PERSPECTS FOR FURTHER DEVELOPMENT OD ADVANCED AUTOMATED TRACKING ADS-X IN AIR TRAFFIC MANAGEMENT AND ITS IMPACT ON IMPROVEMENT SAFETY

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Despite the economic crisis which remains still exist in the world, today is the Aviation in the faster phase of development. Corporations are racing not only in the types of new aircraft, but also in the technical equipment of the aircraft, people are trying to create a functioning the modern space station, scientists are looking for a way to create jet fuel, which would does not cause burning during accident. However, there are places on earth which do not cover by air traffic control. In my thesis I focused at the possible future solution of the problem of monitoring and highlighted the benefits, which will bring the introduction of extended automatic surveillance ADS-X.

K e y w o r d s. ADS-X, prospects for further development of ADS-X,ADS-B,MLAT..

1 ÚVOD

With today's increasing air traffic density is the most widely used systems such as ground navigation aids, radar, voice communications, are becoming the lack of quality air traffic control. Used tracking systems have their limitations. Therefore, one possible solution to this problem is the tracking system ADS. Watching the eyes of ATM used in aircraft for various purposes, including organization of air traffic, weather reports, search and rescue, terrain mapping. ADS, is a technology that would be replaced by today's SSR and could increase situational awareness for aircraft. The surveillance system was established in the United States to improve the capabilities of NAS, and therefore in my work especially the conditions applying to U.S. airspace. Plans for extension of ADS-B system to cover the airspace without air traffic control is planned until 2025. But, scientists are trying to improve this system every day and so it was beginning the idea for the expansion of ADS-B to ADS-X, But, scientists are trying to improve this system every day and so it was beginning the idea for the expansion of ADS-B to ADS-X,which is higher level of surveillance of airspace. That's why the target of my work is this extended version, which brings many advantages, without the introduction of new systems on aircraft and even the cost of ground stations are much lower than the shows of today have used secondary surveillance radar.

2 AUTOMATIC DEPENDENT SURVEILLANCE- ADS

The next step in the development of tracking technology was the introduction of ADS.

Increasing the density of air traffic brings with it many problems.

In the area of monitoring, it´s overloading of transponder mostly, increased FRUIT (False Reply Uncorelatted In Time) and garbling, what are the shortcomings of the secondary radar. There were also adds a limited number of codes for 4096 mode A, and also that the SSR system is very limited data transmission, which can not be transferred except for modes A and C are no other useful information either in the direction of air - ground, air - ground or air - air.

Another problem is the air traffic over the oceans and land areas. There are not covered by radar signals. In these areas, aircraft position reports notified crews only. Long time intervals between reports of lead due to air traffic safety in large spacing between aircraft and thus ,to limit the capacity of the track leading over such areas.

One possible future solution to these problems is the use of automatic dependent surveillance (ADS - Automatic Dependent Surveillance). (ADS-B Automatic Dependent Surveillance-Broadcast, Automatic Dependent Surveillance Extended)

Automatic Dependent Surveillance is the monitoring, in which aircraft automatically detects

and provides data derived from onboard navigation systems, including aircraft identification, four-dimensional position (the position in space, including the time information) and additional data.
ADS is fully dependent on data and systems that are available on board the aircraft. This is the most significant difference between ADS and conventional way of monitoring by radar.
The ADS is the position of the aircraft detected automatically and it's only equipment on board the aircraft. In all radar systems is measured in the sensor itself, which is located on the ground. ADS team has changed the role of measurement of ground facilities (radars measure the exact distance and bearing targets) for communication systems for data transmission. [1]

3 ADS-X NEW GENERATIOIN

Advanced Automatic Dependent Surveillance (ADS-X) is a centralized network-management traffic. It is a solution that combines ADS-B and other multilateral (multilateration – MLAT) technology into one entry. The system is actively promoting the development of ADS-X to meet today's fleet and fully serve the needs and also allow for faster, cost-effective transition to ADS-B implementation. ADS-X integrates MLAT technology to ADS-B infrastructure to help simplify the equipment, verification and transmission of additional data associated with ADS-B. Because the technique can DREGS signals to the transponder in the process of Mode A / C / S, use the network of ground stations to locating the aircraft becomes a trend for new avionics equipment.

