IVS Mark 5 Deployment Plan

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IVS recently adopted the Mark 5 system as its choice for the next generation of VLBI recording systems. We have a strong interest in ensuring that the Mark 5 system is fully deployed as soon as possible throughout the geodetic/astrometric community in order to realize the many benefits of the system. This document describes the goals and strategy for full use of the Mark 5 system (section 1) and presents a plan for deployment and costs (sections 2 and 3). Finally, we ask each station and correlator to review this plan and respond to the questions in section 4 so that we can make this plan as realistic as possible. Please reply by February 14, 2003.

1. Purpose

The IVS goals for fully deploying the Mark 5 system are:

- Improving reliability at the stations and correlators, by changing to modern disk-based systems that are easier to use and have a lower failure and problem rate;
- Enabling higher bandwidth recordings that will yield improvements in results through greater precision of the observables;
- Reducing costs associated with tape and recorders, which require significant technical staff resources to maintain and process;
- Enabling continuing development of e-VLBI, so that we can dramatically reduce the time delay in providing results and products as part of the IVS service.

The strategy for achieving the goals of Mark 5 deployment includes the following steps:

- deploy Mark 5A systems at all geodetic correlators and stations,
- completely replace the tape pool with a disk pool,

We will coordinate the gradual deployment and usage of Mark 5 via the IVS Coordinating Center.

The demonstrated reliability and ease of use of the Mark 5 systems at stations and at the correlators anticipate significant improvements in overall efficiency and cost savings for the geodetic measurement program. However, despite successful usage of Mark 5 in the daily intensive UT1 measurements and in the CONT02 sessions, there remain two bottlenecks to substantially increased Mark 5 usage. The first is the number of Mark 5 systems available on the Mark 4 correlators; only two Mark 5 systems are currently available on each of the Washington, Haystack and Bonn correlators. And, secondly, the supply of available disks is severely limited.

The potential savings from increasing Mark 5 usage are considerable, particularly if sessions can be conducted entirely with Mark 5 systems so that a significant increase in correlator efficiency can be realized. With even a single tape included in an experiment,

the correlator is essentially constrained to the efficiency of tape, with all of the tape motion and unreliability constraints. Furthermore, due to the high reliability of the disk systems, the need for re-processing should drop to near zero, which will also result in faster turnaround times for disk media and, consequently, a smaller required disk-media pool. With all-Mark 5 experiments, we estimate an overall efficiency improvement of ~30-50% in the short term and possibly even more in the longer term when correlator software can be further optimized for disk operation.

The Mark 5A system is a direct replacement for a Mark 4 or VLBA tape transport and works with either a Mark 4 or VLBA formatter. To install the Mark 5A system, simply disconnect the cables from the tape transport and plug them into the appropriate connectors on the Mark 5A I/O panel. The NASA Field System supports the Mark 5A system, so the transition to Mark 5A should not be difficult.

2. Plan

The IVS proposed plan to implement the deployment is shown in the attached charts which give the schedule of system deployment and the number of disks needed for each station (Schedule Chart and Disk Chart). The IVS requests that the agencies responsible for each station and correlator should consult with the IVS Coordinating Center to let us know whether the plan can be achieved as proposed, or whether a different schedule needs to be accommodated. We are aware of some plans for purchase of disks and Mark 5 systems, but we would like to coordinate the plans to maximize the mutual benefit to the agencies, stations, correlators, and IVS. The plan covers calendar year 2003. Later this year we will update and extend the plan into 2004 to include deployment of Mark 5 systems at the remaining stations and acquisition of more disk capacity.

2.1 Schedule

The Schedule Chart shows a proposed schedule for deploying Mark 5A systems at the listed stations and correlators. The schedule chart is set up like a timeline, showing the status of the stations and correlators for each month in 2003. Stations that have Mark 5P systems now will be upgraded to Mark 5A systems early in the year. Stations that plan to purchase Mark 5 systems in 2003 will get Mark 5A systems. Cells in the chart are outlined when a change in status of a station or correlator occurs. Because the use of disks can improve the efficiency of processing at the correlators, we hope that each station can acquire its Mark 5 system as soon as practical.

The correlators should be fully outfitted as soon as possible so that we can maximize the benefits of the Mark 5 through sessions that are exclusively Mark 5. Until that goal can be reached, stations that have a Mark 5 system will record using their Mark 5 system for some of the sessions and their tape recorder for some sessions, depending on how many Mark 5 recordings can be processed at the correlator for each session. This usage will be closely coordinated by the IVS Coordinating Center.

The schedule for deploying Mark 5 systems to the stations is based on the current status of stations, and the plans for acquiring additional Mark 5 systems that we are aware of at this time. The schedule will be modified and corrected as we find out more about actual

plans and dates. We request that each station and correlator keep the IVS Coordinating Center closely informed of progress on their Mark 5 systems (see section 4).

2.2 Disks

The Disk Chart shows the number of disks required to sustain each station in the 2003 observing program and the number of disks already in the pool. For each type of session the typical amount of data to be recorded and number of disks and modules are shown at the top of each column. This chart assumes that the recorded bandwidth remains as planned for each type of session. Although increased data rates are easily possible with the Mark 5 systems, we will have mixed networks, i.e. some Mark 5 and some tape recordings, for all of this year. During this transition period, until the session networks can be all Mark 5, we cannot increase the data rate. During 2004 we will schedule as many "all-Mark 5" networks as possible, anticipating that this data will flow most efficiently through the correlators.

