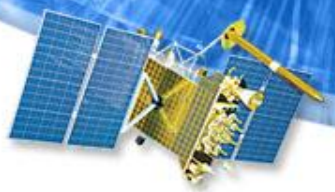
[EN-0015] Global Surveillance System Based on 1090ES ADS-B and Satellite-transmitters

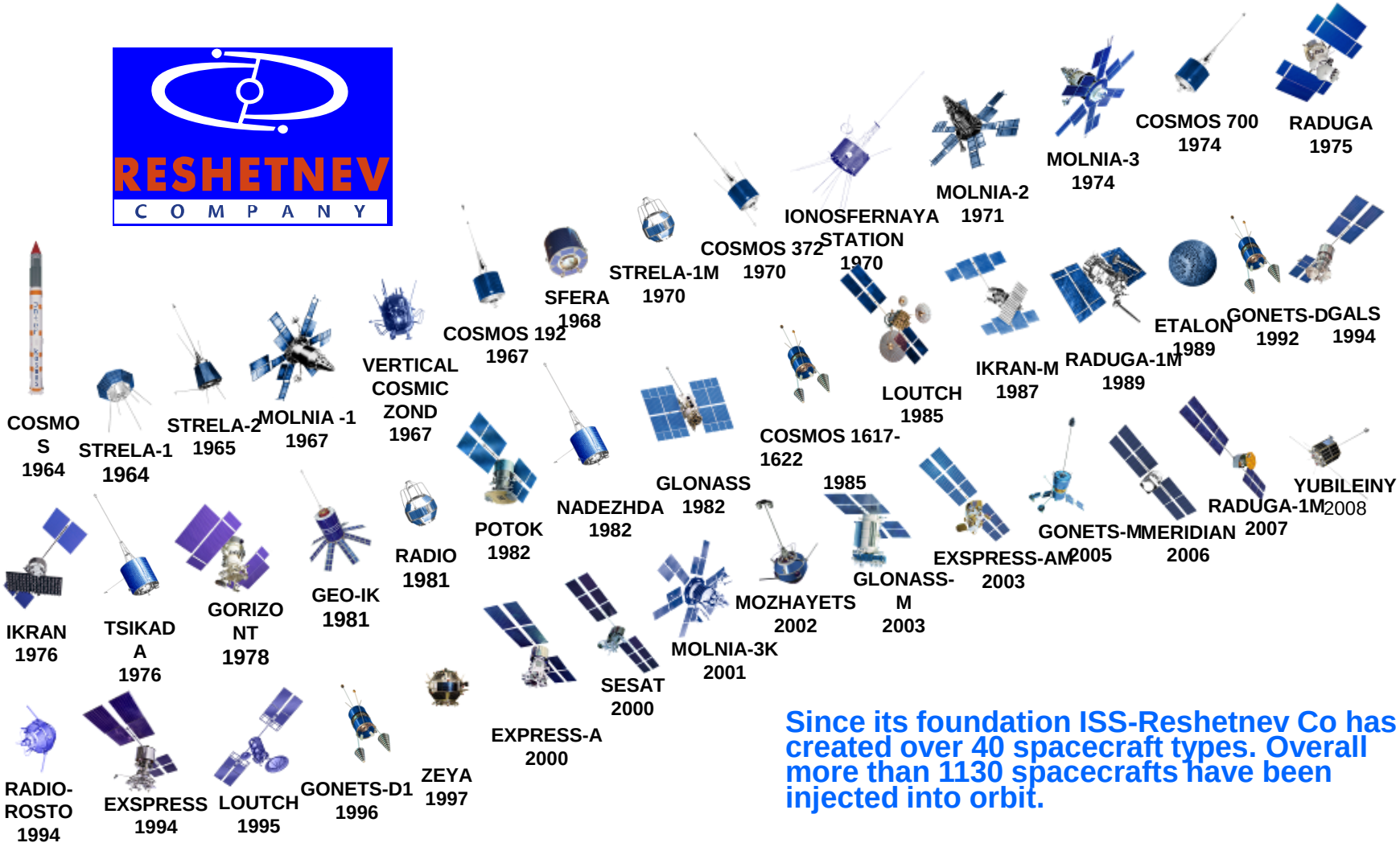


NAVIGATION

COMMUNICATION

GEODESY

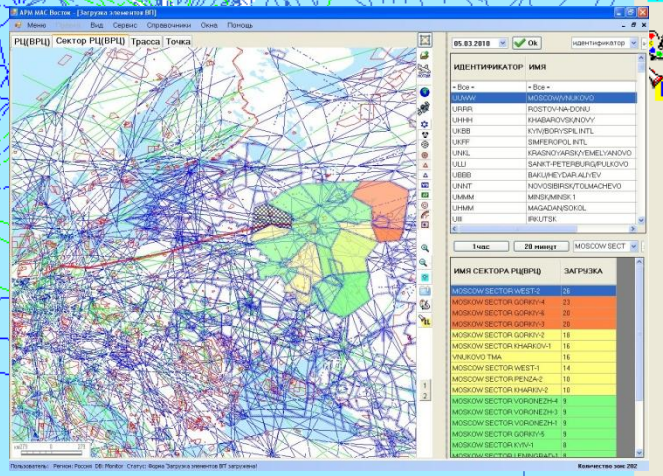
Main spacecrafts



Since its foundation ISS-Reshetnev Co has created over 40 spacecraft types. Overall more than 1130 spacecrafts have been injected into orbit.

