The 3rd e-VLBI Workshop

Abstracts

Oral Sessions

October 6 (Wed.)

Title : The Study of Sustainable System Design for Global e-VLBI Networks

Author : Fujinobu Takahashi(Yokohama National University)

Abstracts : The VLBI technology is a high-end info-communication technology (ICT). The recent e-VLBI system becomes a typical example of commodity ICT. To develop and sustain the next generation e-VLBI network, it is necessary to study the suitability of ICT design for e-VLBI. The collaboration with ICT researchers will be necessary for the design of Global e-VLBI Networks.

Title : e-VLBI and Internet2: Update and Future

Author : T. Charles Yun (Internet2)

Abstracts : This presentation is a summary of e-VLBI networking activities from Internet2's point of view. Charles will identify how the successful VLBI tests fit into a larger framework. These tests will then be compared and linked to projects that are currently in the early stages of development.

Title : eVLBI in Europe, a General Perspective

Authors : Stephen M. Parsley (JIVE)
M A Garrett (JIVE)

Abstracts : In Europe, eVLBI research centres around the EVN-NREN Proof-of Concept project. This has achieved several important milestones in the last twelve months. This, and related projects, will be discussed in general terms leaving the detailed technical issues to Arpad Szomoru. Options for advancing to a future "production" eVLBI system will be considered.

Title : High performance infrastructure for e-VLBI

Author : Yasuichi Kitamura (NICT)

Abstracts : The first trial of e-VLBI in Japan was the "Key Stone Project". This project was the Japanese domestic project. One of the reasons this project was closed inside of Japan was most of the R&E networks in Japan was in the OC-3 level bandwidth. When the international e-VLBI collaboration started, the bandwidth between Japan and USA was already in the Gigabit level. There are lots of e-VLBI researchers who are interested in having the collaborations with other countries. In this presentation, some Gigabit level R&E networks in Asian area will be introduced.

Title : Real-time e-VLBI Experiments at Haystack Observatory

Authors : Alan Whitney (MIT Haystack Observatory)
David Lapsley (MIT, Haystack Observatory)
Yasuhiro Koyama (Kashima Space Research Center, NICT)
Rüdiger Haas (Onsala Observatory)
Chuck Kodak (NASA/GSFC)

Abstracts : The first e-VLBI real-time experiment using Mark 5 data systems and a Mark 4 correlator was conducted on 5 March 2004 between the Westford Observatory in Massachusetts and the GGAO antenna at NASA/GSFC in Maryland at a data rate of 32 Mbps; only the electronic buffers on the Mark 5 systems and at the correlator were used; no disks were recorded. The first-ever international real-time e-VLBI experiment was conducted on 25 March 2004 between the Westford Observatory and Onsala, Sweden, again at 32 Mbps. Since then, several additional real-time experiments have been conducted, both national and international, with data rates as high as 256 Mbps and using prototype VSI-E software. In addition, we plan in the near future to use VSI-E to conduct real-time e-VLBI between antennas using heterogeneous data systems (Mark 5A and K5). We will report on these activities as well as future plans.

Title : eVLBI progress in Australia

Authors : Tasso Tzioumis (ATNF, CSIRO)
Chris Phillips (ATNF, CSIRO)
Steven Tingay (Swinburne University of Technology)
Craig West (Swinburne University of Technology)

Abstracts : The VLBI array in Australia (LBA) has been based on S2 VCR recorders at a maximum recording rate of 128 Mbps and a hardware correlator. In the past

year we have been developing disk-based recording capabilities utilising the MRO recording system, at data rates of 256 and 512 Mbps. In addition, a software correlator has been developed based on the Swinburne supercomputer. Progress will be discussed and some results presented.

Australia has also been developing a fast academic and research network, which will connect all Australian radio telescopes with fibre links at 1 Gbps within a few months and multiple 10 Gbps links within a few years. In parallel, ATNF has been developing a broadband correlator for the ATCA able to handle 4 Gsps per IF and VLBI capable. Thus we expect to have a real-time broadband eVLBI network operating within about 3 years. Details of progress and current plans will be discussed.

