

Prospects for the development of space programs in Kazakhstan and other countries.

The space industry uses the latest achievements in engineering, the best designs of equipment and technology.

In the second decade of the 21st century, significant changes have taken place in astronautics, when, along with proven technical solutions and technologies, new approaches are applied, which leads to qualitative restructuring in the field of space activities.

This is evidenced by the following:

The magazine "News of Cosmonautics" (2018, March) said - in 2017 was launched a record in the history of the number of space satellites - 477 satellites;

Withdrawn into space more than 300 spacecraft with limited goals of weight from one to 50 kg («SpaceWorks» Atlanta, USA, February 2018), which exceeded all expectations;

Company «SpaceX» lifted aerospace technology to new heights, successively restoring the first stage of the launch «Falcon 9» and successfully carried out 5 starts already flying stages, thus making another important step on the way to a truly reusable rocket.

This is also evidenced by the record as the number of successful start-ups «Space X», where steps (years) an increasing number of successful start-up missions.

A total of 60 launches of the Falcon 9, 58 of them were successful.

The launch of a heavy launch vehicle Falcon 9 is estimated at about \$ 50 - \$ 60 (the launch market for medium-class!).

According to Jefferies Investment Bank, it is possible to reduce the cost of rocket launches with a reversible first stage - by 40%, according to the forecasts of SpaceX itself, which SpaceNews cites - by as much as 90%, to \$ 5-7 million.

As of today, these numbers seem fantastic, but Space X at least gave a signal to the market.

To compare the cost of launches, the table of prices for the launch vehicle is shown for the light class and the competitive price for the Falcon 9 launch vehicle.

Competitive cost of launches on LV.

“Before SpaceX entered the commercial market for launch services with the Falcon 9 LV, the United States was inferior to this market in France (Arianespace - TASS) and the Russian Federation, and, interestingly, US companies have not carried out commercial launches on GPOs since 2009. The figure below shows the distribution of ILV launches by country for the period from 2001 to 2017.

SpaceX has brought this multi-billion dollar market back to the United States, ”said T. Hughes, Senior Vice President of SpaceX, in his report to the Subcommittee on Space, Science and Technology of the Committee on Trade, Science and Technology of the US Senate. (14 July 2017).

“Currently, the cost of the SpaceX launch manifesto is more than \$ 10 billion (about 70 missions).

It should also be noted that in the United States, the Evolved Expendable Launch Vehicle (EELV) Development Program in the National Defense Appropriations Act for the 2019 fiscal year, which is being considered by the US Congress, is renamed the National Security Space Launch Program NSSL (National Security Space Launch).

At the same time, the Bill imposes restrictions on the use of disposable launch vehicles by the Pentagon, as reported by the influential publication "The Hill" (USA).

Europe

The Airbus DS concern presented sketches of the Adeline project - the launch vehicle, which will have to land on the airfield with the help of wings (Advanced Expendable Launcher

with INnovative engine Economy), which provides for the reusable use of the taxiway of the 1st stage of the future launch vehicle Ariane 6 (the launch vehicle is ready "Ariane 6" - 2020, and "Adeline" systems - 2025.).

The Airbus DS project proposes the reuse of only its taxiway and avionics, considering its concept to be more rational than that of SpaceX (where for the complete rescue of the 1st stage of the Falcon 9 launch vehicle it is necessary to spend up to 35 tons of SRT to return the stage to the ground - estimated by Airbus DS).

According to the Adeline system, about 2 tons of fuel will be spent on rescue - the main part of the braking task falls on the heat shield, and maneuvering at subsonic speeds using 2 small and economical turbofan engines for landing on the runway.

CNES plans to create a reusable rocket in cooperation with the Russian Federation in the development of a reusable 1st stage (reusable rocket booster - MRU "Baikal"). It also stated that the development of a new methane taxiway has begun, which features reusability.

Russia.

RSC Energia and GRKTs Progress begin the development of a reusable medium-class rocket, which will be launched simultaneously with the creation of its one-time version.

Unification with the one-time Soyuz-5 will allow launching the launch vehicle from Baikonur, Vostochny, as well as under the Sea Launch program.

"In the near future, the issues of reusable use of the 1st stage, as the most expensive part of the launch vehicle, will be considered on an initiative basis. Based on the results, decisions will be made to continue the work. "

"The main factor is the economic feasibility of creating a reusable rocket, it is also necessary to determine the cost of preparing the stages after the flight for the next launches ..., up to 30% of the fuel must be left in the tanks ..." (General Director of RSC Energia Vladimir Solntsev).

