Mark 6:
A Next-Generation VLBI Data System

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XCube data system

(candidate for next-generation VLBI data system)

- System developed by small company in Nashua, NH for automobile industry
- Real-time high-data-rate disk-array data system based on fully commercial-off-the-shelf (COTS) hardware
- 8 Gbps sustained recording rate from RDBE demonstrated
- First COTS-hardware system that (to my knowledge) properly handles slow and/or failed disks during recording
- Runs on Linux platform with some modified kernel code and drivers for efficient memory and disk management
- Hardware/software combination is highly tuned for performance
- System currently under evaluation/development at XCube & Haystack

XCube Demonstrations

- Haystack: Dec 2010
  - Recorded two 10GigE data streams at 4Gbps each (from RDBE) to 20 disks; 8 Gbps sustained for ~10 minutes
  - One 4-disk eSATA cable was disconnected from a module while recording; system transferred load to remaining 16 disks within <1 second
- Socorro: Jan 2011
  - Simultaneously recorded identical 2Gbps data stream from RDBE to both Mark 5C and XCube systems; no problems
  - Cross-correlated Mark 5C vs XCube data with "zerocorr" software by Walter Brisken
    - With exception of minor bookkeeping hiccup, cross-correlation worked perfectly on first try

Some Mark 6 Characteristics

- 1 to 4 10GigE data interfaces
- Up to 16Gbps sustained recording rate (to 24 to 36 disks); ~32Gbps burst mode capture (not yet fully tested)
- Supports inexpensive commodity SATA disks (but disks must be qualified)
- eSATA cable connections from controller to disk module(s) [four disks per cable]; insensitive to cable order
- Records to standard Linux files
- Properly manages slow/failed disks to sustain target data rates
- Can use XCube disk modules (similar to Mark 5 modules); Can convert existing Mark 5 modules to Mark 6 compatibility with new module backplane and front panel (with e-SATA and power connectors); under development
- Playback as standard Linux files
- Good fit to two current VLBI programs:
  - VLBI2010 – currently planning 16Gbps/stn, possibly expanding to 32Gbps/stn
  - mm-VLBI – currently planning 16Gbps/stn, expanding to 64Gbps/stn over next few years

Some Mark 6 VSI-S capabilities

- VSI-S is built as layer on top of XCube XML native software interface
- Recording units are define as ‘volumes’, each of which consists of one or more physical disk modules
  - Multi-module volumes are required for recording rates >~4Ggps
  - Multi-module volumes retain identity thru correlation processing, then are returned to single-module volumes
- Volumes are managed on an ordered ‘Volume Stack’ that allows multiple volumes to be connected simultaneously
  - Allows volumes to be queued in specific order for usage
  - Supports automated switchover to next volume in Volume Stack when current module becomes full; switchover takes place between scans
- Disk statistics gathered during recording allow easy identification of slow/failing disks by disk serial number
- Modules are self-discovered when connected to Mark 6

Work in Progress

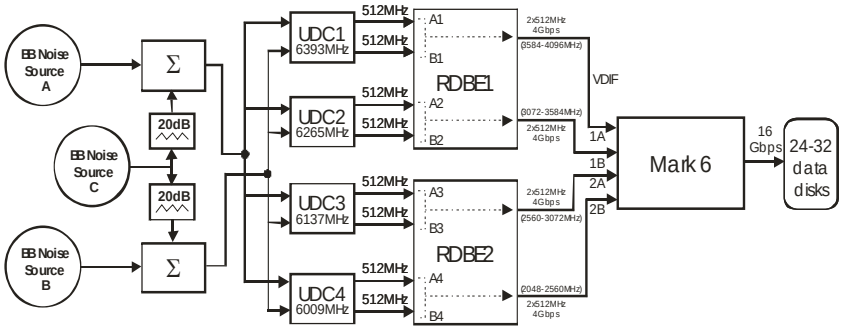
- Mark 6 VSI-S specification has been written and partially implemented
- Minor software revisions being made to support several VLBI-specific issues:
  - Permanent module-serial numbers
  - Gather individual disk-performance statistics
  - Allow one disk module to record/playback undisturbed while utility operations are performed on another (mount/dismount, read MSN, etc)
- Design in progress for new module backplane and front panel to retrofit existing Mark 5 modules for XCube compatibility
  - Must use only SATA disks
  - External cooling must be supplied

Plans

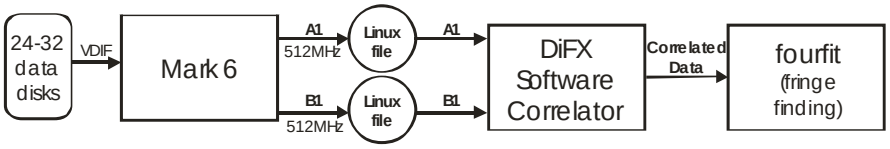
- Complete Mark 6 VSI-S implementation
- Integrate Mark 6 with NASA Field System
- Integrate Mark 6 with DiFX correlator
- Design new backplanes/front-panels for conversion of current Mark 5 to compatibility with Mark 6
- First 16Gbps VLBI experiment with Mark 6 planned for summer 2011 with VLBI2010 system at Westford and GGAO antennas
- Expected Mark 6 availablility to VLBI community ~late summer/early fall 2011

A Mark 6 memo series is available at
http://www.haystack.edu/tech/vlbi/mark6/memo.html

