



e-VLBI developments with the K5 VLBI system

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e-VLBI with the K5 system

- Flexible combination of component units
 - Supports variety of observation modes
 - 40ksps~2048Msps, 1bit~8bits/sample, 1ch~16ch~
 - Scalable, extensible, and sustainable system
 - Maintain and promote compatibility and connectivity by adopting various standards
 - VSI-H, VSI-S, VSI-E, file naming convention
- Being developed to realize global e-VLBI
 - near real-time VLBI : already in practice for IVS sessions ~ data transfer, parallel correlation processing
 - real-time VLBI : IP, VSI-E

K5 system

ADS1000

(1024Msample/sec 1ch 1 or 2bits)



PC-VSI Board

(~2048Mbps)



VSI



IP-VLBI Board

(~16Msample/ch·sec, ~4ch, ~8bits)



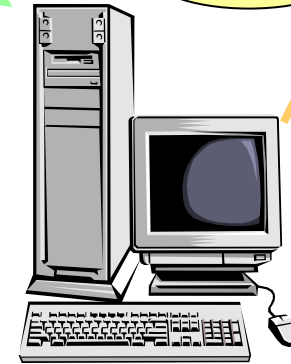
ADS2000

(64Msample/ch·sec, 16ch, 1 or 2bits)

VSI

Correlator
other DAS

Internet



PC : Data Acquisition
Correlation

K5 system

ADS3000
(2048Msample/sec 1ch 8bits + FPGA)



ADS1000
(1024Msample/sec 1ch 1 or 2bits)



PC-VSI Board
(~2048Mbps)



