Cross-polar transit potential of Russia: what prevents its implementation?

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Abstract. Attention is drawn to the cross-polar transit potential of Russia in connection with the expansion of integration ties between the US and Canada, on the one hand, and the countries of East, South-East and South Asia, on the other. It is emphasized that the maintenance of cross-polar routes is considered a product of "high redistribution" and requires significant capital investments. In the Russian literature, the problem of economic efficiency of the organization of transcommunication messages has become the object of research relatively recently. It was the subject of fundamental disagreements among the authors, as some of them are of the opinion that for Russia the operation of Polar routes brings little commercial benefit and poorly takes into account the geopolitical interests of the country. One of the main reasons for this was the transition of the world's airlines to the use of new aircraft models, and, accordingly, non-stop cross-polar flights. At the same time, the hopes of the authorities of certain Siberian regions to "get rich" at the receptions of thousands of flights a month were "put a cross". The hypothetical possibility of Russia closing cross-polar air routes in response to the policy of economic sanctions of Western countries is discussed. It is concluded that such a step is unacceptable due to the hypothetical closure of the sky by EU countries for Russian carriers. The authors are convinced that in any case, the Russian Federation needs to take radical measures to develop its own polar aviation, build new modern airports in Siberia, as well as to improve air navigation services for flights in the harsh conditions of the Arctic.

Key words: cross-polar transit, cross-polar flight, "northern air bridge"

1. Introduction

Thesis that Russia has a huge cross-polar transit potential is one of the axiomatic ones. Its effective use makes it possible to significantly expand European-Asian and American-Asian relations by organizing international transport corridors through the territory of Eastern Siberia. It is known that a geographical map (most often, in the Mercator projection) distorts the shortest distance between two objects on the earth's surface (orthodromy), especially in the middle latitudes. Meanwhile, the inclusion of the Eurasian heartland in the flight zone of cross-polar routes makes it possible to ensure that the path of the aircraft between the two airports is close to orthodromy. It is thanks to the cross-polar route that the current flight time, for example, from New York to Hong Kong is about 15 hours (instead of 21), which allows you to save up to 50 thousand dollars per flight.
The cross-polar potential can be considered as an organic part of the Trans-Siberian aviation potential. Previously, all traditional routes from London, Paris, Copenhagen, Stockholm and other European cities to Japan, although they ran through the North Pole, were interrupted in Anchorage (USA) and then continued over the Pacific Ocean. But, according to ICAO standards, the route assumes the presence of alternate airfields with a fixed flight time of no more than 2.5 hours (in case of failure of one of the engines or other force majeure circumstances). And if we take into account that such a route significantly lengthens the flight time, then cross-polar flights over the Russian territory are extremely profitable for foreign carriers.

Services related to air transportation in the harsh Arctic are a product of "high redistribution", which in a market economy can and should provide the corresponding income to the Russian state. But the efficiency of cross-polar routes is determined by many factors, and not only economic ones. The fixation of many authors' attention on the economy often ignores the geo-political interests of the state, issues of its security, ecology, etc. In the case of the Russian Federation, the geopolitical side of transit flights through its territory is gaining increased attention of the Russian authorities and representatives of military departments.

It should also be noted that cross-polar transit fits seamlessly into the geopolitical goals of the leading states, which have clear strategic objectives for strengthening their positions in the modern dynamically developing world.

2. Discourses in the Scientific Literature and Internet
The problem of regular air traffic from North America to Asia via the North Pole occupies a prominent place in the research of both representatives of academic science and experts-practitioners in Russia, the United States, China, Japan, Canada, India, etc. A fairly complete picture of it can be obtained from the examination of Russian publications, which highlight the works devoted, in particular: state and international policy in the field of regulation of cross-polar flights [1, 2, 3, 4]; analysis of projects and existing transport routes across the Arctic Ocean [5, 6, 7, 8, 9]; the establishment of the necessary aviation and administrative communications infrastructure in connection with the opening of cross-polar routes from North America through the North Pole to East, South-East and South Asia through Siberia [10, 11, 12, 13, 14, 15]; formation of a network of alternate airfields for cross-polar routes [16, 17, 18].

The works of foreign experts on the stated problem are mainly presented by the authors of the United States, Canada and China. If we abstract from purely technological research in the field of aircraft design, then their scientific interests are concentrated in the circle of new opportunities, both for commercial and private tourist markets. The potential benefits of flying along wind-optimal polar routes are evaluated and their potential impact on climate change is evaluated [19, 20 etc.]. Specific requirements of experts for cross-polar flights are discussed, including the low temperatures of the Arctic, special communication capabilities due to the fact that aviators working there rely almost exclusively on satellite communications.