This enables air navigation service providers deploying next-generation technologies without prohibitive cost of national and professional certificates in aircraft modernization solutions. In addition, ADS-X solves the basic Prompt response of ADS-B as is - needs independent backup and validation of ADS-B reports separate positions. Moreover, the inclusion ability MLAT the ADS-B will verify the network location data in real time regardless of time using triangulation DREGS focus. [2]

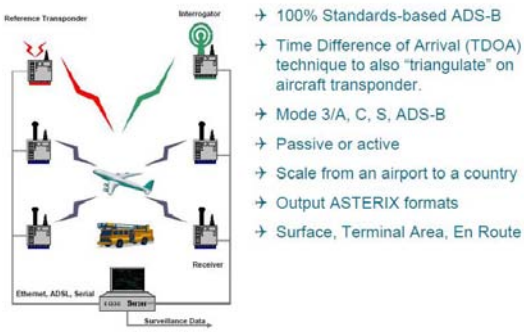

Figure 1 .ADS-B extended to ADS-X [6]

4 THE RANNOCH CORPORATION AND ADS-X

The company, headquartered in Virginia, is a leader in ADS-B system and the system multiúrovňovom threshing floor. Despite ongoing concerns about security, demand for air travel is forecast to continue at an extraordinary rate in both mature and developing markets. In the USA, the NGATS program forecasts that passenger numbers will increase by up to 140% over the next 20 years with aircraft movements increasing up to three-fold, depending on the mix of small and larger aircraft. In Europe, the SESAR Consortium predicts similar challenges, with the number of flights predicted to increase by 150% over the same period . In developing markets such as China, Asia-Pacific and South America the growth is expected to be even greater .
From an ATM perspective, the result will be around twice as many commercial aircraft travelling a more complex network of point-to-point and hub-and-spoke routes to an increasing number of airports. In turn, this will require reduced separation and flexible route planning, which will place significant pressure on improved performance from ATC systems and surveillance technologies.
There is general agreement that Automatic Dependent Surveillance – Broadcast (ADS-B)
will play a significant role at the core of future civil aviation surveillance infrastructure and, following some years of pilot programs (including CAPSTONE in USA, the Bundaberg Trials in Australia, and CASCADE/CRISTAL in Europe)

and discussions about standards and technologies, major ADS-B deployment programmes are now in progress, including the Australian Upper Airspace Program (UAP) and the FAA's NAS NASWide ADS-B Program.[3]

ADS-B uses new on-board avionics subsystems which incorporate GNSS positioning systems (e.g. GPS or alternatives such as Europe's Galileo), an interface to flight management systems, and a transponder to broadcast aircraft position and supplementary. information on a regular basis. This approach offers a number of benefits, especially when compared to traditional radar alternatives: :

- The ground infrastructure required to determine aircraft position is relatively cheap, consisting of radio receivers able to detect and decode the messages within line-of-sight of the transmitting aircraft and up to 250nm distant from the aircraft.
- The resulting data is generally extremely accurate (potentially within tens of metres), of high integrity, and with an update rate far exceeding that obtained from radar.
- ADS-B architecture is two-way, which allows aircraft to receive position and other information directly from other aircraft or from ground based (TIS-B and FIS-B) infrastructure, to provide rich cockpit information and enable new cockpit-based applications.

4.1 ADS-B Implementation Challenges

These benefits present an overwhelmingly compelling case for ADS-B deployment, however there are a number of challenges which must be addressed for ADS-B to be adopted as a primary or sole surveillance solution in order that the benefits can be completely realised.

Firstly, ADS-B requires new equipment on-board each aircraft and, while incremental costs of ADS-B equipage for new aircraft is small, the costs to retrofit existing aircraft, including certification costs and the opportunity costs of the associated operational downtime, are significant. As a result, even with new rules and mandates being introduced, it will be many years until equipage levels are such that ADS-B can be used as a platform for consistent and universal aircraft separation. The FAA ADS-B program assumes that, even with rulemaking support, it will be 2020 until all large commercial aircraft are equipped.

Secondly, the transition from radar to ADS-B will need to address issues of data integrity and validation before ANSPs can undertake safety-critical separation services using position information derived, no longer from their own radar infrastructure, but from information provided directly from the aircraft avionics. It seems likely that, even if the safety case supports ADS-B-only surveillance, issues of governance and responsibility will require ANSPs to establish an independent means of backup and validation for ADS-B and the associated business case will be significantly impacted if this backup system must rely only on ongoing use of a radar infrastructure.

