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# Improving the Quasar VLBI Network for data transfer with the National Research Computer Network of Russia

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**Abstract.** This article presents the results of the phased integration of the VLBI complex "Quasar" into the National Research Computer Network of Russia (NIKS). The VLBI complex "Quasar" has implemented e-VLBI technology in Russia, enabling near real-time radio interferometric observations. This technology is critical for high-precision determination of Universal Time, which is essential for fundamental and applied space research, particularly for the GLONASS system. The complex consists of three observatories: "Badary" (Republic of Buryatia), "Zelenchukskaya" (Karachay-Cherkess Republic), and "Svetloe" (Leningrad Region), with a fourth under construction in Primorsky Krai. Each observatory can register data at speeds up to 16 Gbit/s, while the correlator in St. Petersburg can receive data at up to 96 Gbit/s. The current data transmission from "Badary" and "Zelenchukskaya" is limited to 2 Gbit/s, restricting the complex's functionality. Increasing the transfer speed to 8 Gbit/s or more would significantly improve capabilities. This article details the results of the data transfer speed tests conducted during hourly sessions to the Center for Correlation Processing of RAS in the NIKS network. Additionally, the article explores options for connecting the nearby academic organizations of the IAA RAS to the NIKS network via fiber-optic cable, enhancing the overall data transmission efficiency and reliability of the VLBI complex. The integration of these observatories into NIKS is expected to enhance the "Quasar" VLBI complex, enabling more robust and rapid data processing for various scientific applications.

**Keywords:** techniques: interferometric; telescopes

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# 1 Introduction

The very-long-baseline interferometry (VLBI) complex "Quasar" has implemented e-VLBI technology in Russia, enabling near real-time radio interferometric observations. This technology ensures high-precision determination of Universal Time for fundamental and applied space research, particularly for the GLONASS system. The work at the Institute of Applied Astronomy of RAS (IAA RAS) provides independence in determining Earth Orientation Parameters (EOP). The complex consists of three observatories: "Badary" (Republic of Buryatia), "Zelenchukskaya" (Karachay-Cherkess Republic), and "Svetloe" (Leningrad Region), with a fourth under construction in Primorsky Territory. Each observatory can register data at speeds up to 16 Gbit/s, while the correlator in St. Petersburg can receive data at up to 96 Gbit/s. Current data transmission from "Badary" and "Zelenchukskaya" is limited to 2 Gbit/s, restricting the complex's functionality. Increasing the transfer speed to 8 Gbit/s or more would significantly improve capabilities.

A potential solution is integrating the Institute's network infrastructure into the National Research Computer Network of Russia (NIKS),[1] a successful example of such integration is given in Abramov et al. (2023).

# 2 NIKS bandwidth testing

To assess the NIKS network as a communication channel, bandwidth tests were conducted between the "Badary" observatory (connected via Rostelecom at 2 Gbit/s) and NIKS in St. Petersburg. For about a week, the data reception channel had been switched from the Veroline telecommunications service provider currently in use to NIKS. The test results are shown in Fig. 1. The results indicate that NIKS provides data transfer speeds comparable to Veroline, with consistent performance maintained across hourly observation sessions.

# 3 "Svetloe" observatory – CCP RAS channel testing

Following the positive test results, a phased transition to NIKS was planned for the VLBI complex observatories' data transmission to the Center for Correlation Processing of RAS (CCP RAS). Initially, the CCP RAS was connected to NIKS via a 40 Gbit/s channel, while the "Svetloe" observatory was connected at 4 Gbit/s. Figure 2 shows the data transmission results from the "Svetloe" observatory to the CCP RAS in July 2024. The speed tests revealed that organizing data transmission in four 1 Gbit/s streams efficiently utilized the allocated bandwidth.