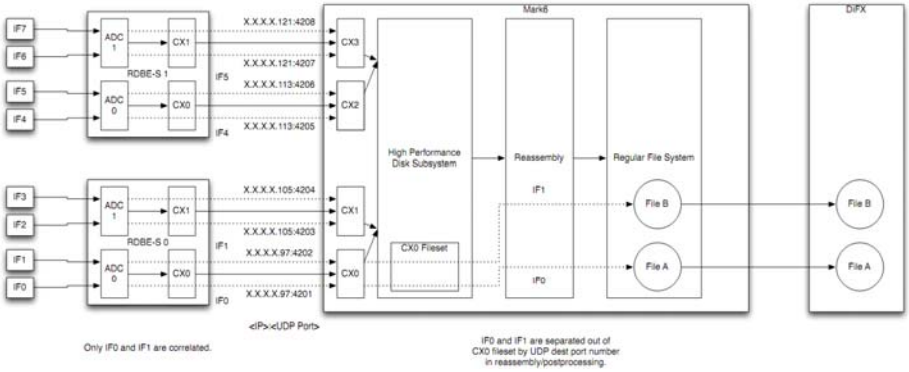
TOW demo (recording)



TOW demo (correlation)

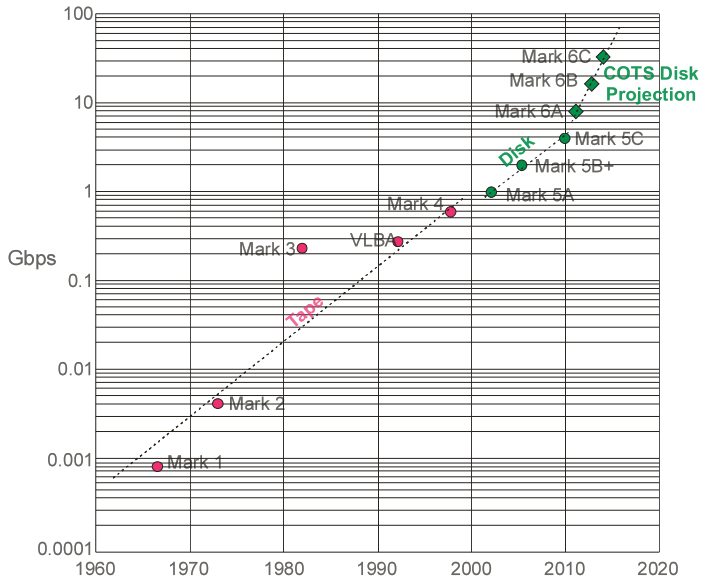


TOW demo

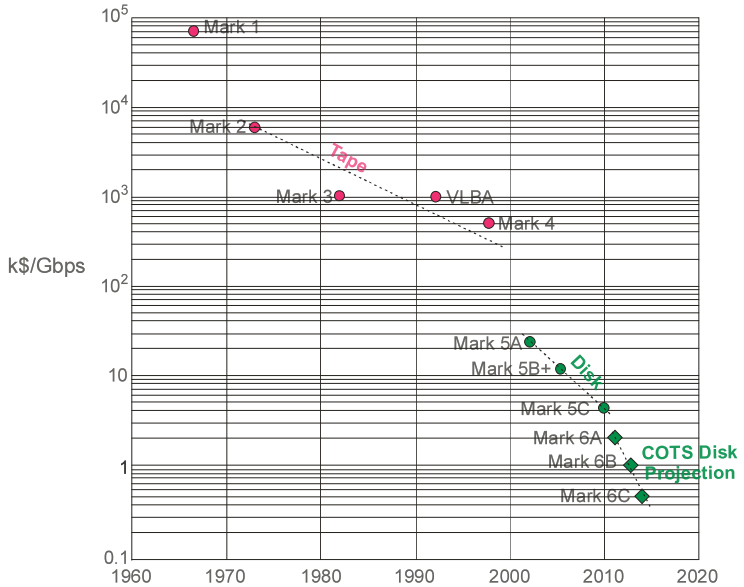


Questions?

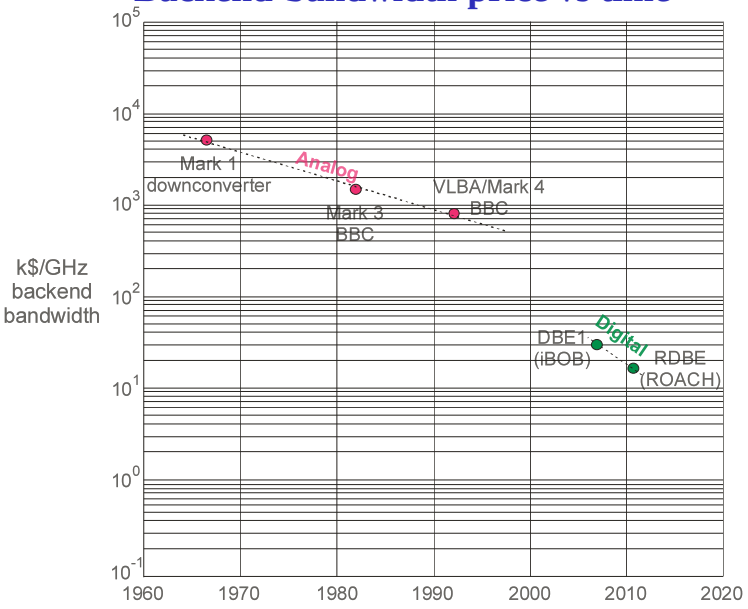
Recording Rate vs Time



k$/Gbps vs Time



Backend-bandwidth price vs time



Disk price vs time