

Notes on High Data Rate Recording

Jun TAKAYAMA

SONY Corporation, Atsugi, Kanagawa 243, Japan

Abstract. This short paper is intended to give scientists a sight (or a view from engineering) on the subject going through the following topics, i.e. COTS product, technology trend, data rate versus packing density, future and quick solution.

1. COTS Product

A COTS (Commercially Off-The-Shelf) product is generally tied with a standard. Both COTS product and standardization mean in nature halt to catch up latest technology for a certain period of time, i.e. until next phase. This is a drawback. However, with this combination, there is a lot of benefit for both users and manufacturers. In case of recorders, those are,

- 1) products with uniform quality, higher reliability and less cost available,
- 2) multiple suppliers* possible,
- 3) crossplay between machines guaranteed,
- 4) less confusion among users.

The first one comes from COTS and the rest mostly as a result of standardization. COTS approach recovers large development cost by subsequent mass-production.

In contrast, with project-by-project based development, all pros and cons are reversed.

2. Technology Trend

In recent years, move from longitudinal recording to helical scan recording is becoming popular not only among instrumentation recorders but also computer tape drives because of the following reasons,

- 1) ease of getting higher data rate and, at the same time, higher areal packing density (track density, more precisely),
- 2) benefit from the infrastructure of consumer and broadcast VTRs (or VCRs).

*For example, ANSI ID-1 recorder suppliers known to date are Kodak/Datatape, Martin-Marietta (former GE Aerospace), Schlumberger (Loral in U.S.) and Sony.

3. Data Rate vs. Packing Density

When data rate gets higher, capacity thus packing density is expected to follow, or vice versa. However, this is an example of conflicting factors in high data rate tape recorder design. In the following, some details is described picking up helical scan format as a case.

Combining parameters of Hi-8 and ID-1 formats, one obtains 2X data rate* and >7X capacity of ID-1 format as seen below. Is this realistic?

Parameters:

	Tp	Wl	Tt
Hi-8	20 μm (NTSC)	0.45 μm (PAL)	10 μm
ID-1	45 μm	0.9 μm	16 μm

where Tp : track pitch,
 Wl : minimum recorded wavelength,
 Tt : tape thickness.

Multiplication factors:

$$\text{Data rate: } 2 = (0.9 / 0.45)$$

$$\text{Capacity: } 7.2 = (45 / 20) \times (0.9 / 0.45) \times (16 / 10).$$

The answer is: real world is not so simple. This kind of argument under a certain circumstance is not more than just a good target. Some of the reasons are,

- 1) track form factor,
- 2) appropriate air film between head and tape.

Track form factor is an indicator of ease of crossplay or tracking. Here, the form factor is the ratio of track length, Tl , to track pitch, Tp .

One would find different figures with different formats. The smaller the figure is, the easier crossplay is. When the figure is comparable, then the larger real dimensions are, the easier tracking is.

Again, the case of Hi-8 and ID-1 is as follows.

$$\text{Hi - 8: } 3.85 \times 10E3 = (77 \text{ mm}^{**} / 20 \mu\text{m})$$

$$\text{ID - 1: } 3.78 \times 10E3 = (170 \text{ mm} / 45 \mu\text{m}).$$

*Assuming the same head-to-tape speed.

**Video plus PCM audio.

This indicates that, if track pitch of ID-1 is reduced down to 20 μm as was in previous discussion, crossplay will be quite difficult.

Appropriate air film is important for head-to-tape lubrication and so-called spacing loss control. The spacing loss in playback is a function of the thickness, D , of air film and the minimum recorded wavelength, Wl .

$$\text{Spacing loss (DB)} = 55 \times (D/Wl).$$

Air film starts to form at head-to-tape speed of a few meters per second. Again as was in previous discussion, if minimum recorded wavelength of ID-1 is reduced to 0.45 μm aiming to double the data rate, spacing loss will be too much, doubled in DB representation, in high data rate region. Similarly, keeping the minimum recorded wavelength, if head-to-tape speed is increased, the spacing loss will be again too much at a certain point.

If a number of heads on the scanner is increased to aim higher data rate, the distance between heads is to reach a limit. In case of our implementation for example, 16 heads are mounted on the scanner wafer of 110 mm diameter as 8 pairs, the separation between the pairs is about 40 mm along the circumference.

4. "Guestimate"

Guess/estimate, what is coming in future?

- 1) Gbits/sec class helical scan recorder
- 2) >1000 channel longitudinal recorder

(MAURICE, 1991).

1.2 Gbits/sec helical scan reel-to-reel recorder has been productized as HDTV recorder (HD VTR). When demand for HDTV or ATV services is becoming popular, several hundred Mbits/sec cassette recorder with mild data compression and/or uncompressed 1.2 Gbits/sec cassette recorder will also be developed for program origination. However, those are specifically designed to VTR, similar but different animal, and will be just bases for instrumentation recorder development.

Beyond Gbits/sec, >1000 channel longitudinal recorder is a candidate providing thin film head technology becomes reality. However, it will be long time away, maybe towards next century.

5. Quick Solution

Striping, a kind of parallel operation, is a solution for data rate hungry applications until higher data rate recorder becomes available. In fact, striping is easier than ever, benefit from recent progress in robotics and by the use of built-in timeline function. The procedure of timeline control is, refer to Fig. 1, where Event consists of Clock time and Task (to begin Record from a particular position on tape at a given time, for example).

- 1) hold and preset Clock (Timeline), one equipment at a time,
- 2) download Event(s), one equipment at a time,

Striping

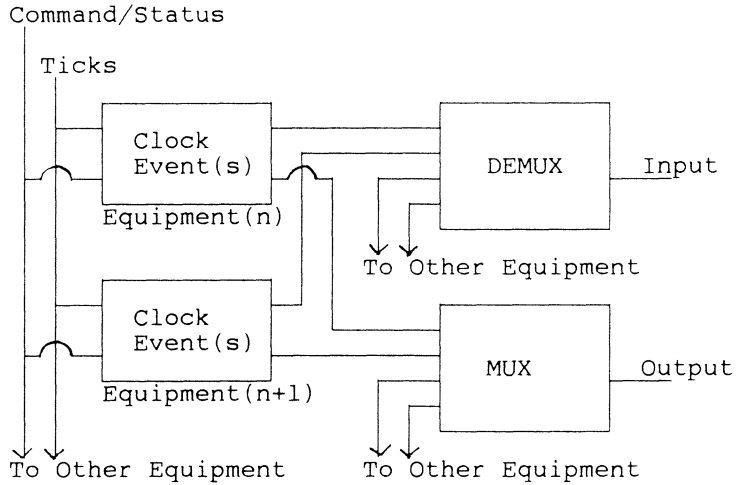


Fig. 1.

3) after all equipment being downloaded, broadcast Timeline Run command at a right time.

Timeline Run command is a trigger for subsequent process to be synchronized. Each equipment performs its task(s) to built-in clock time(s) which is driven by the same ticks. As a result, globally all equipment are in synchronization.

REFERENCES

- MAURICE, F. (1991): Towards the multitrack digital video tape recorder, Proceedings of Magneto-Optical Recording International Symposium '91, *J. Magn. Soc. Jpn.*, Vol. 15, Supplement No. S1, pp. 389-394.