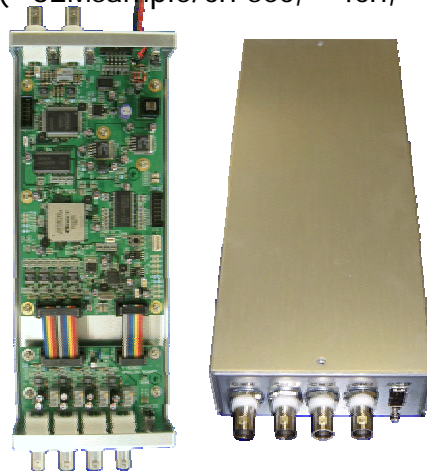
VSI

VSI

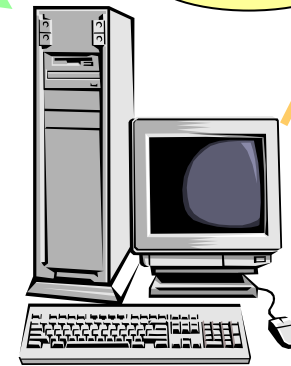
Correlator
other DAS

Internet

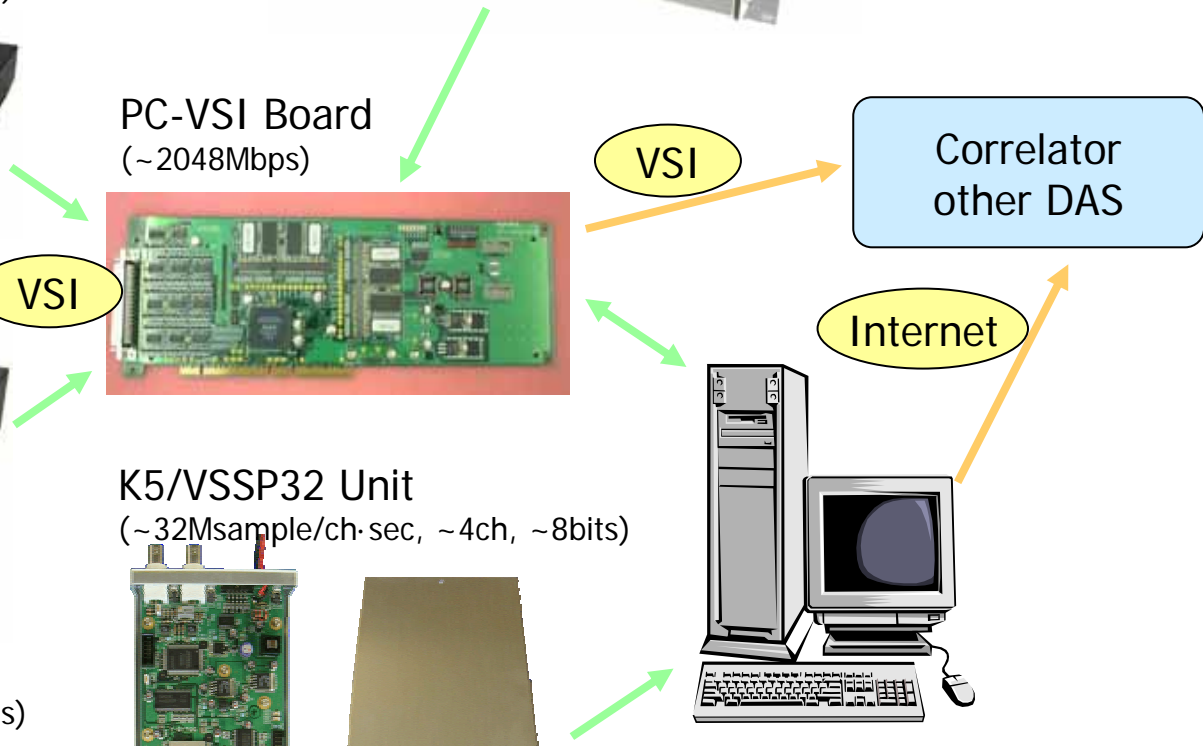
K5/VSSP32 Unit
(~32Msample/ch·sec, ~4ch, ~8bits)



ADS2000
(64Msample/ch·sec, 16ch, 1 or 2bits)



PC : Data Acquisition
Correlation



Recent developments of the K5 system

- USB2.0 version of K5/VSSP = K5/VSSP32
 - up to 64Msps sampling each channel
 - supports up to 1024Mbps with 16 channels
 - no need to have PCI extension bay
- VSI-S implementation to K5/VSI system
 - succeeded to control the unit from fs9 by developing VSI-S command interpreter program modules (N. Takahashi at Yamaguchi Univ.)

Concept of the K5 System

	K3	K4	K5
Data Recorders	Magnetic Tapes Longitudinal Recorders	Magnetic Tapes Rotary Head Recorders	Hard Disks
e-VLBI	Telephone Line	ATM	IP
Correlators	Hardware	Hardware	Software
	1983~	1990~	2002~
	M96 Recorder, K3 Formatter, K3 VC, K3 Correlator	DIR-1000, -L -M, DFC1100, DFC2100, K4 VC (Type-1, 2), TDS784, ADS1000, GBR1000, GBR2000D, K4 Correlator, KSP Correlators, GICO, GICO2	K5/VSSP, K5/VSSP32 , K5/VSI, ADS1000, ADS2000, ADS3000 , Software Correlatos (cor, fx_cor, GICO3)

K5 Family : Selection of Samplers (1)

	K5/VSSP	ADS1000	ADS2000
Sampling Speed	40, 100, 200, 500kHz, 1, 2, 4, 8, 16MHz,	1024MHz	64MHz
Sampling Bits	1, 2, 4, 8	1, 2	1, 2
No. Channels	1, 4, 16 (with 4PCs)	1	16
Max. Data Rate	512Mbps (with 4PCs)	2048Mbps	2048Mbps



K5/VSSP



ADS1000



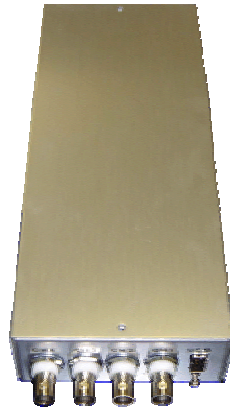
ADS2000

K5 Family : Selection of Samplers (2)

	K5/VSSP32	ADS3000
Sampling Speed	40, 100, 200, 500kHz, 1, 2, 4, 8, 16, 32, 64MHz,	2048MHz
Sampling Bits	1, 2, 4, 8	8
No. Channels	1, 4, 16 (with 4PCs)	Programmable with FPGA
Max. Data Rate	1024Mbps (with 4PCs)	2048Mbps



