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Technical Note #101

Extension Memory in CD-i

Charles Golvin
Philips Interactive Media, Los Angeles

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Abstract

This technical note describes how extension memory is provided in CD-i. It also provides guidelines for the specific instance of one additional megabyte of system memory provided in the Philips Digital Video cartridge.

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To receive Philips Interactive Media technical notes and other publications, or for more information, please contact the person below who is designated for your area.

From Europe and the Middle East:

Hein Zegers
Developer Support
Philips Interactive Media Centre
Maastrichterstraat 63
B-3500 Hasselt
Belgium
Fax: +32 11 242168
Internet ID: hein@pimc.be

From the USA and Asia:

Lucy Lediaev
Developer Support
Philips Interactive Media
11050 Santa Monica Boulevard
Los Angeles, CA 90025
USA
Fax: +1 310 477 4953
Internet ID: lucy@aimla.com
CompuServe ID: 72056,1130

Extension Memory in CD-i

Overview

The *CD-I Full Functional Specification* (Green Book) allows for the extension of the base-case system. Examples of such extensions include the Player Control Keys, Full Motion Video, DYUV+QHY, and an audio mixing unit. Another example of an extension is that of memory in addition to the one megabyte mandated by the Green Book.

RAM Device Status Descriptor (DSD)

As with other devices, both base-case and extension, additional RAM is reflected in the Configuration Status Descriptor (CSD) of the player. The following description may be seen as added to Chapter A VII.2.6.5 of the Green Book (this will be reflected in the updated Green Book):

```
2.6.5.30  RAM  device

Device  Type  Code      30

Device  Parameters
```

Parameter string	Description	Default
SZ#n	Memory size, expressed as a multiple of 1024 x 1024 bits.	4
CO#n	Memory color, where n indicates the color of the memory	1
AT#n	The typical access time of the RAM device. The time is expressed in ns.	100

Note that the priority of the additional memory is not reflected in the DSD; to determine the relative priorities of the memory in the system, an application must query the system data structures (cf. PIMA Technical Note #87, *Memory Allocation in CD-RTOS*). Note also that the access time is intended as a guideline for relative performance; applications should not rely on the performance indicated by this CSD entry. For example, as a guideline, the typical access time of base-case video memory in a Philips 220 player is 510 nanoseconds. Applications aiming for the best CPU performance should, therefore, include some kind of loader program to place the main application code into the fastest RAM available. An example of such code may be found in *The Interactive Engineer*, Volume 2, Number 3, September/October, 1993, p. 6.

System Memory Allocations

The Green Book mandates that, for the base case, the operating system is allowed to allocate up to 64 kB at start up, but no more than 32 kB per plane. That is, prior to the loading of the application program into plane B, there must exist no less than 480 kilobytes of contiguous free memory in each of the base-case memory planes. Some of the system allocations are from a specific plane of memory; the remainder are not plane specific and are satisfied according to the operating system memory allocation scheme.

As explained in PIMA Technical Note #87, memory allocations that are not plane specific are satisfied first from the highest priority memory. In the case in which the base-case system is extended with memory that is of higher priority than the base-case mandated memory, some of the initial static memory allocations made by the system come from this extension memory. That is, some of the base-case memory that is normally diminished by the system remains available to the application; however, in exchange some of the extension memory is allocated to the system. Typically, the roughly 16 kB block that is allocated from low memory in plane A is plane specific, while the other system allocations are not.

Example: The Philips DV+Memory Cartridge

The Philips Digital Video cartridge includes both the MPEG CD-i extension and the memory extension. In this case, the memory extension consists of one megabyte of system memory, with priority $81 (in contrast to priority $80 for planes A and B). In this case, the CSD contains the following entries:

```
30:RAM00:SZ#8:AT#150:
30:RAM01:CO#90:AT#700:
```

The first entry reflects the one megabyte of system memory; the color parameter is omitted since color #1 is the default. The second entry reflects the MPEG memory; in this case, the size parameter is omitted because 4 megabits (512 kB) is the default.

If the Green Book required DSD entries for the base case memory planes as well, their entries on a Philips 220 player would be (based on the performance figure given above):

```
30:RAM02:CO#80:AT#510:
30:RAM03:CO#81:AT#510:
```

Again, note that the size parameter is omitted, because 512 kB (4 Mbit), the size of the base case planes, is the default.

In a Philips 220 player, the system allocates approximately 16 kB from plane A and approximately 19 kB from plane B. When the player is equipped with a Digital Video cartridge, the plane A allocation remains essentially unchanged because this allocation is made specifically from plane A. However, nearly all of the allocations that come from plane B in the base case are of type "don't care" and, hence, are satisfied from system RAM when present. Thus, when the player is equipped with a DV cartridge, the system memory allocations reduce plane A memory by roughly 16 kB, system RAM by roughly 18 kB, and plane B by just over 1 kB. These numbers should be used only to illustrate the point that the system memory allocations can be different when additional, higher priority memory is present in the system. Note also that, due to additional ROM modules and other required system structures, some system start-up allocations may be unique to the DV extension.

Note that, in this case, many allocations made on behalf of the application come from the extension memory. Examples of these include the local data and stack space allocated to the application, sound maps, path descriptors for open paths,

and process descriptors for additional processes. PIMA Technical Note #87 gives a more explicit example of this point.

Summary

The CD-i system may be extended beyond the base-case mandated 1 MB. This extension is reflected in the CSD according to the guidelines described above. These CSD entries provide the mechanism for an application program to determine whether extension memory is present. In particular, an application may take advantage of the increased speed of extension memory, if reflected in the DSD entry for the additional memory.

System memory allocations that normally come from base-case memory may be relocated on a system with extension memory, provided the extension memory is of higher priority than the base-case memory. On a base-case player, prior to the loading of the application program, an application may be assured that at least 480 kB of contiguous memory is available in each base-case plane of memory. This statement must be modified for systems containing extension memory. The following rules hold for players with extended memory (N here represents the size of the extension memory in kB):

1. There will exist at least 480 kB of contiguous memory per base-case plane;

2. The sum of the sizes of the free contiguous blocks will not be less than 960+N kB;

3. The contiguous free block of extension memory will be no less than N-64 kB

Both 2 and 3 say the same thing: the system may not allocate more than 64 kB.

In the case of a Philips player equipped with a Digital Video cartridge, the application is assured of at least 1984 kB of free memory and no less than 960 kB of contiguous free memory in the extension system memory. Note that because the priority of the MPEG extension memory is 0, the system non-plane specific allocations never come from this memory. Priority 0 memory may be allocated only by specific request of that plane.