

PROVISION OF ADS SYSTEMS BY ALTERNATIVE POWER SOURCES

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Still emerging aviation is pushing for the development of security systems, which have much higher coverage than conventional radars. Because there are still places on earth that do not meet the air traffic control coverage. Therefore, the flight space is not used sufficiently effective and and this leads to increase of gaps in time schedule of aircrafts due to their safety. In my thesis, I looked at exactly the introduction of the ADS using multilateration which allows quick and seamless transition. And I also analyzed the power of these systems that would be secured and backed up by power sources. These resources should be recharged by alternative supplying sources.

Keywords: ADS, multilateration, alternative sources.

1 INTRODUCTION

Global air traffic is increasing exponentially. Within the decade, the number of passengers that occupy an already crowded airspace will double. More passengers means more aircrafts. Air traffic, however, is already suffering from delays.

In order to improve efficiency, achieve fluency in operation, minimizing infrastructure costs and most importantly, many of LPS are turning away from traditional radar to different technology and ADS - B and multilateration.

ADS systems, which are able to utilize the space flight as good as possible, of course, require a power supply. Since the device does not require much energy, they can be powered by alternative sources. Additional sources will recharge our batteries used as the source in case of an unexpected failure of the main power supply.

Well-usable alternative source is solar energy, which can be used almost anywhere. Wind energy, mainly used in high wind areas and lowlands. Biomass, which is actually a natural product and therefore very well usable. Hydropower should be used in areas where we can get few different water resources or in coastal and in ocean areas.

And last but not least, we have a geothermal energy, but this one can only be used in areas where there are geothermal spring fountains. We can not forget the energy coming from the combustion of straw or grass in agriculture, this product is sufficient, therefore could also be used as an alternative source of energy production.

2 MULTILATERATION

The essence of multilateration is fact that it provides an elegant transition to ADS-B by using the same infrastructure, providing early benefits through improved monitoring. It is well established technology, tested for decades. It was developed for military purposes to be used for the exact location of aircrafts, many of whom did not want to be seen, using a method known as time-difference of arrival TDOA. It works with a number of ground stations, which are located in strategic locations around the airport, the TMA or the broader field of management, which is located in the surrounding airspace.

These units listen to "reply" typical query signals from local Secondary Surveillance Radar (SSR) or multilateration station. As the aircrafts will be located at different distances from the various ground stations, their responses will be taken by each one of the stations in different times. Using advanced computer technology, data processing, these timing differences will be used for accurate calculations of the position of the aircraft.

Multilateration does not require additional avionics equipment as it uses transponder reply on Mode A, C and S, as well as military IFF transponder and ADS-B. LPS offers the opportunity to provide tracking services for potentially much lower cost with greater reliability and a higher level of accuracy over conventional SSR.

Since the appearance of signals from radar and multilateration "targets" on the screen of air traffic controller are identical, their very high update rate will apart them due to their continuous movement. Screen showing multilateration information can be updated in every second, compared with 4-12-second "jumps" targets, according to the radar.

MLAT ground stations receive responses from any aircraft equipped responder, including indigenous radar ADS-B avionics and help determine aircraft position based on the time difference of the received signals - responses (TDOA). [1]

2.1 ADS systems

Increasing the density of traffic in the air transportation brings along many problems. The viewing area it is particularly the overload of responders, and increased FRUIT and CARBLING. To these problems there are also added limited number of codes for the mode A, and the fact that the SSR system allows only a limited data transmission which does not allow to transfer other than mode A and C any other useful information both in the direction of air - ground, air - ground, and air - air.

Another problem is the air traffic over the oceans and the land areas not covered by radar signals. In these areas, the position of the aircraft is notified by messages from cabin crew. Long intervals between messages because of air traffic safety, lead to large spacing between aircrafts, and thereby to limiting the capacity of the rail lines that run through these areas.

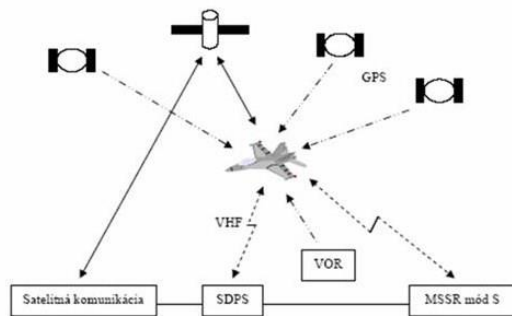
One possible solution to these problems is the use of automatic dependent surveillance (ADS).

