Developments for real-time software correlation e-VLBI

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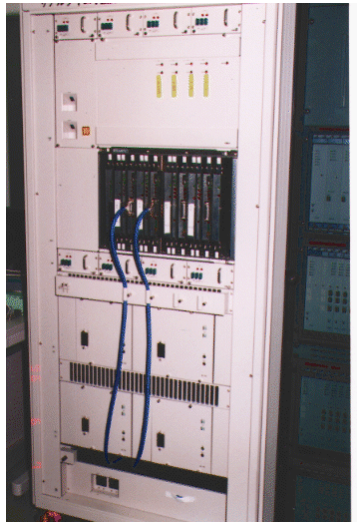
e-VLBI in the beginning

Key Stone Project (1995-2000)



ATM Data
Transfer Unit

Realtime
Collelator

Realtime e-VLBI at 256Mbps (1998~)
Automated Observations & Processing

VLBI Systems : From K3 to K5


K3 Correlator (Center)
K3 Recorder (Right)

K3 System

1983~
Longitudinal Recorder
Open Reel Tapes
Hardware Correlator

K4 Terminal

K4 Correlator

K4 System

1990~
Rotary Head Recorder
Cassette Tapes
Hardware Correlator
e-VLBI with ATM


K5 Data Acquisition Terminal

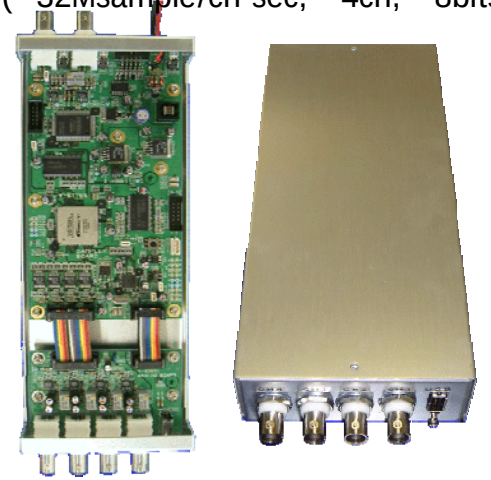
K5 System

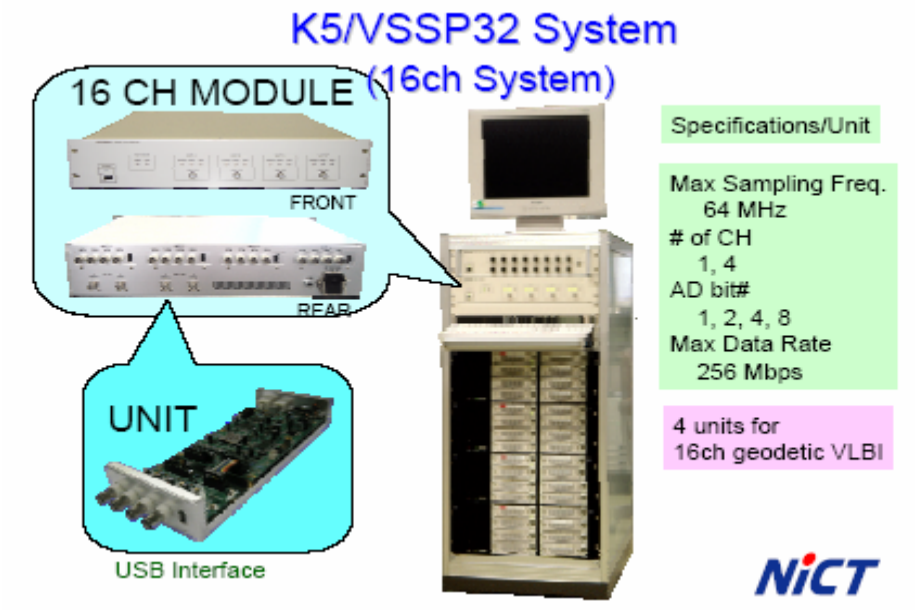
2000~
PC based system
Hard Disks
Software Correlator
e-VLBI with IP

Reports from NICT (1/3)

