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Executive Brief

Integration Drives Consumer Electronics Market For Storage

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About the Author:

Patrick has over 12 years of experience in product development, marketing, and business development at large and small companies. He has consulted to a variety of companies in the consumer electronic and mobile device/software space and has co-authored Digital Entertainment Storage Report 2004 with Coughlin Associates – a comprehensive analysis of flash and hard disk storage in consumer electronic and content distribution applications. Patrick led business development & marketing efforts at Plustream, a start-up developing innovative server & application management software with an initial application of streaming servers for regionally located content delivery networks. Prior to Plustream, he led the marketing organization at start-up CacheVision, a consumer storage systems company integrating CE electronics with hard disks and software for a modular solution. Patrick helped create and spin-out CacheVision from Seagate with storage industry veterans Bob Teal & Steve Kitrosser. At Seagate, Patrick co-founded the consumer business development organization and worked with consumer companies such as Sony, Philips, Thomson, and CE related semiconductor suppliers. At Seagate, Pat held various roles of business development as part of Seagate's corporate development M&A team and invested in several strategic investments related to the consumer strategy. Patrick joined Seagate in the early 90's as an engineer developing hard disk storage products and ramping volume in the Far East. Patrick holds a BS in Engineering from Cal Poly, SLO and an MBA from Santa Clara University.

Consumer Hard Disk Primed for Attractive Growth

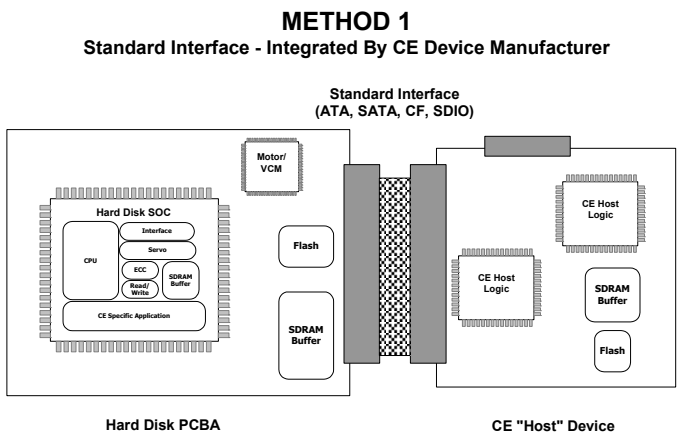
With the world moving toward increased digital content, the consumer electronics market provides an enormous growth opportunity for hard disk providers and consumer electronic companies. The total market for consumer electronic products with hard disks exceeded 18M units last year and forecasts show good growth over the next five years. With this opportunity comes the need for higher levels of system integration that will change the industry, standards, and strategic partnerships. Those that lead the change will be rewarded well for the risks taken to grow the market. Followers will be left with the expense of integration but commodity returns. This document outlines the primary alternatives for integration, as well as noting challenges and requirements. Put simply, this brief introduces a high-level roadmap to consumer electronics storage integration.

Alternative Approaches of Integrating CE & Hard Disk Electronics

There are six primary approaches to the integration of CE Electronics with Hard Disk electronics. Each method of integration has its benefits and challenges and will be adopted to match market opportunity.

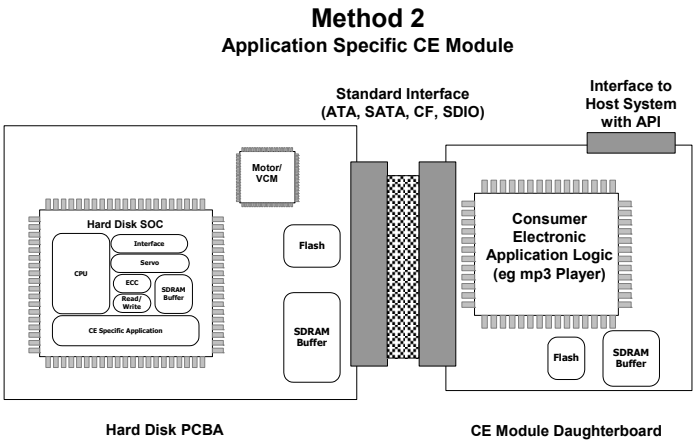
Method 1

Consumer Electronics manufacturer/ODM purchases standard disk drives from a hard disk supplier and integrates the hard disk drive as a component into the final system. This is the current state of the industry as PC hard drives are leveraged for the consumer market. Each consumer electronic product platform group must develop/optimize drivers, file system, and power management features associated with the hard disk. The cost structure of this architecture will limit market growth due to a higher bill of materials cost.