Title : e-VLBI Network and Platform Monitoring

Authors : David Lapsley (MIT Haystack Observatory)
Jason Soohoo (MIT Haystack Observatory)
Kevin Dudevoir (MIT Haystack Observatory)
Alan Whitney (MIT Haystack Observatory)

Abstracts : One of the challenges of e-VLBI has been to achieve high bandwidth data flows across shared IP high speed research and education networks. In part this is because it is difficult to isolate the cause of degradation within a network: e-VLBI data flows must traverse many different networks over many different types of network elements, it only takes an element failure or a configuration error in any single element along the path or at the end sites to cripple end to end performance. Similarly, it only takes one congested link along the path to cripple end to end performance.

Historically, application/network engineers have used tools such as iperf, nuttcp, pchar etc. to investigate the throughput/loss characteristics across various links. iperf/nuttcp work by transmitting streams of packet between two hosts on a network and then measuring the throughput, loss and delay statistics between these servers. Engineers would typically have access to a small number of test servers distributed throughout the network and at each site. By running repeated tests between various pairs of servers it was often possible for them to narrow down the cause(s) of any throughput issues. However, this process is time consuming, error prone and only provides a limited window on the overall performance of the network.

In this paper, we discuss a new class of tools that have been built on top of existing tools (such as iperf, nuttcp, pchar) and how they have been applied to e-VLBI. The Bandwidth ConTroL (bwctl) tool developed by Internet2 is an

example of such a tool. It is built on top of iperf and provides a convenient way to automate the scheduling and execution of experiments in a secure manner. Furthermore, there is a growing network of bwctl-equipped servers throughout the US and the world (e.g. each node in Internet2's Abilene network has a bwctl test node associated with it). These nodes provide convenient test points for authorized users. The Network State Database is a tool developed at MIT Haystack Observatory. It is built on top of the bwctl tool and provides a convenient way to store the results of bwctl tests within a central database accessible by applications and users. NSDB also tracks the configuration of end systems and stores this information in its database. A web interface is provided that allows users to see at a glance current and historical network traffic levels. These tools provide a number of advantages over traditional techniques:

- they help to provide a much more comprehensive view of the overall network state
- by using automated testing, the tools significantly reduce the amount of work required by engineers.
- by leveraging existing bwctl servers, application/network engineers have access to a far greater number of test points than they would normally
- by storing historical state, it is possible for engineers to track changes in network performance and to detect when changes occur
- by making historical statistics available to applications, it is possible to develop a new class of "intelligent" application that can use information about the network state to determine an optimal strategy for transmitting data.

These tools have already been deployed in support of e-VLBI experiments and have already been a great help in diagnosing the cause of network performance problems.

Title : Performance Measurement on Large Bandwidth-Delay Product Networks

Author : Masaki Hirabaru (NICT)

Abstracts : It is difficult to control rate of sending data to a long distant place over a packet switched network or Internet while having a feedback from a receiver because the feedback even at light speed takes time to reach the sender. This gets more serious as the bandwidth gets larger because delay of the control would result in a lot of data losses and retransmissions. Experiments have been taken place to evaluate performance of advanced transport protocols on this kind of large bandwidth-delay product network. However, sometimes the results from different experiments are inconsistent. It seems difficult to reproduce the similar results in a different place under the same conditions. This talk explains possible

performance bottlenecks and shows a way of removing hidden factors in order to obtain a reliable result. One of the important factors often neglected is buffer size on a bottleneck. A method of measuring buffer size will be introduced. Its impact on performance will be also discussed. This technique would help applications in identifying a bottleneck and gaining performance along a path.

Title : VSI-E Implementation and Results

Authors : David Lapsley (MIT Haystack Observatory)
Alan Whitney (MIT Haystack Observatory)

Abstracts : VSI-E promises to provide a standard, Internet "friendly" framework for transporting data across wide area networks. VSI-E will greatly simplify the exchange of data between the VLBI systems of different countries. In this paper, we discuss a reference implementation of the draft VSI-E standard and discuss the performance of the protocol and some important lessons learned during the implementation. Currently, the VSI-E software has been shown to run at rates in excess of 950 Mbps memory to memory in the lab on 1 GHz Pentium III Intel servers. Preliminary tests have been run in the wide area with results similar to this.

Title : LHC Computing Grid : A Globally Distributed Analysis Infrastructure for High Energy Physics

Author : Hiroshi Sakamoto (University of Tokyo, ICEPP)

Abstracts : The LHC (Large Hadron Collider) accelerator is now under construction at CERN near Geneva. LHC provides highest energy proton beams of 7 TeV + 7 TeV and 4 major experiments, Alice, Atlas, CMS and LHC-b detectors will be installed at the colliding points of the beams.