However, other options will also be calculated, for example, the use of parachutes (GKNPTs named after Khrunichev).

For example, the Makeev SRC is developing a reusable rocket.

The Korona has no detachable stages and is actually a soft take-off and landing spacecraft (perspective - long-distance interplanetary flights with crews on board).

Reusable launch vehicles from the Russian Federation must land like an airplane (Deputy Prime Minister of the Russian Federation D. Rogozin, April 2018).

As part of a joint project of the FPI (Advanced Research Fund), Roscosmos and the United Aircraft Corporation (UAC), a preliminary design of a reusable rocket unit of a reusable ultralight rocket and space system has been completed.

During the design, the technological reserve of the Baikal MRU project was used. The scheme of operation of the system provides for the separation of the 1st stage of the LV at an altitude of 59-66 km and its return to the launch area to the usual runway. Purpose - withdrawal of PN with a mass of up to 600 kg to the SSO.

The first private space company, S7 Space, appeared in the Russian Federation, which at one time bought out Sea Launch. They are working on replacing the old and expensive Zenit launch vehicle with the Soyuz-5 launch vehicle, and as Roskosmos' requirements for the new launch vehicle, they have designated the returning 1st stage.

It is becoming clear that bringing back the first stages with expensive stages of launch vehicles is a strategy for the future.

Do not forget that the number of competitors is also growing (in addition to the USA, Russia, ESA), India and China have appeared.

For example, China made its first commercial launch in 2007, and by the end of 2016 it "bypassed" the Russian Federation, and together with the United States (22, 22, 17 launches, respectively) lead the top three in terms of launches.

Not waiting for new successes of the reusable Falcon 9, competitors began to develop their projects.

In the coming years, a whole class of mini-launch vehicles may appear, intended for transporting spacecraft with a PN up to 200 kg.

At least 17 such launch vehicles are being developed independently by a number of companies.

Among them are Firefly Space Systems (RN "Alpha"), "Rocket Lab" (RN "Electron"), "Virgin Galactic" (LauncherOne), "XCOR Aerospace" (Lynx Mark III) and "Swiss Space Systems" (SOAR).

Rocket Lab (USA) sold most of the cargo spaces on its 3 "Electron" launch vehicles to "Spaceflight Inc." company, which is engaged in launches of small and micro spacecraft (20 01.18), the launch vehicle launched a sphere with a diameter of 1 m into orbit, covered with 65 triangular reflectors).

Microsatellites (weighing from 50 kg to 200 kg) and nano spacecraft (from 1 kg to 50 kg) began to be massively deployed to LEO.

Perhaps the most popular format of the satellite platform in recent years has become "CubeSat" - a spacecraft in the form of cubes with a volume of 1 liter and weighing up to 1.33 kg.

Over the past ten years, a little less than 2 thousand satellites have been launched into orbits.

It is planned that by 2022, 580 micro spacecraft weighing up to 200 kg annually will be launched into space (previously it did not exceed 190 spacecraft per year). By the end of 2027, up to 850 spacecraft are planned per year.

Today's mini spacecraft perform the same functions that previously could only be done by spacecraft weighing more than 500 kg. In addition, space trends have changed - in the previous decade, small spacecraft were used either for research or for testing various communication programs.

Now companies are launching spacecraft in groups to create cellular networks, Internet transmission and others.

Analyzing the above, it can be noted that the demand for launch vehicles of the light and ultralight classes has now significantly increased (against the background of how the spacecraft themselves have "felt better") and this trend will be a priority.

By 2028, more than 7 thousand new satellites will appear in low-earth orbit, - forecast of the Euroconsult agency (Euroconsult - 2018, Paris, September 10-14, 2018).

Representatives from Arianespace, GK Launch Services, Spaceflight Industries, Rocket Lab and Mitsubishi Heavy Industries agree that the launch remains an obstacle to the growth of the small spacecraft market.

Space access capacity continues to grow, and this trend will continue with the advent of new ultralight rockets.

The launch price remains in the range of \$ 30,000 to \$ 50,000 per kg of micro- or nano-satellite. There are fewer technical obstacles, but the price is not moving down (on average, the cost of launching a spacecraft in the range from 1 to 50 kg is about 50% of the total project budget).

For information: the current line of spacecraft (according to KNES) by weight:

picoKA - less than 1 kg; nanoKA - from 1 to 50 kg; microKA - from 50 to 200 kg; miniKA - from 200 to 800 kg; medium spacecraft - from 800 to 1500 kg; large spacecraft - from 1500 kg. Below are data on spacecraft and the cost of creating cubesats from 1U to 3U.