Main Activities

- Air space organization
- Communication
- Navigation
- Surveillance
- Air traffic management



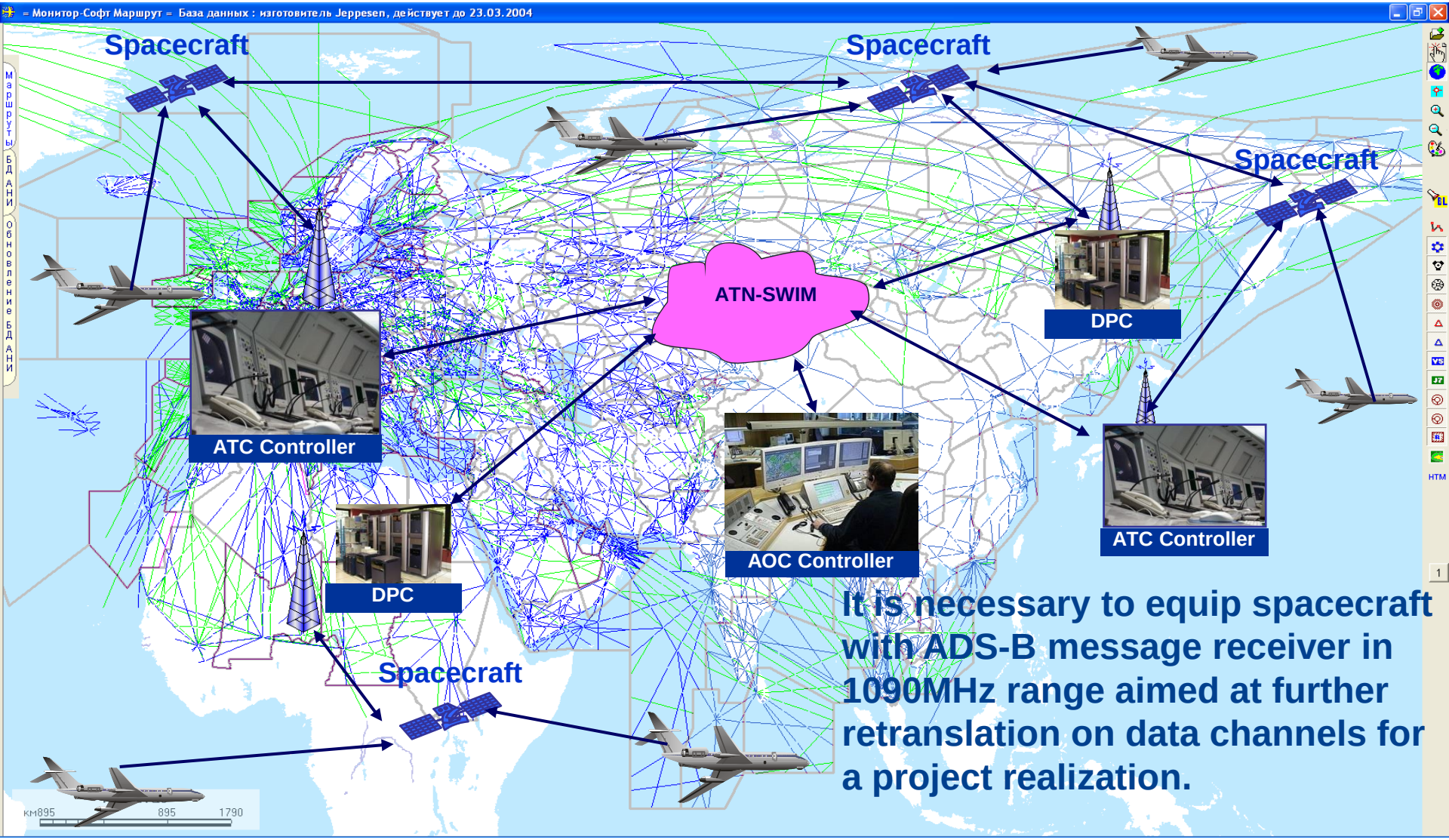
Technology enablers meeting the identified operational and architecture requirements

- **The communication systems** will increasingly use digital technology and protocols to a full integration of terrestrial and **satellite** networks towards a data network connecting all ATM sub-systems.
- **The primary navigation system** will be satellite based with a terrestrial fall back solution to mitigate against a potential full blackout of satellite navigation services.
- **New surveillance systems** e.g. **ADS-B** will increasingly provide improved 4D-trajectory information (position and time).

Global surveillance system. References

- ADS-B 1090Es technology is developed and widely implemented
- Most of aircraft are equipped with ADS-B 1090ES unit with sufficient power for signal transfer to low-orbit spacecraft.
- On-ground equipment for signals receipt and further re-transmission to ATM systems
- Russian Space Agency is in charge of development of space communication system enabling a global coverage for message retranslation

Global surveillance system. Operational concept



Global surveillance system. Technical feasibility

The key principle – minimization of costs

- - installation of receiver 1090 MHz to spacecraft for further data transfer via existing data channels
- - use of the present aircraft on-board equipment for surveillance purposes

