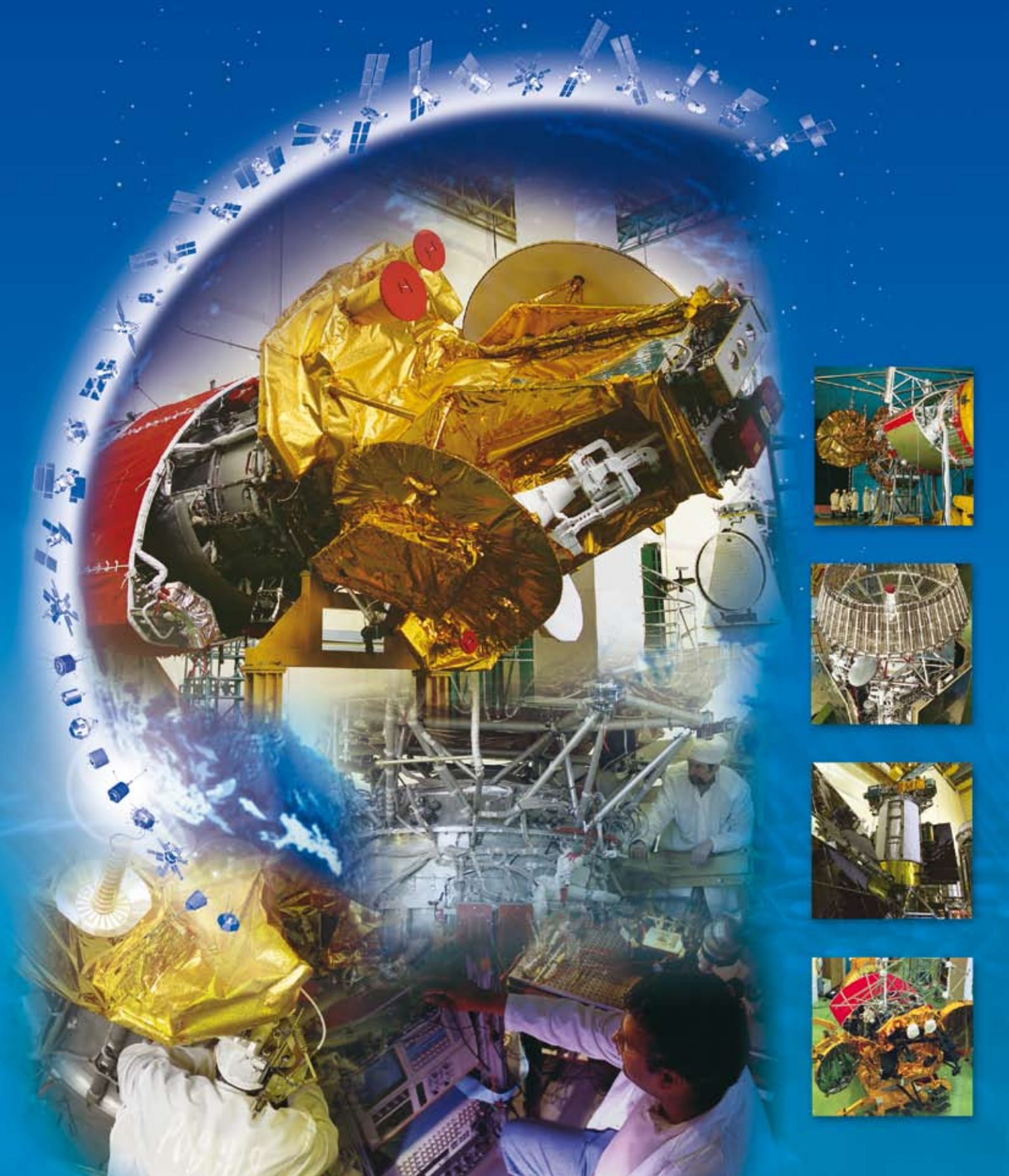
RESHETNEV
COMPANY

INFORMATION SATTELITE SYSTEMS

June, 2007

Joint-stock Company
M. RESHETNEV INFORMATION SATELLITE SYSTEMS



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"Information satellite systems"

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NPO-PM General designer
and General director

Nickolay TESTOEDOV

Reorganization period

Academician w M.F. Reshetnev NPO-PM is the Russian major company in the field of creating communications, navigation and geodetic satellites. For 48 years, more than 2/3 of all spacecraft comprising the Russian orbital constellation were developed and manufactured by the company. More than 1130 satellites were launched into orbits. Today, within the frame of the Federal Purpose-oriented Program "Defense industry reformation and development", the entity "Information satellite systems" is being established with NPO-PM as a primary company. From the legal point of view, it will be an open joint-stock company, with 100% shares being in the Federal possession. The President of the Russian Federation will dispose the shares following the proposals made by the Government.

New Industrial Revolution

Establishing of the integrated structures and agglomeration of entities is the general tendency of the world economy. The last several years the process of company integration is going on, first of all, within complicated science-intensive industries, including motor car construction, aircraft construction, shipbuilding. These tendencies are applicable for both non-Russian and Russian companies. The causes of the agglomeration necessity are that the creation of advanced competitive state-of-art products, whether a car or a satellite, requires employment of high technologies, significant investments into scientific researches and tests. Under such circumstances, a merger of companies belonging to the same industry is a logical process. One can remember the recent mergers taken place in the USA and Europe. For example, a number of European space companies have merged into giant enterprises EADS and Thales Alenia Space. The similar process is ongoing in Russian space industry.

The main idea of all the above processes is not a simple combination of machines, sites and staff. Actually it is a new industrial revolution. These reformations will bring the same effect as did a transition from natural economy to manufactory. The production arrangement improvement is a continuous process. On one hand, a small company is more effective and dynamic in terms of the evolution; on the other hand, a large company has its benefits in terms of specialization, employment of high technologies and scientific achievements. That is why today in the satellite industry one can observe an agglomeration tendency. Besides, intentions to effectively use production facilities, machines, technological lines, tests facilities will lead to higher specialization of enterprises for different products. Nowadays, almost every company involved in satellite-making industry is busy with manufacturing PCBs, and possesses almost complete set of machines for mechanical treatment; and also has its own design approach. On being merged and integrated, some of the functions will be unified to improve the production efficiency.

Activities with a GLONASS satellite

Corporation members

The integrated structure (corporation) being established with NPO-PM as a key company comprises 9 more companies belonging to the Russian space industry, in particular, JSC "Scientific and Production Centre "POLYUS" (Tomsk), JSC "Research & Production Enterprise "KVANT" (Moscow), JSC "SIBERIAN DEVICES AND SYSTEMS" (Omsk), JSC "Research & Production Enterprise "GEOFIZIKA-COSMOS" (Moscow), JSC "Scientific and Research Enterprise of Space Instrument-making "KVANT" (Rostov-na-Donu), JSC "Sibpromproekt" (Zheleznogorsk), JSC ""NPO PM - Razvitie"" (Zheleznogorsk), JSC "TTC - NPO PM" (Zheleznogorsk), JSC "NPO PM - Maloe Konstructorskoe Buro" (Zheleznogorsk). At the level of the integrated structure, these 9 companies will become affiliates though keeping the status of individual legal person. These companies are the subcontractors to NPO-PM and for many years have been cooperating in solving the common tasks related to the domestic satellite-making issues. Recently, they have experienced the diversification to the different extent. Some of them have mastered the production of consumer goods and products specific for other machinery construction branches. Such a situation is absolutely normal. All these companies confirmed their vital capacity during last fifteen years, which occurred to be very difficult for the industry: they have retained their production facilities, personnel and main specialization profile. I am quite confident that being integrated we will be able to achieve better efficiency, to make our products more competitive, enlarge the contract portfolio and capture the leading position in the field of making the advanced space products!

NPO-PM General designer
and General director
Nickolay TESTOEDOV

Top managers of JCS ISS companies-members

Satellite-based navigation

Following the Federal Purpose-oriented Program "Global Navigation system" of the Government of the Russian Federation for the years of 2002-2011, the Reshetnev NPO-PM is modernizing the GLONASS system. The development perspectives of the Global Navigation Satellite System space segment are discussed by the NPO-PM General Designer and General Director, Mr. Nickolay TESTOEDOV.

- Nickolay Alekseevich, today NPO-PM, the company where the Glonass-M navigation satellites are created is responsible for the development of the space segment of the system. Figuratively speaking, will we stay at the highlevel within the space navigation field having in mind continuously increasing competitiveness at this particular space service marketplace?

