Mark 5A/B/B+ Status

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Overview

Systems

• Mark 5A: 1024 Mbps
• Mark 5B: 1024 Mbps
  VSI-H interface
  Built-in formatter for telescopes
  Bypass station units at correlators
  Direct interface to DBE
• Mark 5A+: Allows Mark 5B playback (firmware)
• Mark 5B+: 2048 Mbps (Amazon StreamStor board)

Status: ~150 Mark 5 units installed at telescopes and correlators
Mark 5A, Mark 5A+, Mark 5B and Mark 5B+ are operational
Mark 5B Correlator Interface Boards (CIBs) will ship Jan 07.

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 (DIM) and data playback (DOM)
• Front-panel status display – 8 tri-color LEDs
• DIM and DOM capabilities are separate FPGA downloads
• FPGA is programmable via software

Development supported by Mark 5 development consortium – BKG, EVN, KVN, JPL, MPI, NASA, NRAO, USNO

Mark 5A/B/B+ System Comparisons

<table>
<thead>
<tr>
<th>Feature</th>
<th>Mark 5A</th>
<th>Mark 5B</th>
<th>Mark 5B+</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data Interface</td>
<td>Emissary Mark 4/VLBA tape transport</td>
<td>VSI-H (64 MHz max clock rate)</td>
<td>VSI-H (64 MHz max clock rate)</td>
</tr>
<tr>
<td>Max data rate</td>
<td>1024 Mbps</td>
<td>1024 Mbps</td>
<td>2048 Mbps</td>
</tr>
<tr>
<td>Record modes</td>
<td>8, 16, 32, 64 &quot;tracks&quot;</td>
<td>1,2,4,8,16,32 bit streams</td>
<td>Same as Mark 5B</td>
</tr>
<tr>
<td>Disks</td>
<td>Mark5 “8-pack”</td>
<td>Same</td>
<td>Same</td>
</tr>
<tr>
<td>Chassis</td>
<td>Mark5</td>
<td>Same</td>
<td>Same</td>
</tr>
<tr>
<td>I/O card</td>
<td>Mark 5A</td>
<td>Mark 5B</td>
<td>Mark 5B</td>
</tr>
<tr>
<td>SS card</td>
<td>XP2</td>
<td>XP2</td>
<td>Amazon</td>
</tr>
<tr>
<td>I/O-SS interface</td>
<td>Modified FPDP</td>
<td>FPDP</td>
<td>FPDP2 (clocks on both edges)</td>
</tr>
</tbody>
</table>
Mark 5B Status

- Checkout of Mark 5B hardware is complete
- DIM support software has been released but phase-cal extraction not yet supported
- Successfully tested with 5-m VSI cables at 2048 Mbps expect 20-m cable to work, but not yet tested
- Mark 5B is in regular use at Westford antenna but still need some additional Field System support
- Mark 5B interfaced to Haystack Mark 4 correlator – in routine production use – highly reliable and repeatable
- Correlator Interface Boards (CIB) being built for MPI, JIVE, and USNO correlators for delivery in January 2007
- About 30 Mark 5B IO boards have been built and tested at Haystack and will be distributed to Mark 5 development consortia members in the near future
- Mark 5B can be ordered from Conduant Corp
- Haystack building VSI sampler upgrades for Mark 4 formatter capability with Mark4 DAS, but very few orders (JBI & Yebes)

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 Mark 4 or VLBA4 system, up to 1792 Mbps can be recorded with two parallel Mark 5B systems; current 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
- At JIVE, double spectral resolution at correlator
- Mark 5B+ data recorded at 2 Gbps cannot be supported by Mark 5A+

Mark 5B+ (2048 Mbps)

- 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 DDR 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 a standard Mark 5B or Mark 5A+ system
- Mark 5B+ can now be ordered from Conduant
### Mark 5 Upgrade Costs

<table>
<thead>
<tr>
<th>Target</th>
<th>Mark 5A</th>
<th>Mark 5B</th>
<th>Mark 5B+</th>
</tr>
</thead>
<tbody>
<tr>
<td>Existing</td>
<td>~$18K</td>
<td>~$20K</td>
<td>~$23K</td>
</tr>
<tr>
<td>0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mark 5A</td>
<td>-</td>
<td>~$3K (Mark 5B I/O)</td>
<td>~$12.5K (Mark 5B I/O plus Amazon)</td>
</tr>
<tr>
<td>Mark 5B</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.

### Plans for Serial-ATA Support

- A new module is being designed to support SATA disks.
- Existing 200-pin connector on module will be maintained using PATA signals.
- Conversion to SATA will be on module backplane.
- Prototype SATA modules should be ready in a few months, but we don’t feel any urgency at the present time.

### Disk-Media Reliability

- We have seen only 8 disk drive failures during the past year at Haystack:
  - 4 Hitachi, 4 Maxtor
  - 4 replaced under warranty
- Failure rate of Hitachi had been higher than average, but may now have been fixed.
- Disk reliability at high altitude 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 WD3200BB-01KMA0
    - Hitachi 250-GB Model HDS722525VLAT80
  - Only the Hitachi’s functioned reliably at 14000 ft.
  - (However, all disk drives recovered when returned to low altitude.)

### Mark 5B Command Set

- Very similar to Mark 5A; many commands are the same
- New commands:
  - `1pps_source = <1pps source>`
  - `clock_set = <clk freq> : <clk source>`
  - `DOT_set = <time>`
  - `DOT_inc = <+/-n seconds>`
  - `mode = <data source>:<bit-stream mask>:<decimation ratio>`
  - `TVR = <tvr mask>`

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Mark 5A/B Compatibility

• Mark 5B can play only Mark 5B recordings (VSI format in/out)
• Upgraded Mark 5A ("Mark 5A+") can play:
  - All Mark 5A recordings
  - Mark 5B recordings made in almost all modes;
    playback is in VLBA-track-format
• Mark 5A+ design is complete and tested, but is needed only on correlators that do not yet support Mark 5B
• Existing Mark 5A systems can be upgraded to Mark 5A+ with new Xilinx download and upgraded software

Bottom line: Existing Mark 4 correlators with only Mark 5A/5A+ units will be able to process data from both Mark 5A and Mark 5B units during the transition period to Mark 5B.