AMERICAN INTERACTIVE MEDIA

A Philips/PolyGram Corporation

AIM Technical Note #54

Supersedes AIM Technical Note #43.1 *Recommended Error Tolerance Strategy for Disc Building*, Robert Patton, November 6, 1989.

Error Strategy for CD-I Alpha Tape Deliverable

Alty van Luijt

June 4, 1990

An earlier AIM technical note, #43.1, on recommended error tolerance strategy has been widely ignored by titles in production. The current note describes preferred and minimum requirements for error tolerance for alpha tape deliverables to AIM. Non-compliance with at least the minimum strategy is reason for rejection of the alpha tape.

sector, the correction is done transparently to the application. For real-time Form 1 sectors, it is possible that future players will have hardware correction circuitry on board that would protect the data contained in those sectors. However, the current players are base case in this respect and do not attempt correction for real-time Form 1 sectors.

III. ANALYSIS

AIM completed the following analysis to determine a range of error strategies.

All sectors receive CIRC correction. CIRC correction is a standard feature of all CD-I data delivery, whether Form 1 or Form 2 sectors are used. Form 1 sectors receive additional correction from CD-RTOS in versions 1.0 or later. In current players, this is true for non real-time sectors only. To allow for error correction, only 2048 bytes are available for data in a Form 1 sector; in contrast, 2324 bytes are available for data in a Form 2 sector, excluding subheader and EDC field. In addition, the following two cases had to be considered.

1) **Non Real-time Form 1 Sectors**—The player spends as much time as needed to attempt a correction using the ECC data. Current players correct through the use of software algorithms. It could take up to 300 milliseconds per sector to make such a correction. Future players might use hardware correctors for nearly instantaneous corrections.

2) **Real-time Form 1 Sectors**—The player does not sacrifice real-time play to correct a sector. The latest version of the Green Book specifies that Form 1 correction for real-time sectors must be performed transparently to the CPU and application, if performed at all. Otherwise these errors will be ignored. Therefore, without hardware correction, real-time Form 1 sectors get no additional correction beyond that for Form 2 sectors in current players. Future players might also support ECC correction by real-time hardware for real-time Form 1 files.

Several methods were considered for creating error-resilient titles.

1) DESIGN WITHOUT REGARD FOR ERRORS: STORE ALL FORM 1 DATA IN REAL-TIME RECORDS, AND, THUS, DO NOT USE CD-RTOS, VERSION 1.0, ECC FEATURES.

   In the future, some players may have fast real-time correction circuitry. A title storing all of its critical data in real-time Form 1 sectors might run perfectly on such a player. Until such players exist, the worst case would

result in 1 in 20 to 1 in 400 discs returned to the store by customers and many field complaints because of fingerprints, etc.

2) USE ALL POSSIBLE CAUTION: ENGINEER DISCS USING ALL ERROR CORRECTION TRICKS.

Take advantage of the ECC software feature of 1.0 CD-RTOS. Since the "best" correction can be achieved only with non real-time sectors, set all critical data in non real-time Form 1 sectors and preload as necessary. To make error correction extremely robust, you could also store duplicate data in case even ECC cannot correct an error.

3) COMPROMISE

Put Form 1 data in real-time records for convenience and speed. If an error occurs, use one of the following methods:

a) Implement a title-specific ECC/EDC correction algorithm. We consider it unlikely that title engineers have the resources to implement such technology and to tie it seamlessly into a title.

b) Put critical data in non real-time Form 1 sectors (preloaded), and put all other data into real-time sectors. Any real-time errors that might occur would be ignored.

c) Create a real-time record Form 1 preamble. The preamble contains critical data and is duplicated elsewhere (usually in a postamble). If an error occurs, jump to the duplicate copy of the preamble and retry the play. Then, jump back to the main body (Form 2 sectors) of the real-time record to continue.

