Our current practice of assigning a tape (or tapes) to a project is
limiting us to about 50% science time on the VLBA. Relaxing that
restriction might increase the science observation time by as much
as a factor of 1.5.

On the other hand, we are scheduling just about all proposals that the
referees do not give a really hard time to. I think that the argument
to implement multiple-projects-on-a-tape based just on that factor of
1.5 is not very compelling. There is, however, an interesting exception
to the generalization in the first sentence of this paragraph. There is
a very well rated proposal requesting very short observations very
frequently, which we felt we could not schedule in a tape-per-project
environment. Therefore, there is scientific pressure to implement
this, though it is not overwhelming.

There is an additional cost to using this mode - there will be more tapes
shipped than is currently done, without much increase in the number of
bits recorded on them.

Therefore, although it is not clear to me that we should be pushing
to operate in this mode, it is constructive to consider the properties
such a mode would have, should we choose to implement it.

A multiple-projects-on-a-tape operating style was suggested by Peter
Napier, in a 1991 memo, attached. This is essentiallly a revisit to
that memo.

Peter Napier suggested the addition of two tapes to the weekly allotment,
which would be removed partially filled. I instead incorporate two
times in the array schedule in which tape is not being used - a weekly
Software etc. block of 6 hours, and a weekend nighttime pointing run of
8 hours duration.

About half the weeks of VLBA schedules follow a standard pattern, with
Tuesday Maintenance and Thursday Software times. If we have standard
observing at 128MBits/s, with little time with tapes stopped, then we
can have a standard tape change schedule. Given below is a sample
tape change schedule for such a standard week. Other tape change schedules
can be worked out for other variants.

Symbols:
M - Maintenance time including pre- and post- maintenance tests
    (Tapes changed during Maintenance, so two tapes are mounted & empty at end.)
    Time is 1200-0600 UT.
S - Software (and other non-tape activity) time.
    Time is 1600-2200 UT.
T - Pointing and other non-recording activities
At the given tape change time, tape writing is forced off the current transport
and a fresh tape mounted on that transport.
A - Tape change time for stations in AST or EDT time zones
    Two tapes are mounted and (nearly) empty at this time
E - Tape change time for stations in EST or CDT
C - Tape change time for stations in CST or MDT
M - Tape change time for stations in MST or PDT
P - Tape change time for stations in PST
H - Tape change time for MK

```
    OUT   3      6      9     12     15     18     21     24
T                                MMMMMMMMMMMMMMMMMMMMMMMMMMMMMM
W     MMMMMMMMMMMMM                                 A E C M
T    P   H                               SSSSSSSSSASESC M
F    P   H                                   A E C M P      H
S                                A E C M P    H
S    TTTTTTTTTTTTTTTTT                            A E C M P
M       H                               A E C M P     H
```

This schedule nominally calls for 14 tapes per station per week. However,
the number of tapes actually used will depend on details of the observing
schedule. For instance, the AST/EDT station(s) change at 2000 UT on
Wednesday. There would be zero, one, or two tapes changed at that

time, depending on the individual projects scheduled - if observing
does not start until four hours after the end of maintenance because
of a lack of a proposal with a suitable GST request, only one tape
need be changed. Many spectral line projects have a bitrate smaller
than 128 Mbits/s, and will result in changing only one tape instead of
two at the times above.

When there are tapes to be sent to other correlators, the simplest thing
to do is to revert to the tape-per-project mode. It is simplest if 20h UT
(In working hours at all sites) separates the last thing scheduled in the
fixed-tape-change-mode from the first scheduled in tape-per-project mode
and vice versa.

256 MBits/s can be scheduled with slightly different rules, depending
on the length of the observation:
>   5h or less - single tape - preceeding and following the observation with
>   6h of extra idle (no tape) time will suffice. This guarantees that
>   the average usage will be less than 128 MBits/s between tape change
>   time at all stations, irrespective of where in this 17h interval their
>   tape change time occurs. Somewhat less idle time may be needed depending
>   on the exact day and time, but this sufficient rule provides an easy
>   and automatic way of scheduling things.
>   5.5 to 10h - two tapes - preceeding and following the observation with
>   11 hours of extra idle time will suffice.
>   11 to 16h - three tapes - a rather special deal. It can only start
>   between 1000 and 1400 UT (to get a tape change time during working
>   hours). It is most efficiently scheduled on a Wednesday, and no other
>   observing would be done in the 34 hours between Maintenance and Software.
>   16 to 21h - four tapes - a very special deal. Only reasonable time is
>   Wednesday, 0930 UT to Thursday 0630 UT.

512 MBits/s can be scheduled
>   5h or less - two tapes - preceeding and following the observation with
>   16h of idle time will suffice.
>   5.5 to 10.5h - four tapes - can only reasonably be scheduled on Wednesdays,
>   1430-0100 UT.

We have talked at times, of reserving a small part of the tape scheduled at
high bit rate for use, during what I called idle time above, of a spectroscopic
observation which might have a bit rate very much less than the sustainable
128 Mbits/s. The difficulty of matching suitable projects, with complementary
sidereal time ranges, now impresses me as making such a mode of operation
infeasible, especially so at the current level of proposal pressure.

Appendix - P. Napier memo of June 18, 1991.

From: P.Napier
Subject: VLBA Operation with less than 12 hours tape recording time.

I wanted to get a feel for the impact of having to use tapes that
have only 10.5 hours of record duration at 128 MBit/sec, in the event
that we cannot achieve 12 hours. In particular I
wanted to see if the operational problems are so great that we should
change to larger reels. Here is a weekly tape change schedule that will
work with the 10.5 hour tapes. It is undoubtedly not the best way of
solving the problem, but it does at least show that a solution exists. The
basis of the solution is to add to the 14 tapes per week an additional 2 tapes
each of which is used for only seven hours. These two tapes are changed
during the normal working day so no additional trips to the antenna are
required. Additionally, no tapes are provided during a weekly maintenance day.

All times given below are in antenna local time. In practice stations in time
zones containing more than one station would have their times modified
slightly to provide staggered tape changes. The schedule is based
on the following requirements and assumptions:
>   (1) Tape changes should occur during normal working hours (0800-1700 at most
>   sites) to make it as easy as possible for site technicians to interact with
>   local businesses, shipping companies and AOC personnel.
>   (2) At the three sites that have 3 hours round trip access time (PT, KP, MK)
>   the technician work schedule will be arranged so that on the two days requiring
>   2 tape changes (Monday and Friday) a technician can be on site for seven hours.
>   (3) Only one tape change should be required on Saturday and Sunday.
>   (4) A maintenance day lasting from 0900-1600 will occur every Wednesday.

A possible schedule is as follows:

Day of Week	Time of Tape Change	No of Tapes Changed	Comments
Monday	0800	1	
	1500	2	
Tuesday	1200	2	
Wednesday	1600	2	Maintenance day 0900-1600
Thursday	1300	2	
Friday	1000	1	
	1700	2	
Saturday	1400	2	
Sunday	1100	2	

The 14% increase (16 instead of 14 tape/week) in tape usage does not seem excessive. Probably the biggest problem caused by the double tape changes on Mondays and Fridays is that these extended working days (at PT, KP and MK) will be more difficult to cover when we have less than the total number of site technicians available because of sickness or vacation. My own conclusion is that a tape change schedule of the kind demonstrated above would be preferable to the problems we would probably get into with larger reels.