Automatic dependent surveillance system with space-based elements

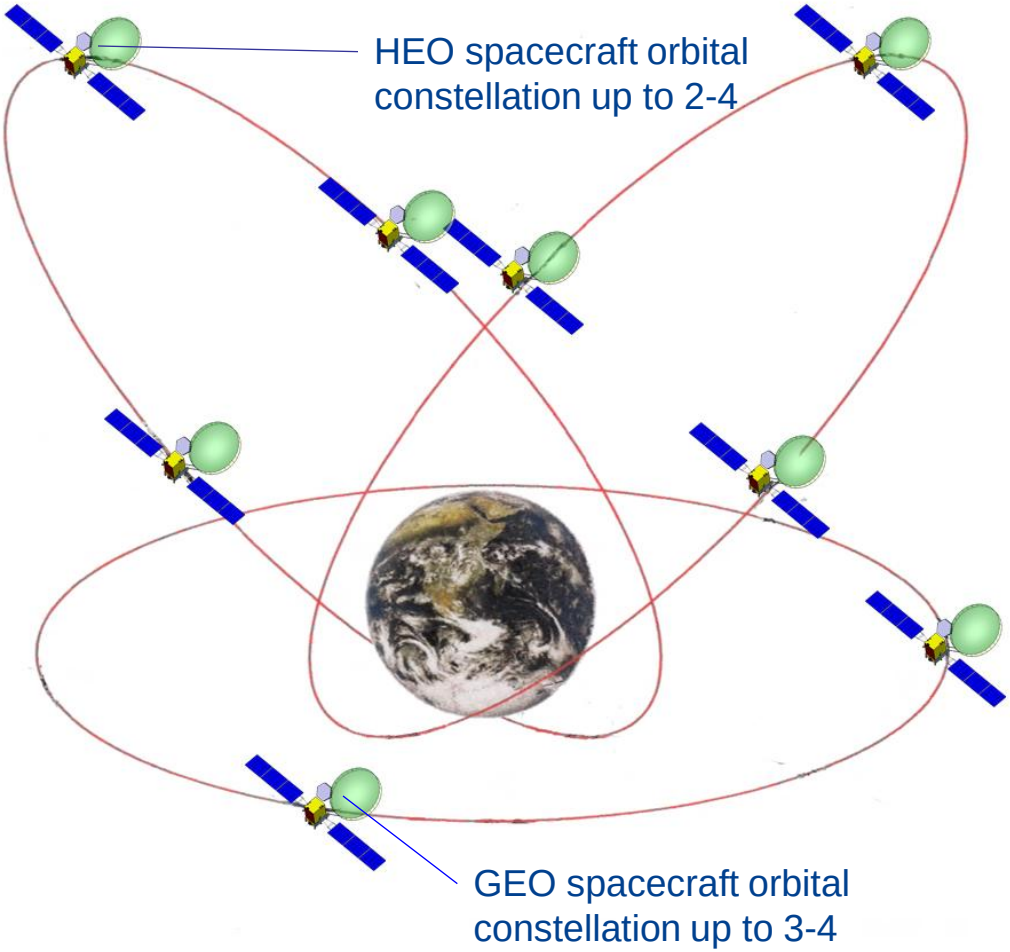
The system shall provide:

- reception of ADS-B signals from aircrafts at frequency 1090 MHz;
- transmission of ADS-B signals received at frequency 1090 MHz to the on-ground gateway terminals.

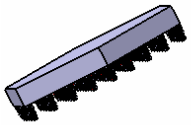
Proposals related to spacecraft orbital constellation generation

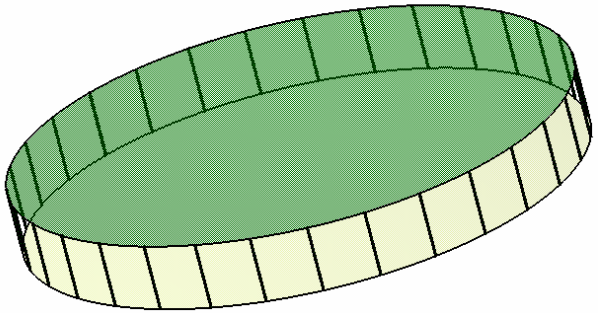
- Preferable orbital positions:
  - 15° W
  - 120° E
- The service of flight routes over the Atlantic ocean, the Indian ocean, a part of the Pacific ocean, Eurasia, Africa and Australia is also provided.
- The flights over the North Pole are serviced by high elliptical orbit (HEO) spacecrafts of “M” or “T” type.