Automatic Dependent Surveillance is monitoring, in which the plane automatically detects and provides data derived from on-board navigation systems, including aircraft identification, four-dimensional position (position in space, including the time information) and additional data. ADS is fully dependent on the data and systems that are available on board. This is the most significant difference between ADS and the conventional method of tracking by radar.

The primary source of information about the position of the aircraft's GNSS (GPS, GLONASS, Galileo) and it is used by most implementations of ADS. Nevertheless, they are used also conventional navigation systems, for example:

VOR, DME and so on.

There are three types of ADS systems : ADS-C, ADS-B and ADS-X. They all have the same requirements for the navigation system, but the distinction is the use of communications data line. [2]



Picture 1. Automatic Dependent Surveillance [2]

2.2 ADS-B and multilateration

The future environment ADS-B, the current secondary radars scans will be eliminated or they will become a backup system: LPS announced program ADS-B, for example: LPS FAA and Airservices Australia have already declared their intentions to reduce their proportion of SSR installation by up to 50%.

Many LPS also considering multilateration as more economical for future backup requirements for continuous analysis of SSR maintenance costs, energy, fuel and other expenses.

Another key aspect is that multilateration systems have built-in capabilities of ADS-B, the fact that the current land multilateration sensors are capable of monitoring the transmission of ADS-B aircraft as efficiently as those in modes A, C, S and Military IFF transponders to.

Four other important arguments that arose.

First: the installation of multilateration network whether the purpose is to serve a new airspace or replace and succeed after of SSR will be the first step towards the ultimate transition to ADS-B: This is so because the newly installed network can immediately follow with older aircraft already equipped for ADS-B.

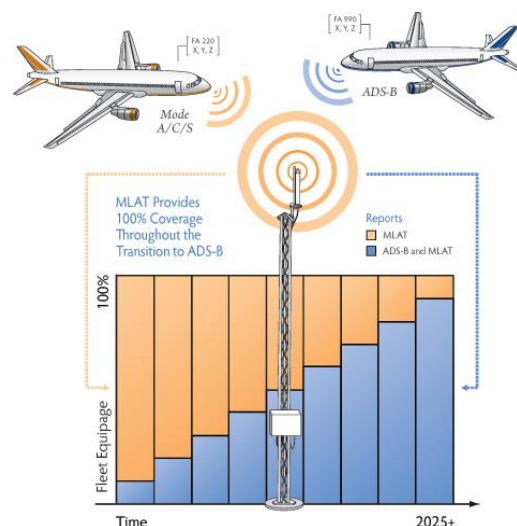
Second: As we approach the transition to ADS-B, multilateration sensors can serve as a fully functional backup for ADS-B transmitters in significant cost savings.

Third: already installed multilateration network can act as primary backup to ADS-B and also perform the functions of verification.

The last one is that multilateration system will continue to monitor the operation without ADS-B during and after the expected transitional period, to ensure the availability of services at minimal or no additional cost to LPS.

MLAT provides 100% coverage throughout the transition period for ADS-B.

Since the MLAT is backward compatible with existing SSR transponder and forward compatible with ADS-B provides coverage for the entire air fleet at present and in the future regardless of the speed of aircraft equipment. [1]



Picture 2. MLAT provides 100% coverage throughout the transition period for the ADS-B [1]

3 ALTERNATIVE ENERGY SOURCES

Alternative sources also called renewable energy sources in the future will partially or perhaps completely replace existing sources that burden and gradually destroy our environment. Their primary and most important advantage is that by nature are virtually inexhaustible: The result of the use of such energy is the same as that of non-renewable resources, with the only difference - the energy required for the production arise (or at least created) wasteful by-products damaging the nature.[3]

Green methods of electricity generation, such as hydro, wind and geothermal, are less than one percent of the world's electricity production, but play an important role in the regional economy and subject to availability: Solar panels for heating and photovoltaic energy created through chemistry, light propeller blade of carbon fiber for production of wind energy, concrete and metal turbines for

hydroelectric power, and corrosion-resistant materials for use of geothermal resources.

