e-VLBI Technology in VLBI Network "Quasar"

Andrey Finkelstein, Alexander Ipatov, Michael Kaidanovsky, Ilia Bezrukov, Andrey Mikhailov, Alexander Salnikov, Igor Surkis, Elena Skurihina

Institute of Applied Astronomy
Russian Academy of Sciences
Kutuzova 10, 191187, Saint-Petersburg, Russia,
e-mail: ipa@ipa.nw.ru

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Institute of Applied Astronomy of the Russian Academy of Sciences carries out regular observations on the VLBI- Network “Quasar” (Fig. 1). This Network consists of three Russian radio astronomical observatories “Svetloe” (Sv), “Zelenchukskaya” (Zc) and “Badary” (Bd) which make up three-element VLBI Network with baselines of about 2015×4282×4404 km assembling with the Control and Processing Center in St. Petersburg. The guideline of the Russian VLBI Network “Quasar” is to carry out astrometrical and geodynamical investigations. Main part in the observational schedule is devoted to the international VLBI sessions with data processing at the Haystack or Bonn correlators. But since 2006 when “Badary” station was put into operation pure domestic observational programs are fulfilled with preliminary data processing at the IAA correlator. To maintain these geodynamical programs and to develop the whole system as well the e-VLBI technology is developing and testing now at the IAA. This presentation describes IAA activity in developing the real-time VLBI system using the high speed digital communication links.

In 2007 all observatories of the VLBI Network “Quasar” were linked by optical fiber lines (Fig.2) to provide both e-VLBI mode for determining Universal Time within intensive 1-hour sessions and real-time remote monitoring each part of the Network. All observatories of the Network “Quasar” were equipped with UNIX servers for data buffering. Now the observatories have communication channels via Internet 100, 40, 2 Mbps bandwidth Bd, Zc and Sv correspondingly.

The first test of data transfer was carried out between the buffer server in IAA RAS and Haystack Correlator using Tsunami UDP protocol. Test scan of Intensive session was transferred via Internet at 50Mbps (Fig.3).

Intensive sessions for determining the Universal Time using e-VLBI mode on network “Quasar” on baselines “Svetloe” –”Badary” and “Zelenchukskaya” –“Badary” have been started in 2009 year. Near real-time e-VLBI mode has been used – VLBI observation data has recorded with Mark5B were transmitted to the buffer server at the end of 1-hour session (Fig.4).

Five transmissions of intensive session data from “Zelenchukskaya” and “Badary” observatories to the IAA RAS correlator data center at the Saint-Petersburg have been done. Intensive session of ~40 Gbytes has been transmitted at 25-40 Mbps rate via Internet using Tsunami-UDP protocol.

Figs.5 and 6 are illustrating the transmission of 2 Gbytes scan of Intensive session via Internet from “Badary” and “Zelenchukskaya” observatories to the correlator data center at the Saint-Petersburg correspondingly.

Fig.7 show UT1-UTC differences of the IAA (RU-U) and IERS 05 C04 series.

This allow us to draw a conclusion that tested e-VLBI mode is reliable and could be used as regular e-VLBI mode on VLBI network “Quasar”.

Fig.1 VLBI Network “QUASAR”