GEO & HEO spacecraft orbital constellation



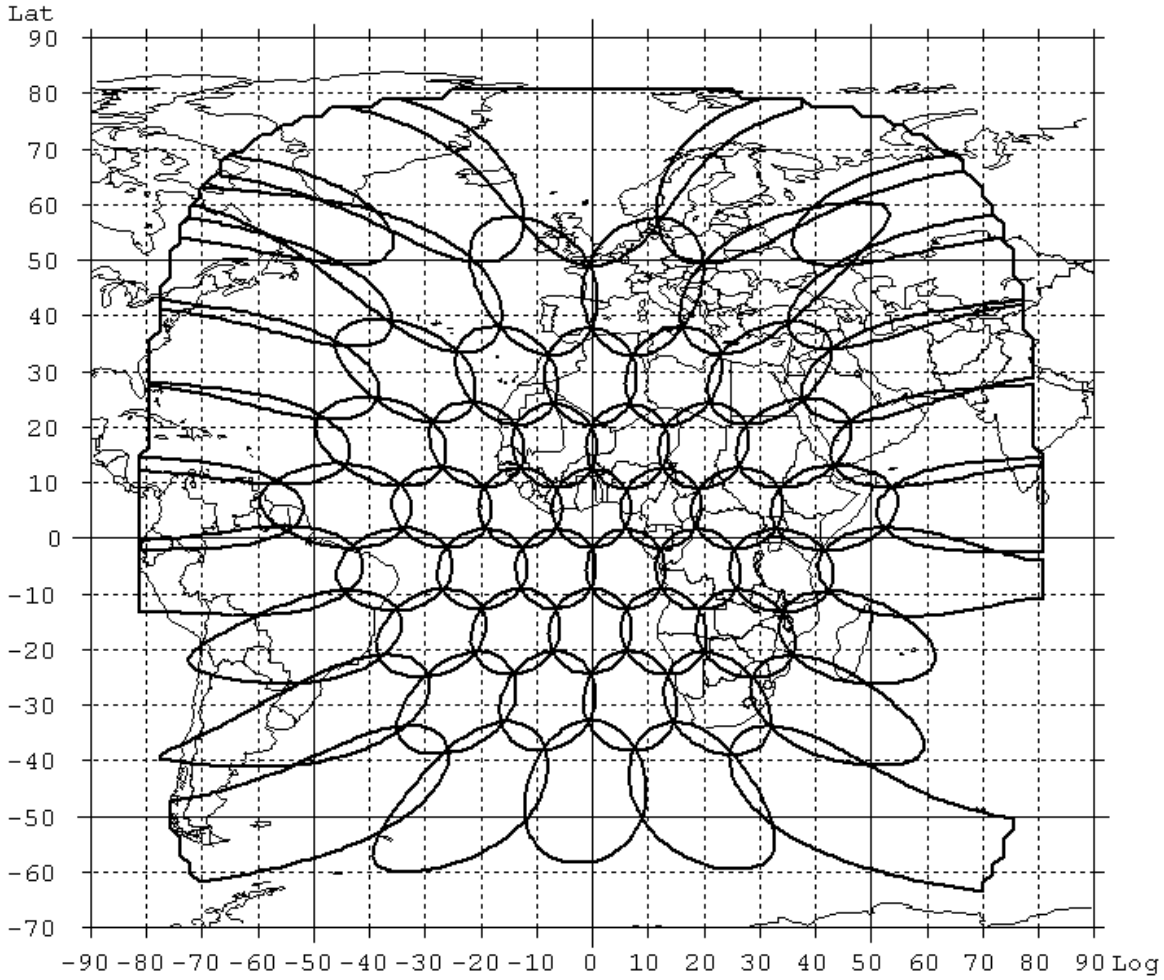
Antenna system for signal reception from aircraft board



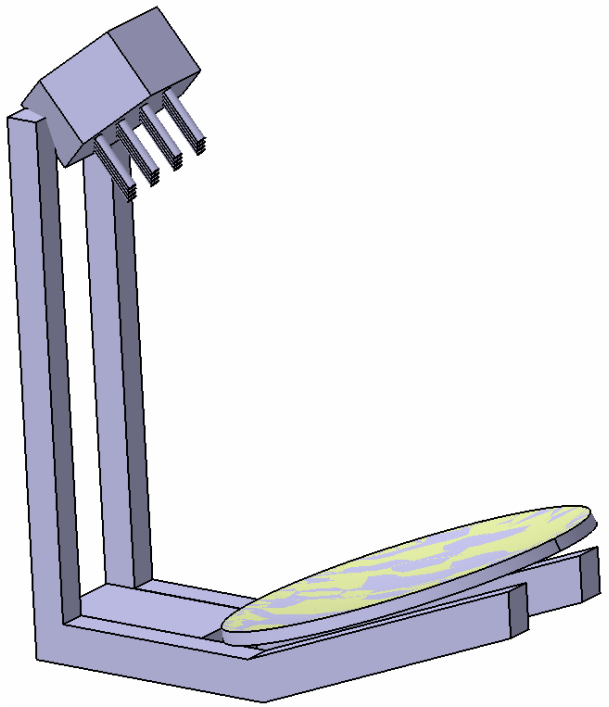


- Hybrid reflector antenna generating 61 beams is required to cover the specified coverage area;
- Reflector diameter is 7 m;
- Feed dimensions are 2790X2460X450 mm;
- Multi-beam antenna feed is a 61-element flat phased array consisting of conic helical radiating elements;
- Helical radiating element is used as a single element of phased array;
- Diameter of each helix is 100 mm at the bottom and 60 mm at the top and the height is 200 mm;
- Polarization type is right-hand circular;
- Gain in the coverage area at the level of minus 3 dB is not less than 27,8 dB;
- Antenna beam width for one beam is 2,4ºx2,4º.