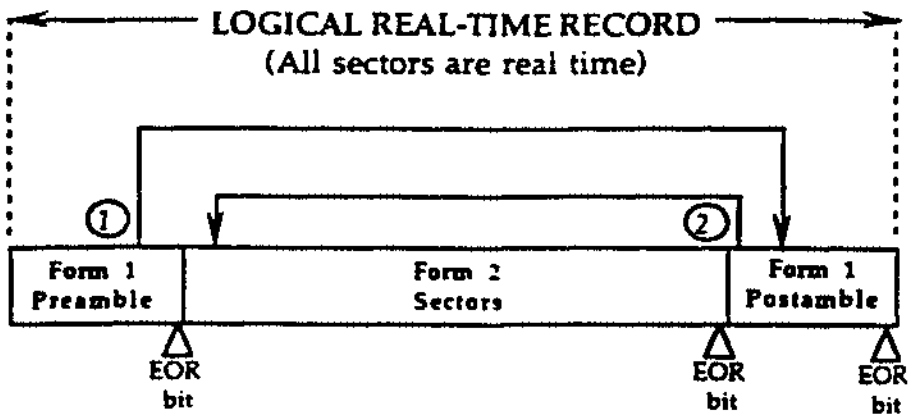
IV. PREFERRED STRATEGIES

1) For those titles that are less than half of the maximum allowable disc capacity, brute force duplication, or even triplication, of the whole disc image is the easiest way to increase error resilience dramatically. All it takes is maintaining an offset and jumping to the back-up copy in case of errors.

2) For the more general case, the ideal strategy is described by option 3c, in which we would create real-time record Form 1 preambles with duplicated postambles. The following figure illustrates the recommended arrangement of Form 1 sectors in the real-time record.

1) *Error detected in preamble: jump to duplicate data in postamble.*

2) *Process critical data in postamble and then process Form 2 sectors.*



If player manufacturers build in real-time correction hardware, our discs simply play better with fewer seeks to the alternate postamble.

V. ACCEPTABLE STRATEGIES

For those cases where implementing the ideal strategy would cause undue hardship, some less ideal strategies can be considered and will be accepted as alpha deliverables.

1) ALL CRITICAL DATA TO BE CONTAINED IN NON REAL-TIME FORM 1 FILES

   The drawbacks, compared with the recommended strategy, are that under normal circumstances (no errors) system performance is slightly reduced by using non real-time files. In case of errors, a "hiccup" in timing might occur due to the non real-time nature of the ECC correction. Also, the robustness of duplicated sectors is greater than that of non-duplicated sectors, even if they have ECC for correction. However, if disc real estate prevents systematic duplication of critical sectors, this might be a good fall-back methodology.

2) NO DUPLICATION OR ECC PROTECTION FOR CRITICAL DATA. RELY ON A DIALOGUE WITH THE USER, URGING HIM/HER TO CLEAN THE DISC IN CASE OF ERROR

This is a very weak scenario that is appropriate only for those productions that are too far advanced to incorporate any of the better strategies without major budget/schedule impact.

This strategy is considered weak, because it is very intrusive to the operation of the disc, and it typically aborts the work in progress. It is still better than doing nothing, because it directs the user to do something that is probably right. Statistically, the odds are such that a dirty disc is approximately one thousand times more likely to be the cause of the problem than a defective disc is.

Since the user has not been confronted with this need while using CD-DA discs, it is not immediately obvious that cleaning is the right solution to the problem. Thus, the message needs to be given in an obvious way at the moment the problem is detected. The alternative of printing it on the paper cover sheet of the disc is probably not sufficiently powerful to make this distinction clear.

Therefore, the dialogue with the user is considered the minimum level of preparation that a title can use to be acceptable as an alpha deliverable. Any of the more advanced alternatives is preferred over this option. In the context of the more advanced error strategies, alerting the user to detected errors through a dialogue box is optional for the application. Ideally, this should be done in a non-obtrusive manner, for example, when the user exits from the disc.