- Developments of K5/VSSP32 system
  - Supports 1024Mbps Observations Mode
  - 4 Systems have been deployed
    - 1 at Tsukuba and 3 at Kashima
  - currently causes spontaneous data error (once every ~150 seconds)
    - need to develop a way to flag bad data in the K5 to Mark5 file format conversion

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





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	IP-VLBI (K5/VSSP, K5/VSSP32), PC-VSI (K5/VSI), ADS1000, ADS2000, ADS3000

Global e-VLBI in Practice

Rapid UT1 Estimation – 2004.6.29 –

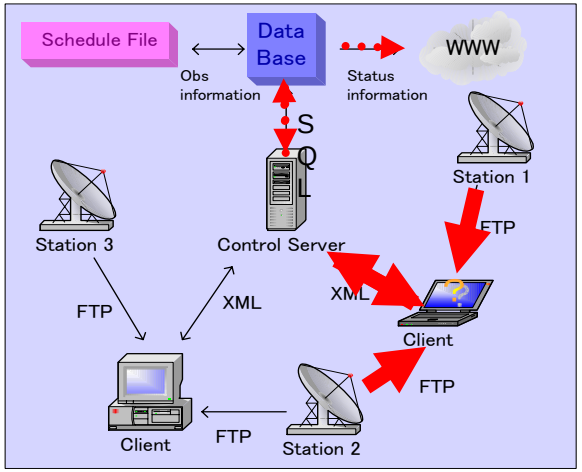
Baseline Length : 9502km

Kashima 34m

Westford 18m

- Estimated UT1 (variation of the Earth's rotation) in 4.5 hours.
- Software Correlation (20 CPUs).
- Observed data were recorded on hard disks and then transferred.
- K5 system was used at Kashima and Mark5 system was used at Westford.
- It has become routine operation for IVS (International VLBI Service) sessions.