Receive antenna system coverage area

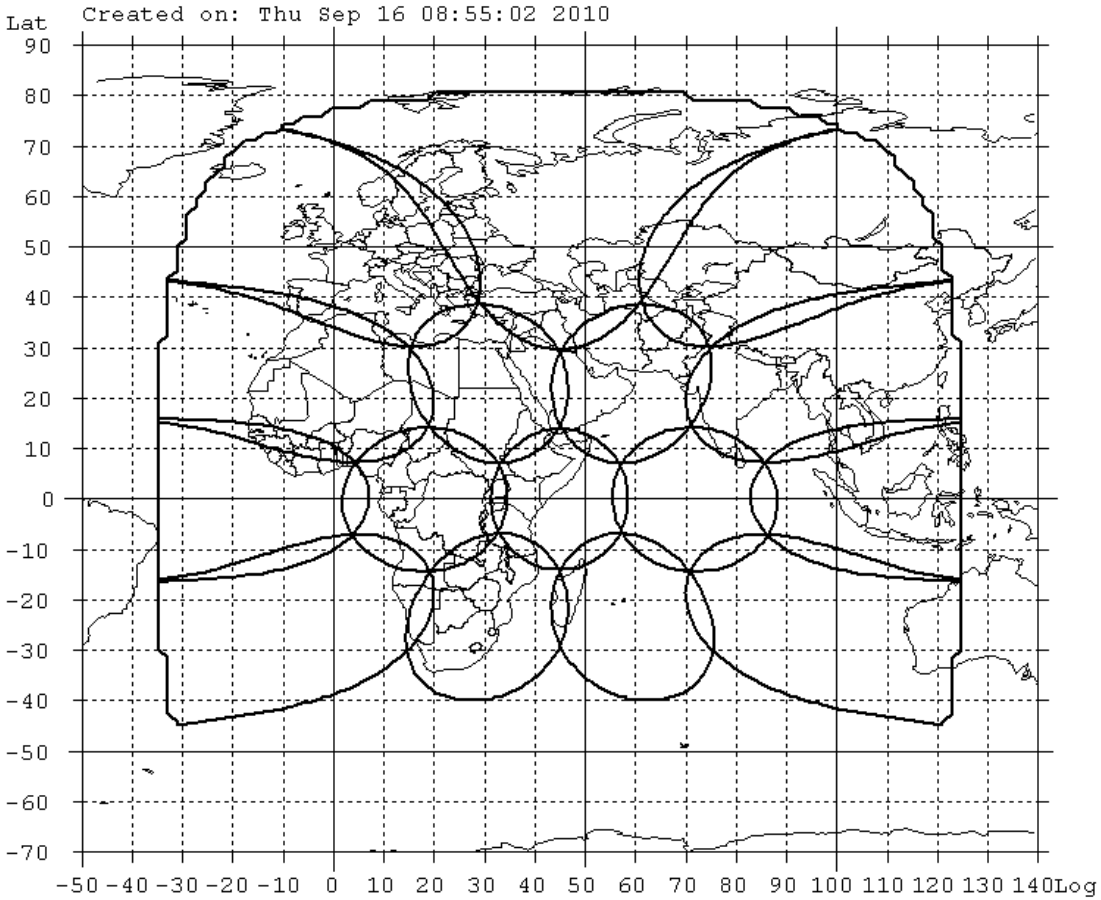


Antenna system for signal transmission to DPC



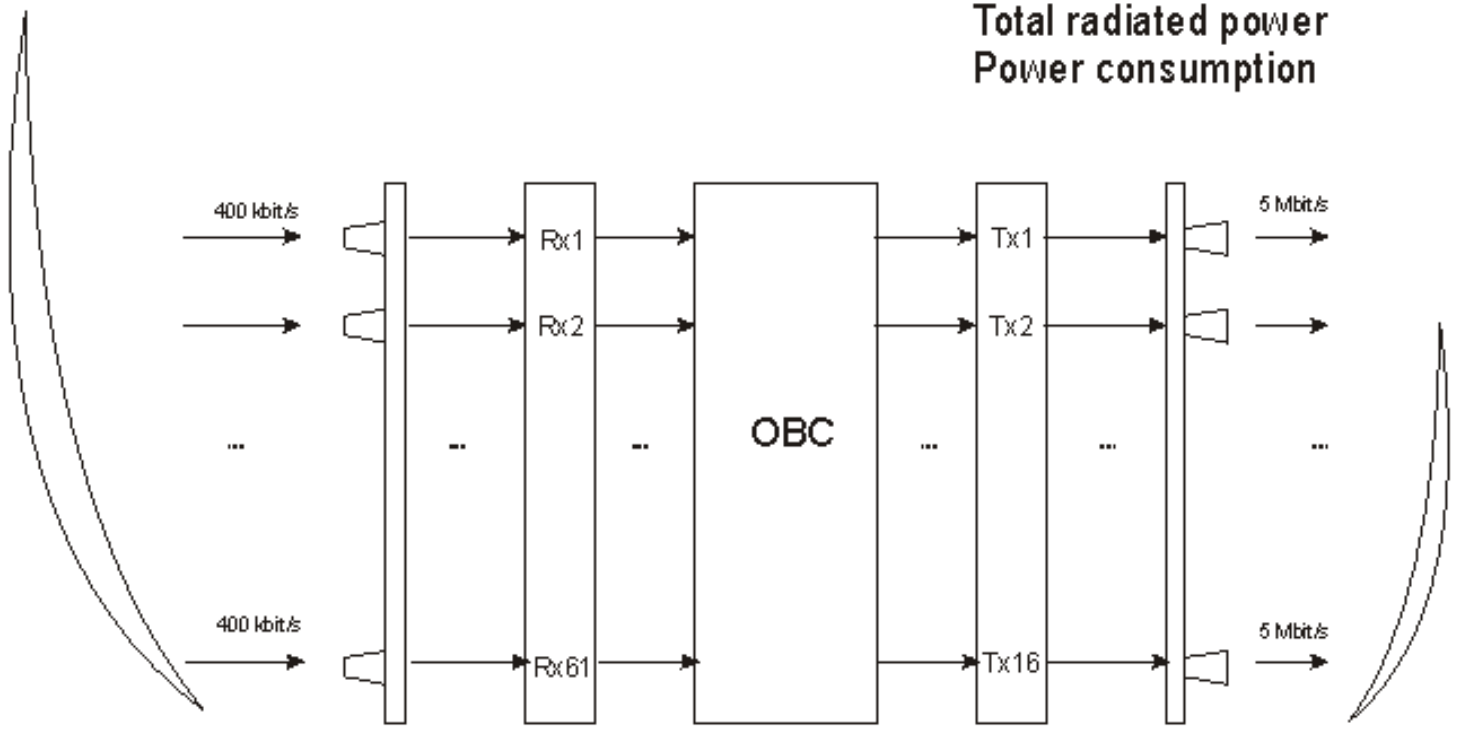
- Hybrid reflector antenna generating 16 beams is required to cover the specified coverage area;
- Reflector diameter is 0,22 m;
- Feed dimensions are 94X1130X100 mm;
- Multi-beam antenna feed is a 16-element phased array consisting of smooth-wall conical horns;
- Polarization type is right-hand circular;
- Gain in the coverage area at the level of minus 3 dB is not less than 22,3 dB;
- Antenna beam width for one beam is 5ºx5º.

