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Professional Paper

NETWORK INCREASED AIRSPACE CAPACITY – WATEN

Ilir Mehmedi

Department of Transportation and traffic engineering, Faculty of Applied Sciences, University of Tetova, RNM
**Corresponding author e-mail: ilir.mehmedi@unite.edu.mk*

Abstract

This work describes, explains and proves the necessity for stabile global air track network World Air Track Elastic Network – WATEN to accommodate future air traffic and enable full automation in process of control and separation of civil aircraft during en-route phase of flight under instrument flight rules - IFR.
According to long term forecasts, global air traffic will rise in an average of 5% per year threatening to overload the airspace and limit future development of civil air transport. New solutions for improving the safety of the flight by automation and **increasing airspace capacity** through more efficient airspace use will enable a continuous increase in the number of flights.
More than 70% of incidents and accidents in civil aviation are caused by human factor, therefore, a strong need exists for a higher level of automation in civil air transport especially in process of control and separation of civil aircraft that are flying under instrument flight rules. Automated systems will separate traffic by using appropriate equipment, software, and procedures. The first phase will exclude air traffic controllers' and their active control of traffic and in the next phase pilots will be excluded too.
One of the basic conditions for full automation in process of control and separation of air traffic is setting of permanent global network of air tracks named: **World Air Track Elastic Network – WATEN** as a physical base for aircraft systematic movement and matrix for separation procedures. It will be established as permanent but with physical and commercial elasticity and based on direct tracks that are part of earth's great circles connecting the most important destinations in the World as a **Strait Line Network**. Other destinations will be included in the **Secondary Network**. Aircraft using this network, Global Navigation Systems and **WATEN MODE** equipment on board of aircraft will have the possibility to separate themselves from the other aircraft in the same or opposite direction of flight as well as to cross the track of other aircraft in a horizontal or vertical plane without external help. Lack of airspace capacity will additionally stimulate a need for a completely new approach to aircraft separation. **Group flight**, which is now reserved for other types of flight, will become a legal part of a regular procedure for commercial aircraft.
Automatically separated traffic will enable a higher level of safety, reduction of number of occurrences, **greater capacity of the airspace** and more stabile flow of civil air traffic.

Keywords: network, airspace, safety, separation, aircraft

1. Introduction

Airspace capacity relevant to this work is greatly dependent on such an airspace organization conditioned by the needs and influences of the airspace users.
According to the users' demands, on macro plan, the airspace organization shall be done in a way to satisfy, to the greatest extent possible, users' global needs and at the same time adjusting the portions of airspace to the local needs of the Member States. The needs to be satisfied are generally set to the possibilities to finance the ATM system of a Member States or group of Member States, if the function is united at the functional block, FABA level or joint services and to assist the financing of regulatory and supervisory function of the Member States.
The initial losses of capacity occur during the global planning because all portions of the airspace are without homogenized regulations, technical equipment, and procedure

development, so the capacity of a portion of the global network may be expressed through the capacity of its weakest part. This is the reason for the homogenizing of the airspace characteristics of the specified elements.
In certain States, the developed regulation has enabled certain parts of the commercial aviation to be relaxed from unnecessary costs by applying certain savings in respect of manpower and equipment according to the law. Examples for this may be found in more intensive use of electronic self-serving of the passengers (computer reservations system, e–booking, remote e-banking, e–check-in, etc.).

2. Euro control technical development

Technical development of the control system and monitoring of the air transport have cut the costs in respect of manpower. Modern communication systems and aviation supervision have enabled the possibility to organize the civil and military air traffic controls and monitoring service in centers covering more and more territories. Sophisticated regional centers so-called functional airspace blocks will follow and control air transport in some joined the Member States only from one center thus ceasing the need for organization of smaller area control centers in each country, and in some more than one center there is only a tendency to unite in future air traffic controls of all European air transport from one center EUROCONTROL.

High level of procedure development enables the traffic operations, at less important airports, to carry out and without the presence of air traffic control authority. Such procedures are based on principles of airspace classification according to the criterion on various needs for different types of air services operation, from which two of them are basic, that is, visual flight rules and instrument flight rules; for carrying out the supervision/control of the air services operation according o the needs of users. Sophistication of aviation (approach and departure, as well as missed approach) procedures have achieved such a high level enabling the commercial flights operated with commercial transport aircraft for carriage at a medium distance to be carried out at airports without air traffic controls.