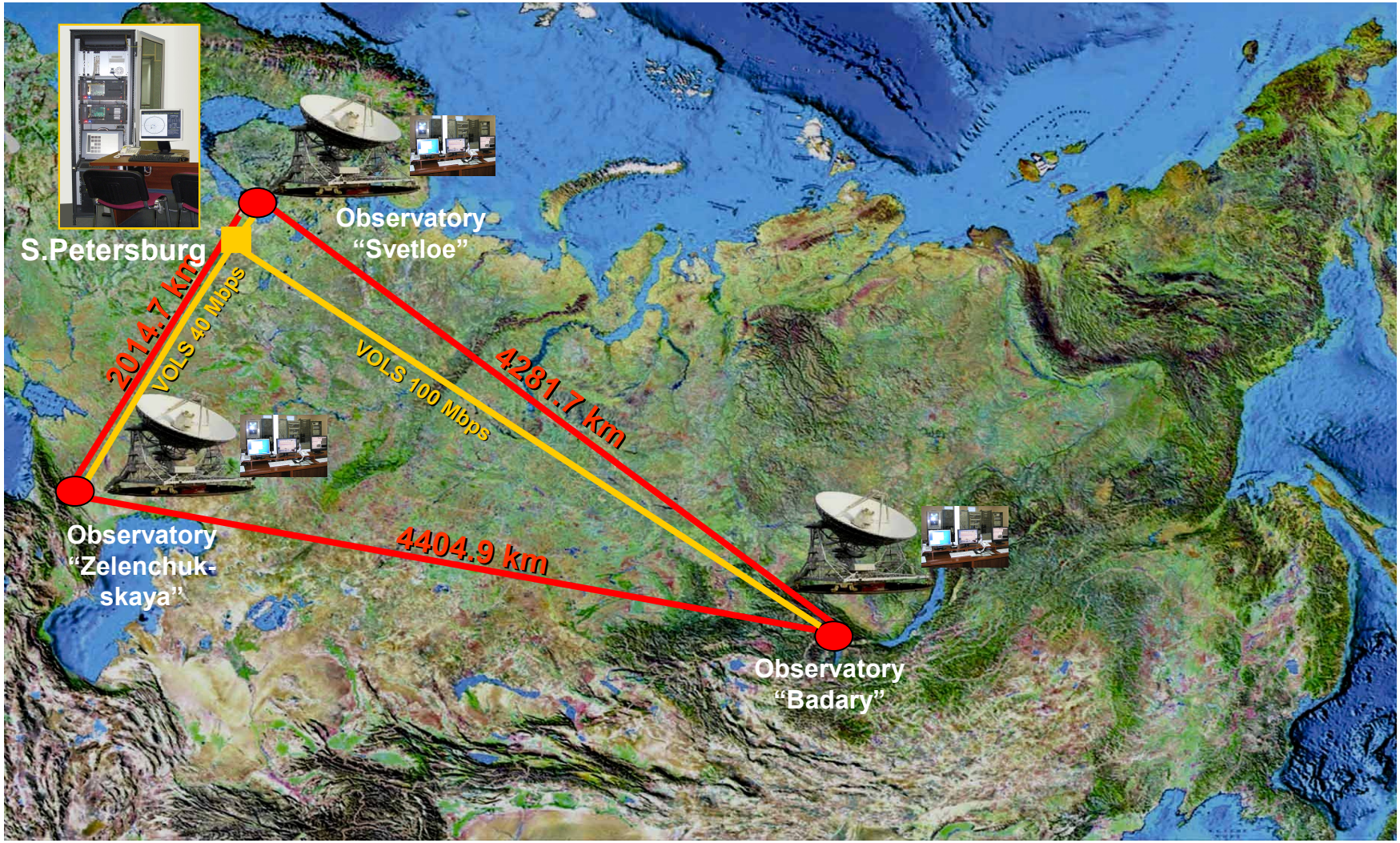
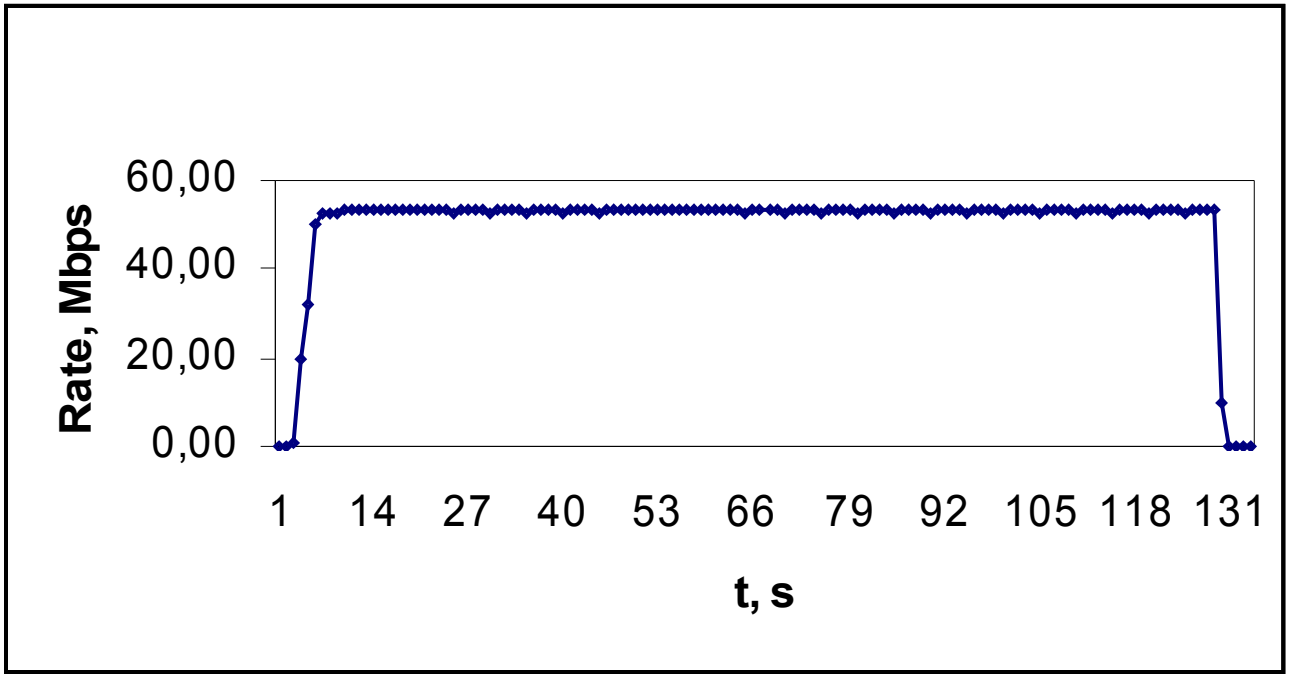