Transmit antenna coverage area for GEO spacecraft feeder line



Payload performance data

Radiated power for 1 channel = 120W
Total radiated power = 1920W
Power consumption = 4500W



Hybrid reflector antenna Ø 7m
Number of beams 61
Gain 27,8dB

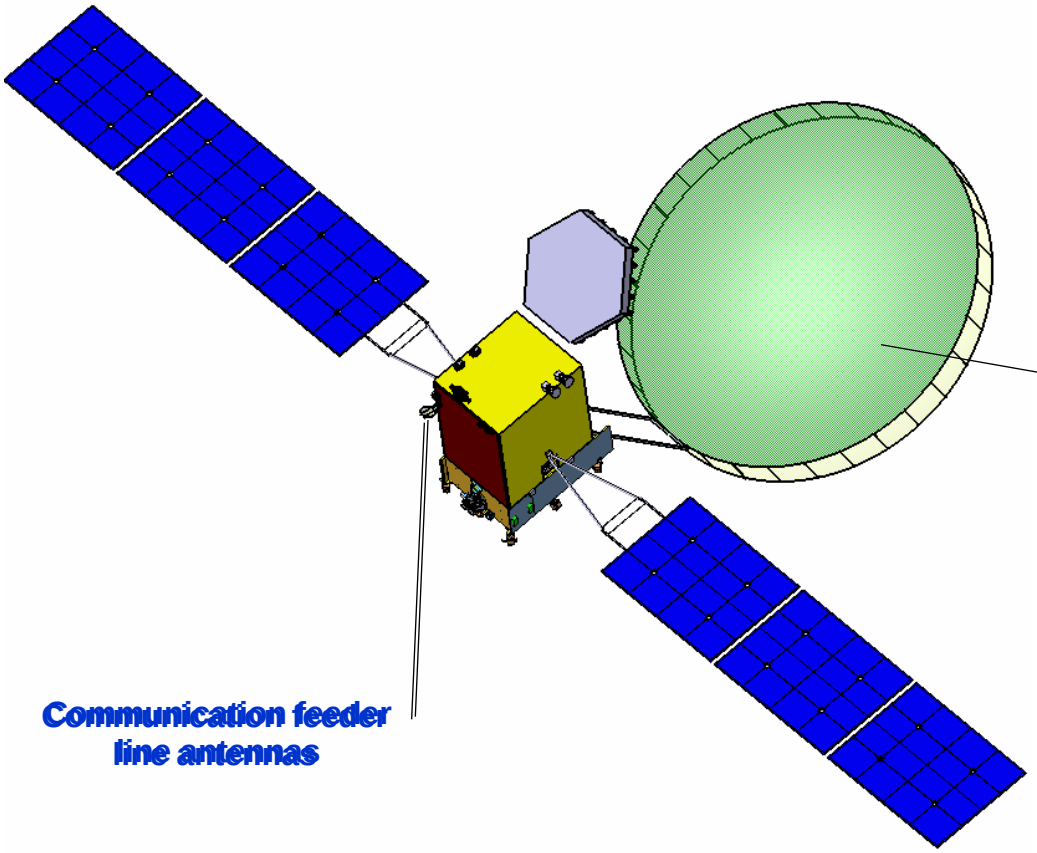
F=1090 MHZ

Hybrid reflector antenna Ø 0,22m
Number of beams 16
Gain 22,3dB

F=17GHz

Payload block-diagram

Spacecraft general configuration

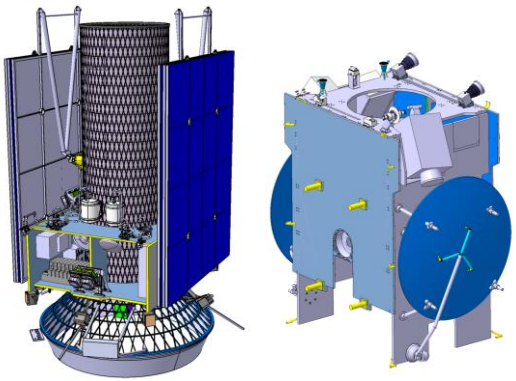


Spacecraft performance data

- Spacecraft mass (based on 1000H platform) 1700 kg
- Spacecraft power consumption 6200 W
- Payload mass 450 kg
- Payload power consumption 4500 W
- Three-axis station keeping accuracy 0,1°
- N-S and inclination
  station keeping accuracy not worse than 0,05 °
- Lifetime 15 years
- Injection into orbit by the launch vehicle Proton-M within the frame of double payload launch.