K5/VSSP32



ADS3000

K5 Systems currently in use

■ K5/VSSP

- IVS Stations : KASHIM34, TSUKUB32, SYOWA
- Other Stations : VERA Mizusawa 20m, Tomakomai 11m, Gifu 11m, Usuda 64m, Uchinoura 34m, Yamaguchi 32m





■ K5/VS1

- ADS1000 : VERA Sites (4), Usuda 64m, Nobeyama 45m, KVN Sites (3: planned), Yamaguchi 32m, Gifu 11m

■ Software Correlator Program

- Based on Free License Agreement : JIVE, Univ. Tech. Vienna, ATNF CSIRO, Istituto di Radioastronomia INAF, NRCan, KVN, Shanghai Observatory CAS, MERLIN
- Based on Collaboration Agreement : GSI, NAOJ, JAXA/ISAS

Network Connection in Japan

-  GEMnet2/GALAXY
-  JGN2
-  Super Sinet
-  Future Plan

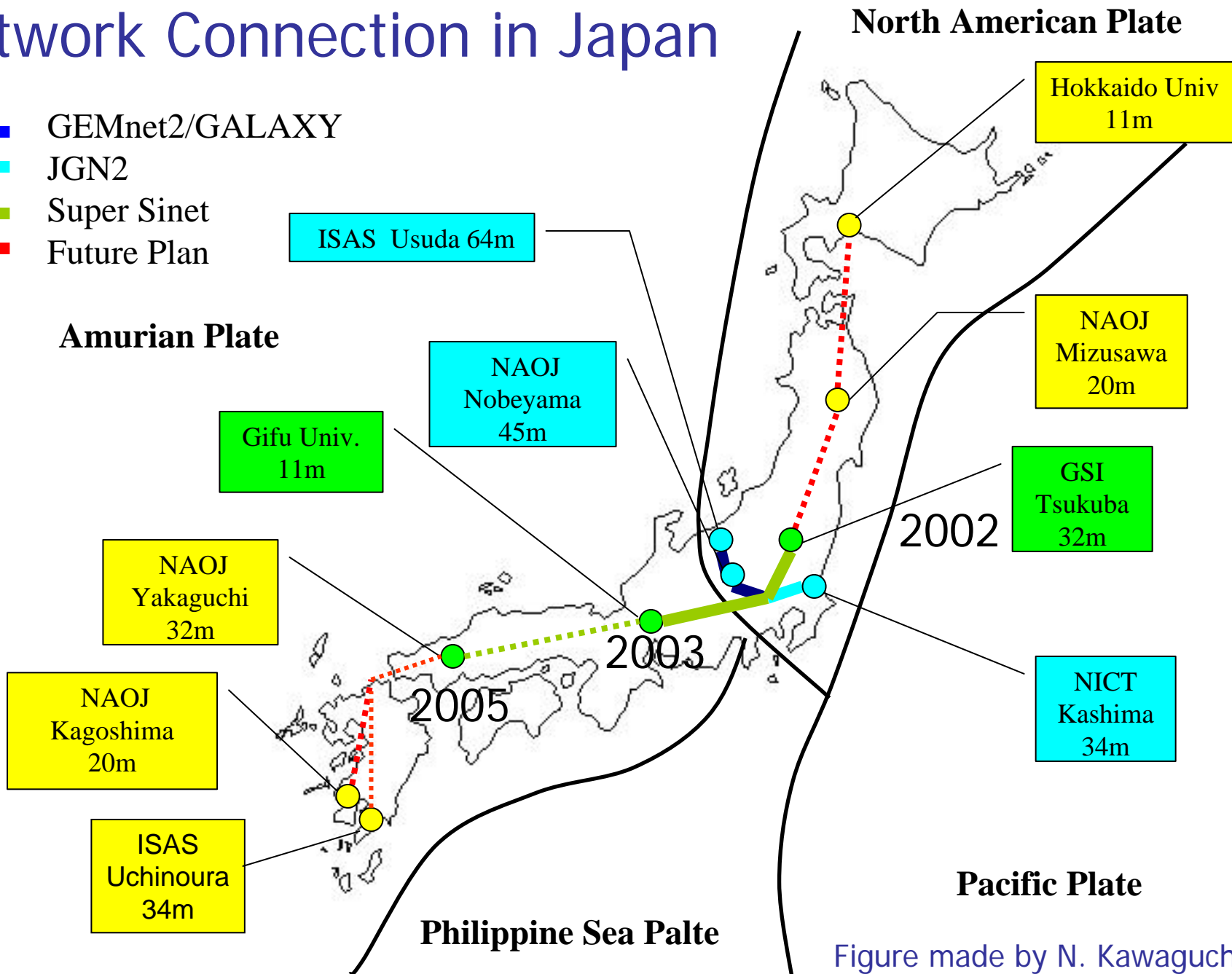


Figure made by N. Kawaguchi

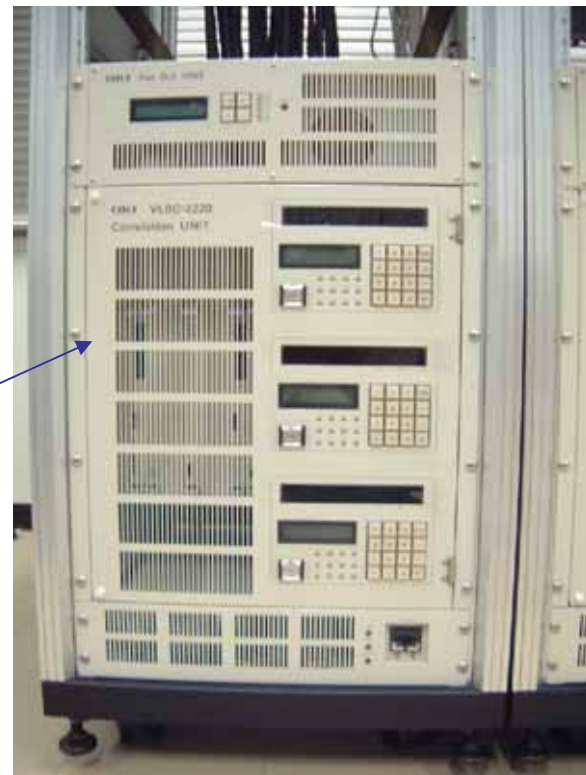
ATM based real-time VLBI system



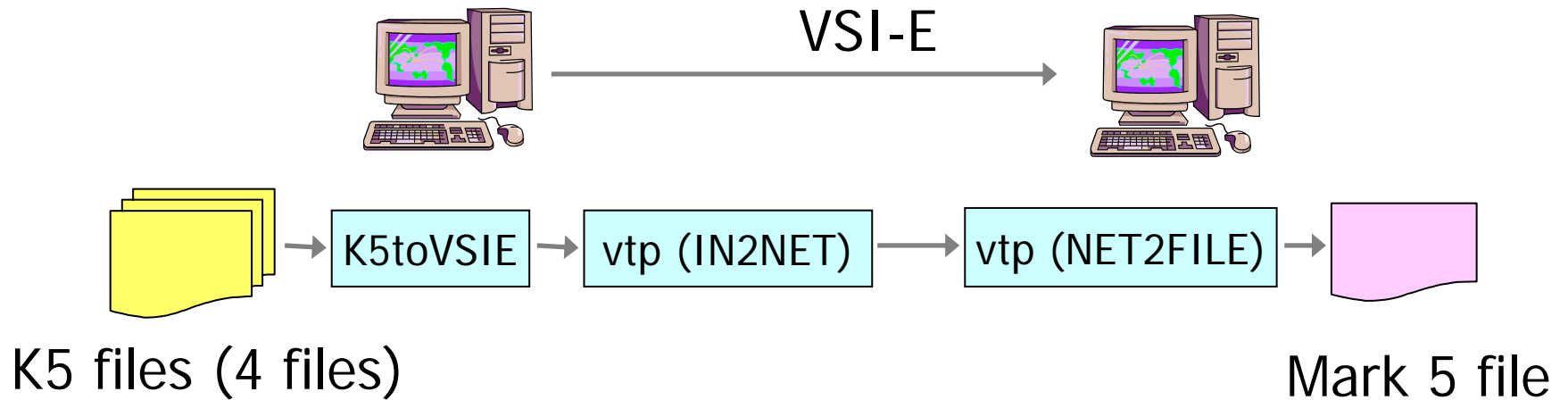
ADS-1000
(A/D Sampler)
: 1024Msps, 2bits AD