- Yes, nowadays, a number of countries are carrying out a very active policy within the space navigation field, including EC and China. However, throughout the world there are no analogs to the GLONAS system or to the US GPS system. The European system Galileo will be put into operation next decade. It will be seriously accounted for only when it has been at least partially deployed and commissioned. Now, it is just a project with the performances being of the promotional nature. All other systems are not global ones; they are the regional systems or the augmentations to the above navigation systems.

As for the GLONASS system, we have gained a vast experience in manufacturing and operating the system; we have the approved plans to recover the orbital constellation in an accelerated manner; and we have the state level support and financing. I mean we have every prospect of success to keep the leading position in the world, the same position as of the GPS system.

NPO-PM ensures the implementation of the main target, namely, the GLONASS space segment creation, support, operation; and provides the possibility to fulfil the mission tasks. I would also like to remind that the GLONASS mission embraces four more tasks covering the transport, geodesy needs, to the benefits of the military and civil users.

The situation with the production of the navigation user terminals is not so good, however, it is outside the responsibility of NPO-PM. The user navigation terminals market is almost completely occupied with non-Russian GPS-receivers. It is very difficult to enter this market with GLONASS user terminals or with combined GPS-GLONASS navigation equipment. However, we believe we can do it.

- It is well known that we have to recover the GLONASS constellation to the complete one. Meanwhile, GPS is already used all over the world. Maybe the better solution is to save our money and employ the US system?

- The answer is very simple. It was formulated, though on the other occasion, by Napoleon more that two hundred years ago: if you do not want to support your own army, you will support a foreign army.

It is worth mentioning that the GLONASS system was initially created as a military system. Today it is a part of the State level security system.

Then, recently the wars and the war conflicts have shown that without precise positioning and navigation services it is impossible to successfully play at any seat of war. There is no sense to spend hundreds of millions dollars or rubles to create a tremendous super weapon, e.g., a missile, if it cannot bring a warhead to the specified point. The navigation and time data services provided during the war operations are the determinating factor to win a victory.

Thus, how can we allow our armament system to be based on the data received from the US navigation satellites? In my opinion, it is nonsense. Yes, today the USA permit everybody to use their GPS services. However, first, signals are coarse ones, not precise ones provided for the US military forces. Second, who knows whether the access to the US system will be kept free tomorrow, in several years?

I mean that to discuss whether the GLONASS system is needed when there is the GPS system, is the same as to propose to refuse producing tanks or war-planes in Russia saying that we can buy them from other countries.

- It is impossible to object to such arguments. However, are there any financial advantages obtained from developing the space navigation?

- The predictions of the Western experts show that in 2011 the market of the civil navigation services will amount $40 bln, by 2015 it will achieve $60 bln. Having in mind that today there are only two space navigation system actually in use - Russian GLONASS and US GPS, any relevant commercial application can be based on one of these two systems only.

As for our country, according to the assessments of the specialists, the 15-year period of the existence of the full-scale navigation filed ensured by the GLONASS system will bring the direct profits (gains from selling the user navigation equipment and rendering the navigation services) exceeding 16 bln rubles. The conditional benefits gained from saving the resources, reducing the building expenses, surveying treasures of the soil, as well as the results of reducing the transport accident rates is assessed at the level of 10 bln rubles.

I can add that today the main attention is paid to the commercial civil use of the GLONASS system, because the country shall obtain all the possible economical advantages and reduce the expenses to be incurred to ensure its defensive capacity.

Reference

GLONASS is designed to render navigation services to airplanes and helicopters, maritime and inland water craft, motor vehicles and railway vehicles; to determine the parameters of spacecraft motion and orbit control; positioning during geodetic and geological survey and measuring activities, for topography and hydrography purposes; to support rescue services, ambulance services and militia (police) services under emergency situations; to determine coordinates when routing highways, roads, pipelines; in-route orientation for tourist groups and individual tourists; to support fundamental investigations and researches.

Spacecraft integration

- And what about the benefits gained, can an ordinary user feel it?

- GLONASS plays a backbone role in a number of practice fields. The economical advantages gained from employing the system are huge, though an ordinary user may not surmise them. An ordinary user does not know that for the purposes of a geodetic network allowing to determine location coordinates with a centimeter-level accuracy required to perform cadastral survey or construction works, it is necessary to establish and maintain throughout the territory of the country a number of triangulation towers equipped with dedicated devices. On the other hand, the same task can be easily solved using a space-based system.

Here, we have approximately the same economical effect as we have from the satellite communications. A communications satellite costs a lot of money - hundreds of millions rubles. However, using this satellite one can "raise" a TV signal by 40 kilometers and transmit it from Moscow to Vladivostok, Khabarovsk, Chita. Otherwise, it is necessary to put triangulation towers (rather expensive) each 40 kilometers throughout the territory of the country. In addition, a service staff is required, and the energy. In total, the expenses are tremendous.

As a result, the space, with all its apparent expenditures, gives the huge profits in the fields not directly linked with the space.

For example, what is a direct benefit to an ordinary user from a cellular phone? At first sigh, an ordinary user only incurs expenses, including user charges, costs of a device. However, today can you refuse a mobile phone? I guess you cannot. A mobile phone makes your life easier, improves its safety, and allows money savings.

I am quite confident that the satellite-based navigation will have the same advantages as the mobile communications. Today it is not very obvious because the space-based navigation is at an early development stage.

The main domestic users of the satellite-based navigation services are entities and enterprises of all ministries, federal agencies and administrations, in particular, aviation and marine fleet, motor and railway transport, cosmonautics, geodesy and geology, topography and hydrography.

GLONASS provides the navigation services to the benefits of Ministry of Defense, Ministry of Home Affairs, Emergency Committee, and frontier forces. GLONASS helps to control cargo transportation and to support search and rescue of distressed objects, enables to perform cadastral survey activities and to solve tasks of geodynamics and earthquake predictions.

Obviously, the best effects will be obtained in the transport sphere. Having in mind that during the last 15 years the satellite-based navigation became the main element of the world economical infrastructure, it

means that it has become an integral support to the economical growth of all social spheres and domestic security areas.

- Satellite systems are very expensive. Are there any mechanisms to refund the budget money invested?

- An ordinary user does not incur a direct payment for using a navigation signal. Both systems - GLONASS and GPS - are declared to be free of charge for 15 years, by the governments.

Neither Russia nor the USA has invented an effective mechanism for the system developers to gain direct profits. The Europeans are trying to do the same by declaring their navigation signals not being free of charge, however these are the plans only.

In the future, the paying back mechanisms will be in the form of receiving money from selling user terminals, licensees for manufacturing the equipment, electronic cards, rendering traffic control services.

First of all, the reimbursement can be ensured by increasing the efficiency of the activities in the field of the GLONASS applications. For example, employment of GLONASS equipment for the field land measuring activities allows tens-times decreasing the costs of these activities. Employment of GLONASS equipment for transport systems - ambulance service, transportation utilities - improves their efficiency by 20-30%.

The number of such examples is tremendous.

- When comparing the technical performances of the GLONASS and GPS systems, which is better?

- The comparison of the systems being designed practically at the same time, in 1980s, shows that they are very close in terms of the mission, output performances, potential positioning accuracy, structure of operating and control logics. Both systems comprise the space segment, launch vehicles, ground segment, equipment/terminal users.

The systems differ in technical parameters and design peculiarities. Moreover, the orbit inclination selected for the GLONASS satellites ensures the best output performances throughout the territories of the Russian Federation, Europe and in high latitudes; the same of the GPS system - throughout the territory of the USA and in low latitudes.

The GPS service area covers the Earth surface and near-Earth space with the height up to 3000 km; GLONASS - up to 2000 km. The systems are based on different orbital structures. They also have different structures of navigation signals and navigation messages, methodology of ephemeris & time data provision including a satellite motion parameter prediction.

The main thing to be stated is that potentially the GLONASS has the better performances versus the GPS system over the territory of the Russian Federation and adjacent territories. In particular, the GLONASS system has the advantages in the navigation services for the users located in the middle and high latitudes, but it is not so good as the US system for the low latitudes.

- In this case, the navigators who use the signals of both systems - GLONASS and GPS - are the gainers?