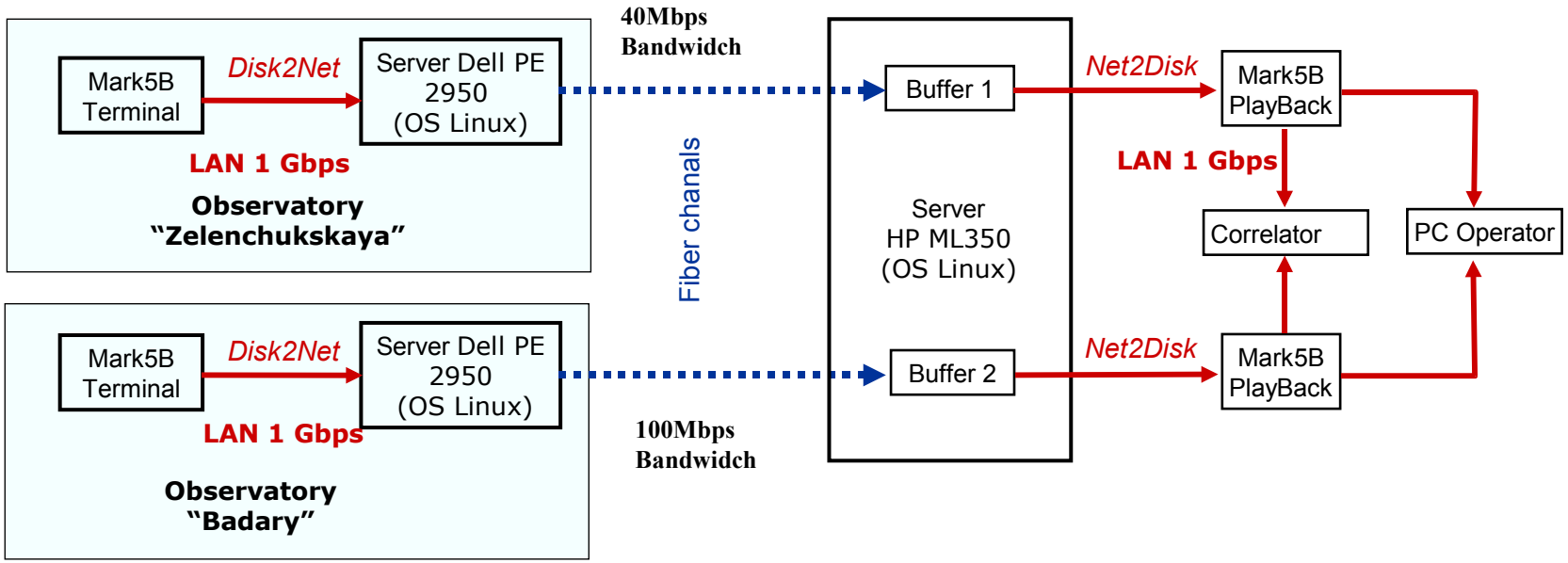
Fig.2 Optical Fiber Lines

Fig.3 Transmission of 0.5 Gbytes Scan of Intensive Session via Internet Using Tsunami UDP Protocol.