Unlike Russian publications, western ones pay much closer attention to the role of aviation in changing the environment of the Arctic. Although the greatest pollution occurs in the airport area during the landing and take-off of aircraft, given the "virginity" and crunch of the natural systems of the Arctic region, the role of expanding cross-polar routes seems dangerous to the authors. In the study of this aspect, scientists from NASA, as well as the Institute of Atmospheric Physics of the German Aerospace Center, succeeded.

A valuable analysis of individual aspects of the problem of improving the cross-polar communication system is contained in the reports and documents of aviation and aerospace organizations using updated statistical reviews published on the Internet. Central among them is International Civil Aviation Organization (ICAO), a specialized agency of the United Nations that sets international standards for civil aviation and coordinates its activities. Among its main goals are those that are directly related to the problem stated in the article:
- development of principles and methods of international air navigation;
- promoting the planning and development of international air transport in order to ensure the safe and orderly development of international aviation;
- promotion of the development of air routes, airfields and air navigation facilities for international aviation;
- ensuring full respect for the rights of States and fair opportunities for each of them to use air enterprises engaged in international air traffic;
- ensuring flight safety in international air navigation;
- promoting the development of international civil aeronautics in all its aspects.

3. Purpose and Methods of Research
The common phrase that “the economic efficiency of operating cross-polar routes is obvious” is in fact incomplete, since efficiency depends on a combination of several factors. The current situation is such that the countries directly involved in passenger and cargo turnover mainly benefit from exploitation. Russia, which provides its skies for transit air traffic, according to many Russian experts, remains "deprived". The problem here is not only in the unresolved systemic problems of the Russian air transportation industry - undeveloped airport and airfield infrastructure, lagging legislative framework, etc. The purpose of the article is to analyze the main reasons for the low economic efficiency of cross-polar transit for the Russian Federation and the obstacles that arise in the way of access of Russian airlines to the largest Asian-North American market.

The research methods used in the work are traditional: collection and systematization of empirical and statistical material, unity of historical and logical approaches, analysis and synthesis of real processes. A special task in processing the obtained data was to find causal and functional relationships between numerous factors in the development of air transport.

4. Research Results

4.1. Difficulties of air navigation in the Arctic
The spatial scope of cross-polar routes is delineated in different ways. Thus, the Federal Aviation Administration of the United States defines the territory of the route as all the space that lies north of latitude 78, while in Russia it is more often associated with the Arctic Circle [21]. These details are not essential. In any case, in the Arctic (as well as in the Antarctic) latitudes, it is necessary to take into account many specific conditions of aircraft navigation, such as:
- features of natural light associated with the time and spatial boundaries of the polar day and polar night, changing on different sections of the route;
- a lower location of the tropopause (the layer of the atmosphere in which there is a sharp decrease in the vertical temperature gradient), as a result of which part of the atmospheric protection from solar storms is lost, and the impact of solar radiation on the crew and passengers increases compared to flights in the temperate zone; (recall that radiation at a typical height of a jetliner is considered safe - less than a chest X-ray);
- the danger of approaching the fuel temperature to the freezing point due to the long duration of the flight and the predominance of very cold air masses, which imposes increased requirements on the quality of fuel;
- the poverty of landmarks (the immensity of the snowy desert, especially in winter; the rarity of settlements on the coast, etc.), which allow for visual and radar orientation;
- very sharp angles of convergence of the meridians, as a result of which the rapid change in longitude during the flight makes it difficult to use a magnetic compass, which can lead to tragic errors in determining the correct course of the liner and maintaining the intended flight path;
- the increased magnitude of the magnetic declination, the presence of magnetic anomalies and storms, the northern lights, which make it difficult to use astronomical orientation, as well as the instability of the readings of magnetic and gyromagnetic compasses (due to the small value of the horizontal component of the Earth's magnetic field);
- instability of the meteorological situation, manifested in a sharp change in the direction and speed of the wind, frequent changes in the height and nature of clouds, the predominance of low temperatures;
- unreliability of propagation of radio waves (especially short ones) during magnetic storms, aggravated by the lack of a sufficient number of ground-based radio navigation equipment, etc.

Thus, not every professionally trained pilot is able to perform cross-polar flights without long-term special training and in particular: without studying the airbrushing and climatic characteristics of the flight route and existing instructions regulating flights in the Arctic; mastering the skills of aeronautics by using astronomical technical means due to unreliable operation of magnetic compasses, etc.