Fifteen institutes from Japan, including our center, belong to the Atlas experiment and are collaborating for preparation. Requirements to its computing are very severe. The detector consists of many subsystems and the total read-out channels exceed 100 million channels. Beam bunches collide with each other every 25 nsec at the colliding point.

The purpose of our experiment is the discovery of new particles or new phenomena, and therefore we want to record as much data as possible. By our present estimation, a few hundred MB of data will be selected per second, and consequently, petabytes of data will be accumulated in a year. Analyzing this amount of data is a real challenge. It is too huge to be managed at a single analysis facility.

Our approach to this challenge is done as follows. The first stage of data processing will be done at the experiment site (CERN), and the resultant will be distributed to major analysis centers scattered around the world. The second stage of processing takes place at these regional centers and the result will be distributed again to national analysis centers of collaborating countries.
In order to realize this model, a new technology, data-intensive computing grid technology plays a key role. The LHC Computing Grid (LCG) project was launched in 2002, as collaboration among LHC experiments and grid technology developers. Since then, development and deployment of the infrastructure software, middleware, has been continuing and practices with heavy computing loads have been done by the experiment groups. Now, 80 centers around the world, with more than 9,000 CPUs are connected to LCG to form a big 'virtual' analysis infrastructure. Present status of the LCG project and our contribution to it will be given.

Title : The e-VLBI Operations on Three Stations at 2.5-Gbps in Japan

Authors : Noriyuki Kawaguchi (National Astronomical Observatory, Japan)
Yusuke Kono (National Astronomical Observatory, Japan)
Hiroshi Suda (National Astronomical Observatory, Japan)
Hiroshi Takaba (Gifu University)
Kazuhiro Takashima (Geographical Survey Institute)
Yasuhiro Murata

Abstracts : Three radio telescopes, Usuda 64m, Tsukuba 32m and Gifu 11m, are connected with two fiber optical cable links of 2.5-Gbps transmission rate each, and are regularly operated twice a month or more often for the purpose of wideband geodesy or highly sensitive astronomical purposes. Two correlation processor at Mitaka and Gifu is working for the coreelations of two 2-Gbps data streams from above three stations. The authors will present the current state of the operation and show the observational results specially paied the attention to the engineering view.

October 7 (Thu.)

Title : Ongoing e-VLBI Developments with K5 VLBI System

Author : Hiroshi Takeuchi (Kashima Space Research Center, NICT)

Abstracts : K5 VLBI system is a pc-based data acquisition system developed at Kashima. In the system, sampled data is not directly recorded to hard disk drives, but

transferred to PC's shared memory so that multiple software applications can access the data in real-time. This is the important architecture which distinguishes K5 system from the other acquisition systems. Because of this architecture, various kinds of real-time operations such as spectrometer, total power meter, oscilloscope, p-cal detector, software baseband converter, software correlator, real-time data transfer and real-time recording are realized by writing software programs. In my presentation, the development of software baseband converter and current status of distributed software correlator will be described in detail.

Title : Current status of K5 software correlator

Author : Tetsuro Kondo (Kashima Space Research Center, NICT)

Abstracts : Current status of the performance of K5 software correlator (K5 cor) is reported here. As for the processing speed, it is about 8 Mbps with a Pentium III 1GHz CPU and about 16Mbps with an AMD Athlon 64 3200+ CPU for calculating 32-lag correlation function with the detection of phase-calibration-signals at present time. K5 cor can process not only K5 data but also Mark5 data, but data format conversion should be executed first for processing Mark5 data. K5 cor is now being updated so as to handle Mark5 data directly.

Title : Design of Experiment Guided Adaptive Endpoint

Author : David Lapsley (MIT Haystack Observatory)

Abstracts : The Experiment Guided Adaptive Endpoint (EGAE) is an intelligent end system that is able to optimize the transfer of e-VLBI data according to a set of high level objectives and constraints provided by the scientist and its knowledge of the network state. The EGAE is able to operate in real-time or non-real time mode. It transports data using the draft VSI-E format and implements intelligent congestion control. The EGAE can adjust its transmission strategy based on feedback it obtains about the network state. This feedback can be end to end network characteristics as measured by the VSI-E protocol, or it could come from an external source such as NSDB. If it determines that the network bandwidth is not sufficient for it to meet its objectives, the EGAE can take pre-defined actions. These actions could include: selective discard of a small fraction of data, halting of transmission until sufficient bandwidth is available and/or an increase of its loss tolerance threshold. The EGAE is also able to make use of less-than-best-effort service to ensure that it does not impact other network users. In this paper, we discuss the design of the EGAE and some preliminary

results.