In Europe, the cost of setting up a university:

1U cubesat - 200 thousand euros;

2U cubesat - 400 thousand euros;

- 3U cubesat - up to 1.5 million euros.

At the same time, in the USA, the creation of a 3U remote sensing cube by Planeta is 100 thousand euros.

The urgency of creating a Kazakhstan space rocket complex with ILV of light or sub-light class using MKT

Kazakhstan has at its disposal the Baikonur complex, where the process of transferring the right flank to its ownership is under way.

The Special Design and Technology Bureau of Space Technology (SKTB KT of the Aerospace Committee of the Republic of Kazakhstan) has been created, where satellites will be designed, including those of our own production.

The creation of the Assembly and Testing Complex for spacecraft (SIBK KA RK) is being completed for testing satellites of various missions, both domestic and foreign.

In this regard, the question arises about the creation of our own launch vehicle of light or ultralight classes, which will allow launching spacecraft, both our own and other countries, built and prelaunch training at SKTB KT and SIBIK spacecraft launched from the Baikonur complex. For example, Japan's expenses for the creation and launch - 400 million yen (\$ 3.6 million) were financed by the Ministry of Economy, Trade and Industry of this country.

At the time of launches, it was the smallest launch vehicle for launching a CubeSat class launch vehicle into near-earth orbit.

The ability to launch a spacecraft at the right time into orbit with the required parameters may outweigh the financial losses from the time spent waiting for the accompanying "large" spacecraft.

Quite low price of launch services.

The infrastructure of the Baikonur cosmodrome is not fully used.

Does not give a sufficient multiplier effect for the development of sectors of the country's economy.

The project can be used in cooperation with universities and universities in the country.

Execution of these programs can give the following results.

Will be loaded with orders from SKTB KT of the Aerospace Committee of the Republic of Kazakhstan.

Prelaunch tests of spacecrafts will be carried out in SIBIK spacecraft of the Republic of Kazakhstan, both their own and other countries.

The complex "Baikonur" will be developed, which will be taken out of the lease of the Russian Federation into the ownership of the RK.

Participation in the project for the creation of a KKK with a light or ultralight class launch vehicle using MRI will create a multiplier effect for the development of sectors of the economy of Kazakhstan.

Oil refining, precision engineering with 3D printing, aerospace and other areas of activity, obtaining and using new materials and technologies will be developed, higher educational institutions and scientific institutes will be involved in the work.

New jobs will be created in the field of high technologies and new technologies will be mastered.

These general considerations suggest that attention should be paid to filling the niche of launch missions for nano satellites (1 kg to 50 kg) and micro (50 kg - 200 kg) * and by creating light and sub-light launch vehicles using MKT.

Having created a KKK using the ICT, the Republic of Kazakhstan can become one of the 30 members of the space club.

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In Kazakhstan, four universities have opened departments of "Space Engineering and Technology", but only at the ENU named after Gumilyov there is a special design bureau. At the Department of Space Engineering and Technology, there is a Special Design and Technology Bureau "Aerospace and Special Engineering" (SKTB AKSI). The work of the SKTB is headed by the professor of the department Kasymov Umirzak Tazhigalievich, with production experience in the design of operational-tactical and cruise missile systems of the USSR. He is a graduate of the Bauman Moscow State Technical University with a degree in Rocket Launch Complex.

Undergraduates, students and graduates of the department take part in the work of the SKTB.

SKTB is engaged in the design of aircraft structures:

- spacecraft;
- launch vehicles with liquid propellant rocket engine;
- launch vehicles with a solid propellant engine;
- cruise missiles for military purposes;
- rockets for scientific and technical purposes;
- aerostatic aircraft of modern type (Airships);
- tethered aerostatic aircraft for stationary monitoring of local areas and for television and radio communications;
- aircraft vertical take-off and landing;
- aircraft drones;
- other types of aircraft and technical devices for various functional purposes.

SKTB presentations were previously sent to various addresses in Kazakhstan and foreign countries. Feedback was received from different people and organizations, from investors and lenders.

The SKTB AKSI program also provides for the development of the near subspace at altitudes from 15 to 100 km from the Earth's surface using aerostatic aircraft and returnable stratospheric sealed capsules with an autonomous life support system. Scientific and technical complexes, including a small stratospheric telescope for space exploration, can be placed on board these aircraft.

Professor Kasymov U.T.