Method 2

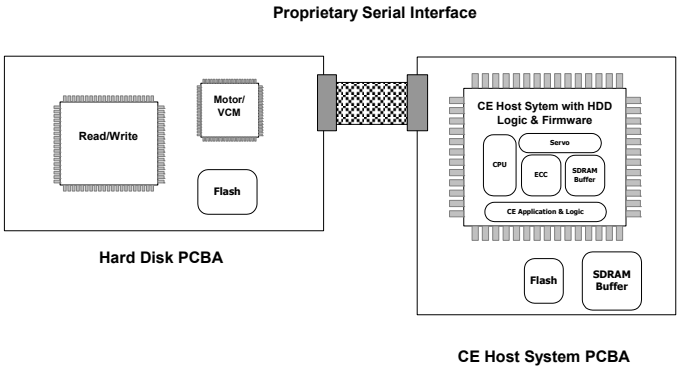
Hard disk is integrated with core CE electronics and sold as an application specific module to an ODM/CE Manufacturer. This method has been attempted in the past without success due to a questionable value proposition to CE Mfg's. It was less expensive to use method "1" and incur the additional development costs. This approach looks promising for portable/mobile applications where integration lowers cost, speeds time to market, and there is a huge gap in competencies associated with the integration of disk drives into these products.



Method 3

This approach to integration pushes hard drive system electronics from the hard disk assembly onto the host system. A new (currently proprietary) interface is used to transmit raw NRZ data to the host system. This approach has merit in that total system cost can be reduced through shared memory and CPU resources. But, the increased effort to integrate hard disk electronics into many CE host system platforms will be challenging and the development costs may outweigh the unit cost reductions. The proprietary nature of the interface without multiple supplier compatibility will also pose challenges to this approach.

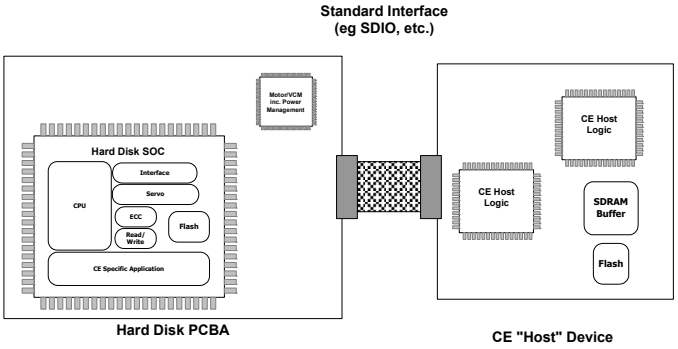
Method 3
Storage Module - HDD Electronics Integrated with CE Host



Method 4

Hard disk SOC (System on a Chip) designed specifically for CE applications. The approach has the advantage that it's designed to optimize power and still retain a standard interface that can allow for the drive to be either embedded or removable. These drives have lower data rates and a small internal buffer in the SoC to conserve footprint in mobile power sensitive applications. It enables the hard drive system and RTOS to operate separately from the integrated CE application, enables parallel development of hard disk and CE application firmware and logic, and it enables a clear division in testing and failure analysis that minimizes disruption to current hard drive production back-end testing investments. CE application software architecture can be leveraged off existing PC code, with reduced caching, SMART, etc. commands.

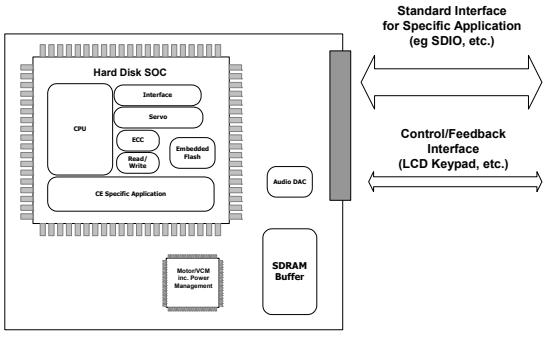
Method 4
Hard Disk SOC w/Embedded Flash & CE Optimization



Method 5A

Hard disk SOC (System on a Chip) with larger embedded processor that has enough cycles to run specific CE applications synchronous with the disk drive embedded system. This approach has significant merit for more mature and standards based applications such as mp3 recording and playback. Semiconductor providers must provide integration for this approach to be successful. The CE application portion will be pre-tested at the chip level so that standard hard drive production and testing procedures can be utilized.