JSC ISS-Reshetnev platforms for air traffic control spacecrafts

Express-1000H platform



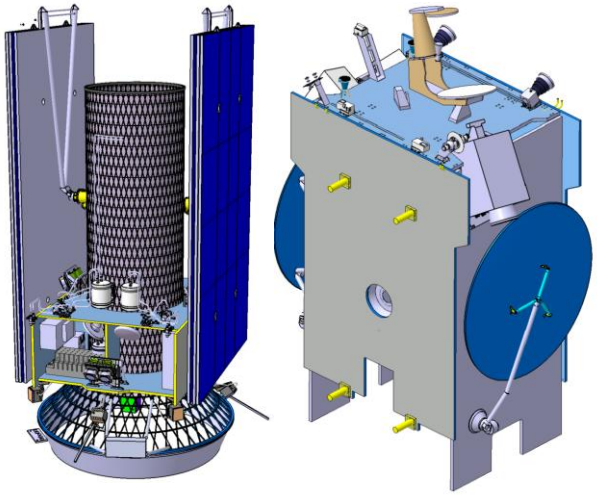
Payload performance data:
- PL power up to 5600 W;
- PL heat dissipation up to 3500 W;
- PL mass up to 500 kg;

Lifetime is 15 years;

Launch mass up to 1700 kg;

Platform application:
- Amos-5;
- Telkom-3 and current tender contracts.

Express-1000SH platform



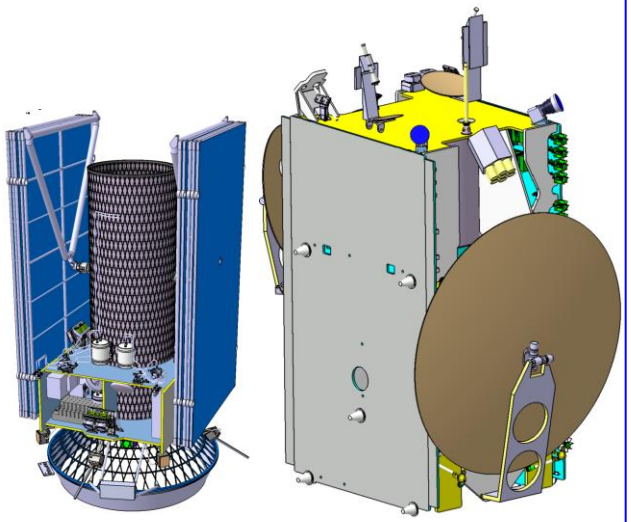
Payload performance data:
- PL power up to 8500 W;
- PL heat dissipation up to 5000 W;
- Pl mass up to 700 kg;

Lifetime is 15 years;

Launch mass up to 2200 kg;

Platform application:
- Azersat;
- Express-AM8.

Express-2000 platform



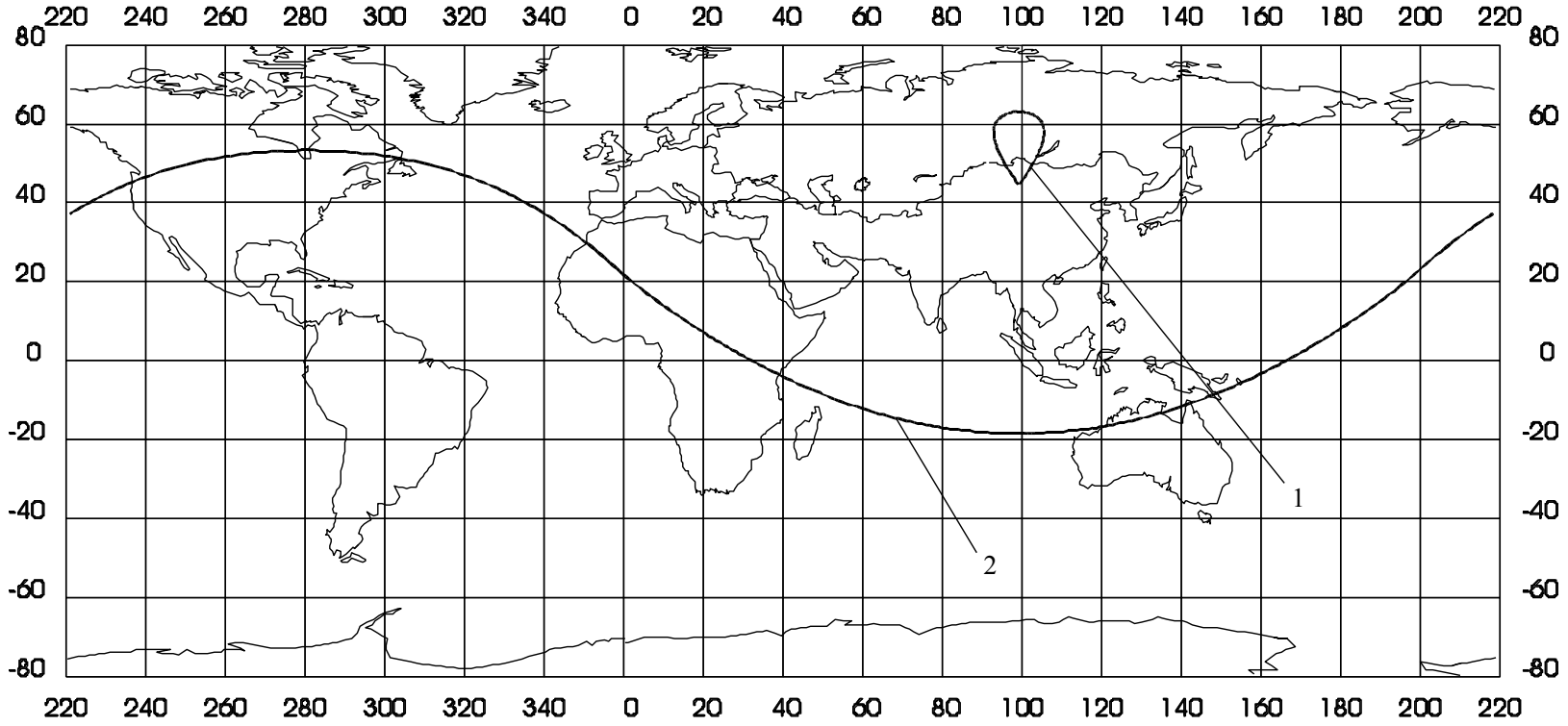
Payload performance data:
- PL power up to 14000 W;
- PL heat dissipation up to 7500 W;
- PL mass up to 1000 kg;

