Current Status of Software Correlators Developed at Kashima Space Research Center

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Kashima Space Research Center/CRL

History of XF-type Software Correlators

• 1960's : Mark-I
  – 144Mbits (720kHz sampling \( \times \) 200sec) Processing (15-lag correlation) => 90 minutes (IBM360/50) 26.7kbps

• 1980's : CCC* (developed by Kashima Group)
  – 16Mbits (4MHz sampling \( \times \) 4sec) Processing (64-lag correlation) => 150 minutes (HP1000/A900) 1.8kbps

Soft correlator was developed, but it took time too much

* CCC : Cross Correlation in a Computer

CCC developer
On April 1, 2004 CRL and TAO will be reorganized as the National Institute of Information and Communications Technology

**Historical e-VLBI Experiment using Software Correlator in JAPAN (1986)**

It took about only 10 hours to get fringes!

**First Canada-Japan WFC VLBI using Software Correlator (1990)**

CCC was used in the first Canada-Japan Wave Front Clock VLBI experiment in 1990

CCC worked!

on the ARO 46m Dish
History of XF-type Software Correlators (continued)

- 2000's: K5 Software Correlator (Kashima) developed by
  - 8Mbits (8MHz sampling → 1sec) Processing (32-lag correlation) => 1 sec (PC Pentium4 2GHz) 8Mbps

K5/VSI Gigabit Software Correlator (FX-type Kashima)
- 100 Msamples => 1sec (PC AthronXP-2500+) 100Mbps
  developed by Kimura-san

Note: K5 (16-ch geodetic VLBI system with PC sampler board)
K5/VSI (Gigabit VLBI system with PC-VSI interface)

Requirements for a Software Correlator for Geodetic Use

- Compatible with conventional hardware correlators, such as K3, KSP correlators
  - Consistent definitions in delay, clock parameters, etc.
  - Pcal phase detection
  - Check bit slip or make
  - Processing using a schedule file

- Both K5 and Mark-5 data processing
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K5 - Mark5 Fringes
Oct. 15, 2002
Kashima - Westford

X band

S band

Mixed Raw Data Processing

Current

Mark5 data

K5 data

FMT Conv
Mark5 => K5

Software Correlator

Future

Mark5 data

K5 data

Software Correlator

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**Operation Mode of Internet VLBI (e-VLBI)**

- Offline VLBI (ftp-VLBI)
- Quasi real-time VLBI
- Real-time VLBI

![Diagram of VLBI modes](image)

**Development Plan of Software Correlators**

- Current medium-term (5-year) program period:
  - 2002-2006

- K5 (Geodetic)
  - core
  - network-distributed system
  - VLBI@home

- K5/VSI (Gigabit System)
  - core
  - network-distributed system
  - astronomical applications

On April 1, 2004 CRL and TAO will be reorganized as the National Institute of Information and Communications Technology.
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Examples of Benchmark Test Results

<table>
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<tr>
<th>序号</th>
<th>CPU</th>
<th>グラフ journaled (MHz)</th>
<th>OS</th>
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Benchmark Test Results

Border for real-time processing for 1ch data

8MHz-1bit-4ch sampling
32-lag 1sec integration

Intel Roadmap

after http://pc.watch.impress.co.jp/docs/article/intel/20030820/desktop.pdf
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Summary

- Software Correlator for geodetic use can process 10 Mbps data in real-time at present time.
  
  Note: Ultra High-Speed Software Correlator developed by Kimura for K5/VSI has a processing speed faster ten or more times (100Mfps data in real-time)

Near Future Plans

- Network distributed processing (VLBI@home)
- Real-time Internet VLBI