Of course, the flight crew of cross-polar flights today does, basically, without Russian aviators. However, in the future, the Russian authorities plan to change this situation. Unfortunately, the huge shortage of qualified flight personnel in the Arctic regions, the de-pressive state of domestic production of wide-body aircraft, as well as the weak material and technical support of aviation training centers that train flight personnel for the Far North and the Arctic, postpone the solution of this issue for an indefinite time.

4.2. Cross-polar airways today

The term "cross-polar flight" first came into literary use in 1937, thanks to the non-stop flight of the crew of the Soviet pilot Valery Chkalov on the route Moscow-Vancouver, although then the crew made an emergency landing, unable to reach the estimated landing site. (By the way, if we follow the truth, the first transantarctic flight in history was carried out by the zeppelin "Norway" back in 1926). In subsequent years, the term was adopted by leading airlines, air traffic control headquarters, aircraft designers, geopolitics, representing mainly the United States and the USSR (including the famous Russian-American aircraft designer and military analyst Alexander de Seversky) [22].

The de facto scheme of cross-polar communications between North America and Asia was clear to specialists as early as the 70s, but it took another two decades to organize a system of such communications and harmonize it with the world's air navigation systems.

Following the initiative of Russia in 1995 at the ICAO meeting in Bangkok on the creation of cross-polar routes, a special Russian-American coordination group was established to identify routes with the participation of representatives of Canada, China, Japan, Mongolia, two Korean states, ICAO experts and the largest airlines in the world (United Airlines, British Airways, KLM, Boeing Corporation, etc.). Demonstration flights were carried out between the United States and China on Boeing-747-400, while their number in 2000 increased to three hundred. But the beginning of the era of regular cross-polar flights can be considered 2001, when the airlines of the United States and China with the help of a four-engine Boeing-747 and a more modern twin-engine Boeing-777–200 established a stable connection on the routes Chicago-Beijing, New York–Hong Kong, Detroit-Beijing, Detroit-Shanghai, Chicago-Hong Kong.

Scheduled flights began in 2001, when American and Chinese airlines operated 754 flights between the cities of Detroit-Beijing, Detroit-Shanghai, Chicago-Hong Kong, New York-Hong Kong, Chicago-Beijing. In addition to the four-engine Boeing-747, a more modern and efficient twin-engine Boeing-777–200 was also used. The advantages of cross-polar flights were quickly appreciated by the business community of foreign countries and had a strong impact on the development of economic ties.

In recent years, a system of cross-polar routes over Siberia has been formed, which are not limited to the most mentioned four main routes:
- "Polar 1" - provided flights between central North America and India/Pakistan (runs over the territory of the Krasnoyarsk and Altai territories, Tomsk and Kemerovo regions);
- "Polar 2" - connected the central and eastern parts of North America with the countries of Southeast Asia (Burma/Kampuchea/Malaysia/Singapore /Thailand/ Indonesia) (Krasnoyarsk Krai, Irkutsk oblast and Buryatia);
- "Polar 3" - runs from central and eastern North America to China / Hong Kong /Taiwan / Philippines (Yakutia, Chita and Amur regions);
- "Polar 4" - connected the central and eastern parts of North America with China/ Hong Kong/Taiwan/South Korea (Yakutia, Chita and Amur regions) and numerous connecting routes. By the way, such "bundles" allow you to adjust the transition from one route to another, especially taking into account the wind component. The result of such a step is a reduction in the cost of airlines by reducing the distance, flight time, fuel consumption, as well as increasing the intensity of flights on the corresponding routes. These routes on the map almost "merge", but in reality they all have considerable specifics, largely related to the type of flight. If Polar-1 is convenient for flights from Los Angeles to India, then Polar-2 passing through Buryatia is suitable for flights from New York to Hong Kong or Singapore, etc.

In the last decade, regular cross-polar flights have been operated by Boeing 747-400, 747-8, 777-200ER, 777-200LR, 777-300ER and Boeing 787-7, 787-9 and 787-10 aircraft, as well as Airbus A340, A350 and A380 aircraft with a range of about 7,000 nautical miles (8,100 miles; 13,000 km) or more. Such airliners are able to continuously overcome large distances between fixed airports (which, ahead of our thought, in some cases does not quite agree with the economic interests of the Russian Federation, which plays the role of a transit state seeking to more effectively use international transport corridors passing through its territory). In parallel, the number of flights carried out is growing, exceeding 20 thousand in 1918.