Title : Rapid turn around UT1 estimation with e-VLBI

Authors : Yasuhiro Koyama (Kashima Space Research Center, NICT)
Tetsuro Kondo (Kashima Space Research Center, NICT)
Hiroshi Takeuchi (Kashima Space Research Center, NICT)
Masaki Hirabaru (NICT)
Kazuhiro Takashima (Geographical Survey Institute)
David Lapsley (MIT Haystack Observatory)
Kevin Dudevoir (MIT Haystack Observatory)
Alan Whitney (MIT Haystack Observatory)

Abstracts : On June 29, one hour e-VLBI session between Westford and Kashima stations was performed and the UT1. By processing the observed data promptly after the observing session, rapid turn around UT1 estimation was demonstrated as short as about 4.5 hours. Following the success, we are planning to establish extra intensive sessions between Tsukuba and Wettzell stations on every Sundays to fill the remaining day of the week for the intensive sessions. By establishing the Sunday intensive sessions, UT1 estimation from VLBI observations will become possible everyday. We will report the initial results of the Sunday session and discuss about extending the e-VLBI into the other intensive sessions.

Title : Throughput Test of Satellite Data Transmission for Space Geodesy using the TCP/IP link in the South Pacific

Authors : ICHIKAWA Ryuichi (Kashima Space Research Center, NICT)
HASEGAWA Akio (ATR, Japan)
OSAKI Hiroo (Kashima Space Research Center, NICT)
KONDO Tetsuro (Kashima Space Research Center, NICT)
TAKAHASHI Fujinobu (Yokohama National University)
Eroni Vari (Lands & Survey Dept., Suva, FIJI)
Paserio Samisoni (Lands & Survey Dept., Suva, FIJI)
David A. PHILLIPS (UNAVCO, USA)
Michael BEVIS (Ohio State University, USA)

Abstracts : Full-time observations at globally distributed VLBI stations are desirable for the real-time monitoring of the earth orientation. However, Pacific and southern hemisphere coverage is not sufficient for such observations. If we are able to use a high speed TCP/IP data link using an optical fiber network or wideband satellite communication at the South Pacific Islands, we will be able to fill a gap

in the VLBI observation network. In addition, the monitoring of the plate motions and sea level changes using GPS measurements in the South Pacific supports studies of natural hazards and climate change. Unfortunately, since there are no VLBI stations in the South Pacific Islands, the position coordinates of GPS stations are not tied to the global reference system with sufficient precision. The local tie between the VLBI station and the local GPS network will improve the precision. Thus, we started to develop the VLBI and GPS data transfer system using the satellite TCP/IP link!

The satellite communication system over the West Pacific is available to evaluate the feasibility of GPS and VLBI data transmission. There is one satellite station in the University of South Pacific (USP), SUVA, Fiji. Though the band width of 1536Kbps is not enough to transmit the huge data sets such as Gigabit VLBI data, we can actually evaluate the R&D results to send the space geodetic data from Fiji to Japan. Our first experiment was successfully carried out during the period of February 9-14, 2004. We used a state-of-the-art satellite router which can improve the maximum throughput of a TCP connection to avoid the time delay due to the round trip time (RTT) for a data packet over a satellite link. The peak throughput using the router was more than approximately 1440 Kbps which is up to about 94% of the nominal maximum throughput.

Title : Astrometric VLBI observation of Spacecraft with phase delay

Authors : M. Sekido (Kashima Space Research Center, NICT)
R. Ichikawa (Kashima Space Research Center, NICT)
H. Osaki (Kashima Space Research Center, NICT)
T. Kondo (Kashima Space Research Center, NICT)
Y. Koyama (Kashima Space Research Center, NICT)
M. Yoshikawa (Institute of Space and Astronautical Science, JAXA)
T. Ohnishi (Fujitsu Co. Ltd.)
W. Cannon (SGL)
A. Novikov (SGL)
M. Berube (NRCan)
NOZOMI VLBI group (NICT, ISAS/JAXA, NAOJ, GSI, Gifu Univ., Yamaguchi Univ., Hokkaido Univ.)