- It goes without saying. It is worth mentioning that a navigator-device

Assembly of spacecraft constituent components

Reference

The GLONASS system was put into pilot operation in 1993 and deployed to the nominal constellation (24 satellites in orbital constellation in simultaneously use) in 1995, four years after the commissioning of the US GPS system.

From 1995 to 2002 period, due to the lack of financing, the system degraded. The "GLONASS" satellites with 3-year lifetime lost their operability, without being replaced with new ones. Today, in orbit there are 17 satellites, some of them have the lifetime completely expired. In 2007, it is scheduled to launch 6 modernized satellites "GLONASS-M" with 7-year lifetime. By 2009, the task is to complete the constellation to 24 nominal satellites.

Machine to build payload structures

installed on a car, or a wrist one shall "see" at least four satellites in order to provide the location coordinates. The GLONASS and GPS orbital constellation are designed so that to ensure that within the device field of view there are 6-7 satellites of each system, simultaneously. The device selects four ones with the strongest and most stable signals and based on their data, provides the location coordinates.

If we discuss the possibility of using a combined GLONASS-GPS constellation, it means that automatically the density of the orbital constellation will be doubled. In this case, a device can select four "beacon" not from 6-7 satellites but from 12-14 ones. As a result the device will operate uninterruptedly under any conditions, for example, in a city or in mountains, the surface features of which can "put a shadow" for the satellites when they are close to the horizon.

On this point, the combined devices designed to receive signals from GLONASS and GPS systems, have some advantages versus single-signal devices.

- What are you doing in order to improve the GLONASS accuracy and reliability characteristics?

- The issue of improving the accuracy characteristics is the key issue for any navigation system. The accuracy level will determine the quality of the services rendered to the users and, finally, the competitiveness of the system. Should you have a choice, you will obviously prefer the system allowing more precise coordinates.

In 2006, NPO-PM together with Roscosmos developed and are now implementing the program to improve the accuracy characteristics of our system. Today a civil user, through the GLONASS system, can determine his position coordinates with the accuracy of 7-10 meters; in 2011 the accuracy will be at the level of 1-1.5 meters.

This level is to be achieved thanks to a number of dedicated measures to be realized. In particular, thanks to new satellites equipped with better devices, new apparatuses to be used for the ground control segment (GCS). Also, there will be new equipment of inter-satellite links allowing to compare attitude and time-related positions of satellites without the GCS support.

Another aspect is the establishing of a network of ground stations allowing monitoring the spacecraft statuses. One should feel the difference between having three ground monitoring stations (as we are having today) and having a network of such station throughout the territory of the country and abroad. This will enable uninterrupted and global monitoring of the spacecraft statuses and prompt implementation of operation corrections.

Moreover, the process is ongoing. New cleanliness standards and new monitoring standards are being implemented. In particular, new quantum-optical means will be used to calibrate spacecraft instrumentation.

The full recovery of the GLONASS constellation - up to 24 nominal satellites - is scheduled by 2009.

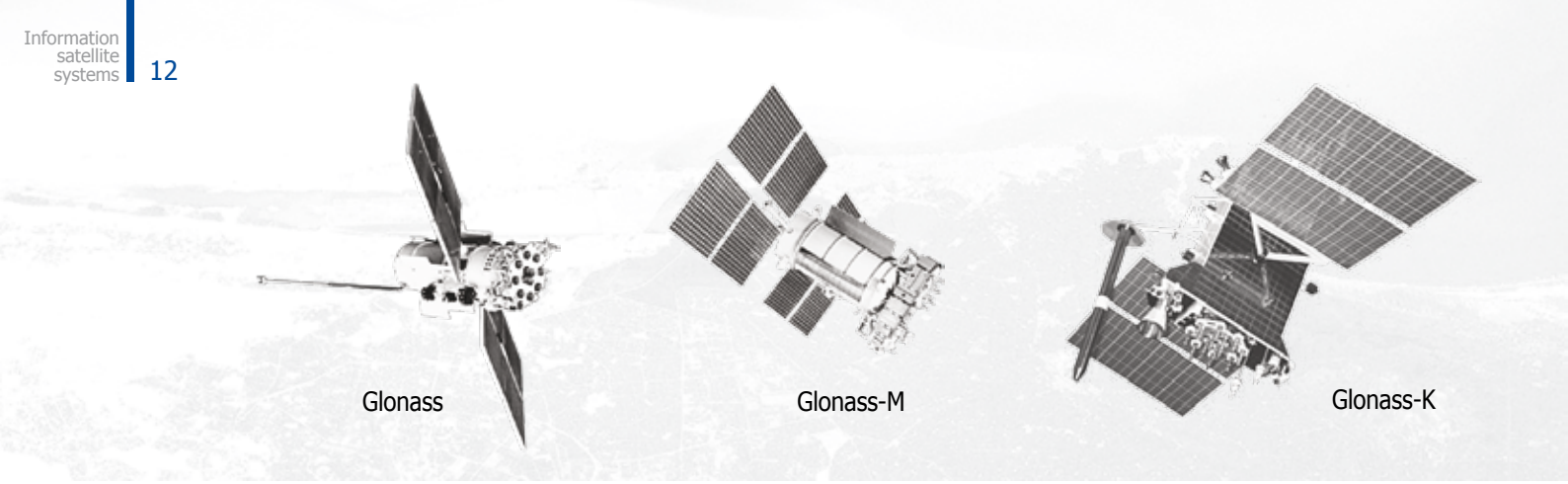
In short, the system performances are improved in a goal-directed manner, following the dedicated program. Step by step, we mitigate the errors in the device data. Finally, the GLONASS system will be at the same accuracy and reliability level as that of Western systems.

- When, using the GLONASS system, will airplanes be able to perform radar ("blind") landing in any weather conditions?

- In principle, today airplanes are able to perform radar landing using GLONASS, GPS, and Galileo - in perspective. To do that, in accordance with the ICAO (International Civil Aviation Organization) requirements to the flight navigation support, a navigation differential system shall be installed in the airport vicinity. In a real time mode, it will transmit to an airplane the corrections improving the accuracy and reliability of navigation data.

- How are the tests of the modernized GLONASS-M satellite carried on and what are the differences versus a GLONASS satellite?

- The first stage of the GLONASS-M flight tests has been completed.



Based on the results, the modifications improving the operation reliability have been implemented. As per the predictions, the last GLONASS satellite shall be decommissioned in 2008.

Being compared with a GLONASS satellite, a GLONASS-M satellite will have an increased life - up to 7 years (versus 3 years of GLONASS). A civil signal on the L2 frequency will be implemented. The navigation determination accuracy will be 2.5 times better. Besides, a modernized satellite will be equipped with additional devices enabling monitoring of the adherence to the international agreements on test ban of nuclear weapons.

- A GLONASS satellite life has been increased. Meanwhile, the life of American navigation satellites is two times longer. Are you solving the task?

- Today, NPO-PM is developing a "GLONASS-K" satellite with a life of 10 and more years. This satellite will use the third frequency in L-band to improve the accuracy and reliability of the navigation determinations. As a result, the accuracy of the navigation determinations will be two times better versus the accuracy of a "GLONASS-M" satellite.

A satellite mass will be halved. Consequently, the costs related to a satellite launch will be reduced, as a less powerful launcher will be required.

Unlike a GLONASS-M satellite, a "GLONASS-K" satellite design will be based on a non-sealed container. It will be equipped with additional equipment ensuring rescue of distressed human beings.

The first "GLONASS-K" satellite launch is scheduled in 2009. In 2018, according to the predictions, the last "GLONASS-M" satellite will be decommissioned.

– Are you not afraid that the accelerated process of manufacture and launching of new satellites will result in reduced quality level? Do you manage to implement new technologies?

– The accelerated recovery of the GLONASS orbital constellation will be ensured with the increase in number of the satellites manufactured. This task is solved by arranging the additional working areas at the enterprises manufacturing satellites and their constituent components.

NPO-PM and the subcontracted enterprises are close to complete the arrangement of the additional working areas, with the existing technologies transferred, maintaining the current scope and contents of the ground tests required to keep the specified levels of product quality and reliability, in particular, of "GLONASS-M" satellites. New technologies are to be employed with the aim to keep the concerned working areas available for the manufacture of perspective "GLONASS-K" satellites.

– Why does the orbital GLONASS constellation change in number?

– Today, the orbital constellation is being deployed to the nominal one using satellites manufactured both in lot production and pilot production. Some of the satellites are under flight tests. Periodically, they are deduced from the constellation and subjected to the dedicated tests.

