in the area of the airport, where the potential interaction could occur, such as near piers or sirens DME.

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