

On-Board USB connections for Digital Media Devices vs. Removable Media and Readers

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Direct Connection or Reader Interface for Digital Media Devices

The handheld digital media device craze is arguably the fastest growing segment in the consumer electronic market; PDA's, cell phones, MP3 players, digital still and video cameras, the list is growing by leaps and bounds. These devices incorporate the processing power of earlier personal computers into the products of the everyday user, who may or may not have previous computer use experience.

The scope of this paper focuses on devices utilizing removable digital media for data storage as compared to fixed memory, traditional film or tapes. Digital media, including but not limited to Compact Flash, Secure Digital/Multi-Media Cards, Memory Stick™, and Smart Media, varies in physical size, storage capacities and format characteristics, however media is simply portable electronic data storage, not dissimilar to traditional floppies.

The combination of processing power and removable digital media offers device manufacturers cost effective means to enhance product features and functionality, create greater product differentiation and enhance the user experience. The added value relative to the computer industry is that media content is directly transferable to the home or office computer. Data files, whether music, video or still photos benefit from the same ease of use as copying a file from one drive to another.

Connectivity

Another shared feature of new digital devices is the need to connect with the "outside world", be it a personal computer or another digital device. The enhancement in user functionality and designed interoperation with collateral devices has changed the device use model. For example, it is possible to connect a digital camera directly to a color printer for immediate print out of your pictures. Software applications are available to manipulate and archive data on the owners' personal computer.

Typical of the computer interface, the connections are via direct attaching cables (serial, parallel, Universal Serial Bus (USB), IEEE1394, etc.). The most prevalent option for both computer peripherals and consumer devices is the now ubiquitous "Plug-n-Play" USB. USB offers device manufacturers the lowest cost to connect and the greatest ease of use for the consumer. Since 1999, all WinTel and Apple computer systems include a host USB connector and OS software.

The alternative to the direct device connection model is the digital media reader model. Whereas removable media drives (like Iomega's Zip® or Jaz® Drive products) popularized the "traveling data" paradigm with traditional computer users (due to their ease of use and larger memory), the data cartridges do not lend well to the smaller size of consumer devices. Hence, digital media. The reader model allows the user to remove the device media and interface its content to the computer separately. If the digital device is in use elsewhere, the media content is still available for use with the computer.

USB Connection native in the Device

Many of the digital devices today offer a direct USB interface native in the device. The sole purpose of the connection is to communicate the data in the device with the owners' computer. Two examples; still image cameras download pictures directly to the computer and PDAs synch up data with host computer applications.

Typical of a lower cost native connection, device characteristics (the features and functions of the device as programmed in firmware) are set in the factory at production time. Whether the product was developed in adherence with a defined Class Compliant Driver interface or as a Vendor Specific interface, the inability to re-configure the device may limit forward compatibility.

When the customer decides to update their computer system or operating system, there is no guarantee the device will operate as intended with out additional user intervention. The cost to the user is that they may lose certain functionality with their device after the update. In turn, this may generate a call to the device or computer manufacturers technical support services. The result is a less than satisfactory user experience and the cost of the technical support call.

Unlike traditional film cameras that allow field film replacement, the direct connection paradigm also infers a limit to the device usability. As the customer must connect the camera to the computer to off load the images, the limitation of the memory may cause the user to stop taking pictures when the camera is full. Even if the customer replaces the digital media in the field, the battery cost as noted above may also alter the user experience.

Removable Media and Readers

The alternate to the direct USB native connection is the use of removable media and dedicated media readers. Instead of the device needing to be attached directly to the computer, the device allows for the easy removal, and insertion, of the media card. The media is then placed into a reader that transfers the stored data to the computer.

The removable media reader model takes the emphasis of the computer connection out of the digital device and places it in an optimized reader connection intended specifically for use with the computer. In digital cameras, this removable media model more directly approximates the traditional camera and film use model. The user is inclined to obtain multiple pieces of digital media and use them as they would a roll of film. Instead of sending the film to the development lab, the media is "developed" with the reader.

Of significant benefit to the device manufacturer is that key resources are allowed enhance the device and not on the connectivity interface. The rewards for maintaining focus on their respective core competencies include increased product features, market presence and lower cost to produce.

The separation of the device functionality from the computer interface changes the way the consumer views the digital device as well as the media. Using the camera model again, the camera is used as a camera. The consumer is

conditioned to treat the digital media as they would a roll of film. The media reader serves only as an interface to “develop” the film.

Device manufacturers may offer more than one product. Additional offerings that use digital media can also be marketed to an already “digitally aware” consumer. Leveraging the reader and media cross platform further conditions the use of media as a storage tool, much as a floppy diskette or cassette tape. The device manufacturer can market additional media to customer that is used cross platform.