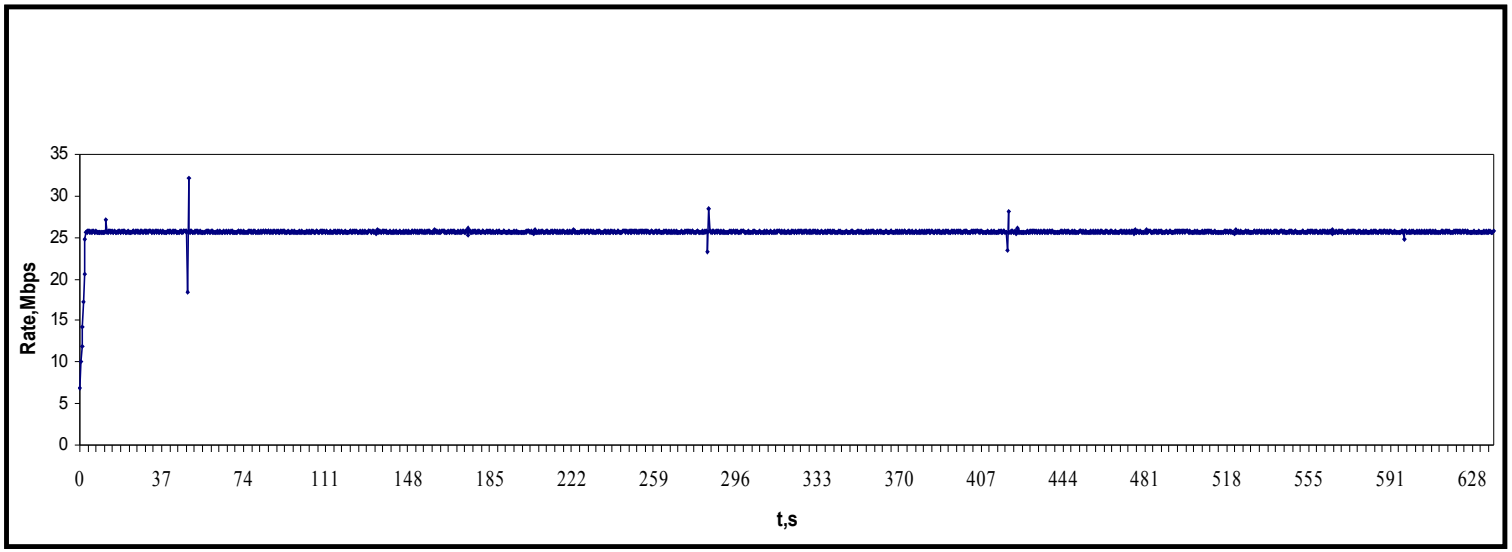
ISP RAS (100Mbps Bandwidth) from St.Petersburg to Haystack. 50 Mbps Rate.

Fig.4 Algorithm of Data Transmission in e-VLBI Mode.



