

e-VLBI Development at Haystack Observatory

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Overview

- 32 Mb/s real-time e-VLBI demonstration experiment between Westford and GGAO
- Westford/Kashima e-VLBI experiments are continuing.
- Establishing e-VLBI connections to Kokee Park and U. of Regensburg (near Wettzell) for near-real-time Intensive UT1 demonstrations.
- Much is going on
 - Haystack has 3-yr grant from NSF for development of new protocols for e-VLBI.
 - Haystack is a collaborator on DRAGON (Dynamic Resource Allocation via GMPLS Optical Networks).

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Real-Time e-VLBI

- Data transferred to Haystack correlator in real time.
- No disks
- Westford-Goddard baseline
- 32 Mb/s
- Commodity 100 Mb/s internet connection
- 10-minute scans
- For more information, see
 - <http://web.haystack.mit.edu/mark5/newsletter5.htm>
 - <http://web.haystack.mit.edu/mark5/newsletter5.pdf>

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Recent e-VLBI Activity

- Several US to Japan demonstrations
 - Support of Geodetic e-VLBI experiments:
 - Up to ~ 100 Mbps sustained for near Real-time data transfer
 - Sub-24 hour UT1 estimate
 - <http://web.haystack.mit.edu/mark5/newsletter2.htm#results>
- Recent **500 GB** data transfers of real experimental data from Kashima to Haystack and Washington
 - CRF22, CRF23, T2023, T2024, T2026 part of IVS schedule
- Network performance characterization and protocol testing
 - ~ **900 Mbps** memory-to-memory transfer rate in Tokyo to US experiment using rate-based flow control
 - Internet2 Demonstration - October 2003
 - ~**644 Mbps** using FAST TCP
 - ~**400 Mbps** using High Speed TCP (HSTCP)

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DRAGON

- Dynamic Resource Allocation via GMPLS Optical Networks.
- GMPLS is Generalized Multiprotocol Label Switching
- Collaborators
 - MIT Haystack Observatory
 - University of Maryland
 - Mid-Atlantic Crossroads (MAX)
 - Information Sciences Institute (ISI),
at the University of Southern California (USC)
 - NASA Goddard Space Flight Center (GSFC)

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e-VLBI Antenna Connectivity

- Wettzell, Germany (E3 - 34 Mbps)
- Kashima, Japan (100 Mbps currently, 1 Gbps 2004)
- Arecibo, USA (OC3 - 155 Mbps)
- Kokee Park, USA (OC3 - 155 Mbps)
- GGAO, USA (1 Gbps)
- Haystack, USA (1 Gbps, 2.5 Gbps 2004)
- Onsala, Sweden (1 Gbps)
- Torun, Poland (1 Gbps)
- Westerbork, The Netherlands (1 Gbps)
- Westford, USA (1 Gbps)
- JIVE Correlator (3 x 1 Gbps)

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Conclusions and Next Steps

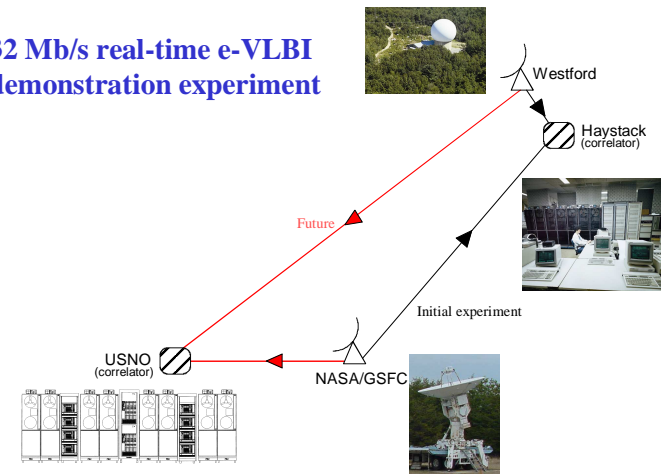
- e-VLBI has huge implications for new science and significantly improved operational efficiency
- International in nature
- Last-mile bandwidth is a challenge.
- VLBI community working on standardizing data transport framework
 - VSI-E RTP (Real-Time Protocol) draft currently circulating
- Ramping up of real e-VLBI experiments as part of IVS Schedule
- Advanced transport protocols will be able to take advantage of unique characteristics of VLBI traffic to more efficiently transport VLBI data
 - Experiment Guided Adaptive Endpoint

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32 Mb/s real-time e-VLBI demonstration experiment



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