Therefore, the number of the satellites in use can vary even without any satellites additionally injected into the orbit. On completing the flight tests, the satellites will be in the nominal operation during their lifetime, including the specified maintenance periods. Besides, some satellites exceeding their mission lifetime are decommissioned when expiring the lifetime.

– What happens to the GLONASS satellites with the lifetime expired?

– Today, for the orbits of the navigation satellites GLONASS and GPS there is a necessity to de-orbit satellites with expired lifetime to the grave orbit. As a result, the collision of the satellites is unlike. However, in the future the problem will take place and will have to be solved. By the way, the issue is now under discussion at the international level.

– Do the military customers make their requirements to the GLONASS system more stringent?

– The GLONASS satellites transmit dual-use signals: of standard accuracy (SA) and precise accuracy (PA). SA signal is intended for the civil users and is available for all domestic and foreign users. PA signal is solely intended and available for military users. All new requirements imposed by military users are satisfied completely at each modernization stage - in "GLONASS-M" and "GLONASS-K" satellites.

The space navigation technologies employed for armament systems make the systems not only of high precision level but also more manoeurable and economically attractive, as the technologies ensure the high operation efficiency with reduced costs. And again, the role of the navigation component becomes dominating with subsequent probability to become the key requirement imposed by military customers ■

Interview prepared by
Sergey VALCHENKO
For "Interfax-AVN"

"EXPRESS-AM4": high powerful satellite of the future

The top management of Academician M.F. Reshetnev NPO-PM is intensively involved in the forming the contract portfolio for the nearest few years. The special attention is paid to the commercial contracts. Today, one of the most perspective directions of the enterprise activities is the creation of high powerful heavy communications satellites "Express-AM4".

Victor KOSENKO, NPO-PM First Deputy General Designer

Implementation of tasks foreseen in the Federal Space Program

THE Russian State order covering the creation and employment of the space products for the scientific and social & economic purposes is based on the Federal Space Program (FSP). The FSP for 2006-2015 foresees the creation of several high powerful communications satellites of the EXPRESS family. Following the FSP, new requirements are imposed to the perspective communications satellites. The national satellites shall be improved significantly in order to increase the scope and quality of the services rendered to users throughout the territory of the Russian Federation.

The Russian Satellite Communications Company which is the major Russian operator of the satellite communications systems and the main customer for the NPO-PM's products has imposed new requirements to the advanced telecommunications satellites. The background for these new requirements was the status and the development tendencies of the current service market.

The mass of a perspective satellite shall be at the level of 3200 kg; the lifetime shall not be less than 15 years. The tasks of the satellite are to ensure the fixed, mobile president and government-level communications in C-, Ku- and L-bands, as well as the TV broadcasting. The fixed service areas shall be enlarged. Simultaneously, there should be a possibility to employ a number of steerable service areas. One of the main requirements is to ensure a high reliability level during the specified lifetime, corresponding to the world standards. Moreover, solely qualified flight proven equipment shall be installed on the satellite.

"Express-AM4" design developed by NPO-PM

As the major Russian satellite-making company, NPO-PM is interested in being awarded with contracts on procurement of new EXPRESS family satellites, starting with an "Express-AM4" satellite, meanwhile busy in developing a satellite design.

The "Express-AM4" satellite design is being developed having in mind the fact that the satellite will be put in the orbital slot 80 E at late 2009. It will be a high powerful (with a payload consumption of up to 14 kW!) spacecraft featuring advanced technical and operational performances.

So far, NPO-PM has developed the technical proposals for the "Express-AM4" satellite, presented at the 12th annual Conference of operators and users of the Russian satellite communications and broadcasting network, held in April 2007. The satellite will ensure the communications in C-, Ku-, Ka-, and L-bands (24, 16, 2 and 4 active transponders, respectively).

With the aim to build the satellite, NPO-PM is ready to involve the domestic subcontractors already demonstrated high reliability and technical level, and western subcontractors. Our long-standing partner Thales Alenia Space, former Alcatel Alenia Space, is ready to support NPO-PM in implementing this project, actively participating in building a new satellite platform and a payload module. While creating the satellite we can fully employ the experience gained within the "Express-AM" program to ensure high operational performances.

More detailed requirements will be formulated by RSCC by this August, after that the design engineers of NPO-PM will start developing the more detailed proposals on the satellite. Being supported with the traditional subcontractors, NPO-PM is ready to complete the satellite during 32 months ■

Victor KOSENKO,
First Deputy General Designer

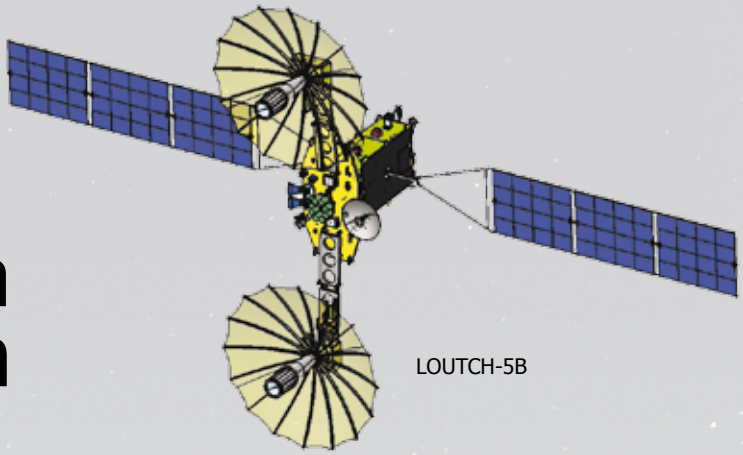
PROJECTS

Main satellite characteristics

Characteristics	Value
Communications characteristics :	
■ Frequency bands	L, C, Ku, Ka,
■ Number of active channels	56
■ Channel output power:	
L-band	25 W, 85 W
C-band	100 W
Ku-band	150 W, 200 W
Ka-band	150 W
Life	15 years
Satellite mass	3000 kg
Payload (antenna + repeater) mass	700 kg

Characteristics	Value
SA power at EOL	16,8 kW
Payload power supply	13,5 kW
Antenna pointing accuracy (half-cone)	0,16°
E-W and N-S station-keeping accuracy	(0,05)
Autonomy	14 days
Launch vehicles	PROTON-M launcher with BREEZE-M booster or PROTON-M with DM-03 booster

"Loutch"
multi-purpose data relay space system


LOUTCH-5B

"Loutch" multi-purpose data relay space system (RMSS) based on "Loutch-5A" and "Loutch-5B" geostationary satellites is being created at the Academician M.F.Reshetnev Nauchno-Proizvodstvennoe Obiedinenie Prikladnoi Mekhaniki (NPO PM).

The Russian data relay space system was based on "Loutch-5A" and "Loutch-5B" satellites developed by NPO PM at late 1970s - early 1980s. These satellites expired their lifetime and finished working in 1998.

The development of the "Loutch" RMSS based on "Loutch-5A" and "Loutch-5B" satellites was made by the recommendation of the scientific and technical board of ROSAVIACOSMOS following the results of the "Loutch" RMSS pre-design review and included in the Russian Federal Space Program for 2006 - 2015.

The data relay satellites will work with LEO satellites (up to 2000 km above the Earth surface) including the manned space complexes and, first of all, the Russian segment of the International Space Station, and also with other rocket and space objects (launchers, boosters, etc). "Loutch-5A" and "Loutch-5B" satellites will receive the data from them while on the active and passive orbit arcs out of visibility from the Russian territory and transmit it to the Russian receiving centers in the real time mode.

The data relay channels in S-band and Ku-band to be connected to the data receiving centers through the unified trunk channel, are foreseen on a "Loutch-5A" satellite.

A data relay satellite will point its user antennas, with the high accuracy, towards the objects in the low orbits, "capture" and "track" them along the motion trajectory. Each of two user antennas of "Loutch-5A" satellite can track independently "its" low orbit spacecraft. One antenna operates in Ku-band, another antenna operates in S-band.

Ku-band channel capacity is 150 Mbit/s, S-band channel capacity is 5 Mbit/s

To ensure the satellite communication with the Ground Control Segment, in S-band, the LEO satellite TM-data downloading and command data uploading in the Multi-Station Access (MSA) mode will be provided. At the same time, at least, two low orbit spacecraft will be able to transmit data through "Loutch-5A" and to call the Ground Control Center simultaneously in case of an abnormal situation onboard a satellite, which is out of visibility from the Russian territory, and also to receive the command data from GCS.

