Digital Video Drives the Design of Next-Generation Personal Computing Devices

Five Trends that Affect IC Designers, ODMs, and OEMs—and What They Can Do About Them.

1950: Computer fits in a single room
1960: Computer is moveable
1970: Computer is moveable by one person
1980: Computer fits on my desk
1990: Computer fits on my lap
2000: Computer fits in my pocket
2010: I've lost my computer

Introduction: Computing Devices Are Everywhere (and Shrinking)

One of the innumerable jokes floating around the Internet is a timeline of the evolution of the computer (see sidebar). Aside from the humor, this visual highlights the unrelenting drive toward miniaturization that has characterized the computer from its inception.

The Personal Computing Device: A Definition

For the purposes of this paper, a personal computing device (PCD) is any electronic product that:

- Is normally owned and operated by one person
- Can be easily transported from place to place

Incorporates:

- A high-resolution video display
- A microprocessor
- An operating system (whether you can directly access it or not)
- Significant amounts of system memory and local storage
- Offers a wide range of applications and services

This definition takes in an array of electronic products such as smart phones, netbooks, laptops, tablet computers, and MP3 players—plus any number of categories that don't even exist yet.

What is a Computer?

In recent years, the line between computers and other electronic devices has been blurring. Take a typical modern "smart" cell phone. It features a high-resolution display; runs an operating system, features a Web browser and scores of other applications (a.k.a. apps); and incorporates a state-of-the-art microprocessor, wireless connectivity, and gigabytes of storage. You may not think of it as a computer, but in fact this device offers far more raw computing power and capability than a top-of-the-line laptop or desktop PC from just a decade ago.

Neither of these technology shifts shows any sign of lessening; in fact, they are accelerating. Throw in a wildly competitive marketplace and ever-shorter life cycles, and the net result is a pressure-packed environment for anyone involved in the design and manufacturing of computers and other electronic devices. Semiconductor manufacturers, original design manufacturers (ODMs), and original equipment manufacturers (OEMs) are scrambling to keep up with the marketplace—and each other.

Who Should Read this Paper

This paper looks at the unique challenges faced by business decision makers, IC designers, and system designers. It offers insight into the growing importance of one type of content—digital video—and suggests ways that designers can take advantage of these trends to create competitive advantage in the personal computing device market (see sidebar, "The Personal Computing Device: A Definition").

The Wild, Wild World of Personal Computing Devices

In recent years, the PCD marketplace has seen a steady succession of disruptive events, as newly introduced products displace existing ones, and in some cases, even create entire markets. An interesting case in point is the rise and fall of the netbook computer.

When Toshiba introduced the netbook in 2007, this miniature form-factor computer quickly racked up impressive sales figures. Over one million netbooks were sold in 2007, and that number ballooned to 14 million in 2008—all the more surprising given the sluggish state of the global economy at the time. Much of the spurt in netbook sales came at the expense of notebooks, that is, the low end of the laptop market.

At the start of 2010, the netbook seemed to be poised for a long run as a top-selling consumer device—until Apple announced the iPad on January 27. An instant and unprecedented success, the iPad set numerous sales records—and stopped the netbook in its tracks (see sidebar "iPad: from Zero to 1 Million in 28 Days").

This example highlights the essential character of the PCD market: fast-moving, unpredictable, and subject to disruptive events that can remake the landscape in months.

The iPad: from Zero to 1 Million in 28 Days

When it was introduced in February 2007, the Apple iPhone sold 1 million units in just 78 days, unheard-of volume for a new, untested electronic product. That record didn't stand for long. Just three years later, it was broken by

Apple itself with the iPad launch. The iPad's meteoric takeoff easily eclipsed the iPhone, passing the million sales mark in a mere 28 days.

Even more astonishing is the fact that the iPad created a completely new category in consumer electronics, which currently stands in fourth place, trailing only TVs, smart phones and notebook PCs. Netbooks were hit particularly hard, with sales plummeting as soon as Apple announced the iPad in January, 2010.

Nothing like the iPad phenomenon has been seen before, but it's a virtual certainty that—given enough time—it will happen again.

Who Benefits—And Who Doesn't?

