

Implementation of Data Processing Center for Space VLBI Projects.

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Abstract.

IT support of two VLBI projects are described: currently running Radioastron project and future Millimetron project.

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Radioastron - is the international project led by the Astro Space Center of Lebedev Physical Institute, Moscow, Russian Federation. 10 m Space Radio Telescope is the main payload of Spektr-R spacecraft. The project goal is to create together with a ground based radio telescopes the huge Ground to Space interferometer with a baseline up to 350 km. After successful launch on 18 July, 2011 the Radioastron missions started systematic investigations of the Universe at broad radio frequencies range.

Millimetron - observatory ("Spektr-M" project) is a 10-meter space telescope aimed at solving a wide range of astronomical problems in the wavelength range from far-infrared to millimeter. "Millimetron" orbit will lie in the vicinity of L2 Lagrange point in the anti-Sun direction, at a distance of about 1.5 million km from the Earth.

Data Processing Center of Radioastron project is one of the important segments of the ground support of the project. It is a center for collecting and distribution different kinds of information. This is necessary for the organization of the ground

and space radio telescopes observations, control onboard equipment and processing of the data.

The tasks of the scientific data processing center are:

- organization of service information exchange,
- collection and storage of all scientific data,
- processing of scientific information.

Data Processing Center (DPC) of Radioastron project is a dynamic and scalable system.

DPC has developed and grown very much since Radioastron had been launched. It was determined by many factors. The growth of scientists interest have led to the increasing of the amount of ground telescopes taking part in observations from 5 to 40. And we expected that only 2-3 telescopes could work simultaneously because of the shape and moving of the Earth. Nowadays sometimes up to 30 ground telescopes can work simultaneously with Radioastron. It was expected that only 1 tracking station in Pushchino would take part in the project at the time of Radioastron launch in 2011. Today two tracking stations in Pushchino and Green Bank are working with us. The number of sessions has changed from 20 to 120-140 per month and the duration of the Space Telescope observations has increased too. Information volume per month has grown from 10 TB to 120 TB. Amount of observations increased from 20 to 100-120 and amount of information has grown too.

Our storage has increased from 100 TB to 1 PB on-line and 2 PB off-line.

Technology has changed too. We moved from DAS to NAS. We had to eliminate many bottlenecks. We have expanded Internet channel from 100Mb/c to 600Mb/c. We also have expanded 10Gb network to accelerate network interaction.

We have reformed our DPC several times over five years for expanding and optimizing its performance.

After five years of operation, DPC - is several rooms equipped with air conditioning and uninterruptible power supply, video cameras and system of monitoring.

Main components of DPC are:

- On-line storage system for collecting information - 500TB;
- On-line storage system for data processing - 80TB;
- On-line storage system for processing results - 160TB;
- The archive of data on hard drives on 2500TB;
- Archive tapes for 2500 TB;

The total storage capacity is more than 5PB!

- Computer system;
- 1Gb/s and 10Gbit/c network infrastructure, and 600 Mbit/s Internet channel.

We have collected about 2200 TB of information for the five years of observations.

Transferring of large amounts of scientific information over long distances and delivery of information in on-line mode requires a high-speed communication channels. We organized optic lines connecting the processing center and tracking station in Pushchino and tracking headquarter. We also had to organize the delivery of data from the second tracking stations in Green Bank and many ground-based telescopes.

The next VLBI project Millimetron will take much more recourses of computer technique.

Previous scheme of the data processing center for Millimetron project looks like scheme for Radioastron. All information should be collected and analyzed in processing center. We will also have to organize quick exchange of the information between participants of the project. We'll have to collect, store and process all scientific information.

According to preliminary calculations if data transferring speed from Space Telescope is 1.2 Tbit/c in period 5 years of working from tracking stations and from three ground telescopes we'll receive about 80PB of data.

We are planning to implement Data Center for storage and processing all of this information.

The first problem we have to solve will be engineering infrastructure.

- Appropriate room or special building with protection from leaking and fire-extinguishing system

- Redundant power supply
- Independent power supply (diesel generator)
- Uninterruptible power supply
- Air-conditioning on N + 1 systems
- Video surveillance and monitoring of all systems
- Room for operators
- Communication channels

Conclusions:

- The structure and functions of ASC Data Processing Center for Radioastron project are fully adequate to the data processing requirements of the Radioastron Mission.

- When we created data processing center for the Radioastron project, we got experience of working, transferring and storage of large volumes of data. The experience will be useful for our next project "Millimetron".