The Disk Chart assumes that the disk size is 120 GB which is the current "best buy" disk, although larger sizes are anticipated soon. The required number of disks takes into account the number of sessions each station participates in and the time needed for shipping and correlation. The number of sessions in the processing "pipeline" indicates how many sets of disks need to be available to accommodate the time required for shipping to the correlators, processing, release and re-packaging, and shipping back to the stations. The numbers in the chart are based on experience with shipping times and processing backlogs in 2002.

Each set of disks must be mounted in a carrier module that can hold up to 8 disks. For the 56 Mb/s sessions, 4 disks will be used and will require a single module. For the 256 Mb/s sessions, 12 disks will be used mounted in two modules (one with 8 disks and one with 4 disks).

The number of 120 GB disks and the number of modules for each station are totaled at the right end of each station row. These numbers are guidelines for participation in the geodetic pool, at current data rates and using the current networks. The size of disks continues to increase and we would like to take advantage of the market as much as possible. For example, if the 200 GB disks are used for the higher data rate sessions such as the R1s, then a single module would be needed instead of two, saving on shipping costs.

We encourage stations to purchase as many disks and modules as possible for the geodetic pool. Please consult with the Coordinating Center so that we can determine the optimum purchase for your station, based on planned participation, correlator and network deployment status.

3. Costs

3.1 Overall Costs

The cost of a Mark 5 system is modest compared to purchase of any other VLBI recording system. The basic system is just $17,500 (see next section for details), which is less than the cost of replacing a single headstack on a Mark 4 tape drive. The need for new heads every few years on every tape recorder plus the drain on maintenance personnel to keep recorders in good condition means that the cost of the Mark 5 will quickly repay itself. The cost of disk media at ~$1.25/GB is already lower than the cost of tape which is ~$2.00/GB.

The plan shows a total of 40 systems in place by the end of this calendar year, for a total investment of about $700,000 over the entire VLBI network. Purchasing enough disks and modules to replace the current tape pool is an additional $300,000. The total investment is therefore about $1M, shared among many agencies and stations. This investment will result in significant increases in geodetic VLBI data throughput and reliability plus dramatically reduced dependence on tape, tape recorders, and their maintenance. The follow-on plan for 2004 will aim to outfit the remaining stations and increase the disk pool capacity either through more disks or larger ones.

3.2 Mark 5 System Cost and Availability

The information in this section was provided by Alan Whitney in an e-mail sent in late October to most of the VLBI mailing lists.

Conduant Corporation has agreed to become a builder and distributor for Mark 5A systems. Conduant is offering the following:

Mark 5A system excluding drives/modules - $17,500:
This includes:

- (1) TK200 Chassis
- (1) Motherboard - SuperMicro P3TDLE (with 1 P3 1.26GHz Processor, 256MB ECC) Matrox G45MDVP32DB Video Card)
- (1) Antec 550w Power Supply
- (1) 40GB System Drive
- (1) CD or CD/Floppy Combo
- (1) Red Hat Linux
- (1) Mark 5 I/O Board
- (1) I/O Panel
- Cables/Assembly/Test
- 1 Year warranty on Conduant Products, passthru warranty on remaining products

'8-pack' module with eight 120GB disk drives (assembled/tested); w/o shipping covers - $1750

'8-pack' module with eight 200GB disk drives (assembled/tested); w/o shipping covers - $3425

'8-pack' drive module without disks or shipping covers - see Note 3 below

- $260ea (Quantities 1-20),
- $238ea (Quantities 21-50),
- $225ea (>50 units)

Shipping covers for single '8-pack' module - $16 - see Note 4 below

Notes:

1. All items are ~60-day delivery. Payment is net 30 days.

2. Note that these prices are *only* for the VLBI community and are much lower than normal commercial prices. Haystack Observatory would not be able to build and sell these units any more cheaply due to standard MIT overhead, so we feel that Conduant is giving the VLBI community a good break.

3. Note on '8-pack' modules sold without disks: In order to keep prices down, '8-pack' modules sold without disks are not functionally tested before shipment. This is due to the high labor cost involved in testing modules (they must be loaded with disks, tested, then disassembled). However, an express swap/replacement is offered for any non-operating module. In practice, it is expected that the non-operating rate will be quite low. If you wish to purchase empty *tested* '8-pack' modules, please contact Conduant for a price.

4. A two-piece metal shipping cover is available which encloses the '8-pack' module to guard against static electricity, protect the disks and, to some extent, hide the disks from casual eyes.

5. Conduant is also considering offering extended 24 or 60 month warranties with 21 day repair or replacement (at Conduant's discretion) and would like to know whether anyone might be interested. They have not yet been priced. Let Alan Whitney or Conduant know if you might be interested.

6. Additional information on the Mark 5A system is available at http://web.haystack.mit.edu/mark5/Mark5.htm

7. To place an order with Conduant or obtain more information, contact Mark Walker (mark@conduant.com).

4. Questions for All Stations and Correlators

We would appreciate receiving the following information from each station and correlator:

1. What are your plans for purchasing a Mark 5 system for your station or correlator? We would like to know the time schedule for ordering and delivery. Even if your plans are not firm, please let us know that.

2. What are your plans for purchasing disks and modules for your station? We need to know the size of disks you plan to buy and would like to advise how many modules would be needed for the observing program. We would like to know when you plan to purchase the disks.
3. Please review the Schedule and Disk charts. Are they accurate? What changes should be made? If you have plans to purchase a Mark 5 but it is not shown on the chart, please inform us.

We will modify the Mark 5 deployment plan to accommodate the needs and schedules of the stations and correlators, but we need to know your plans. Please respond so that we can make the plan as realistic as possible. Please reply by February 14, 2003. Please send information to ivscc@ivscc.gsfc.nasa.gov.