A "Loutch-5A" satellite is also capable of receiving "COSPAS/SARSAT" signals in P-band and transmitting these signals in L-band to the ground control center. The same frequency bands will be used to gather and transmit hydrometeorological data provided by the "Planeta-C" system .

Unlike a "Loutch-5A" satellite, a "Loutch-5B" satellite will be equipped with neither MSA data relay equipment nor "COSPAS/SARSAT" equipment. Instead, a laser and radio communication channel will be set.

"Loutch-5A" and "Loutch-5B" satellites will be set at three geostationary orbit slots registered by Russia for data relay satellites: in 16°W above the Atlantic ocean, in 95°E above the Indian ocean and in 167°E above the Pacific ocean. Thus, an uninterrupted receipt of LEO satellite data with subsequent transmission of this data to the Russian territory will be provided in the real time scale.

The satellite design is based on a non-sealed platforms "Express-1000" developed by NPO PM. The mass of each satellite will be about 950 kg. It will allow to use a "Soyuz-2" launcher with "Fregat-SB" booster to launch these satellites from the Baihkonour site.

The on-board data relay equipment for "Loutch-5A" and "Loutch-5B" satellites are manufactured by NPO PM in cooperation with NPP "Radiosvyaz" (Krasnoyrsk), NII "Radio", RNII of Space instrument making, NII of High precision equipment making (Moscow), and also in cooperation with some foreign suppliers of the relay equipment components.

The on-board service systems for "Loutch-5A" and "Loutch-5B" satellites are developed by NPO PM in cooperation with some Russian enterprises.

The on-board control subsystem is developed by NPO PM in cooperation with NTTs "Module" and RNII of Space instrumentation making (Moscow).

NPP "Geofizika-Cosmos" (Moscow), NPTS "Polyus" (Tomsk), NPP "Kvant" (Rostov-na-Donu) are subcontractors for the Attitude Determination and Control Subsystem. These enterprises are the members of the corporation "Information satellite systems" where NPO PM is the major company.

OKB "Fakel" (Kaliningrad) will supply propulsion subsystem thrusters.

The electric power subsystem will be manufactured by NPO PM in cooperation with OAO "Saturn" (Krasnodar) and NPTs "Polyus" (Tomsk).

Today, the documentation for "Loutch-5A" and "Loutch-5B" satellites is being issued, the experimental samples for on-ground tests are being manufactured, tests of the most complicated elements of

LOUTCH-5A

satellites are being performed. One of such elements is an antenna. Each spacecraft has two user antenna with a 4.2-m dish diameter, which are equipped with the precise tracking electromechanical driving gears. All these elements are developed and tested by NPO PM. The experimental samples of the antenna have been already manufactured. This is our "know-how": the "umbrella" scheme as it was on previous "Loutch" satellites, the spokes made of composite materials, radio-textile made of gilded micro-wires.

Many new technical solutions made by NPO PN and other subcontracted enterprises have been implemented in Loutch-5A" and "Loutch-5B" satellites. The main of them are:

- a satellite structure based on honeycomb panels with built-in heat pipes;
- a thermal control subsystem based on heat pipes;
- solar array photo-voltaic cells based on gallium arsenide;
- Earth orientation devices of a static type;
- employment of the star tracker in the ADCS subsystem.

Following the Russian Federal Space Program for 2006 - 2015, "Loutch-5A" and "Loutch-5B" satellites should be manufactured in 2009 and 2010, correspondingly. The launches of these satellites are scheduled for 2010 and 2011.

Taking into account that NPO PM is the only Russian enterprise which has gained a 25 year experience in developing, manufacturing and operating data relay satellites, the high quality of the project performance can be guaranteed ■

Sergey ROSKIN,
Project manager

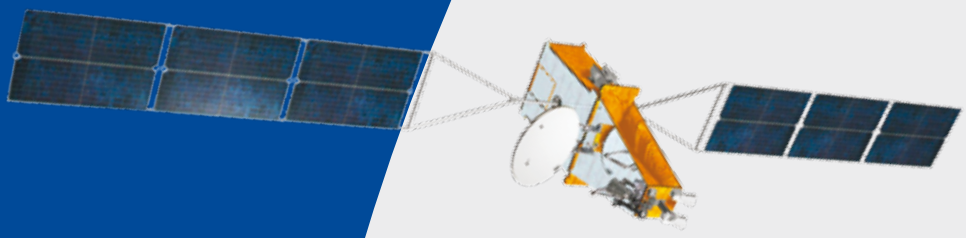
LOUTCH-5A reflector

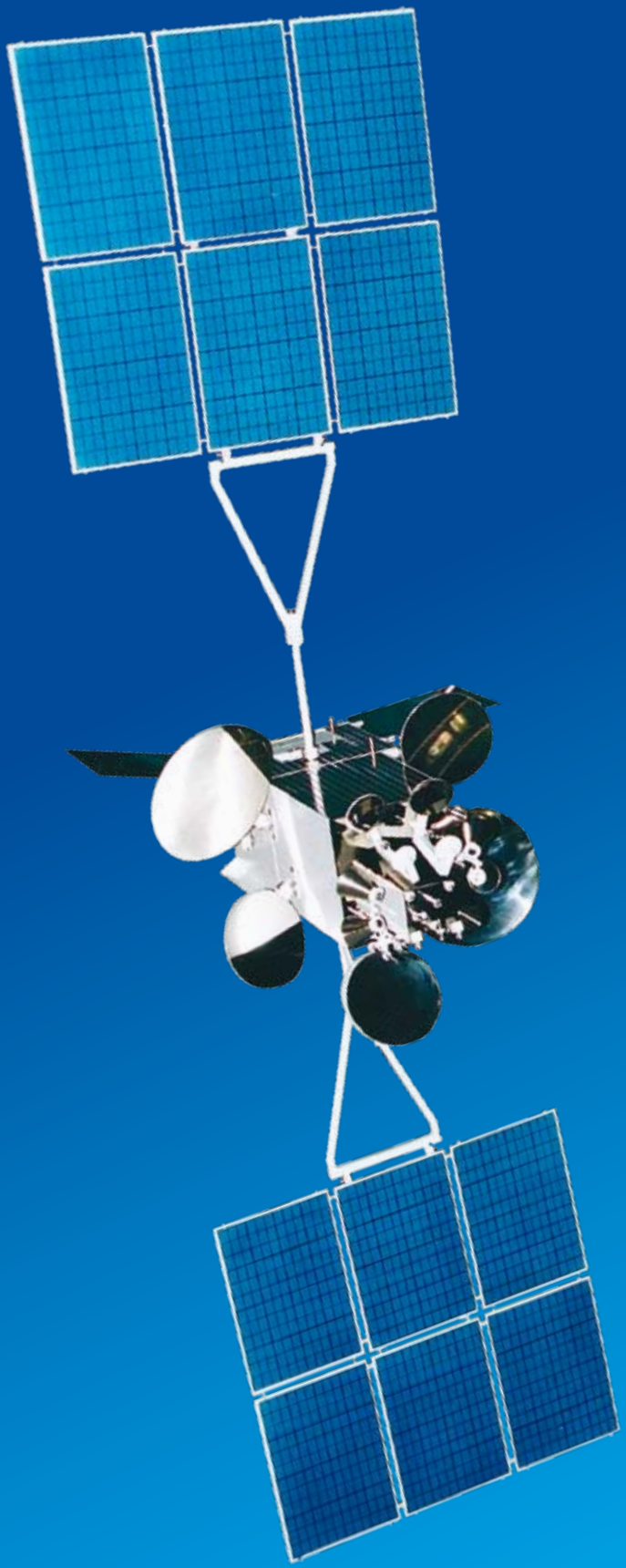
PROJECTS

Main characteristics of "Loutch-5A" and "Loutch-5B" satellites

	Loutch-5A	Loutch-5B
Mass, kg	950	950
Life-time, years	10	10
Number of data relay channels	7	6
On-board data relay equipment frequency range, GHz	2.3/2.1; 15/11; 0.4/1.7	2.3/2.1; 15/11; optical
Antenna patterns	Spot, steerable and global	Spot, steerable and global
EIRP of channels, dBW	from 23.9 to 59.6	from 34.0 to 59.6
G/T of channels for Tx, dB/K	from -12.6 to 24.1	from 8.5 to 24.1

Scheme of interaction between elements of Multi-purpose data relay system





Great achievement in satellite broadcasting

TELEVISION role in modern society is continuously growing. Therefore, in this country it is paid special attention to development of telecommunication means for TV-broadcasting. Nowadays, the most important strategic task is modification of Russian TV and radio broadcasting (broadcasting) network in connection with the transmission to new broadcasting formats: digital TV, HDTV and mobile TV. New generation satellites that are being developed by NPO Prikladnoi Mekhaniki will allow to speed realization of these plans.