In conclusion, we note that in Russia, all management and organizational and financial functions related to cross-polar air traffic services are assigned to the State Civil Aviation Service, and more specifically, to the State Air Traffic Management Corporation. In the United States, similar functions are performed by the American Federal Aviation Administration, in China-by the Civil Aviation Administration under the Ministry of Transport, etc.

4.3. "No dividends, except for image"?

The problem analyzed below is in fact the key one in the article, since it is directly related to the economic efficiency of transpolar transit.

The willingness of foreign airlines to actively participate in the development of cross-polar routes over the territory of Siberia has never been questioned, since the reduction of flight time (which means saving fuel, engine life, staff pay, etc.) promises to increase the profitability of companies and guaranteed success in the fight against competitors. And for Russia, the question of the economic efficiency of operating cross-polar routes has always been the subject of fundamental disagreements and even caused a dull murmur in the aviation environment. It was widely believed that Western countries operate Polar routes in a completely commercial mode, while Russia, in addition to "image dividends", remains a "loser" [23].

The well-known Convention on International Civil Aviation (signed in 1944 in Chicago with the participation of the USSR), which formed the main principles of aviation transport, played a certain negative role in this. According to one of its articles, the State that ratified the Convention was obliged not to charge rent for the transit passage of airliners over its territory, with the exception of fees for air navigation services. And taking into account the small size of such a fee and the technological modernization of the liners themselves, Russia's profit with the opening of the Arctic sky grew slowly. And if during the Cold War and the Iron Curtain, when cross-polar routes remained inaccessible to Western carriers, the payment for transit flights was of little concern to the Russian authorities, then with the collapse of the USSR and the formation of market principles in the economy, the situation changed.

Of course, in addition to image dividends, Russia today receives a certain financial compensation for permission to use its airspace in Siberia. We are talking about the artificial "re-qualification" of part of the transit payments into the category of air navigation fees. This forced admission made it possible to avoid reproaches for Russia's violation of the above-mentioned Convention on International Civil Aviation.

However, these funds (several hundred million dollars) are clearly not enough not only for the construction of new airports, but even for the technical re-equipment of air navigation equipment,
taking into account modern international standards. Real profits of domestic airlines would be possible in cases where foreign cross-polar airliners would make stops at Russian airports constantly, and not in emergency cases (due to a sharp deterioration in weather conditions or aircraft malfunction). Finally, the operation of cross-polar lines could hypothetically be commercially justified when used by Russian companies, but the weak level of cargo exchange with the United States and Canada, the lack of an appropriate fleet of domestic aircraft and passengers on both sides necessary for cost-effective loading of the sides "work" against this.

Hardly a random statement by the former Deputy General Director of "Aeroflot", who was responsible to the company for implementation of strategic programs A. Kanisheva: "operation cross-polar tracks foreign airlines will only reduce the revenues of our national carrier and will bring nothing other Russian aviators" [35]. Apparently, the subsequent dismissal of Kanishechev from his post was not accidental - as a result of differences in the views of the company's management on its development strategy. The company's press service declined to comment on the details of the official's departure.

It should also be noted that the plans that appeared in the early 2000s to create airports in a number of Siberian cities for cross-polar flights of such giants as Cathay Pacific and Northwest Airlines, United Airlines, American Airlines, Delta Airlines, All Nippon Airways, Japan Airlines, turned out to be utopian in nature. Then the authorities of several subjects of the Russian Federation believed that their regions would become the best strategic points for intermediate landings of cross-polar liners and their refueling. The press spread "sweet dreams" that the implementation of the planned projects would help them not only to end the economic crisis, but also to ensure prosperity for the regions. In particular, it was about loading the work of construction companies, catering for passengers, repairing aircraft, reviving the hotel and tourism industries [25].

Alas, these rosy, fantastic projects were not destined to come true for one simple reason. The world's leading airlines sought to provide passengers with non-stop cross-polar flights. "We have long been committed to non-stop cross-polar flights," says Anthony Tyler, Corporate Development Director at Cathay Pacific Airways in Hong Kong, "which will allow us to significantly reduce costs and offer better conditions for our customers" [34] The introduction of new models of passenger aircraft "put an end" to the desire of Siberian "dreamers" to build local airports that can take thousands of flights a month and cost billions of dollars. Although on the other hand, much cheaper, not at all giant replacement airfields (at a distance of 1 hour and 20 minutes of summer) are needed in Siberia.

