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E-LFVN - An Internet Based VLBI Network

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Abstract. A narrow band e-VLBI system is operating as a part of the LFVN (Low Frequency VLBI Network) activity taking advantages by the relatively small portion of band necessary in a certain class of radioastronomy observations. Data are acquired using a simple dedicate terminal and recorded on disk. The maximum recorded signal band is 48 MHz wide, flexibly scalable up to few kilohertz and then with the concrete possibility to transfer the full amount or portion of it in near real time to a correlation point, using the standard Internet connection, when narrow band acquisitions are appropriate. Radar, spectral lines, low frequency, spacecraft navigation observations can benefit from this inexpensive solution in those stations where large antennas and sensitive receivers are available, and where is still missing the possibility to use standard VLBI terminals, giving then yet the possibility to perform radio astronomy research. The network terminal is at present placed in Noto (Italy), Bear Lakes (Russia), Urumqi (China), Simeiz (Ukraine), Evpatoria (Ukraine) and is going to be expanded with a digital baseband backend system. During 2003 and 2004 this terminals and method have been successfully tested in real experiments having as targets debris, asteroids, planets. A further improvement will be to add station based pre-processing steps to optimize the data transfer. This work was supported by INTAS 01-0669, INTAS IA-01-02, RFBR 02-02-17568 and RFBR-02-02-39023 grants.

1. Low Frequency VLBI Network Project

The LFVN project was started in 1996, having the purpose to arrange the international VLBI cooperation with participation of former Soviet Union radio telescopes. During the project 18 VLBI experiments were carried out using various combinations of radio telescopes and correlators in Canada, China, Urumqi, England, India, Italy, Japan, Latvia, Poland, Russia, South Africa, Ukraine, and USA.
Main directions of LFVN activity are:
Learning the VLBI radar method combination of classic radar and VLBI for Studying of short-periodic variation of proper rotation for the Earth group planets, improving the orbits of asteroids crossing the Earth orbit, measuring the space debris population at geostationary and high-elliptic orbits;
Developing new methods of the solar investigations: mapping the solar wind irregularities, measuring the spatially-temporary structure of solar spikes;
Mastering the near-real time differential VLBI technique for determining the satellite and deep space mission coordinates;
Traditional VLBI astronomic observations for AGN and OH-maser imaging, investigation of active stars and stellar coronae structure.

2. The NRTV terminal

The NRTV Internet based acquisition, transfer and correlation system has been used starting with the 2003 in different radar sessions, and it has been proved to be flexible enough for getting information even during the observation period. The system is based on a 1 or 2 bit sampling stage at base band level, with further data packing and recording through a dedicated board. Data are recorded as files that are then collected to a processing facility, now placed in Noto. During radar observations echo signals in the different stations is detected in order to confirm goodness of operations and proper doppler estimation. Further Internet data transfer is the only method to link stations, without any need for disks shipment.
An upgrade is planned for 2005, when a fully digital backend system will be added to the front part of the acquisition chain. Such system, named E-DBBC, is able to feed the 48 MHz required by the recording system in a IF range coming from the receiver between 80 and 128 MHz, and is mainly set and used via network. Tuning and filtering can handle bandwidth from 500 KHz up to 16 MHz, with a tuning step of 50 KHz. Moreover a GPS receiver will be integrated with the system in order to simplify the synchronization, now assured by station 1PPS and NTP servers.
A software correlator is at present adopted, sharing more processes among different PC platform, baseline dependent. A simplification and correlation time reduction could come from the introduction of an initial preprocessing in the acquisition station before sending data to the correlation point. This could allow to take into account the restricted portion of band interested by the detected signal in those situations when a monochromatic tone has to be processed.