Project objective

New satellites for Russian broadcasting network are being developed in the framework of the project Express-B, included into the recent Federal Space Program in Russia for the period till 2015. The General customer of the project is FSUE Russian TV and Radio Broadcasting Network (RTRN). NPO Prikladnoi Mekhaniki is the prime contractor on the project development and arranging of satellite complex under “turnkey” condition. The satellite complex comprises two (plus one for the broadcasting redundancy) relatively not expensive customized small satellites Europe1 and Asia1 in the geostationary orbit and ground infrastructure, including ground control centre and satellite communications centres.

The task of these satellites is to provide receiving and transmission of single-program and multiprogram packages of TV-radio programs, multimedia and information service through satellite channels to small ground C-band station network in the territory of Russian Federation. In this case the satellites allow to multiplex single-program digital TV signals, coming from different areas of Russia, and generate from them single multiprogram digital TV-radio program packages directly on

Satellite launch scenarios

Single launch of one satellite using SOYUZ-2 launcher

Group launch of three satellites using PROTON-M launcher

the board of the satellite. It makes satellites extremely convenient for regional broadcasting companies.

The satellites Europe1 and Asia1 will provide support of four types of digital TV program packages at general federal level:

- TV-radio program packages of state central television;
- TV program packages of central commercial broadcasting companies;
- TV program packages of provincial, regional, republican centres (using on board multiplexing technology SkyPlex);
- TV program package in the HDTV format.

The constellation of customized small satellites Europe1 and Asia1 as a part of single production and technical complex FSUE RTRN will allow to increase significantly the quantity of TV-radio programs distributed in the RF territory, to reduce the service cost for broadcasting companies by 1.5 times and speed the transfer to digital broadcasting in this country. After launching of Europe1 and Asia1 satellites for the first time there will be available to all, Russian HDTV channel. Based on new technologies in the design of these satellites, RTRN will provide the higher level of regional television development, including "province" channels.

Unique satellites

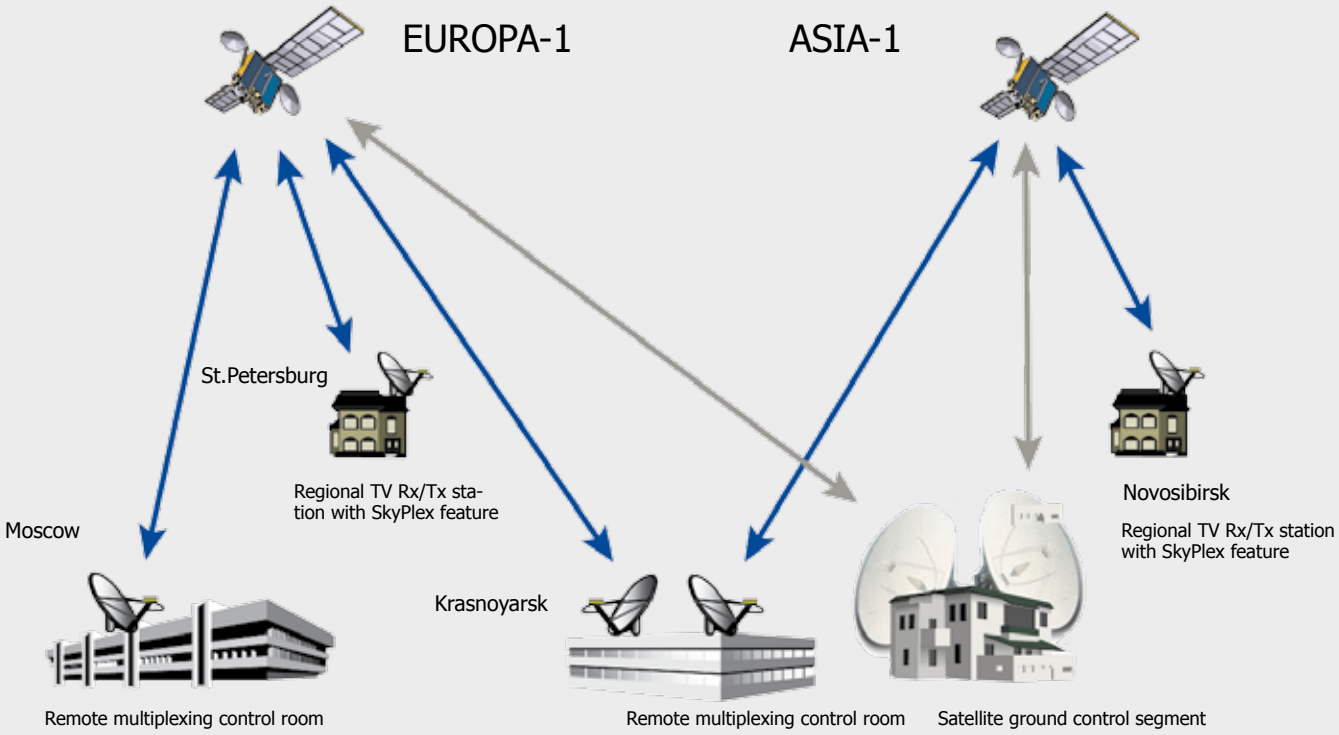
In order to fulfill these tasks the satellites shall meet high requirements for technical performance.

For the first time in this country the new generation satellites Europe1 and Asia1 have been specially optimized with respect to mass, dimension, efficiency and price with the purpose to realize the task and organize the broadcasting in the territory of the Russian Federation.

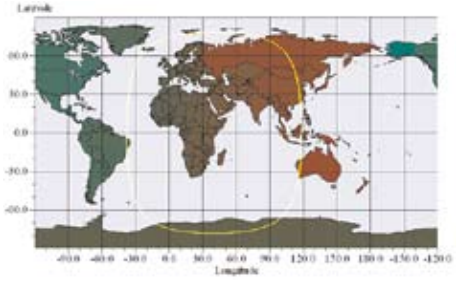
Main performance of satellites Europe1 and Asia1

Orbit type	Geostationary
Mass of one satellite, not more	830 kg
Station keeping accuracy	±0,05 dg
Guaranteed lifetime	15 years
Operational bandwidth	From C (6/4 GHz)
Quantity of active transponders	10
Transponder bandwidth	36 MHz
EIRP over contour of RF territory	43 dBW
G/T over contour of RF territory	-1 (peak -3 (in coverage area) dB/K

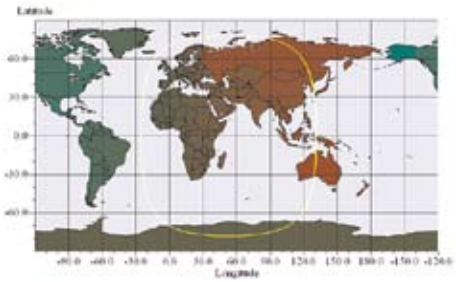
Scheme of EURASIA ground infrastructure supporting the nominal operation of EUROPA-1 and ASIA-1 satellites



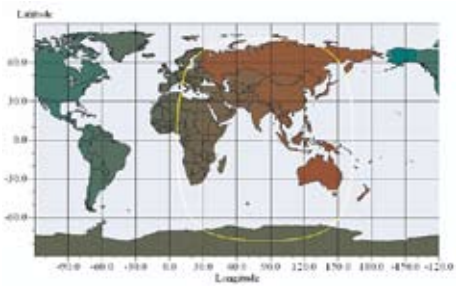
West orbital position (EUROPA-1 satellite possible orbital slot)