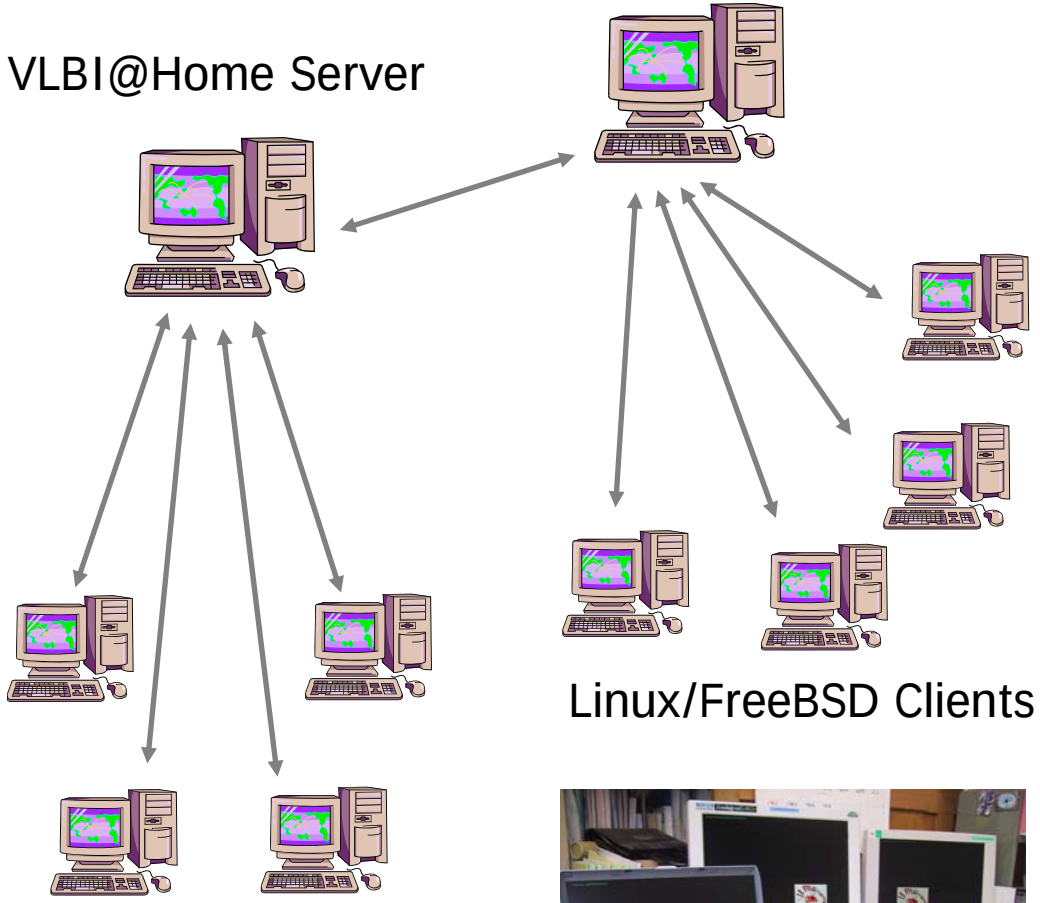
Distributed Software Correlation



Correlation Master Table / Database

Master Server

VLBI@Home Server



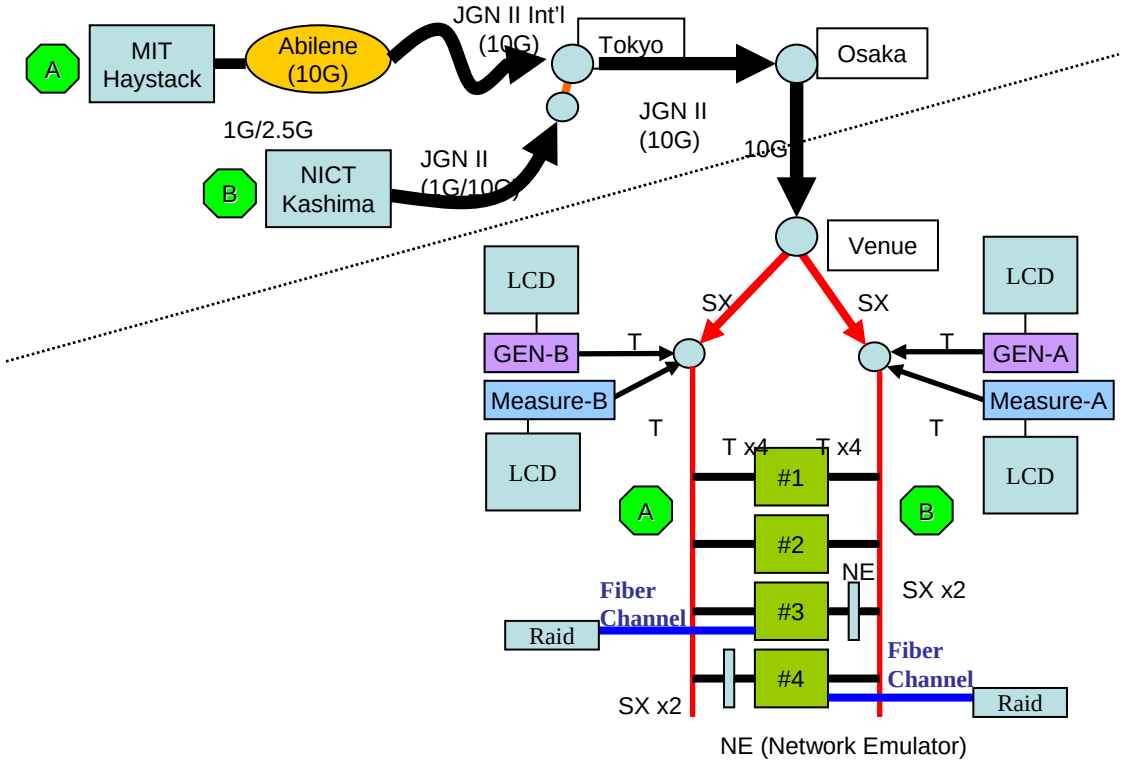
Linux/FreeBSD Clients

VLBI@Home Client PCs

JGNII Symposium 2005 in Osaka

2005/1/17-18 @ Osaka, Japan

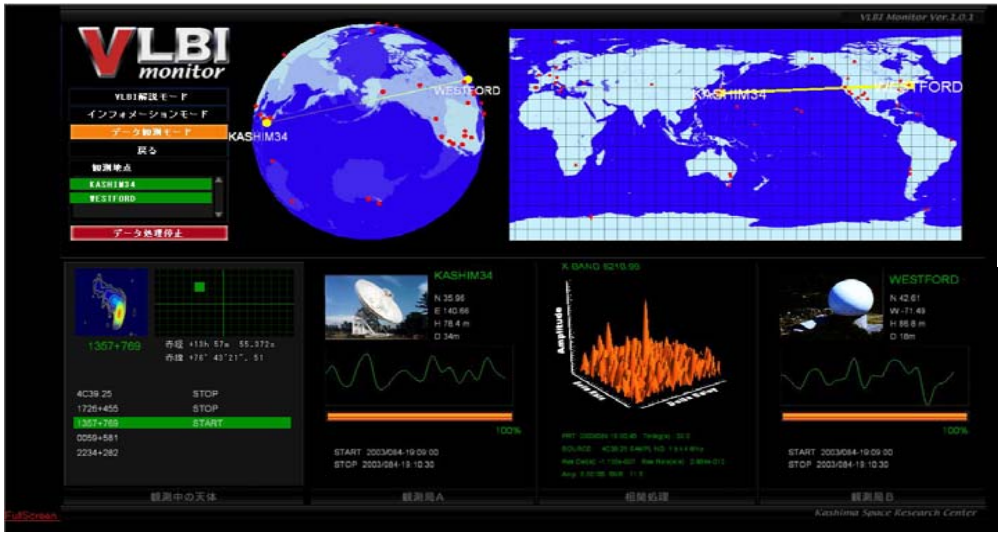
- Run a program at Kashima and Haystack to generate fake data
- Data were transferred to Osaka in real-time (~400Mbps) and the data were processed for cross correlation processing with distributed software correlator program