Method 5A
Hard Disk SOC for CE Apps - Single CPU W/Semi Company Integration



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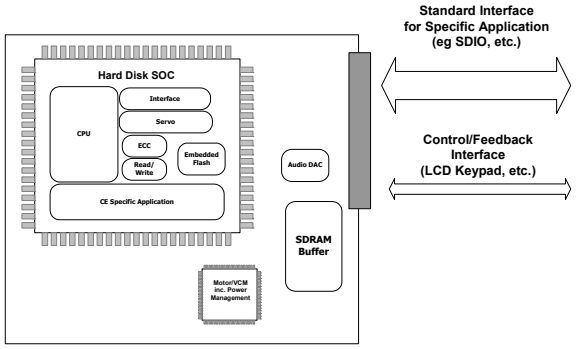
Method 5B

A variation of method 5A is for the CE manufacturer to port their applications to the CPU on this hard disk SOC independently. This has the advantage that it only requires an upgrade in CPU performance but has some severe limitations and potential issues for system developers. Writing to a proprietary RTOS will make it difficult for CE manufacturers to develop products. CPU interrupt priority set to favor servo/drive functions over the CE application may lead to end user performance issues. Hard disk testing processes and failure analysis may be adversely affected by this approach. In addition, the independent development of the CE system and the hard disk may be increased in difficulty.

Method 5B

Hard Disk SOC for CE Apps - Single CPU W/CE Company Integration



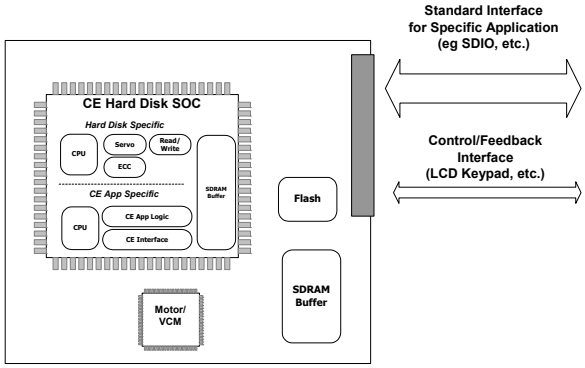
Hard Disk PCBA w/CE Application

Method 6

Hard disk SOC with second CPU and custom logic for CE applications. As unit volumes in key segments grow, this approach is the most likely long-term outcome as it balances the needs of system level cost reduction with the dynamics of the value chain. This approach has many advantages. It enables the hard drive system and its RTOS to operate separately from the integrated CE application, enables parallel development of hard disk and CE application firmware and logic, and it enables a clear division in testing and failure analysis that minimizes disruption to current hard drive production back-end testing investments.

Method 6

Hard Disk SOC for CE Apps - Multi CPU & Custom CE Logic



Hard Disk PCBA w/CE Application

Items to Consider on the Path to Integration:

- ***Integration will Follow progressive steps to balance investment and return potential***

The path to higher levels of integration will follow progressive steps that match market demand with return potential. Significant investment from industry leaders is required to reach each step of integration that must be justified by sufficient return to justify the risks.

- ***Approaches 5A and 6 will prevail long term and can co-exist depending on the application***

Integration approaches 5A and 6 will prevail longer term because they remove the most cost while balancing the needs of the value chain while minimizing disruption to current production and testing investments. These approaches also provide the best value in terms of size and power reduction where cost is not the only factor driving integration.

- ***Integration must provide flexibility to differentiate***

Higher levels of semiconductor integration must still provide adequate flexibility for hard disk and consumer electronic manufacturers to differentiate their products in the marketplace. Each consumer electronics company must have enough flexibility to position their product in the market in a way that matches their brand and target customers.

- ***Collaboration of leaders in value chain necessary for success***

Higher levels of integration will no doubt challenge some suppliers' existence in the value chain and will require that leaders work together to make the path to integration swift and financially rewarding for the strong. Partners must work together to realistically balance core competencies, partition integration components with consideration to capital investments in manufacturing and testing, and drive the establishment of new standards.

- ***Mobile products will see integration sooner than stationary products***

Mobile products will see higher levels of integration sooner than stationary because of the size and power consumption constraints in addition to pure cost reduction requirements. The current volume shipments of smaller form factor storage devices is also much lower than 3.5 inch and 2.5 inch products where there is already an economy of scale.

Critical Step in Market Growth from Niche to Mass Market Products

Consumer electronics market growth for disk drives is highly dependent on higher levels of integration for long term growth. This is an iterative cycle for the industry in that integration drives market growth and market growth drives the attractiveness to invest in higher levels of integration. Integration will follow steps of increasing complexity that are rewarded with higher margins for the first generation but become commodity features as the next step of integration and features are added to the system. Integration is a key factor in restoring profit potential to the value chain while lowering system costs and increasing market growth.

Coughlin Associates to Publish In-Depth Report on CE/HDD Integration

This Executive Brief has introduced the primary methods of hard disk and consumer electronic systems integration. Coughlin and Associates will publish an in-depth report on the topic. An outline and pre-order information are available by contacting the author at email address patrick@patrick-hanlon.com. Please feel free to email the author with any comments or question you may have before the in-depth report is released.