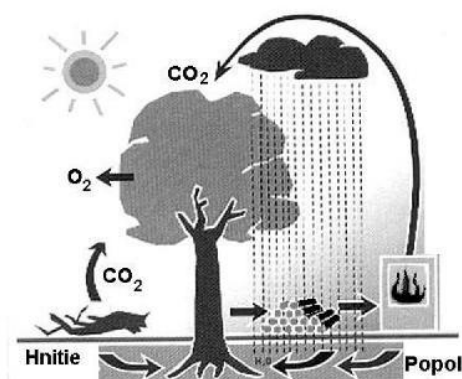
The alternative and inexhaustible resources include: biomass, solar energy, wind energy, hydropower and geothermal energy. [4]

3.1 Biomass

Biodegradable fraction of products, or the rest of the plant and animal substances from agriculture, forestry or the biodegradable fraction of industrial and municipal waste is biomass.

Chemically preserved solar energy is the biomass in the form of plants. The plants use the carbon dioxide from the atmosphere to grow and water from the ground, which, through photosynthesis transform into hydrocarbons - construction articles biomass. Solar energy, which is the driving force of photosynthesis is actually stored in the chemical bonds of the organic material. The burning of biomass energy is recovered, stored in chemical bonds. Oxygen in the air combines with the carbon in the plant, which produces carbon dioxide and water. This process is cyclically closed, because the carbon dioxide formed the input material for the new biomass.

We can divide biomass by the sector where it is produced. There is agricultural sector biomass which includes grain, rape, maize straw. Also hemp, animal excrement, waste from orchards and vineyards, and dedicated energy crops. Furthermore, there is forest biomass where we include firewood, branches, stumps, roots, bark, wood chips, fast growing trees. These are followed by wastes from wood processing industry as cuttings, shavings, sawdust. Finally, municipal waste which falls under the solid combustible waste, biodegradable waste, landfill gas, sewage gas. [5]



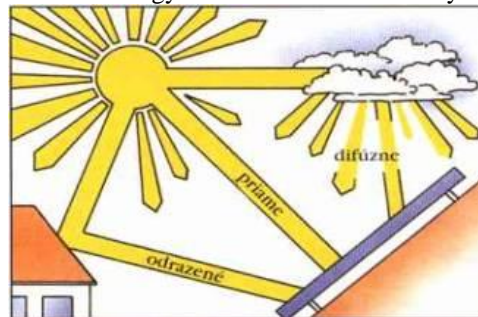
Picture 3. Formation of biomass [5]

3.2 Solar energy

Each year the sun hits the Earth about 10 thousand times more energy than mankind consumes in this period. Amount of incident solar energy on the territory of Slovakia is about 200 times larger than the present consumption of primary energy sources in our country. It's huge, yet almost completely untapped potential. The

use of solar energy today is the cleanest way of using energy at all, and unlike other sources (including renewable energy), the impact on the surrounding environment is negligible. Solar energy is a driving machine of life on Earth.

Solar energy warms the atmosphere and the Earth, it creates wind, warms oceans, allows evaporation of water, gives strength to watercourse, allows plants to grow and in the long run creates and fossil fuels. Solar energy and its related renewable energy sources - wind, water and biomass can be used for the production of all forms of energy that humans use nowadays. [6]



Picture 4. Formation of solar energy [6]

3.3 Wind energy

Wind, as it is present everywhere, man has used since time immemorial. Moreover, this energy is also attractive today because its use does not produce any waste, does not pollute the air and does not have a negative impact on human health. Wind as a primary source of energy is free and can be used decentralized in nearly every part of the world.