Abstracts : A series of VLBI observations for spacecraft NOZOMI was performed in the period between the end of 2002 and July 2003. Observations were performed by using IP-sampler board, which is PC-based vlbi recording system developed by NICT. And data file transfer was mostly made by FTP through the internet. Using IP-sampler board was suitable for narrow band signal form the spacecraft

and have great advantages in operation and data transfer, becase remote operation and data transfer was much easier and quicker than conventional recording system with magnetic tapes.

We have made astrometric analysis of the VLBI data with gourp delay and phase delay via absolute astrometry technique. Phase delay observable was used to overcome the disadvantage of low delay resolution of group delay for spacecraft signal. Consequently about 3 order of improvement in delay resolution was achived by phase delay observables.

Title : A sub-mm VLBI netwrok, Horizon Telescope II

Author : Makoto Miyoshi (National Astronomical Observatory, Japan)

Abstracts : Imaging the vicinity of black hole is one of the ultimate goals of VLBI astronomy. SgrA*, the closest super massive black hole, located at our Galactic center is the leading candidate for such observations. Because of the apparent Schwarzschild radius is estimated to be larger than 6- micro arc seconds from the mass (2.6-3.7*10^6 solar mass) and the distance (8 kpc), the corresponding shadow of black hole is 30 micro arc seconds in diameter and because mm and sub-mm VLBI will soon obtain the sufficient spatial resolutions for the imaging.

Recent detections of the rapid flaring from a few hours to 30 min at mm-wave, infrared, and x-ray emissions mean that the structure of the black hole system of SgrA* will also change rapidly. One of VLBA observations at 43GHz really shows such rapid changes of structure of SgrA* occur.

We also show performance of a supposing but realistic ground-based sub-mm VLBI array for imaging the SgrA* black hole system.

Title : Space-VLBI after VSOP, RadioAstron Age

Author : Hisashi Hirabayashi (Institute of Space and Astronautical Science, JAXA)

Abstracts : Space-VLBI test experiment was demonstrated by using TDRSS in 1986-1988, and dedicated space-VLBI was successfully performed by VSOP mission with radio astronomy satellite HALCA since its launch in 1997. Efforts is being payed for Russian RadioAstron mission to be realized by its launch in a few years. HALCA is already 7 years old, and VSOP team has defined the second generation mission VSOP-2, and design study and development are in progress. Specifications for VSOP-2 are improved much from those of VSOP, to realize one order of magnitude increase in maximum observing frequency, interferometer sensitivity and angular resolution. The spacecraft will carry 9m off-set Cassegrain antenna and 3 band receivers at 8, 22 and 43 GHz band, and the

VLBI data is transferred to the ground tracking stations at 1 Gbps. The route to VSOP-2 idea is introduced, and what will remain undone will be discussed. These must be taken into account for the future design. e-VLBI, SKA, ALMA also will have significant impacts on far future missions after VSOP, VSOP-2.

Title : The feasibility and Scientific Goals of the Japanese e-VLBI System

Authors : Hiroshi Sudou (Gifu University)
Noriyuki Kawaguchi (National Astronomical Observatory, Japan)
Kenta Fujisawa (Yamaguchi University)
Yusuke Kono (National Astronomical Observatory, Japan)
Hiroshi Suda (National Astronomical Observatory, Japan)
Kazuhiro Takashima (Geographical Survey Institute)
Masayoshi Ishimoto (Geographical Survey Institute)
Yasuhiro Murata (Institute of Space and Astronautical Science, JAXA)
Tomofumi Umemoto (National Astronomical Observatory, Japan)
Kazuo Sorai (Hokkaido University)
Yasuhiro Koyama (Kashima Space Research Center, NICT)
Hiroshi Takaba (Gifu University)
Kenichi Wakamatsu (Gifu University)
Shigeru Yasuda (Kagoshima University)

Abstracts : We are developing the e-VLBI system with optical-fiber links and carring out test observations. Our final goal is to construct the e-VLBI network covering Japan and East Asia. This system is very storong probe of very weak sources, such as low-luminosity active galaxies, protostars, and steller atmospheres. The feasibility and scientific merit of the network will be presented.