Express-AM1 40E

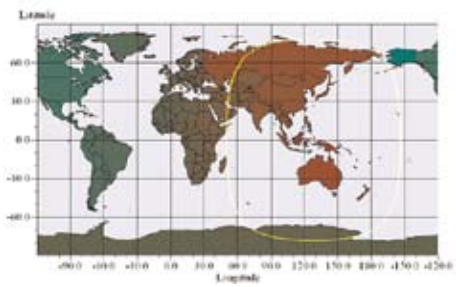


Express-AM22 53E

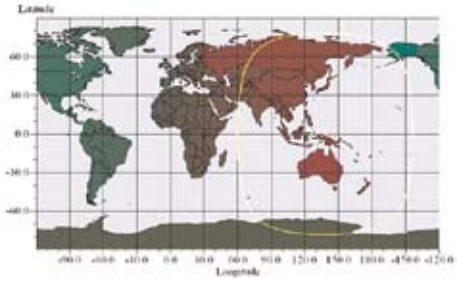


Express-AM2 80E

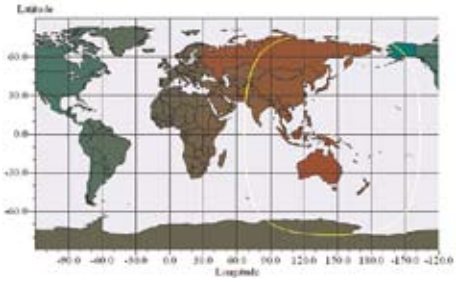
East orbital position (ASIA-1 satellite possible orbital slot)



128E



Express-AM3 140E



Gorizont-45 145E

Satellite broadcasting standard DVB-S2

Each satellite comprises a payload module and a platform (subsystem module). The satellites Europe1 and Asia1 are designed based on the domestic platform Express 1000. During the platform design it is ensured heritage concerning materials, technologies and parts, equipment and on board subsystems design, as well as software provision with all perspective developments of FSUE NPO PM and its cooperation.

Payload Module

The payload modules development is realized in the framework of cooperation with the Thales Alenia Space corporation.

The payload modules will provide the simultaneous operation of ten C-band active transponders, as well as receiving and retransmission of signals with digital modulation both in continuous mode and TDMA mode, multisignal and single-signal. The satellite payload module will allow to use four (and even more, if necessary) on board multiplexers SkyPlex for separate TV programs receiving, multimedia and Internet-data and its retransmission together with multimedia service in one package. Regional broadcasting companies will transmit digital signals of their TV programs on the board of the satellites Europe1 and Asia1 independently of each other in SCPC mode (one program per one carrier). On the satellite board the received digital signals of regional broadcasting companies will be demodulated and with the help of the on board multiplexer SkyPlex will be combined into one digital package, which later will be retransmitted on the ground in MCPC format (several programs per one carrier). In this case frequency-power resource of the satellite will be used of 100 %.

It is foreseen to launch the satellites Europe1 and Asia1 from Baikonur launch site in 2008. For the satellite injection into the orbit it might be used either the launch vehicle Souz-2 with the booster Fregat-SB (single launch) or the launch vehicle Proton-M with the booster Briz-M (group launch of 3 satellites) ■

Head of Marketing Research Centre of NPO Prikladnoi Mekhaniki
Andrey KOZLOV

Director of digital network of program distribution management FSUE Russian TV and Radio Broadcasting Network
Nickolay PASETCHNEY

Means of on ground centre of multiplexing control will provide:

- control of the complex data base;
- control of information service;
- telemetry acquisition and analysis of the on board equipment SkyPlex;
- acquisition and processing of events, all data of network configuration, definition for execution of necessary procedures and operations in the network, provision of weather data;
- control of network objects based on the standards protocols.

PERSONALITY

ERA of RESHETNEV

For employees of NPO Prikladnoi Mekhaniki Mikhail Fedorovich Reshetnev is not only a well known person. He is personification of an era of space exploration. He always believed in success of mutual work despite any failure. In memoirs of his colleagues, friends and near relations one can feel love and respect. And looking back we have realized how much Reshetnev managed to do.
The book "Academician M. F. Reshetnev" published on the eve of establishment of a cooperation Information Satellite Systems is dedicated to pay tribute to the founder of the enterprise. Some fragments of the book we have published in the magazine.

Beginning

Even at school Reshetnev was non-ordinary. For one day he was a first-form boy, at the end of the second day his "first teacher" said: "It is too easy for you here". The second-form program was coped by Reshetnev by November and the clever boy was moved up into the third-form. In 1939, Reshetnev graduated the school extremely well and decided to conquer Moscow Institutes. But entrance examinations did not allow the 15-eyar-old boy to pass the exams without having a passport. It was not like Reshetnev to waist time. In 1940 Mikhail passed successfully the exams and became a student of Moscow Aviation Institute.

Reshetnev was obsessed by the studies. Being a first-year student and the youngest one Mikhail became a faculty leader and as well as a leader of the joint weight-lifter team. Even domestic difficulties could not weaken his rush. For example, the hostel was so crammed that Reshetnev and his eighteen friends were asleep in the "Place of honor".

The student life was not serene for long time. In a year a war broke out. The Institute, where Reshetnev studied, was evacuated to Alma-Ata. The student hostel was placed in the theatre: the beds were in the auditorium, on the stage, in the utility room. In June 1942, all students of Mikhail course received call-up papers except Mikhail, who was under age. Then Reshetnev went to a military registration and enlistment office by himself. After the head of the office looked at the determined youth he understood that there was no point in arguing with Mikhail and gave an assignment to be taken as a cadet at Serpukhovskiy military college of aeromechanics. In October, Reshetnev as a sergeant of maintenance came for a service to the 26th fighter regiment. Till October 1945, he was involved into battle planes preparation at military airdromes all over the country. War rewards are evidence that Mikhail Fedorovich did his duty with honour.

Your turn has come!

In 1950, Reshetnev had a brilliant presentation and obtained the first-class degree. A young specialist was assigned at Special Design Bureau #1 (OKB-1). Starting from this time the life of Reshetnev was closely connected with the cause of Sergey Pavlovich Korolev - chief designer of rocket-space systems. Mikhail Fedorovich remembered later "the difference of Korolev school was that it required from everybody not only great self-denying work but it selected, brought up and promoted talented specialists". Quite soon the young engineer Reshetnev attracted Korolev's notice, Sergey Pavlovich had attentively been watching his behavior, promotion.

In February 1957, Korolev invited Reshetnev to a meeting and said: "Your turn has come!" He offered Reshetnev the position of a leading designer on article R-11. At that time it was the most fearful weapon - intermediate-range ballistic missile with a nuclear war-head on mobile start. It was not easy to create an own project. The first launch had a failure. But Korolev accepted this quite calm: "not all details have been thought over, there will be failures, but the article exists, it works". From November and till the end of 1958, the specialists and workers had to work in three shifts, they we provided meals and rest. Reshetnev sheared these difficulties with the staff. As a result the task was fulfilled. Later Reshetnev often remembered this period and all people he worked with. Most people later would leave with him to work to Siberia…

The activity in OKB-1 was the important life period for Reshetnev not only concerning a profession. Here he met his future wife. Being clever, beautiful, a queen of athletics - Ludmila conquered his love. The first dish she treated her future husband was compote, which Michael found delicious. Since then compote became an obligatory dish at family solemn events. In December 1951, Mikhail and Ludmila had a youth wedding and in September 1953 their daughter Tamara was born.