Lifetime is 15 years;

Launch mass up to 3400 kg;

Platform application:
- Express-AM5;
- Express-AM6.

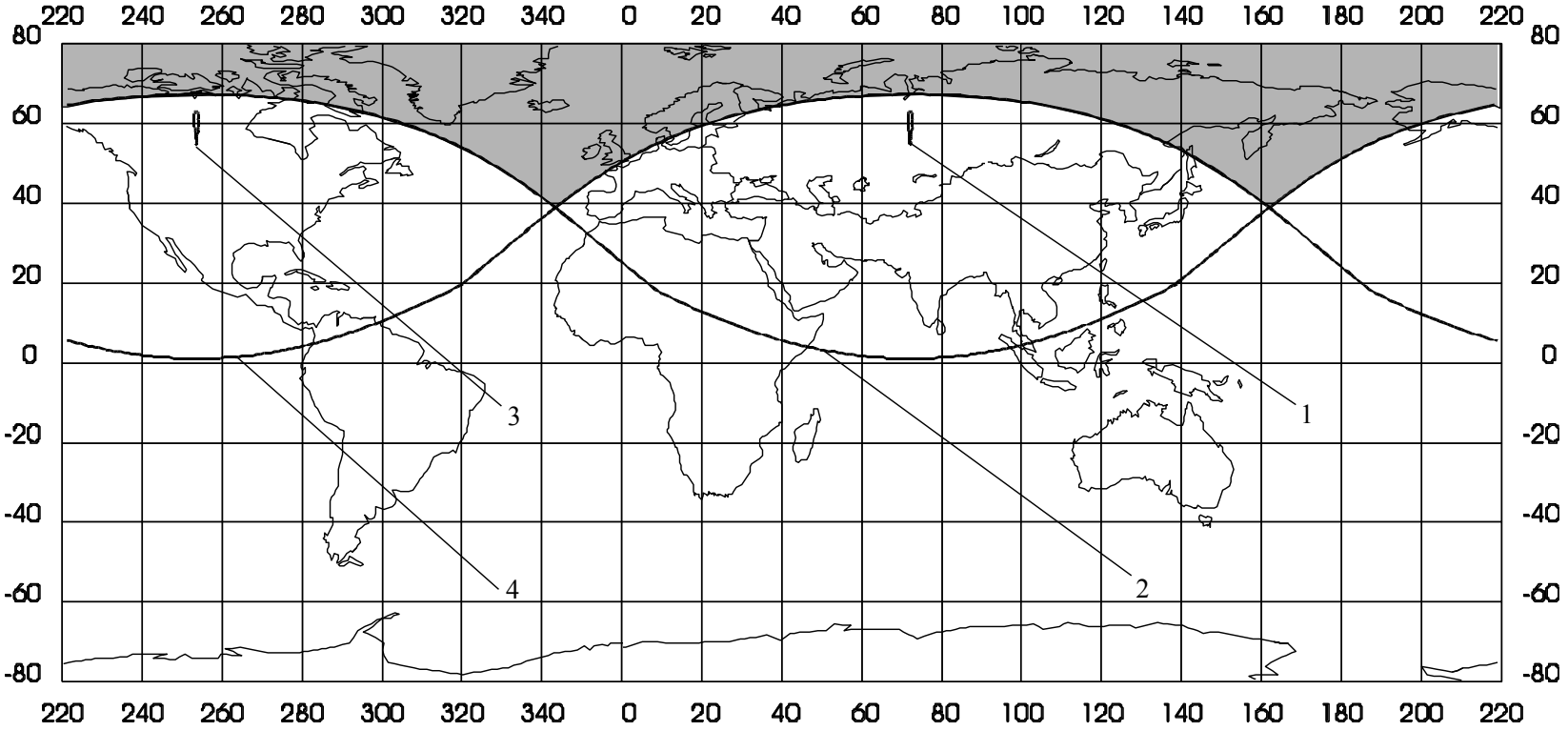
T-type HEO spacecraft coverage area



1 – spacecraft path over the communication session area; 2 – radio coverage area limit

Figure 3.2. Radio coverage area at γ = 20° for T-type orbit

M-type HEO spacecraft coverage area



1 & 3 – spacecraft paths during the communication session;
2 – radio coverage area limit for the main revolution; 4 – radio coverage area limit for the adjacent revolution

Radio coverage area at $\gamma = 20°$ for M-type orbit

M-type HEO spacecraft coverage area

- Russian Space Agency realizing the global scope and importance of the system application is considering the possibility of the international cooperation in terms of the system development and implementation.

- ESA has also supported this program. RSA and ESA have created the dedicated workgroup.

THANK YOU FOR YOUR ATTENTION!

ANY QUESTIONS?