Thirdly, surveillance based on the broadcast of self-reported aircraft position raises security issues, both in terms of the ease with which aircraft can be tracked from the ground by almost anyone using low-cost and readily available ADS-B decoding units, and also by the potential for an aircraft to knowingly mislead a surveillance system by spoofing its position information and appearing to be in a position other than the position. at which it is actually located.

In May 2006, the potential vulnerabilities to spoofing were described in a letter from the Australian Civil Aviation Authority's former Chairman to the Australian Government's Minister for Transport and Regional Services which highlighted the potential for malicious or capricious actions, stating that "any electronics boffin, using a second-hand or 'borrowed' transponder from a small GA aircraft connected to a $5 data lead, a $5 aerial and a laptop computer, can create ten,twenty or even fifty false aircraft on an air traffic controller's screen"

Finally, the introduction of ADS-B surveillance will require the finalisation and global adoption of a significant new body of associated standards for both aircraft and ground domains.[4]

4.2 ADS-X – The Integration of ADS-B and Multilateration Techniques

Firstly, because multilateration techniques can be applied to existing (Mode A, Mode C, Mode S) transponder signals, the network of ground stations is able to determine the position of aircraft without the need for new avionics. This allows ANSPs to deploy the next generation, low cost technologies without the need for a contentious early mandate for equipment retrofit whilst still potentially avoiding the need to replace SSR systems. Figure 2 shows indicative coverage of "SSR-visible" aircraft (ie. Aircraft with operational transponders) in an ADS-X network, and how the network provides SSRequivalent coverage independent of the speed of the ADS-B transition.

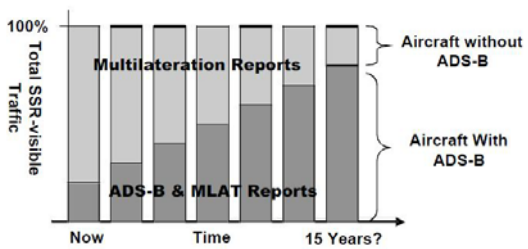

Figure 2. Fleet coverage ADS-B and MLAT [5]

The second ADS-B implementation challenge - the need for independent backup and validation of ADS-B self-reported position, is also addressed by the inclusion of multilateration capability in the ADS-B network, as each ADS-B position report is validated in real-time by TDOA triangulation. In effect, the address shown at the top of the letter the message is independently compared to the postmark on the envelope containing the message to assess the validity of that message.

The FAA, in its recent industry briefing , has both confirmed the need for a backup and validation system for ADS-B and has identified and short listed three candidate strategies to address this requirement. The first candidate strategy relies on the continued use of a (reduced) SSR network, which is likely to have a significant impact on the economics of the overall programme. The second and third trategies are both based on the use of multilateration as the backup technique, with the two strategies differentiated by the inclusion of active interrogation for terminal areas in strategy three.
Furthermore, it is clear that the backup and validation system will not only mitigate the risk of accidentally erroneous self-reported position, but will also address the potential for deliberate spoofing of aircraft position, as the independently-derived multilateration solution will be extremely difficult to spoof without actually emitting a signal from the location in questione.[5]

5 PERSPECTIVE OF ABS-X as the possibility of other solutions FUTURE

The contribution of my thesis was to create questionnaires for business air traffic control for the pilots in our country and abroad. Questionnaires are written in both languages. According to this survey can determine the conditions under which pilots fly as a secure area where monitoring is regularly flies.
From the results I found that a large company such as Korean Air, which flies regular transatlantic flights using aircraft such as A330, which is still used as s Basic of the ADS system, which regularly fly through areas which by now are not covered for monitoring ATC. ADS-B provides much better coverage than today's radar, even ground ADS-B stations are smaller and simpler than the location of radar.
Many companies in this new system does not hold, while United States is trying to cover the entire continent using this technology for several years. There are still places today even without radar coverage. Examples of such remote places as the Gulf of Mexico is, areas in Alaska that will soon be covered by ADS-B technology. When pilots are flying across the Gulf of Mexico at low altitudes, the radiation used procedural navigate the aircraft, with the help of crew reports, no visible current position of the aircraft flying. Because of this uncertainty, the radiation need to use more vertical spacing to avoid a possible collision of aircraft in the air, while not intentionally reduce the use of airspace for flying more aircraft. In this sector, ADS-B really help to reduce the separation requirements, and also greatly increase the safety of crossing such as helicopters flying regularly to oil platforms in low altitudes.