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, too.



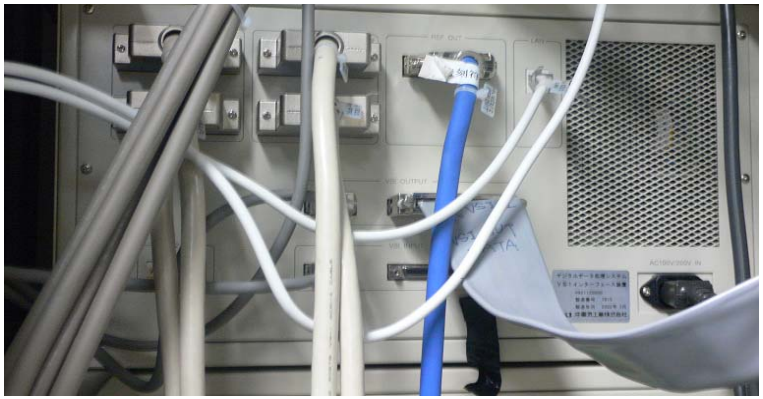
Developments of Software Correlator for VERA

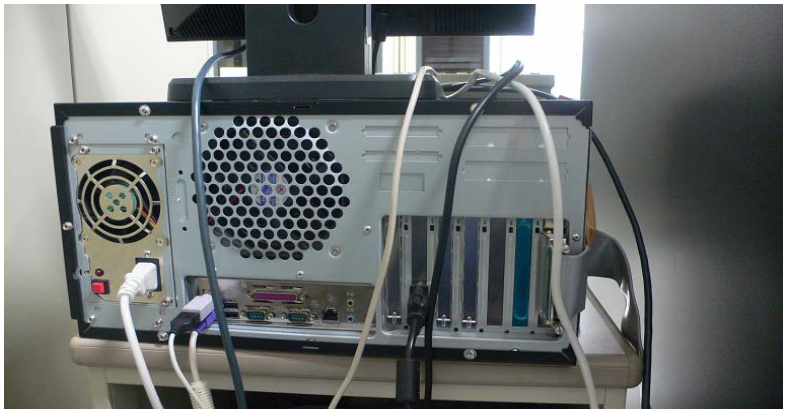
# Stations	5
Algorism	FX
Speed	0.5~1.0 x real-time @ 1Gbps x 5 stations
Output	FITS, CODA
Modes	1024Msps x 2bits x 1ch 256Msps x 2bits x 2ch 32Msps x 2bits x 16ch
Freq. Res.	~16K @ 32/256/512/1024Msps
PP	1 sec ~ 0.01 sec
Size	19 inch rack x 20U
Cost	~20MYen (180K$)