Title : The eVLBI in Chinese VLBI Network

Author : Xiuzhong Zhang (Shanghai Astronomical Observatory)

Abstracts : The eVLBI station equipment, communication system, data processor and experiments in Chinese VLBI Network should be introduced in this paper. The near real time VLBI system used by Chinese Lunar Project is reported in briefly.

Title : Status of VLBI and e-VLBI in Urumqi Astronomical Observatory

Authors : Sun Zheng Wen (Urumqi Astronomical Observatory)
Zhang Hua (Urumqi Astronomical Observatory)
Li Guang Hui (Urumqi Astronomical Observatory)

Abstracts : UAO is a member of EVN and IVS and joins in many VLBI observations each year. We have a Local Network which connects to the Internet through optical fiber lines. Recently we have upgraded our acquisition system to Mark 5A and discussed the possibilities of e-VLBI. This paper introduces the status and VLBI and e-VLBI at UAO.

Title : Recent eVLBI developments at JIVE

Authors : A. Szomoru (Joint Institute for VLBI in Europe)
S. Parsley (Joint Institute for VLBI in Europe)

Abstracts : During the past year considerable progress has been made at JIVE in the field of eVLBI; nowadays we can routinely perform real-time eVLBI experiments. These experiments however still are limited to fairly low datarates. Our short-term goal is to achieve at least 512Mbps real-time eVLBI, connecting at least three telescopes.In this talk I will report on the ongoing efforts at JIVE to make this possible.

Title : Recent eVLBI developments at Metsähovi

Authors : Jouko Ritakari (Metsähovi Radio Observatory)
Ari Mujunen (Metsähovi Radio Observatory)

Abstracts : Two years ago Metsähovi Radio Observatory developed an PC-based VLBI recorder that is compatible with most VLBI equipment (Mark4, the ADS-1000 gigabit sampler, VLBA, S2 etc). The recorder stores the VLBI data in normal Unix files, which enables the use of standard Unix programs for the transfer and processing of VLBI data.

During the last year the performance of the MRO-designed equipment has been further enhanced in eVLBI use, when new motherboards with native gigabit Ethernet controllers have arrived. Also the new reliable UDP-based protocols (UDT, Tsunami, Reliable Blast UDP, GTP etc) show great promise for eVLBI use. In the file transfer tests from Espoo, Finland to Dwingeloo, the Netherlands in 17-21 September 2004 we consistently achieved 640 Mbit/s disk-to-net-to-disk transfer speed using the Tsunami protocol between two normal Linux computers. This result was achieved using the Funet, Nordunet, GEANT and SURFnet networks. Parameter tuning or jumbo frames were not needed.

Title : E-vlbi in Italy

Authors : M. Nanni (CNR Ist. Radioastronomia)

G. Maccaferri (CNR Ist. Radioastronomia)

Abstracts : We need to give a short report about the status of the connections of the italian radiotelescopes to the Garr network backbone and the test of transmission to Jive.

Poster Session

Title : Experiences of Upgrading to 2.5 Gbps using DWDM Technology

Authors : David Lapsley (MIT Haystack Observatory)
Alan Whitney (MIT Haystack Observatory)

Abstracts : MIT Haystack Observatory is currently in the process of upgrading its high speed e-VLBI connection from 1 Gbps to 2.5 Gbps. This upgrade is being done through the use of advanced optical Dense Wave Division Multiplexing technology capable of handling multiple 10 Gbps wavelengths. In this paper we discuss the technology used to upgrade our connection, the architecture of our existing connection and the steps taken during the upgrade procedure.

Title : The Application of Cluster Computing to e-VLBI

Authors : David Lapsley (MIT Haystack Observatory)

Abstracts : Many scientific applications are taking advantage of Cluster Computing to provide a cheap way to manage computationally intensive applications. In e-VLBI, Kondo-san et. al [1] and Takeuchi-san et. al [2] are already making use of cluster/grid computing for managing distributed correlation. In this paper, we discuss the use of cluster/grid computing for the management and control of e-VLBI data transfers. We describe the system architecture, discuss results to date and present our future plans.