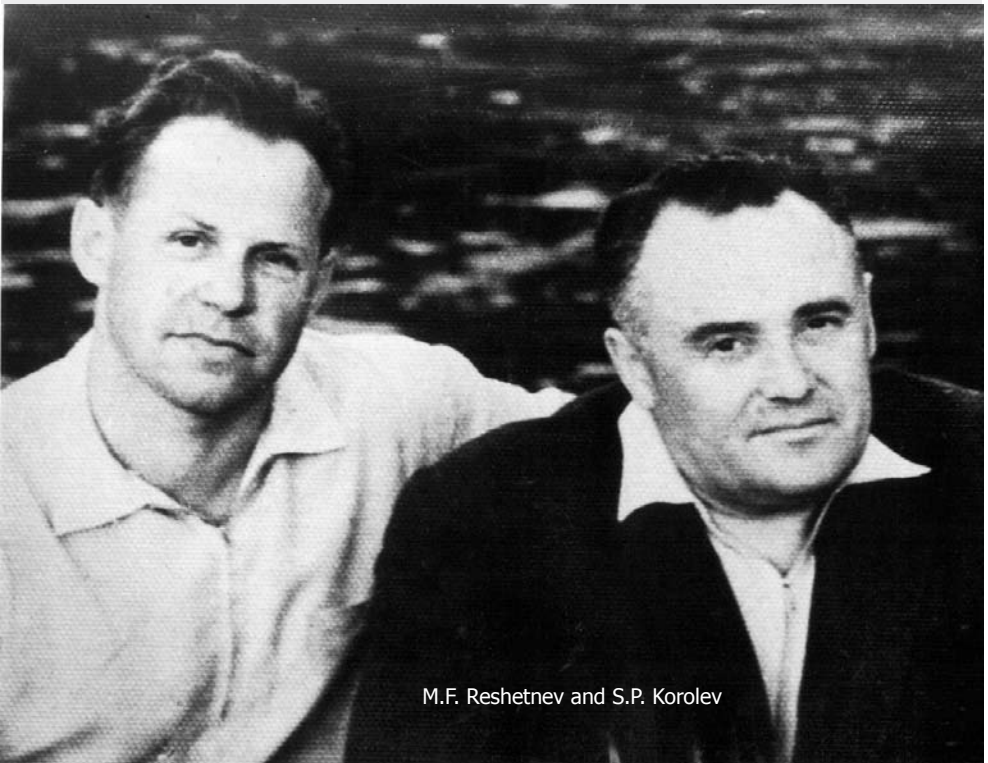
Creation of NPO PM

In summer 1953, Korolev suggested establishing of OKB subsidiary in Krasnoyarsk-26. "I do not know why I was appointed the leader of the subsidiary: at that time I was young and did not have sufficient authority in comparison with oth-

Mikhail Fedorovich Reshetnev

Life-years: 10.11.1924 - 26.01.1996.

Took part in the Great Patriotic War. Graduated the Moscow Aviation Institute and obtained the first-class degree (1950). Doctor of Technical Science (1967). Since 1959 till 1996 - the General Designer and General Director of Nauchno-Proizvodstvennogo Obiedineniya Prikladnoi Mekhaniki. Being a leader of young staff he managed the enterprise in the way it achieved a high level in the sphere of rocket-space technical equipment. Reshetnev gave lectures at Siberian Aeronautical Academy, headed the department "Spacecrafts". Professor (1975). Corresponding Member and Academician of Russian Academy of Science (1976 and 1985, accordingly). Academician of Russian Engineering Academy and International Engineering Academy (1992). Results of his work are described in more than 200 special proceedings and 40 inventions. Honourable citizen of Zheleznogorsk. The laureate of Lenin Prize of the USSR (1980), State prize of Russia (1995), socialist labour Hero (1974). Reshentev was elected a deputy of regional council and Supreme Soviet of the Russian Soviet Federative Socialist Republic. Was rewarded with medal of S. P. Korolev of Academy of Science of the USSR, 4 medals of Federation of Cosmonautics. NPO PM, sponsored by NPO PM Zheleznogorskiy Lyceum # 102 and Siberian State Aeronautical University have been named after Mikhail Fedorovich Reshetnev. The street and square of Zheleznogorsk, planetoid (asteroid) # 7046 1977 QG2 have been named after his name.



M.F. Reshetnev and S.P. Korolev

PERSONALITY

ers who worked with Korolev"- said then Mikhail Fedorovich. - But all my life I have been working in the way that nobody could think that Korolev had made a mistake".

Nowadays, it is difficult to imagine how much effort and believe it was needed to create here in Siberia a unique enterprise. It became the cause of Reshetnev life and those who worked with him. For 36 years Mikhail Fedorovich had been the leader of the enterprise. Narrative about his destiny is a story about unique manufacture, satellites which were produced and, of course, about people that were involved into this activity, about people that were united by space exploration activity and by Reshetnev.

A. E. Mitrofanov, the director of NPO PM plant said: "The manner and principle of Reshetnev management was not petty-minded meddling, but full trust and independence in decision taking under certain control and strict report concerning the activity. The achieved success was based on the perfect management, technical re-equipment, labour productivity increase, as well as due to the atmosphere of confidence, mutual understanding and responsibility created by Mikhail Fedorovich".

How to be a real man

Being strict and exigent manager Reshetnev expressed the best features of human character in relations with the employees: he communicated in a simple way with people, he was modest and attentive to opinion of other people, was reluctant to help.

L. G. Reshetneva: "Whatever position he had he always was sensitive towards people's troubles and misfortune. He was restrained, laconic, calm and reasonable, he liked to repeat: "We should perceive a person as he is". Ludmila Georgievna told: "We were sitting in the station square and noticed two 9-year-old boys eating ice-cream, another one a thing, smudgy, closely cropped boy wearing only the pants was sitting on the ground and watching them... Mikhail Fedorivich then pronounced: "Can you see how people still live? Help him!"

It is hard to understand how the life of one person can comprise so many events and affairs as Reshetnev managed to do for his life. In January 1975, Mikhail Fedorivich became a professor of Machinery Design Department (plant - Institute of Technology). In 1985, he was elected as a full member of Academy of Sciences of USSR. Later he became a president of Siberian branch of Russian Engineering Academy and soon an Academician of International Engineering Academy. For four years he had been a deputy of Supreme Soviet of USSR. Each thing he did at his full capacity.

Those who knew Reshetnev underlined his neat and sports appearance at any time and any situation. Michael Fedorivich started going in for sport being a student, he constantly did exercises, went jogging, was interested in yoga. If he allowed himself to relax, his rest was always active.

A. E. Mitrofanov: "During rest Mikhail Fedorivich was the life and soul of the party. We pitched tents, he enjoyed making a fire, picking up currants, he made sweet-scented tea with currants leaves. During a holiday he used to ware his traditional striped vest. He liked swimming even in the cold Yenisei river".

Endurance, good organization, tolerance and capability to work with a good result helped Reshetnev and his team to overcome later a difficult period of 90s.

Last deed

The starting period of "market relations" shook many enterprises of military-industrial complex. And it was a merit of Reshetnev that NPO PM overcame this period as a winner. He fought for his "creation" up to the end. He did not fear and did stake on integration and cooperation with the best world companies. In October 1989, the first large foreign delegation visited NPO PM and highly estimated NPO PM potential. But it was too early to speak about victory. It was a hard job to get over distrust of foreign specialists and our Russian bureaucrats! Reshetnev worked at full stretch, often regardless his own health.

E. N. Korchagin: "In January 1992, Reshetnev had to meet with Canadian businessmen. The flight duration to Canada was for 11 hours. He should arrive at 15.00 on the day of the negotiation, there was some short time for a rest before the meeting. The flight was delayed for four hours. When at 20.00 there appeared neat and good-looking Reshetnev the audience applauded".

Reshetnev always believed in work success and never lost heart. This helped in spite of all predictions of bureaucrats to win a tender on manufacturing and launch of telecommunication satellite Sesat for the international organization EUTELSAT. It was the victory. For the first time in history of Russia the contract on the satellite was signed with the western customer. Space and telecommunication organizations have known NPO PM as a competitive market partner.

E. N. Korchagin, director of Satellite Communications Centre, Zheleznogorsk. One must see a young shining face of Reshetnev! He realized that for NPO PM it was the time to break into a new era, prepared by previous 30-year-duration activity of all staff. We were walking round Paris until 3 in the morning and discussing the future plans".

Alas! Fate decreed in another way. Reshetnev did not participate the Sesat satellite launch and further projects, which NPO PM employees are proud now. Memory about Reshetnev - it is not only the street, plane and planet, books and lines in encyclopaedias named in honour of Reshetnev... Main memory about the life of this person is NPO PM - the enterprise, produced more than 30 space systems and over 1000 satellites under management of the enterprise founder. The enterprise, that became a part of life for many people in Zheleznogorsk and for Reshetnev. The enterprise based on which today there is under establishment a new corporation Information Satellite Systems combining the best companies of the country ■

After meeting un Senate. Paris, 1995

After signing the SESAT contract. 1995

ROSCOSMOS

RESHETNEV
COMPANY

Joint-stock Company
M. RESHETNEV INFORMATION SATELLITE SYSTEMS

KVANT (Moscow)

GEOFIZIKA-COSMOS (Moscow)

KVANT (Rostov-on-Don)

SIBERIAN DEVICES AND SYSTEMS (Omsk)

POLYUS (Tomsk)

NPO PM-MKB (Zheleznogorsk)

NPO PM-RAZVITIE (Zheleznogorsk)

TTC-NPO PM (Zheleznogorsk)

SIBPROMPROEKT (Zheleznogorsk)

WE BUILD BRIDGES THROUGH THE SPACE