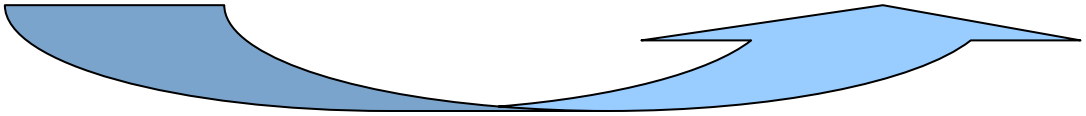
Mitaka FX Correlator

Data Transfer Test at FX Correlator

(Mitaka, NAO)



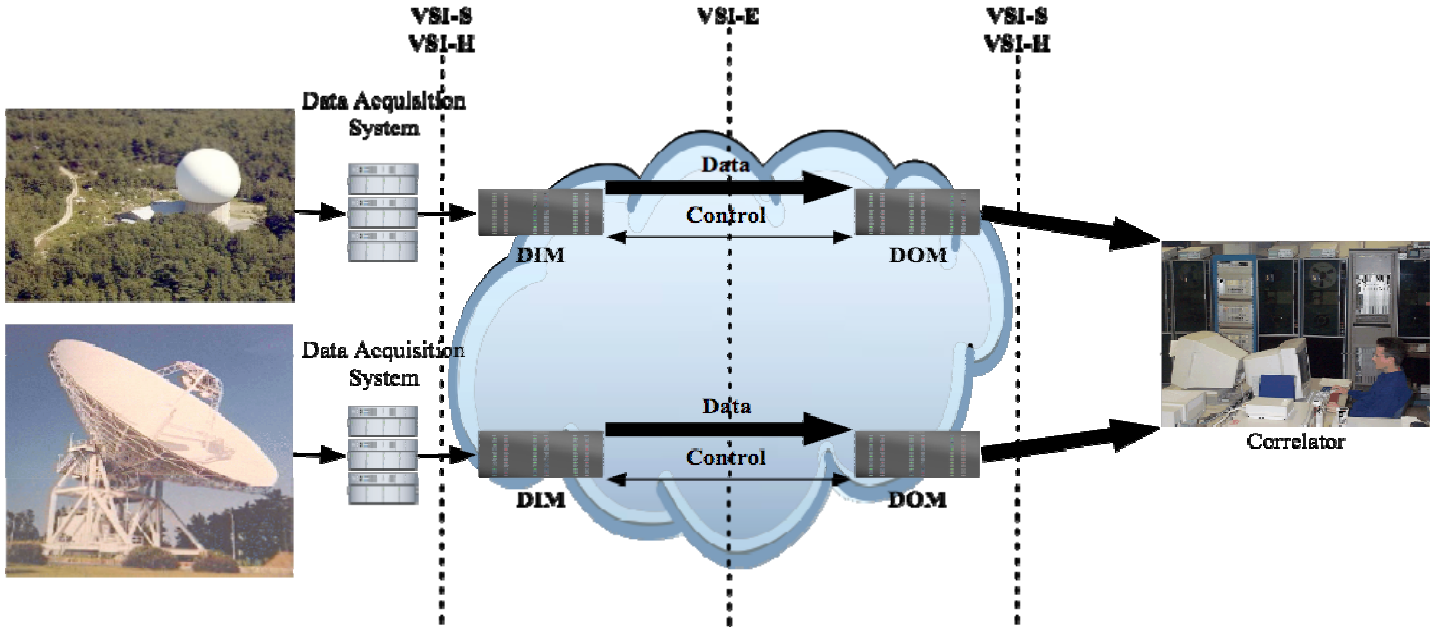




VSI

Remaining Challenges

- Real-time inter-operability between different systems (K5, Mark5, EVN System, etc.).
- Efficient distributed processing (GRID).
- Large scale (~40 stations) e-VLBI for VLBI2010.
- Higher speed for better sensitivity.



K5-Mark5 real-time correlation
(near future plan)