[1] Kondo, M., M. Kimura, Y. Koyama, H. Osaki, "Current Status of Software Correlators Developed at Kashima Space Research Center", IVS 2004 General Meeting Proceedings, 186-190, 2004.
[2] Takeuchi, T. Kondo, Y. Koyama, and J. Nakajima, "VLBI@home - VLBI correlator by GRID computing system", IVS 2004 General Meeting Proceedings, 200-204, 2004.

Title : Mark 5 Network Performance Issues

Authors : Kevin A. Dudevoir (MIT Haystack Observatory)

Abstracts : In addition to providing direct high-bandwidth recording of VLBI data to disks, the Mark 5 also provides paths to/from high-speed network interfaces for this data. This paper examines the system data throughput to/from networks as a function of motherboard/NIC platforms. Some recommendations are given for avoiding bottlenecks and maximizing performance.

Title : E-LFVN - An Internet Based VLBI Network

Authors : G. Tuccari (IRA - INAF)
I. Molotov
S. Buttaccio
Y. Gorshenkov
L. Xiang
X. Hong
M. Nechaeva
G. Nicotra
A. Volvach

Abstracts : 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.

Title : High Performance PC based Gigabit VLBI System

Author : Moritaka Kimura (Kashima Space Research Center, NICT)

Abstracts : Development of the PC based gigabit VLBI system has been performed over the past five years at NICT. The performance of PC is improving dramatically in the meantime. The recording speed of this system has reached 2048Mbps and software multi baselines correlation speed has reached almost 1024Mbps. Compared with five-years before, current software correlation speed per PC is 100 times faster. This tendency is further expectable several years from now on. In this presentation, the PC based VLBI system will be introduced and demonstrated.

Title : Current Status of the Next Generation Space VLBI Mission: VSOP-2

Authors : Yasuhiro Murata (Institute of Space and Astronautical Science, JAXA)
Hisashi Hirabayashi (Institute of Space and Astronautical Science, JAXA)
Makoto Inoue (National Astronomical Observatory, Japan)
the next generation space VLBI working group.

Abstracts : Next Space VLBI mission:VSOP-2 is currently being planned by next generation space VLBI working group in ISAS/JAXA. Various kinds of developments are being made for the mission. We are also studying the system configuration of the VSOP-2 satellite and the orbit appropriate for the expected launch vehicle, the M-V rocket.

VSOP-2 science goals include imaging the accretion disks around the massive blackholes in the nuclei of the active galaxies, studies of magnetic field orientation and evolution in jets, and the highest resolution studies of spectral line masers and mega-masers.

Here we describe the design and the development of the space antenna, high speed sampler, and the satellite system.

We also think that the e-VLBI system will be one of the most possible system to treat the space VLBI data.

Title : Broadband VLBI Data Downlink of VSOP-2

Authors : Yusuke Kono (National Astronomical Observatory, Japan)
Yasuhiro Murata (Institute of Space and Astronautical Science, JAXA)
Hisashi Hirabayashi (Institute of Space and Astronautical Science, JAXA)
Kiyoaki Wajima (Korea Astronomy Observatory)
Nanako Mochiduki (Institute of Space and Astronautical Science, JAXA)
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Abstracts : Following the success of the VLBI Space Observatory Programme (VSOP), a next generation space VLBI mission, currently called VSOP-2, is being planned. The mission will provide a downlink data rate of 1 Gbps to improve observation sensitivity. A possible band based on frequency allocation regulations is 37-38 GHz. The uplink frequency will be 40 GHz. The two-way link will also be used for reference signal transfer. We adopt the OFDM (Orthogonal Frequency Division Multiplex) method with 8 channel QPSK modulation to reduce the emission in the outband of the transmitting band for the downlink. We studied the link budget, and found that the condition is more severe than that of VSOP data downlink, but still it is possible. Because the feedback even at light speed takes time to reach the sender. This gets more serious as the bandwidth gets larger because delay of the control would result in a lot of data losses and retransmissions. Experiments have been taken place to evaluate performance of advanced transport protocols on this kind of large bandwidth-delay product network. However, sometimes the results from different experiments are inconsistent. It seems difficult to reproduce the similar results in a different place under the same conditions. This talk explains possible performance bottlenecks and shows a way of removing hidden factors in order to obtain a reliable result. One of the important factors often neglected is buffer size on a bottleneck. A method of measuring buffer size will be introduced. Its impact on performance will be also discussed. This technique would help applications in identifying a bottleneck and gaining performance along a path.