5. Points for Discussion
A hypothetical response of the Russian Federation to the sanctions policy of Western countries could be the closure of not only trans-Siberian, but also cross-polar air routes for airlines representing these countries. This point of view is expressed from time to time by individual authors, including well-known Russian politicians. They believe that the closure of Russian airspace for transit flights of Western airliners will lead to the inevitable bankruptcy of many airlines, which, they say, are teetering on the verge of survival [24].

The specific consequences of such a step can hardly be calculated with high accuracy, but they are likely to be reckless and unacceptable for the country. The problem here is not the loss of hundreds of millions of dollars from royalties and air navigation fees going to the Russian treasury. It is also strange that even Western experts attribute the hypothetical ban on flights of Western airlines mainly to the loss of Russia's "royalties", which are comparable to taxes for foreign companies wishing to fly over the territory of the country. For greater persuasiveness, the decision of the Russian authorities in the early noughties on the forced landing in Moscow of all aircraft of transit routes is given, as a result of which some foreign companies in response chose northern or southern routes bypassing the Russian air space, which are about 20% longer" [26]. In this regard, it is concluded that the application of sanctions against Western airlines deprives Russia of payments for flights, which is tantamount to imposing sanctions against itself.
(By the way, there are examples when the "struggle for royalties" ended successfully for Russian authorities. So, in 2007, after the ban on transit cargo flights of Lufthansa over its territory in order to convince it to move its transit center to Siberia, the German company initially changed the route, but, suffering losses, later "gave up").

The real threat to Russia lies in the response of Western countries. For many of them, the "closure" of the Russian sky can really turn into a real aviation collapse. (Data provided by the worldviews website Flightradar24.com show that the share of European and American airlines accounts for a significant part of foreign flights flying in the sky over Russia). But the main thing is that this decision may be followed by the closure of the sky for Russian carriers. And this circumstance will have an extremely painful impact on the work of Russian civil aviation.

According to the Board member of the World Aviation Safety Foundation (FSF), President of the Advisory and Analytical Agency "Flight Safety" V. Shelkovnikov, "we will have to review air flows, changes in the aircraft fleet, international schedules, loads on dispatchers, the entire organization of air traffic...We have already passed the conditions of the Cold War. And the mighty civil aviation of the USSR, also in the grip of sanctions, for decades flew over neutral waters, open seas and oceans to Cuba, Vietnam, and many other places in the world ">[27].

6. Conclusion
The implementation at the turn of the 20th and 21st centuries of the project of cross-polar routes through the airspace of Russia ("Northern Air Bridge") was an event of historical significance. It gave the green light to the most dynamically developing air transport sector in the world. Prior to the force majeure associated with the Covid-19 pandemic, the number of annual cross-polar passenger and cargo flights was several thousand (including routes other than Polar-1, Polar-2, Polar-3 and Polar-4). The elapsed time of operation of the "Northern Air Bridge" through the territory of the Russian Federation is quite sufficient to draw appropriate conclusions.

1. The use of Trans-Siberian routes for the implementation of Asian-European transit has given Western airlines, as well as China, Japan, India and other Asian countries, an undoubted economic advantage by reducing flight time, reducing fuel consumption and other financial costs.

2. Flights across the North Pole are associated with numerous difficulties caused by the geophysical specifics of the Arctic zone, and require airlines to upgrade their air navigation equipment, and additional training from airliner crews. The mentioned difficulties are very low temperatures in the Arctic (they can lead to a decrease in the fuel temperature in the fuel tanks to a critical value of 37 C); possible errors in satellite navigation systems and interruptions in radio communication; increased value of magnetic declination, presence of magnetic anomalies and instability of readings of magnetic and gyromagnetic compasses, etc.

3. There are good reasons for the assertion that by opening the sky over Siberia for cross-polar routes, the Russian Federation has not received the opportunity to significantly replenish its budget and has found itself in a "loss". It did not receive the expected impetus for the development of infrastructure capacities, the creation of new jobs, etc. This was partly the fault of Russia itself. Its aircraft fleet was uncompetitive in comparison with the airliners of the leading world powers. The level of air navigation support for flights over Siberia was also not at the proper level.

But by opening the sky to cross-polar routes, the Russian authorities pinned their hopes on full-fledged integration into the world community and access to the US-Asian aviation market, but in return they received ...economic sanctions. In this regard, why can't strict sanctions against the Russian aviation industry be interpreted as under-paid royalties from cross-polar flights? According to the authors, it is also possible that in the conditions of growing military tension in the world, the introduction of non-stop flights, which led to a decrease in Russia's income, should be reviewed for the purpose of inspection of transported goods.

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