Cost to Implement

Prior to defining the product characteristics, the device manufacturer must understand the cost implications for either direct connection or reader model implementations. These costs are a combination of the actual cost to produce a solution (hard costs) and the cost to develop, use, warranty, and support the solution (soft costs). Whereas the hard costs are calculable based on BOM costs, the soft costs are more intangible, especially the user cost. Development and support costs too are quantifiable but will vary based on the development conditions and support services employed from manufacturer to manufacturer

Hard Costs

The direct, USB native device connection interface offers arguably the lowest hard cost (currently estimated at ~\$8 to \$10/connection, including cable). The cost of the readers varies with features and media interfaces. Typical entry level readers retail from ~\$30 to \$50 at various computer and retail outlets. However, the cost for a digital device manufacturer to offer the reader, either bundled or as a purchase option, is significantly lower than the retail cost. Single slot reader costs range from ~\$10 to \$15 per unit in various OEM configurations.

The table below offers a comparative cost analysis between the native connection and the reader model. Cost of the digital media and any application software, whether home grown or third party licensed, is not included as it is assumed used in both models.

Hard Cost Only Comparison

Native Connection

Item	Cost*
USB Type “B” Connector	\$ 1.50
USB uC (Full Speed/Bulk mode)	\$ 3.00
USB Cable	\$ 1.00
USB Driver SW disk/CD (if Vendor Specific interface)	\$ 1.00
USB specific product line testing	\$ 1.00
Total Hard Cost	\$ 7.50

Reader

Item	Cost*
Single USB reader (MSD Class Compliant, over mold w/cable)	\$ 9.00
USB specific product line testing	\$ 0.10
Total Hard Cost	\$ 9.10

* - Figures based on industry analysis at time of publication.

Based solely on hard cost comparison, the native interface is the least costly implementation (>\$1 less) for the device manufacturer. Additional savings may be realized in lower cost components, use of a low speed USB controller interface and if the USB camera interface is also Mass Storage Device (MSD) Class Compliant. Of course volume efficiencies will also assist in driving down production cost.

Soft Costs

The soft costs incurred by the manufacturer, and of the user, must include discussion of the cost efficiency of either the direct connection interface or reader interface option. As noted above, soft costs are more difficult to compare as each manufacturer's business models differ. However, an outline of these costs is noted herein. For the purposes of this paper, the soft costs are defined as;

- Development Costs
- Warranty Costs
 - User Experience Costs
 - Support Costs

Development Costs

Development costs for implementing the native USB, or other, connection need to be realized and amortized over the life and number of devices produced. Whether the interface is "home grown" or purchased "off the shelf", the device manufacturer will incur NRE to create the connection.

As noted above, there is also the consideration of core competencies of the device manufacturer. The opportunity cost of engineering resources used to develop the connection interface as opposed to creating product enhancements or reducing product cost should be considered as well.

If the device vendor chooses a Vendor Specific interface, additional development costs will be incurred to create and support the OS specific drivers. Given that USB has been deployed on computer systems since 1998, and the number of OS iterations between both Microsoft and Apple, the software development burden may be extensive.

Development costs for the separate readers are not borne in the digital device, rather they are the burden of the reader manufacturers. As media is used cross platform in a variety of devices, development costs will be amortized over a greater number of readers. As the reader manufacturers core competency is the reader itself, they optimize their business and engineering models to offer the highest return on their investment.

In both instances, the use of Class Compliant device interfaces will reduce some cost and burden on the manufacturer. The most common of these is the Mass Storage Device Class, MSD. The operating system vendor provides these drivers, with Microsoft and Apple being the major platforms. The USB MSD drivers are written to a common specification maintained by the USB Implementers Forum.

Warranty Costs

User Experience Costs

User experience costs are defined as those costs, direct and indirect, that the user may incur to use the digital device. One significant intangible to the user experience cost is the use paradigm of the product. Referring to the camera example, the user may be conditioned to the old “analog” camera, replacement film method of taking pictures and must re-learn to use the new digital camera.

The MP3 player market offers another example of intangible user costs. When not purchased new, cassette tapes are made by the user on their home stereo system and then used with personal stereos, in the car or shared with friends. The MP3 player manufacturers emulate this paradigm with removable digital media cards expanding the user experience and the manufacturers marketing opportunities. Were the MP3 player to offer only a direct connection to the computer, the user would be limited to listening only to the music recorded on the one piece of media.

Another user cost consideration in the direct connection scheme is battery life. Especially with still image cameras, the transfer of data between the camera and the computer depletes precious camera battery life. Cameras by nature require significant power to capture and store pictures. Should battery life wane during a data transfer, the captured images are at risk of corruption or complete loss.

User costs of the direct connection model may also include optional power bricks (to offset the battery life problem) and USB cables that often get misplaced or misused. If the device employs a Vendor Specific interface, the user may need to update drivers and/or application software to continue to use the product in new OS environments.

As previously noted, the dedicated digital media reader use paradigm does more readily model the traditional cameras use model. Potential user costs include the reader (if not included by the device manufacturer) and additional digital media cards. The increased device battery life and the lack of need to invest in accessories or replacement parts may offset these costs to the user. Although there is not a removable digital media module, one excellent example of the dedicated reader paradigm is the PDA market.

