The Mark 5B VLBI Data System

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NRAO-Haystack meeting
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Mark 5B Data System Features

- Full VSI-H compatibility
- Same chassis as Mark 5A; uses same disk modules; requires Mark 5B I/O card
- 1024 Mbps record/playback
- Eliminates need for external formatters, but requires sampler adapter for Mark 4/VLBA DASs to provide VSI-compatible output
- Station Unit capabilities for connection to Mark 4 correlators is designed into Mark 5B
- Extensive built-in phase-cal extraction and state counting on both data record and data playback
- Front-panel status display – 8 tri-color LEDs
- DIM and DOM capabilities are separate FPGA downloads
- FPGA is programmable via software

Development support from Mark 5 development consortium – BKG, EVN, KVN, JPL, MPI, NASA, NRAO, USNO
Figure 1: VSI-H Functional Block Diagram

Notes:
1. Shaded items are for illustrative purposes only.
2. PVALID is optionally transmitted from DIM to DOM.
3. PDATA is optionally transmitted from DIM to DOM.
4. Data delay in DOM is required only for storage-based systems.
5. See text for discussion of use of optional use of P/QSPARE1/2 signals.
6. If DIM/DOM in single box, ALT1PPS/DPSCLOCK/DPS1PPS share single MDR-14 connector.
7. This diagram does not show all functions and options – see VSI-H specification for details.
Mark 5A/B System Comparisons

<table>
<thead>
<tr>
<th></th>
<th>Mk5A</th>
<th>Mk5B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data Interface</td>
<td>Emulates Mk4/VLBA tape transport</td>
<td>VSI-H (64MHz max clock rate)</td>
</tr>
<tr>
<td>Max data rate</td>
<td>1024 Mbps</td>
<td>1024 Mbps</td>
</tr>
<tr>
<td>Record modes</td>
<td>8, 16, 32, 64 “tracks”</td>
<td>1, 2, 4, 8, 16, 32 bitstreams</td>
</tr>
<tr>
<td>Disks</td>
<td>Mk5 “8-pack”</td>
<td>Same</td>
</tr>
<tr>
<td>Chassis</td>
<td>Mk5</td>
<td>Same</td>
</tr>
<tr>
<td>I/O card</td>
<td>Mk5A</td>
<td>Mk5B</td>
</tr>
<tr>
<td>SS card</td>
<td>XF2</td>
<td>XF2</td>
</tr>
<tr>
<td>I/O-SS intf</td>
<td>Modified FPDP</td>
<td>FPDP</td>
</tr>
</tbody>
</table>
Mark 5B Functional Block Diagram
Mark 5B I/O Board

FPDP
VSI Output
VSI Cntl/Mntr
VSI Input
PCI Connector
256MB memory
Mark 5B Status

• Checkout of Mark 5B hardware is complete; first rev of DIM software has been released
• Mark 5B is in regular use at Westford antenna; also used in large mm experiment in April 2006
• Mark 5B is interfaced to Haystack Mark 4 correlator and in routine production use
• ~30 Mark 5B I/O boards have been built and tested – will be distributed to Mark 5 development consortia members in near future
• Mark 5B can be ordered from Conduant Corp in Loveland, CO
Reasons to adopt Mark 5B

• Eliminate need for expensive external formatters; particularly important for new stations or stations without existing Mark 4 or VLBA formatters
• With a 14-BBC Mark4 or VLBA4 system, up to 1792 Mbps can be recorded with two parallel Mark 5B systems; current 14-BBC systems can only generate a maximum of 1024 Mbps of formatted data
• Extensive phase-cal extraction and state counting capabilities for better diagnostics and better system calibration
• Replace unreliable Station Units on Mark 4 correlators; SU capability is built into Mark 5B
Mark 5B+ (2048Mbps)

- Conduant has introduced an upgraded StreamStor (dubbed “Amazon”) that supports up to ~3 Gbps on FPDP2 interface.
- Mark 5B I/O card has been designed to support input VSI-H clock rate of 64MHz, as well as FPDP2 compatibility, to support max recording rate of 2048 Mbps with Amazon board.
- May be desirable to record across 2 disk modules (16 disks) simultaneously.
- Playback is limited to 1024 Mbps.
- Recordings made on Amazon are playable on standard Mark 5B system.
- Mark 5B+ can now be ordered from Conduant.
# Mark 5A/B/B+ System Comparisons

<table>
<thead>
<tr>
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<th>Mk5B</th>
<th>Mk5B+</th>
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<td>Same</td>
</tr>
<tr>
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<td>Mk5</td>
<td>Same</td>
<td>Same</td>
</tr>
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<td>Mk5B</td>
<td>Mk5B</td>
</tr>
<tr>
<td>SS card</td>
<td>XF2</td>
<td>XF2</td>
<td>Amazon</td>
</tr>
<tr>
<td>I/O-SS intf</td>
<td>Modified FPDP</td>
<td>FPDP</td>
<td>FPDP2 (clocks on both edges)</td>
</tr>
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</table>
# Mark 5 Upgrade Costs

<table>
<thead>
<tr>
<th>Target</th>
<th>Mk5A</th>
<th>Mk5B</th>
<th>Mk5B+</th>
</tr>
</thead>
<tbody>
<tr>
<td>Existing</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>$18K</td>
<td>~$20K</td>
<td>~$23K</td>
</tr>
<tr>
<td>Mk5A</td>
<td>-</td>
<td>~$3K (Mk5B I/O)</td>
<td>~$12.5K (Mk5B I/O plus Amazon)</td>
</tr>
<tr>
<td>Mk5B</td>
<td>-</td>
<td>-</td>
<td>~$9.5K (Amazon)</td>
</tr>
</tbody>
</table>

Note: Does not include external cabling costs, typically a few hundred dollars
Disk-Media Reliability

- Based on statistics collected at Haystack, average disk drive failure rate is ~0.5% per year
- Failure rate of Hitachi 250GB has been higher than average, but may now have been fixed
- Conduant is shipping these disks in assembled Mark 5 disk modules
- Disk reliability at high was investigated in Mark 5A tests on Mauna Kea in early 2006:
  Tested disk drive types were:
  - Maxtor 300-GB Model 7L300R0
  - Seagate 300-GB Model ST3300831A
  - Western Digital 320-GB Model WD3200SB-01KMA0
  - Hitachi 250-GB Model HDS722525VLAT80

→Only the Hitachi’s sustained good performance at 14000ft
(However, all disks recovered performance when returned to low altitude)