Wind units are built all around the world. They are also ideal technology for developing countries, where there is currently a great demand for new production capacities in the field of energy. The advantage of wind turbines is, that compared to conventional power plants, they can be easily, cheaply built in relatively very short time, and connected to the public network. Developed countries today show the interest in wind turbines not only in terms of environmental protection, but also for economic reasons. The price of produced electricity is declining in some countries, and it is comparable to the price of electricity produced in conventional power plants. Today, even the most conservative power engineers predict the development of large wind technology in the near future. [7]

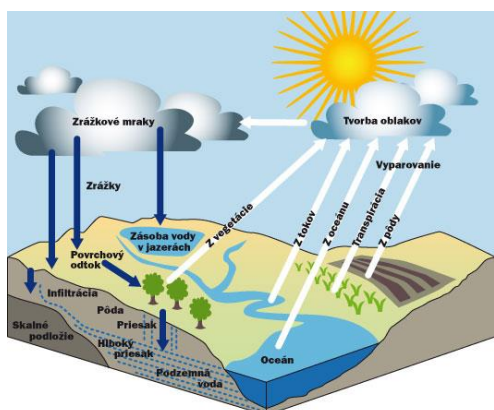


Picture 5. Wind turbines [8]

3.4 Hydropower

Water is on earth and its atmosphere in a constant motion. As a result of activities of the sun, it evaporates from bodies of water, it creates clouds of steam and falls down to earth as rain or snow. The energy of this water cycle is very effectively used by hydropower stations or water-driven mechanical works. The use of water as a power to drive mechanical equipment is very old activity and reaches far into the past. Simple water-powered wheels, replacing hard work, humankind used since time immemorial. The first mention of such equipment occurs at the ancient Greeks around 4000 BC. Greeks used hydro power mainly for grinding grain. The use of natural energy has become even easier and more widespread after what the development of first water turbine at the beginning of the 19th century. Since that time there was strong promotion of electricity made by hydroelectric power stations. Latest technology of electricity production from water are based on the use of marine tidal wave or temperature difference water in the oceans. From those types of hydropower the only marine tidal energy is not the result of the sun, its activity, but is caused by the Moon gravity. Wave energy is a direct result of wind power, which is caused by the sun and its activity.

Hydropower potential at any point is determined by two variables: amount of water (flow) flowing per unit of time and the vertical height of water drop. Gradient may be a natural result of in a gradient, or may be artificial, for example dam. Level drop in contrast to water flow rate is fixed. Flow changes as a result of varying intensity and distribution of rainfall. In addition, it also depends on evaporation or infiltration into the ground. [9]



Picture 6. Hydropower [10]

3.5 Geothermal energy

Geothermal energy is not, strictly speaking renewable energy source because the origin of the hot core of the earth, from which heat escapes through cracks in the volcanic rocks. Given the vast, almost unlimited supply of energy, but tends to be clustered among these

sources. Core temperature is estimated to be over 4,000 st. Celsius and in coat of 10km land package, which is available to current drilling technology, there is enough energy to meet our consumption for a period of several thousand years. The glowing heat proceeds from the the Earth's centre toward the surface. Temperature increase is ranges from 20 to 40 ° Celsius for vertical kilometer of local maxima (geothermal) At a depth of about 2500 metersis water is often warm up to 200 ° Celsius.

The use of geothermal resources reaches far into the past. There are archaeological records that American Indians have more than 10 000 years ago settled the area in the vicinity of geothermal resources. Sources such as geothermal hot springs were popular and ancient Romans, Turks and Maori in New Zealand. The first records of the industrial utilization of this energy goes back to 1810, when it started with the extraction of minerals contained in geothermal hot waters in Larderello in Italy. Nine plants using geothermal water in this area were built in 1816 to 1835.

Geothermal energy is mainly used for heating buildings such as pools, greenhouses, as well as residential buildings connected to the district heating system. Such heating has been installed in the U.S. in 1890 Boise (Idaho State) In Reykjavik, Iceland geothermal water was heated 45 000 homes and 95,000 square meters of greenhouses as early as in 1960. There is also a special group called heat pumps, and these use the heat to prepare the ground heat energy [11]



Picture 7. Geothermal energy [12]

4 USE OF ALTERNATIVE POWER SOURCE

The contribution of my thesis was the use of all alternative sources in the area which would be where the specific resource is efficient.