Distributed Correlator
: 1024Msps, 2bits,
3baselines
(developed by NAOJ)

Network Access Unit
(VOA-100) : OC48 x 2 (developed by NAOJ)

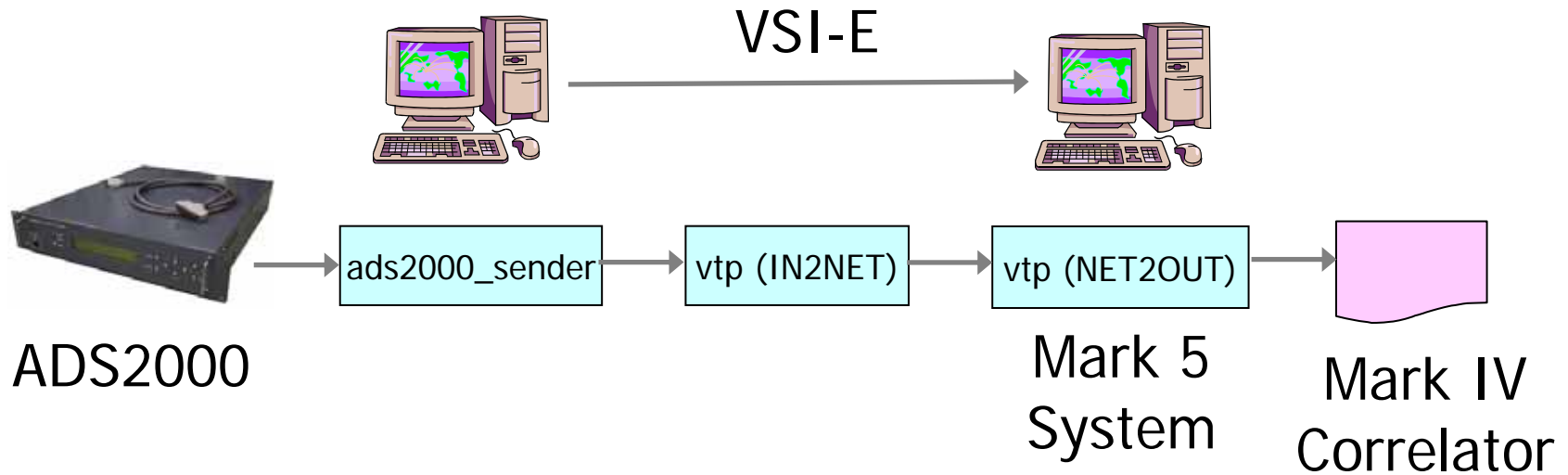


K5 - Mark 5 file conversion through VSI-E



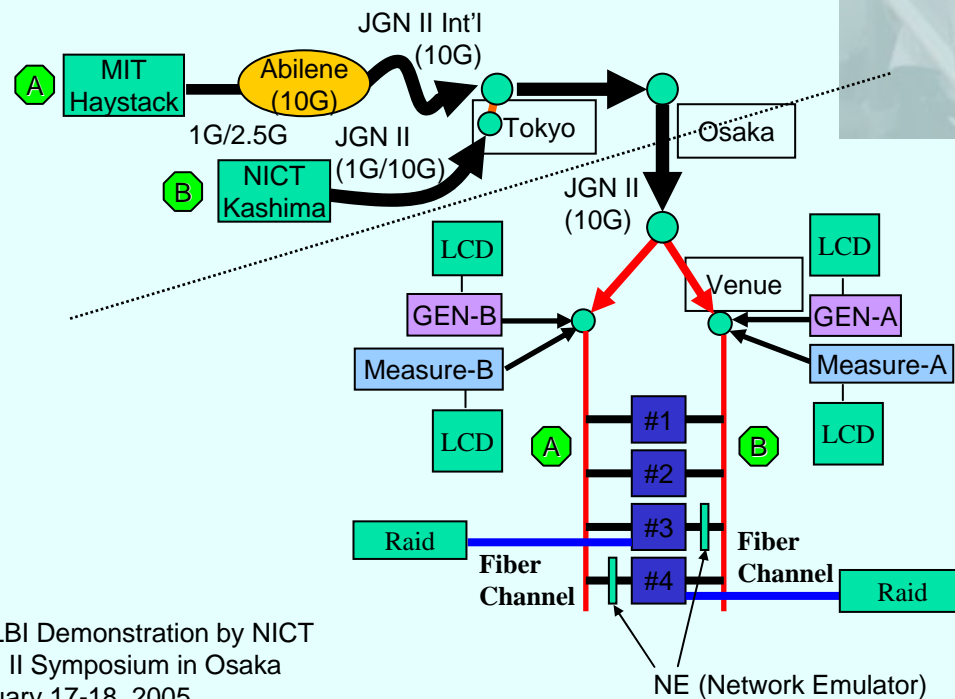
* 'vtp' codes have been developed by David Lapsley and his colleagues at Haystack Observatory