For information, I note that just in the Gulf of Mexico today is a whopping 5500 oil areas and regular daily flights of helicopters are in the range between 5000 to 9000 operations per day. FAA installed on some oil rig system ADS-B ground stations using helicopters and just because the FAA has received a valuable platform for naval platforms and began a massive collaboration between flight operations and oil companies in an effort to provide better coverage. But while oil companies must comply with that if such an aircraft to land on an oil rig, platform must have ADS-B equipment. Thus, this area receives many benefits that this system will bring.

Canada respectively. NAV CANADA has decided to project that by the end of 2020, wants to cover 1.3 million square kilometers of airspace over the North Atlantic (busiest airspace over the ocean in the world) with a combined coverage of ADS-B and radar (see figure below)

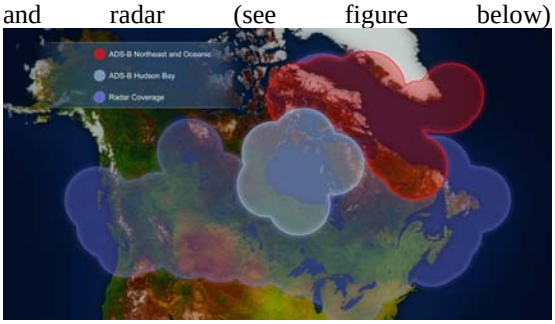

Figure 3. **plan covering the North Atlantic in 2020** [2]

The questionnaire, which I compiled for a pilots, I applied at a Korean Air. Pilots of the company gave me the answers to the questions of which I could conclude my analysis.

The questionnaire was filled by a very experienced group of pilots who have flown over 6,000 flight hours even one of the pilots more than 14,000 hours. Mostly flying the aircraft type B777 and A330, so commonly encountered with the system ADS. However, not all use a newer version of ADS-B (only pilots type 777). Thereby, the pilots who fly through the area without ATC coverage using an older type of ADS, as well as aircraft equipment is different. My research I wanted to point out that an essential condition to pilots why this system is not used anywhere- is the price. In doing so, on the contrary, the price of introducing ADS-B or ADS-enhanced version of X is less than cost, of other SSR SSR. And I think that is also one of the key reasons why many companies still do not use ADS-B on board their aircraft and ground stations.

6 CONCLUSION

My thesis was focused on the prospects of further widespread use of automatic dependent surveillance ADS-B ADS-X and focus on air safety in the world today. Surevillance is the eyes of ATM, which is used in aircraft for various purposes, including organization of air traffic, weather reports, search and rescue, terrain mapping. ADS, is a technology that could replace today's SSR and could increase situational awareness for aircraft. The surveillance system was established in the United States to improve the capabilities of NAS.

ADS-B provides air traffic controllers and pilots more accurate information that will help keep aircraft safely separated from other aircraft in the sky and on the runways on the ground. This allows for better monitoring and improved situational awareness for pilots and air traffic controllers.

ADS is the future pilots and control connections to a single unit. Today we live in a time of technological development, and scientists have developed a new technique daily, only Australia has covered the whole sky just ADS-B system. Although the prospect of my work was to focus on a completely new version of ADS-X system. I have compiled questionnaires rather general technique for ADS / ADS-B, which is longer used. I hope, that I brought a few interesting information of ADS-B/ ADS-X to better understanding of surveillance technique of Air space..

BIBLIOGRAPHY

[1] **Fabry, Ing.Lubomir.** [Online] http://web.tuke.sk/lf-klp/Fabry%20Lubomir.

[2] **faa.**faa.gov.[Online]2011.http://www.faa.gov/nextgen/portfolio/trans_support_progs/adsb/.

[3] **AlexSmith,CEO.**faa.gov.[Online]June2006.http://www.faa.gov/about/office_org/headquarters_offices/ato/service_units/enroute/surveillance_broadcast/program_office_news/ind_day/media/Rannoch.pdf.

[4] **Alex Smith and Russell Hulstrom, Rannoch Corporation.** www.sra.com. [Online] october 2006. http://www.sra.com/media/era/pubs/ADS-X%20-%20Next%20Genera.pdf.

[5] **Creativerge and era corporation-Multilateration guide.** multilateration.com. [Online] 2010. http://www.multilateration.com/downloads/MLAT-ADS-B-Reference-Guide.pdf.

[6] **Ramsey,Marc.**pacificsoaring.org[Online]November4,2006.http://www.pacificsoaring.org/articles/ADSB_ramsey06.pdf.

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