[1] https://niks.su/

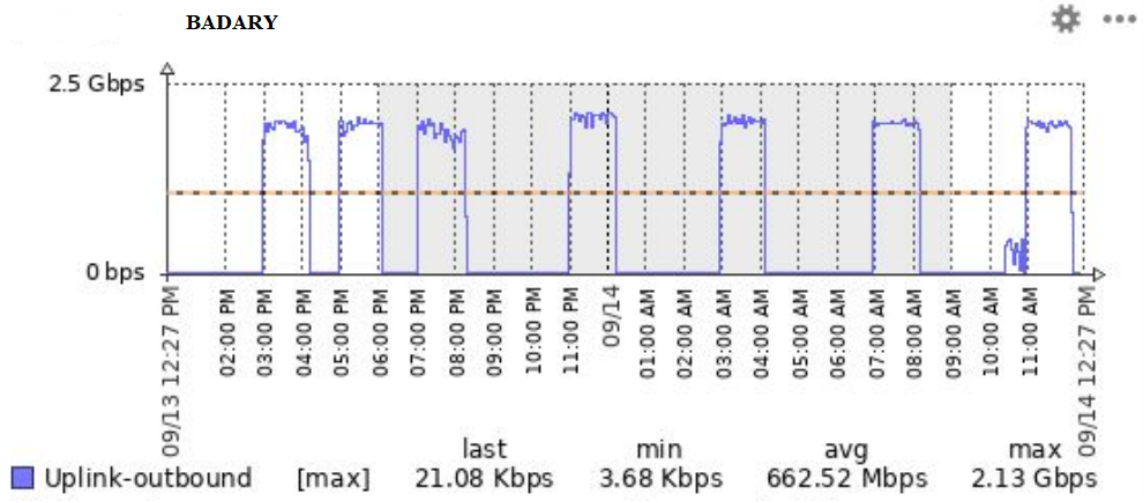


**Fig. 1.** Data transmission of hourly sessions from the "Badary" observatory to the CCP RAS via NIKS, St. Petersburg.

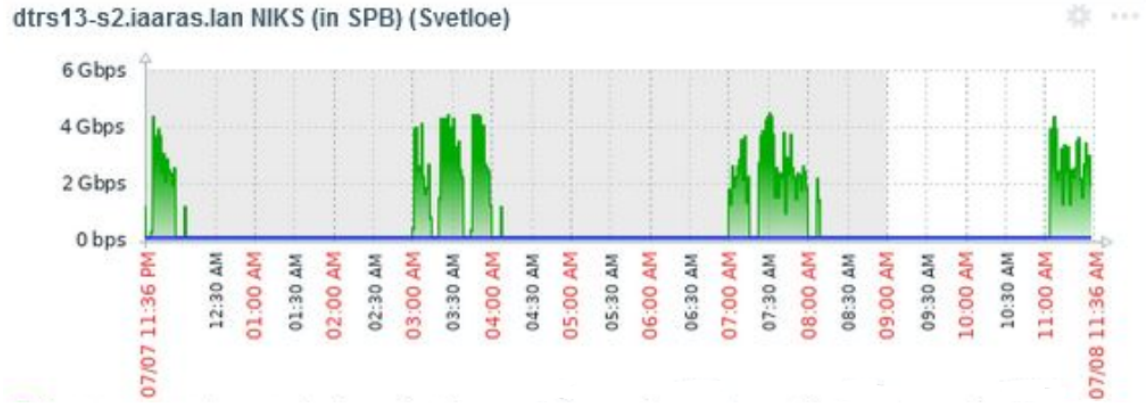


**Fig. 2.** Data transmission of hourly sessions from the "Svetloe" observatory to the CCP RAS through NIKS.

## 4 NIKS integration plans

Based on the positive interaction with NIKS, further integration of the observatories and nearby RAS institutes are planned.

**First stage (2024).** Connecting the "Zelenchukskaya" observatory to NIKS at 4 Gbit/s, establishing a regional access node for future expansion to other facilities like RATAN-600 of SAO RAS.

**Second stage.** Developing solutions to connect the "Badary" observatory and the nearby observatory of the Institute of Solar-Terrestrial Physics of the SB RAS to NIKS (currently connected to the Internet at 0.1 Gbit/s). Considering a possibility to switch the St. Petersburg units of the IAA RAS to NIKS to improve fault tolerance and data processing quality.

## 5 Conclusions

Successful cooperation with NIKS in 2024 enabled access to the NIKS network (traffic exchange node in St. Petersburg SPB-IX BM-18) for the CCP RAS via fiber-optic cable (FOC) with a bandwidth of 40 Gbit/s and for the "Svetloe" observatory of the IAA RAS VLBI complex in the Leningrad region via FOC with a bandwidth of 4 Gbit/s. This collaboration marked a significant milestone in enhancing the data transmission infrastructure for the "Quasar" VLBI complex.

The broadband access to the NIKS network for the CCP RAS and "Svetloe" observatory has ensured reliable data transmission from the observatory to the CCP RAS at a speed of about 4 Gbit/s. This improvement reduced the data transmission time of the hourly session to one hour, greatly increasing the efficiency of data processing and enabling more duly scientific analysis.

Additionally, a preliminary agreement was reached between NIKS and Rostelecom to connect the "Zelenchukskaya" observatory via FOC with a bandwidth of 4 Gbit/s in 2024. This forthcoming connection is expected to further enhance the data transmission capabilities of the VLBI complex, supporting higher data throughput and enabling more comprehensive and rapid data analysis.

## References

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