Member States are with various social system/order, great differences in respect of the state administration organization and efficiency, differences regarding the aviation practices and infrastructure development which directly affect the differences of the capacity of the respective airspaces. Negative influence on capacitance results from the elements such as territorial aspect of certain Member State (the ratio of a dimension of state territory or a portion thereof maybe 10:1 or worse as the case is with Chile), in which a part of airway network has been arranged to its character aiming to set up the most frequent destination along its longest dimensions thus enabling a successful commercial effect and at the same time reducing the unit rate (unit rate is a right of every country to establish, through the cooperation with the neighboring countries and international organization and aviation industry associations on the base of a unique mathematical coefficient, the base for calculation of air traffic services charges on the territory and airspace for which the respective air traffic control is in charge). Due to the various methodologies used for calculation of coefficients and differences in applying stimulating and disincentive tariffs regarding the services charge are occurred which in addition to the influence on the scope and frequency of the air services within the respective country, that is, within the part thereof, determine the commercial efficiency of the neighboring countries even of physically detached countries which consecutively due to the deviation of the traffic by the change of the charge collection structure in certain countries may increase the served traffic or decrease it, and in extreme cases may dense the airspace or block the air traffic flow.

3. Political and economic factor

In certain cases the political and commercial factors are contradicted in certain neighboring members (there are examples of such contradictions of interests even in members which are not neighboring, but the consequences of intervention on network portions may set them on contrary positions because such interests of different members are complementary, that is, there is no possibility to accomplish all of them in the scope, but they form constant value and they may only share such constant value in various ratios. Direction networks which would be set only according to the criteria of the global indicator would create different political and commercial effects to various members. Such a difference would be defended by common global interest reconciling respective interests unlike local network development which could not avoid local influence, and thus it may not be led to the common overall benefit criteria.

By comparison of possible and realized routes, commercial losses caused by political reasons may be illustrated in Figure 1.

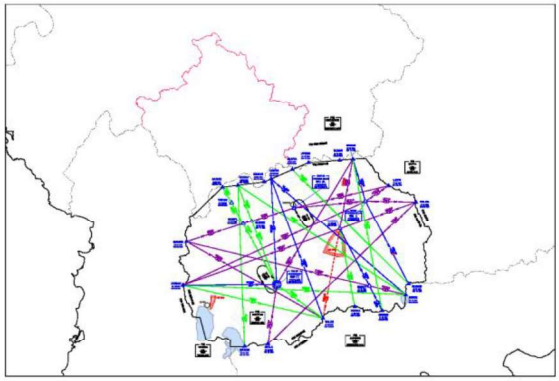

Figure 1. Image of Republic North Macedonia and Kosovo border with routes used by aircraft taking-off and landing at the Airport in Pristina

A sufficient number of ports/connections at global the network are left for local purposes, while the local created networks with described characteristics condition the ports/connections quality, so the difference in allocation of accessibility to global network and main traffic flows could not be compensated. (Global traffic flows are variable due to the influence of a great number of factors, so the position and influence of the members conditioned by the same global criteria will be variable).

For the purpose of conducting the efficient airspace organization and its capacity increase at global community level, it is necessary to establish common principles based on mathematical calculations representing commercial interests of the airspace users (even though they are owned by certain Member States or are part of their economic system, thus, to a certain extent, being representatives of the interest of that members), as well as objective criteria. (objectivity is a subjectivity conditioned by the participation intensity and possibility to influence the decision-making process, which should be substituted by a consensual decision by the Member States instead of majority decisions. It could be possible to use compensation of injured members because the air transport would achieve an additional value enabling the compensation by increase of capacity and thus the conditions for commercial efficiency).

4. Increase airspace capacity

Meteorological influences on airspace capacity would be to the greatest extent possible compensated by globalization of network routes unlike the existing practice in which the traffic diverting has due to meteorological obstructions been carried out within the borders of one (each respective and often in contrary to or discrepancy to the diversion carrying out in the neighboring Member State, because there is no standardized procedure regarding the united diverting in the region, nor in certain countries with several area control centers, which are not coordinated in that sense) Member State or at most in cooperation between two Member States at the borderland, while the global network would have the possibility to avoid adverse meteorological conditions by turns which involve a great number of members, regions even continents.

Favorable meteorological conditions are a unit measure of meteorological influences, that is, they are a minimum of such influence enabling the maximum airspace capacity measured by means of such criteria, and this is called basic airspace capacity according to the meteorological influence criteria.

Fully agreed commercial influences are commercial influence unit rate enabling maximum airspace capacity measured by such criteria and it is called basic airspace capacity according to the commercial influence criteria.

Allocation of the airspace capacity allocation and management systems capacity and traffic control are territorially different. The most successful approach can be carried out by means of the application of a global strategy. Capacity increase of airspace capacity as well as of operative systems capacity, at the local level, within one member or group of members would be nullified by the insufficient capacity of the neighboring member or group of members.

Airspace capacity decrease shall increase the loading of the control system and air traffic management by increased activity of system resources, first of all, of human resources.