According to the rules and options, there are also addressed ways and locations to position of alternative sources. Systems must of course be fed conventional electricity but should any unexpected loss of power occur, it is necessary to have a backup power system. The backup system I have in mind is powered by alternative sources of energy. Backup system would work the running battery power that would have been conquering various substitute sources of energy such as solar, hydro, wind, biomass, geothermal etc. Since ADS systems are

deployed around the world in different climates, we would use in a specific area a specific type of alternative energy.

Solar energy is one of the most widely used alternative sources which is available everywhere, because the sun is shining throughout the world. The charging of the batteries would be best if we use photovoltaic cells that convert solar energy into electricity. This will recharge the battery, which would serve as a backup system when unexpected power outage occurs. The largest application of this kind of source is, where there is heat and drought, such as various desert regions. There is the largest power plant to generate electricity using photovoltaic in California.

Hydropower is only used in areas where there is good access to some waterfront as a river, a lake, a sea or a ocean. The device, which would be located near any water area, we would power by the pawn using micro turbines or we would use energy waves. Micro turbine would be placed in locations where there is either low drop of water or excess water or combination of both. Use of energy waves is particularly effective because the waves pass over greater distances without losing its power on. Technology that uses the energy based on their capture in an enclosed space, and their kinetic energy is transformed into electricity. Both types of energy can be used in areas along the oceans and seas such as England, America, Australia.

Wind energy is a form of solar energy produced by uneven heating of the earth's surface. Wind is present everywhere, therefore, this form of alternative source we can put to use almost anywhere. Most preferably, however, the high windiness where using small wind turbines will power to recharge the batteries that serve as back-up power system for ADS. Areas where we use wind energy the most the USA, Hawaii, California, but also Denmark, Germany and Austria.

Biomass is also one of the alternative sources, works on the principle of combustion and the production of steam, which drives a steam turbine. Biomass is a purely natural product with its combustion does not occur to such air pollution than conventional fuel combustion. The resulting combustion we can transfer the energy into electricity, which will serve us to charge the battery. The battery, which will be serving as an alternative source for the unexpected loss of normal power. Biomass needs for its grow the soil and favorable climate conditions, which are mainly in tropical areas. Countries where the highest biomass production is and at the same time we would like to use our alternative power source for ADS are Brazil, Ethiopia, South Africa, Hawaii and Queensland in Australia.

Burning straw would also be a possibility of obtaining energy to power our alternative source. Straw has a higher specific heat value than lignite and is actually waste arising from agricultural activities so that it is economically challenging. Country where the burning of straw is used are India, China as well as Denmark, Austria, United Kingdom.

Geothermal energy originates in the hot core of the earth, from which heat escapes through cracks in the volcanic rocks. Huge resources are practically inexhaustible energy so that rank among renewable sources. Hot springs are used in Italy, in the U.S. state of Idaho, Iceland, New Zealand, Mexico, Philippines, Sweden, Finland, Slovakia. Since these countries are rich in geothermal energy could be used as an alternative power source for ADS systems.

5 CONCLUSION

The still growing air transport and the associated security requires multilateralization, which is there to be used for an elegant transition to ADS-B. Compare to secondary surveillance radar this system helps cover larger areas at lower cost. In the past, the requirement to cover the airspace can only be considered within the purview of traditional SSR outputs. In the past the need of coverage was often limited and compromised, the need for further "the patch gap" with other devices, or simply the limitations of aircraft and places where aircraft can maneuver safely. Multilateralization does not have such limitations and its global adoption confirms the flexibility of this technology. Current and future role of the MLAT consists in adding or replacing secondary radar.

Air transport brings along many challenges posed by increasing traffic density. Although air traffic over the oceans and land areas that are not covered by radar signals, causes significant problems. The position of aircraft is announced by cabin crew in these areas. These problems would be resolved by Automatic Dependent Surveillance in which aircraft automatically detects and provides data derived from on-board navigation systems, including aircraft identification, four-dimensional position and additional data.

Alternative sources of power, which we call the renewable would be partially or completely replacing the current source as damage to the environment. Although ADS systems could be powered by alternative sources of capital in the event of failure of the primary power supply. Secondary power supply would be put in use in an unexpected failure of the primary power supply and would be fed by the batteries that are recharged by various forms of renewable energy. Selection of the source would depend on the area where the system is located, or the climate and weather conditions.

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