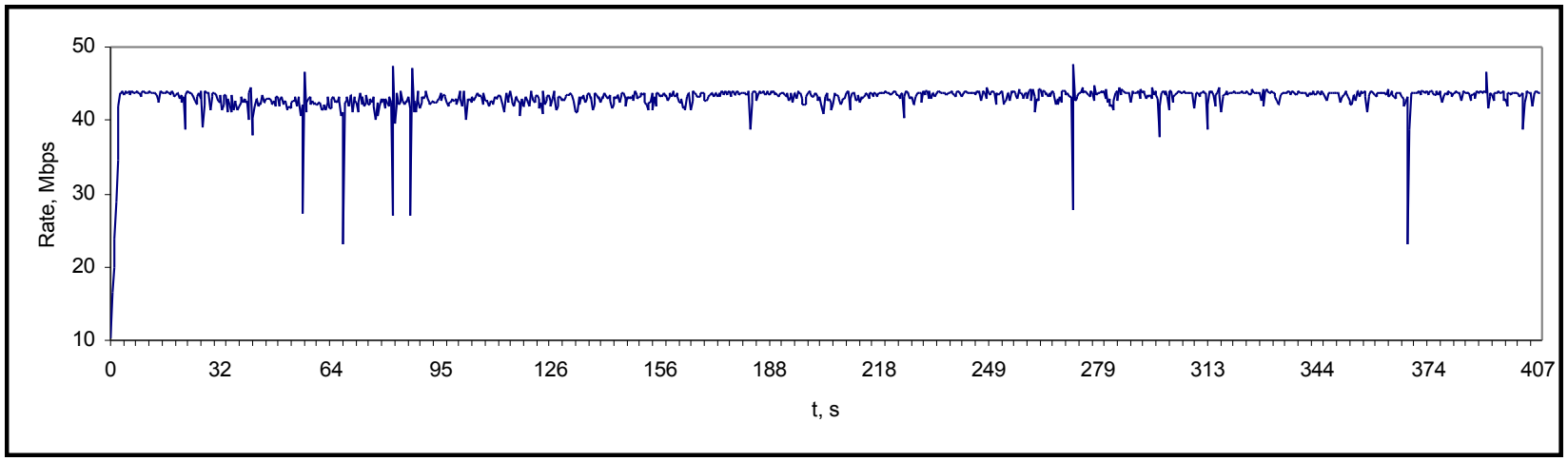
Mark5B – LAN – Buffer Server – **Internet** –
Buffer Server – LAN – Mark5B – Correlator.
Network testing was realized with ***iperf*** (end-to-end).

Fig.5 Transmission of 2 Gbytes Scan of Intensive Session via Internet Using Tsunami UDP Protocol.



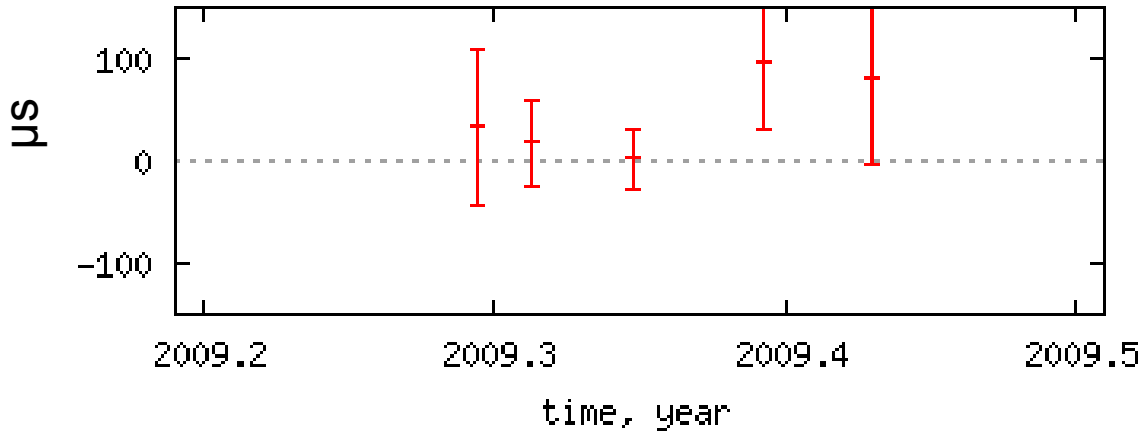
ISP “South Telecom” (40 Mbps Bandwidth) from “Zelenchukskaya” Observatory to St.Petersburg. 25 Mbps Rate.

Fig.6 Transmission of 2 Gbytes Scan for Intensive Sessions via Internet Using Tsunami UDP Protocol.



ISP “Siberian Telecom” (100 Mbps Bandwidth) from “Badary” Observatory to St.Petersburg. 40 Mbps Rate.

Fig.7 UT1-UTC Differences of IAA (RU-U) and IERS 05 C04.
Five e-VLBI sessions.



rms 37μs

Our Nearest Future

We plan to develop algorithm to automate overall data transfer process from Mark5B recorders at observatories to the correlator.

By the end of 2009 the Network ``Quasar'' observatories and the Control and Processing Center of IAA RAS will be supplied with hardware and software providing VLBI data transmission rates of at least 100 Mbps from all observatories.