All the above-mentioned factors and influences make the airspace capacity to have dynamic changes. Dynamic changes shall have a backward effect on the basic capacity.

Conventional networks of air markings decrease the total capacity because the aircraft are laterally separated by minima routs separation, while in using of elastic marking, the lateral aircraft separation has been achieved by minimum aircraft separation from aircraft. Conventional networks achieve maximum capacity per unit of time thus preventing traffic flow in desired term. This imposed measures which decrease the network load by equal traffic allocation during 24 hours. The elastic networks may, by increased capacity, handle/receive traffic increase during peak periods/terms. In such a way, the commercial effect of the traffic users has been increased, both individual and total.

Having in mind the fact that the airspace capacity is a dynamic value, and available instrument for future capacity prediction is required. Total capacity at conventional networks increases, limited by capacities of network parts. Because there is possibility for local influence on great number of the said factors, global control of such network, which satisfies the contradicted demands of local communities, is impossible to be carried out. By the establishment of a global network, such global influence would be eliminated (if the weather influences are not seen as a local factor because they in their nature are not such) and the

number of capacity limitation factors would be decreased, as well. Such a small number of factors would be possible to control at a global level by a single network management system. A smaller number of factors would also be possible to predict, thus enabling a successful forecast of the future airspace capacity in a tactical, utility, strategic and development sense. Reducing the capacity decrease factors (we are not talking about an increase of capacity, because a single capacity is in the same time theoretical maximum capacity that is undisturbed capacity. The task of future investigators is to show airspace capacity in a form of equation/formula which variables would be globally controlled capacity decrease factors).

Any activity in the field of airspace management is directly dependent on its capacity. In the present state, there is a diverse direction of influences that is the capacity depends on airspace management, as well. Such a state will be present until there is a local influence on the global capacity, as described above. When such influence ceases to exist, final airspace organization and modeling will be possible such moving it to the maximum capacity according to this criterion that is according to the airspace organization and classification.

5. Automatic support

The technical requirement for such management is the support of semiautomatic and automatic support systems.

Processing techniques and software solutions have achieved the required speed and capacity level to support the operation of such systems. Due to the lack of prerequisites till now there has been impossible to set such aims. Control and air traffic management semi-automation has to a great extent increased the airspace capacity.

Further improvements may be expected by aircraft optimization and standardization. The present commercial fleet is composed of different aircraft types. It is worth mentioning that special effect on capacity has the difference in speed as well as the difference of the effect of turbulent air movement on aircraft on routes because suspension of reduced vertical separation minimum, RVSMmay be caused by which the airspace capacity is amounted to 2002 when this program was realized and when by its application the growth of number of flight levels by 6 was achieved thus improving the airspace capacity enabling the increase of flights number in regions where the program was realized and in 2011 during which a return to standard increase of over flights number in Europe of 3 – 4% per year according to the IATA Report (International Aviation Transport Association – IATA). In addition, the effect of air mass turbulent movements is dangerous for airspace capacity due to the different weights of aircraft engaged in commercial air traffic by which application of method for aircraft separation in turbulence conditions per different categories (ICAO Doc 4444, ATM Chapter – Separations) has been caused. Anticipated future work on optimization of commercial aircraft types would, due to the decrease of such risks, the effect on the increase of airspace capacity.

Experientially and use of commercial aircraft led to empirical knowledge (visual at products sold by the two biggest commercial aircraft factories in the world, Airbus and Boeing), that the future development of commercial air fleets will not be based on offers diversity trying to cover greater number of segments demand for aircraft types used at various routes and different load capacity, but by spreading of Hub and Spoke airport network organizations the needs of most airlines would be covered by two basic types for long and regional distances.

Having in mind that those two basic aircraft types are not used within the same airspace portions (aircraft engaged in regional operations use lower altitudes unlike those connecting Hubs that is carriages on sub-continental and intercontinental routes) so a greater fleet percent is unified in such segmented airspace portions enabling the increase of capacity.

When total unified of two types covering the needs of Hub and Spoke transporting systems were achieved, the separation applying the unique separation minima and thus homogenized use of the airspace at volumetric unit enabling increase of airspace capacity would be allowed.

The subsequent phase would be the decrease of such separation minimum by applying new safety models by which additional production standards resulting in additional homogenization of transport commercial aviation would be enforced.

Conclusion

Airspace capacity has been defined as the capacity of a portion of the airspace handling/serving certain phases of aircraft operations, air transport as well as of military planes operations. Such capacity shall be calculated on the base of aircraft physical characteristics such as airspeed, size and weight, and their mutual influence while using the common airspace by required application of vertical separation minima on the ground of above mentioned characteristics as well as legal restrictions and influence of adverse weather conditions.

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