K5 - Mark 5 real-time correlation (in progress)



Real-time software correlation demo

Real-time software distributed correlation was demonstrated at JGN2 symposium in Osaka (January 17-18, 2005). Fake random data were generated at Kashima and at Haystack and transferred to Osaka by using Abilene and JGN2. The data were correlated by using 8 CPUs (Apple X-serve G5) and about 400Mbps throughput without fringe rotation processing was achieved (the speed was limited by the network data transfer).



e-VLBI Demonstration by NICT
JGN II Symposium in Osaka
January 17-18, 2005

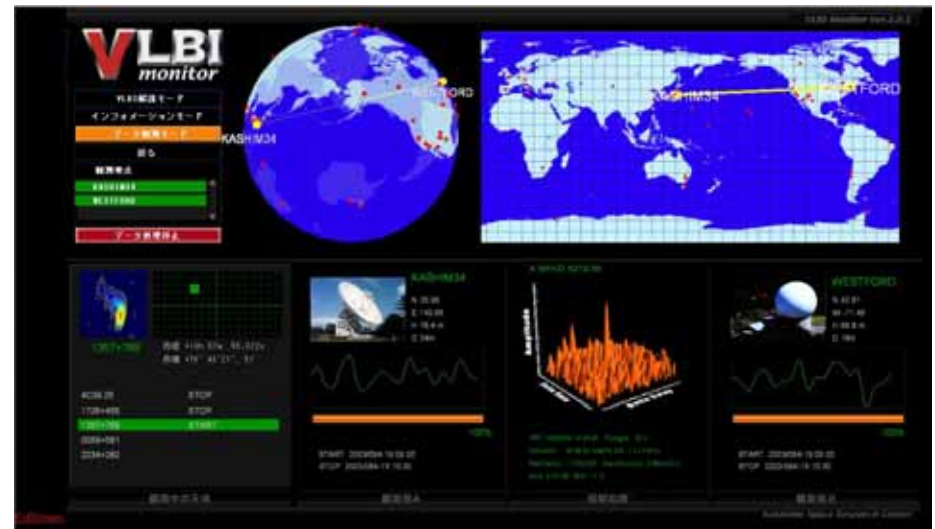
The data were correlated by using 8 CPUs (Apple X-serve G5) and about 400Mbps throughput without fringe rotation processing was achieved (the speed was limited by the network data transfer).

Another recent event at Kashima

Emperor and Empress of Japan visited Kashima and they learned about e-VLBI (June 5, 2005)



Demonstration software was developed. The software was designed to be useful for actual operation.



Remaining Issues

- real-time VSI-E data transfer and correlation by Mark IV correlator and K5 software correlator
- VSI-H output from K5/VSI system
- VSI-S implementation to K5/VSSP and K5/VSSP32 systems
- FPGA programming for ADS3000 to realize various modes of Digital BBC

Acknowledgements

- Haystack Observatory for various e-VLBI activities
 - Jason SooHoo : routine administration for data transfer
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- NAOJ, GSI, JAXA/ISAS, NIPR, NTT Lab., KDDI Lab., Yamaguchi Univ., Gifu Univ., Kagoshima Univ., and Hokkaido Univ. for e-VLBI collaboration in Japan
- JGN2, TransPAC2, Abilene, GEMnet2/GALAXY, SuperSINET, and APAN networks for their supports to e-VLBI