PDA manufacturers like Palm and Handspring offer their own synch cradles as opposed to a direct USB connection. The cradle is directly attached to the computer or docking station. The user simply places the PDA in the cradle, and initiates a synchronization session with the host application. The cradle is powered by the USB saving PDA battery life. As the cradle is attached to the computer, there are no cables to lose or to plug into the PDA.

In short, if the user experience is simple, time efficient and easy to learn and apply the customer will enjoy greater satisfaction. K.I.S.S.

Support Costs

Product support costs include any post purchase consumer or channel related inquiries relating to the use, service or compatibility of the given product. These costs can be the largest revenue drain on any product manufacturer. Computer industry analysis estimates each phone call to technical support costs a minimum of \$25/call. This is just to answer the phone!

Manufacturers spend a great deal of engineering, marketing, product packaging and information resources prior to and during production to reduce potential support calls once the product is deployed. The goal is to assure that once the product is put in use, the user has a minimum to no need to contact the manufacturer in order to continue to use the product for its given life.

Incorporating the native USB connection in the digital device adds a layer of complexity above and beyond the end device function. The customer must rely on the direct connection in order to communicate with the "outside" world. If this connection scheme malfunctions, the device usefulness is negated, even if the primary device function is still operable, (the camera still takes pictures).

Separation of the device function from the data transfer function insulates the user and the manufacturer in the event of device failure. If both functions are in the one device and either function fails, the whole device must be serviced rendering the user without the device. If the digital media reader fails it does not effect the digital device function directly.

Separation of functions provides options to the user and manufacturer in how to solve the problem. The recourse to alleviate the trouble is not limited to returning the digital device to the manufacturer or service center. If the trouble is with the reader, the user can opt to buy a replacement reader or contact their sales outlet for a RMA, however, the device is still operable. If the device manufacturer bundles a low cost reader with their device, they may opt to simply send a new reader to the customer. This is not feasible with an integrated host connection.

In the direct connection paradigm, technical support personnel must be knowledgeable in both the end device function as well as the connection technology. Just determining the cause of the customers' problem, whether with the device function or the communication function will add complexity to the call.

In the digital media reader paradigm, problem determination is much easier to isolate. If the device fails to function, the reader is not the cause. Conversely, if the reader fails to recognize or interface with the digital media reader, the device is not the cause. The technical support personnel can more quickly determine the problem cause.

Repair functions, performed either at a depot or direct with the manufacturer, are streamlined in the digital media reader paradigm. When both functions are combined in the one device, repair technicians first must determine the error prior to affecting a cure. The repair technician must be versed in both the device function and the communications function. If the functions are in separate enclosures, specialized repair technicians can focus on their respective area of expertise.

White Paper

May, 2001

The bottom line, if the device manufacturer includes the connection interface inside their device, they will bear the costs should that interface fail the user. If the connection interface is outside the device, the reader manufacturer will bear the cost. This applies to all aspects as discussed herein.

The table below offers a combined comparative hard and soft cost analysis between the native connection and the reader model. Again, cost of the digital media and any application software, whether home grown or third party licensed, is not included as it is assumed used in both models.

Hard and Soft Cost Comparison

Native Connection	Reader
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Item	Cost*	Item	Cost*
USB Type "B" Connector	\$ 1.50	Single USB reader (MSD Class Compliant, over mold w/cable)	\$ 9.00
USB uC (Full Speed/Bulk mode)	\$ 3.00		
USB Cable	\$ 1.00		
USB Driver SW disk/CD (if Vendor Specific interface)	\$ 1.00		
USB specific product line testing	\$ 1.00	USB specific product line testing	Inc.
Sub-Total Hard Cost	\$ 7.50	Sub-Total Hard Cost	\$ 9.00
(Estimated per unit costs)			
Amortized USB NRE Expense/unit	\$ 0.50	Amortized USB NRE Expense/unit	Inc.
Warranty Cost		Warranty Cost	
Tech support allowance/unit	\$ 1.00	Tech support allowance/unit	Inc.
RMA allowance/unit	\$ 1.00	RMA allowance/unit	Inc.
Sub-Total Soft Cost	\$ 2.50	Sub-Total Soft Cost	\$ 0.00
Total Cost	\$ 10.00	Total Cost	\$ 9.00

* - Figures based on industry analysis at time of publication.

Summary

The dedicated reader model is often perceived as more expensive. Yet, the business model for this solution offers options for production, service, support and the marketing of additional products and accessories that dilute the initial reader cost. If your goal is to develop a broad range of digital devices, adopting standard memory modules across product lines will further the cost benefit of a reader implementation over native connectivity.

If only manufacturing one device, the native approach may offer a cost competitive solution. However consideration of the issues noted herein must be researched in order to make the best business decision.

The proliferation of consumer and computer digital devices rests on users willingly embracing these products. Ease of use that emulates, and then enhances their current specter of use will have consumers incorporating new devices more quickly into their everyday lives. Treating the digital media as a portable data storage concept, much like film or cassette tapes and not as some mysterious technology will speed the digital device adoption.