Korean VLBI Network (KVN): Correlator

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KVN Backend System & Correlators

VLBI Backend
Korea Japan Correlation Center (KJCC)
DiFX SW Correlator
Correlation Status
KREONET and e-VLBI
At each KVN antenna
- Mark5B (1ea)
- Mark5B+ (1ea)
- Mark6 (1ea) + 1ea (2017)

Input Freq: 8-16GHz

22 GHz FE
43 GHz FE
86 GHz FE
129 GHz FE

2Gbps

ADC

4 x 1Gsp

DDC

4 x 16Gbps

4 x 2Gbps

Mark5B
Mark6
Mark6
eVLBI

10G Switch

OCTAD (32Gbps)

ADC
ADC
ADC
ADC
Korea-Japan Correlation Center (KJCC)

- **Daejeon Correlator**
  - Joint Development & Joint Operation by KASI & NAOJ
  - Input Data Rate = (4 x) 2Gbps x 16 stations
  - KaVA & EAVN

- **DiFX Software Correlator**
  - Linux Cluster / KVN only data
Korea-Japan Correlation Center (KJCC)

- Daejeon
  - Joint Interface
  - Input
  - K-5 OCTADISK
  - Optical Fiber

- DFX System
  - Link

Diagram:
- Mark5B
- VERA2000
- Raw VLBI Data Buffer (RVDB)
- VLBI Correlation Subsystem (VCS)
- Peta-scale Epoch Data Archive (PEDA)
- Correlator Control & Operation S/W

AOJ
DiFX SW Correlator

- 1 front node: Intel Xeon E5-4650, 2.7GHz, 32cores
- 35 computing nodes: Intel Xeon E5-2470, 2.3GHz, 560cores (16core/node)
- Peak performance:
  11 Tflop/s
- Storage: 1.3 PB directly attached to the front node
- Network: FDR IB, 10G, 1G
- Rocks 6.1
- Mark5s
## Correlation Status in 2016

<table>
<thead>
<tr>
<th>Correlator</th>
<th>Array</th>
<th>Experiment</th>
<th>Obs. Time (Hr)</th>
<th>Data Size (TB)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>KJCC</strong></td>
<td>KaVA</td>
<td>176</td>
<td>~ 1,220</td>
<td>~ 4,750</td>
</tr>
<tr>
<td></td>
<td>EAVN</td>
<td>4</td>
<td>~ 32</td>
<td>~ 42</td>
</tr>
<tr>
<td><strong>DiFX</strong></td>
<td>KVN</td>
<td>183</td>
<td>~ 1,860</td>
<td>~ 4,230</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>~ 150</td>
<td>~ 2,160</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td>363</td>
<td>~ 3,300</td>
<td>~11,200</td>
</tr>
</tbody>
</table>

### Key Points:
- **Correlation Strategy**
  - e-shipping via KREONET
  - DiFX correlation
- **KaVA & EAVN data**
  - diskpack shipping
  - KJCC correlation
- **Correlation management**
  - [http://kjcc.kasi.re.kr](http://kjcc.kasi.re.kr)
MAP OF KREONET 2016
KOREA RESEARCH ENVIRONMENT OPEN NETWORK

- KVN Sites: 10GbE
- Daejeon: 100GbE
- Remote Operation
- e-Transfer & e-VLBI

by KISTI
(Korea Institute of Science and Technology Information)
Upgrade Activities (KJCC)

Wideband Support
SW Digital Filtering
Data Archival System
Italy-Korea Correlation
8Gbps auto-corr by Daejeon correlator (k16248a, 22GHz, BLLac, 4IFs x 512MHz BW @KYS)
Correlation itself is perfectly conducted, but auxiliary system such as CODA/FITS gen SW is needed to be prepared soon.
Normal operation of 8Gbps will be proceeded from 2017.
In order to solve the different observation mode such as 2Gbps(512MHz BW x 1IF) or 1Gbps(32MHz BW x 8IFs), SW Digital Filtering method was considered and developed.

Advantage: if VERA HW DFB has problem, it will be helpful to process.

Disadvantage
- Current version is very slow. It needs to be modified the algorithm for speed up.
For wideband correlation
[Daejeon Correlator?]

- **VCS specification**
  - Already designed and implemented for wideband (8 Gbps)
  - But the other equipment as playback terminal and output saving system are also needed to be prepared.

1. The software for data splitting and upload to the RVDB are required.
2. The playing back of the RVDB with 8 Gbps observation data to the VCS is needed.
3. 8 Gbps correlation by the Daejeon correlator is also needed according to the 4 VSI input.
4. CODA/FITS SW (Post processing SW) for correlated result is also needed and improved.
Data Splitting and transmission SW

- KVN 8Gbps observation
  - 1024 Mps x 2bits x 4streams/station
  - The obs data of 22, 43, 86 and 129 GHz frequency for the KVN multi-frequency simultaneous observing system is combined with 4 data streams as time-ordered.
  - Mark6, file system is combined with 8Gbps → need to split
  - Data Splitting SW development was finished and will be tested

- VERA 8Gbps observation
  - 4 frequency like KVN is not supported, but 2 frequency (22/43, dual-beam) simultaneous obs mode are supported
  - In this case, 22/43 LCP/RCP obs for KaVA will be used.
  - OCTADISK2, file system is separated with 2Gbps each.
Data Upload to RVDB
Data Splitting & Transmission Basic

- **IF1 (512MHz BW), 2Gbps**
- **IF2 (512MHz BW), 2Gbps**
- **IF3 (512MHz BW), 2Gbps**
- **IF4 (512MHz BW), 2Gbps**

Data Splitting SW → Develop. was recently finished

- **IF1 (512MHz BW), 2Gbps**
- **IF2 (512MHz BW), 2Gbps**
- **IF3 (512MHz BW), 2Gbps**
- **IF4 (512MHz BW), 2Gbps**

Data Trans. SW

- **8Gbps Playback**
- **OCTADDB1**
- **OCTADDB2**
- **OCTADDB3**
- **OCTADDB4**

8Gbps
The maintenance service of current Archive system from Vender will be terminated in this September 2016.

For introduce new archive system, KASI searched for some vender(EMC, HP, DELL etc). And we also discussed with Elecs industry for modifying OCTADISK2 to some storage system.

Elecs proposed that OCTADISK2 is also some kind of storage and it is able to be modified storage. They could provide receiving SW from VCS. The test performance experiments proposed VCS Data Archive(VDA) is satisfied as VCS maximum output speed.

By the Public Procurement Service(PPS), the competition was finished and made a contract with Elecs Industry(Metaspace). It was installed in the end of August 2016.
New Data Archive System
VDA (VCS Data Archive)

- CPU: Intel ZEON, 32 cores
- Memory: 32GB
- Storage: 160TB (RAID 5, 6)
- Interface:
  - 10GbE x 8 ea, SFP+(4 VCS, 4 External)
  - 10GbE x 4 ea, 10GBASE-T (Gluster File System)
  - 1GbE x 4 ea, 1GBASE-T (Control)
- Access speed:
  - Write: max 1.4GB/sec
  - Read: max 2.2GB/sec

- Installed and tested
  - Full speed (1.4GB/s) of VCS results are saved
Help to data conversion of VERA

- Data bit-assign of VERA is different from standard Mark5B (Italy, KVN)
- KJCC developed many data handling SW such as data conversion (mk5b to vdif, octa-vdif to std-vdif, vdif to mk5b, etc.)
- Test conversion of short VERA data was successfully done. Now whole VERA data is converting to deliver Italy for make correlation.
for the best mm-VLBI system

Korean VLBI Network

Thank you.