

**THE SYSTEM OF INJECTION OF SUBMINIATURE  
SATELLITES (NANOSATELLITES) TO NEAR-EARTH ORBIT  
ON THE BASIS OF AN-124-100 AIRPLANE**

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**СИСТЕМА ВЫВЕДЕНИЯ СВЕРХМАЛЫХ СПУТНИКОВ (НАНОСПУТНИКОВ)  
НА ОКОЛОЗЕМНУЮ ОРБИТУ НА БАЗЕ САМОЛЕТА АН-124-100**

В статье предложен способ выведения наноспутников на околоземную орбиту на базе самолета Ан-124-100, позволяющий снизить стоимость запуска и увеличить доступность данного способа в сравнении с «классическими» ракетами-носителями для выведения спутников.

Beginning of the third millennium coincided with a new stage of development of technologies of miniature spacecraft: micro- and nano-satellites. Nano-satellites (nanosatellites, nanosats) are spacecraft with a mass from 1 kg to 10 kg, the size of 1U (10\*10\*10 cm), 2U (10\*10\*20 cm) and 3U (10\*10\*30 cm), designed to solve simple and important tasks. Nanosatellites will be used for remote sensing, environmental monitoring, earthquake prediction and study of the ionosphere.

The time of individual breakthroughs and first successful experiences of small satellites building is over. The main task today is the insertion of nanosatellites into orbit. The cluster launches of subminiature satellites on large launch vehicles have inherent disadvantages.

It is proposed to launch nanosatellites as a payload on the basis of An-124-100 airplane, which is used as a mobile launch pad to launch the SS-24 light class solid-propellant launch vehicle (LV). The airplane with LV placed in cargo compartment will take off from a conventional airfield and lift to a height of about 20 km, where with the help of air-launcher including transporter-erector-launcher (TEL) and parachute system.

The LV located on the TEL starts to move on the floor equipment (rollers) under the parachute forces towards the cargo door as a result of preparations for the dropping operations related to cargo door opening, activation of control systems, etc. The belts binding the LV and TEL or other devices are disconnected at the moment of physical separation from the airplane.

Using own solid-propellant engine (during the initial stage of the flight) and from force of inertia afterwards the LV with the launch container including nanosatellites, goes to a height of about 600 km which is targeted for dropping a payload in the form of miniature satellites. Following this the TEL lands by means of parachute in a

predetermined position and is ready for further (multiple) use. The nanosatellites are installed on the platform inside the container and are pressed to the cover by springs.

The electric pulse from the LV activates the release mechanism of the cover that rotates 170° and a nanosatellite is separated along the guide rails by spring mechanism to predetermined speed, which is determined by the used spring and nanosatellite weight. A small payload is separated due to the magnetic-impulse drive with capacitive energy storage.

The proposed project is best suited to existing and other potential limitations owing to launching from airplane using customers' aerodromes and air space.

Fundamentals of business. The injection of subminiature satellites (nanosatellites) into near-earth orbit on the basis of An-124-100 airplane:

- allows to reduce significantly the launch cost and increase the availability of this method in comparison with the classic satellite launch vehicles;

- simplifies the preparation of nanosatellites launch (the customer waits for vacancy in launch vehicles from a few months to several years when the conventional launch vehicles are used);

- induces mass use of general-purpose small satellite due to low cost of launch.

The project involves the wide use of existing practices and technology.

Existing markets of launching. Market of launches is a relatively new and dynamic sector of the world market of high-technology services. Ukraine controls almost 10% of the international launch market. Euroconsult research company (Paris) expects that the market of space launches will increase significantly next 10 years. The experts note that the expansion of space capabilities of developing countries, in particular India and China, will favor to reduce the price of the spacecraft production services, thereby increasing the demand for launch services for the injection of nanosatellites into near-earth orbit.

Target customer profile. The target customers interested in existing practices and techniques for injection of subminiature satellites (nanosatellites) into near-earth orbit are: Ministries and Departments as well private and public corporations-manufacturers of satellites up to 10 kg, institutes from all over the world, research laboratories and various centers, who need to inject small size spacecraft into near-earth orbit to continue research, experiments and remote sensing the Earth, environmental monitoring, earthquake prediction, ionosphere study, nonterrestrial objects and space study, human possibilities expansion and access to space for millions of worldwide people.

In addition, large groups of nanosatellites in the future will enable to solve complex tasks requiring more accurate and quality data about our planet and space around.

A new advanced application is usage of nanosatellites as a platform for nanotechnology experiments, nano-components and materials testing. Nanosatellites with small size and weight are simple and cheap means of scientific research in the short-range space.

Sizes and rate of growth of the target markets. The market size is determined by number of customers. All existing (and future) launch vehicles are evaluated according to a common criterion of efficiency – by cost for orbital injection of one

kilogram of payload. Nowadays the unit cost of injection into orbit varies from 10,000 to 20,000 \$ per one kg of payload. This is a major constraint for further development (extension) of the market. According to some estimates, the market of nanosatellites injection into orbit could reach \$ 2.5 billion by 2018.

Currently nanosatellites injections into orbit are carried by conventional launch vehicles. PolyITAN-1 nanosatellite (Ukraine, about 1 kg in weight and 10\*10\*10 cm by size), created in Kiev Polytechnic Institute, was injected into near-earth orbit by Dnepr launch vehicle (Ukraine) with the aid of the launching containers with 33 nano-satellites, created by scientists from 17 countries. The launch was made from Yasny launch facility at 23:11 local time, June 19, 2015. There are no competitors in the market of Ukraine for nanosatellites injection into orbit on the basis of An-124-100 airplane.

The indirect competitors to launch nanosatellites into orbit are Celestia Aerospace company (Spain, it intends to get to nano-satellites market by development, production and launch of nano-satellites on demand), companies from the United States and Russia (SoyuzStart-H centre of nanosatellites launch services). The nano-satellites are injected by means of launch vehicles requiring a lot of time and costs.

Strategy. In order to gain a foothold in the world market the basis of the strategy should be consistent position to increase investment in new quality production.

To promote the product to the world markets both regional and the concentrated sharing space technology markets, the formation and use of the new global business strategies, various and multifaceted marketing strategies are characteristic features.

It is supposed to use the innovative marketing strategies, to study in-depth types and forms of the world market, its operation environment, to analyze recent research and publications, dynamics of development and functioning of the world's space launches, to study scientific and technological level of design, trends of global competitiveness transforming.

In order to expand successfully our participation in international cooperation and world space projects, as well to increase in future the share of Ukraine space products at the world market, it is necessary also to investigate the basic factors, trends and characteristics that affect the criteria of formation and relationship of functioning of launch markets.

The proposed method of nanosatellites launching into orbit on the basis of AN-124-100 airplane is planned to implement by government customers interested in using the existing developments with subsequent entering to the world space market.

## Rerences

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