As is the case with any disruptive event, some groups benefit from the turmoil in the PCD market. Consumers experience a steady stream of new products with an ever-greater list of features and declining prices due to competition and innovation. Businesses can take advantage of giving more powerful productivity-enhancing tools to their increasingly remote and distributed workforces, at decreasing unit costs. Retailers see continued strong demand for the latest and greatest PCD offerings, and more rapid product replacement by their customers—all leading to higher revenues and profits.

For those in the PCD design and supply chain, however, these trends pose challenges. Because of the lengthy design cycles and capital investment required for integrated circuits, IC manufacturers must try to predict the direction of the market several years into the future, a difficult task in the face of such volatility.

OEMs (original equipment manufacturers) such as Apple, HP, Lenovo, Toshiba, Acer, Samsung, Sony, NEC, and many others place bets on consumer and business market trends in the full knowledge that another game-changing innovation such as the iPad could again render their plans obsolete.

ODMs (original design manufacturers) such as Quanta, Flextronics, Asus, Positivo, and others must invest in people and technology so that they can support the needs of both large OEMs and smaller, more aggressive companies trying to enter the market.

At the end of the day, IC manufacturers, OEMs and ODMs will succeed or fail in the PCD market based largely on the efforts of their design teams. By understanding the nature of the changes—and more importantly, what's driving those changes—designers can not only accommodate them but leverage them to create a competitive advantage.

Digital Video Holds the Key

Among the many factors that affect PCD design, one that is gaining in importance is digital video. For one thing, the sheer amount of video traversing public networks is growing astronomically. Cisco Systems, the leading supplier of networking equipment, predicts that it would take 72 million years to watch the amount of video that will cross global IP networks during calendar year 2014 alone. This burgeoning amount of content, and the increasing desire of consumers to access it, will have a major impact on the PCD market for years to come.

The following sections discuss five major trends related to digital video on PCDs, how they will affect the market, and what designers can do to respond.

Trend 1: Video Will Dominate the User Experience

Over the last five years, the big players in the Internet space have been opening their wallets to fund major acquisition and product introductions related to digital video:

- Google buys YouTube (2006): This $1.65 billion dollar acquisition signaled the increasing importance of video content to consumers.
- Cisco investment in conferencing and telepresence: The introduction of Telepresence (2006) and the acquisitions of WebEx (2007) and Tandberg (2010) show that Cisco expects that video content will dominate Internet traffic over the next decade.
- Other networking vendors, including Juniper Networks and Alcatel-Lucent, have invested heavily in products to transport video over commercial and business networks.
- Microsoft buys Skype (May 2011): More recently, Microsoft paid $8.5 billion dollars in cash for Skype, a substantial premium for a company with just over $1 billion in annual revenue. In interviews on the day of the acquisition, Skype CEO Tony Bates pointed to video as one of the key factors in Skype's growth.

The rising amount of rich media consumed by end users will drive PCDs to higher levels of performance and more storage space. Fortunately, IC manufacturers continue to reach higher levels of performance and denser storage with each new generation of integrated devices. As long as PCD designers choose an IC vendor with a robust roadmap, they have little to fear from this trend.

Trend 2: High-Definition Video Requires More Bandwidth

Within the category of video content, high-definition video is growing at a disproportionate rate. Content providers such as Google understand this well, as evidenced by YouTube's 2009 decision to support high-definition videos on the popular video sharing site. Device manufacturers are equally aware of the need for high definition. For example, the iPhone 4 has a video resolution of 960-by-640 pixels and can displayed videos encoded in high-definition formats such as H.264 and MPEG-4.

High-definition video by its nature has more pixels for a given screen size, and that increases the amount of data needed to drive the display. As a rough comparison, the bandwidth for displaying a standard definition video at good quality ranges between 500 kbps and 1 Mbps. In contrast, a high-definition format such as H.264 requires between 2 and 4 Mbps, as much as a factor of eight greater.

The increased need for bandwidth has necessitated revisions in data communication standards. In recent years, standards organizations have released new protocol versions with higher levels of performance. For example, the Video Electronics Standards Association (VESA) issued specifications for DisplayPort 1.2, which has twice the data rate of the previous DisplayPort 1.1 standard, and the USB Implementers Forum defined USB 3.0, which outperforms USB 2.0 by a factor of ten.

While these changes are both necessary and welcome, designers still have to incorporate the new protocol versions into their PCD designs. The implications can be profound, since higher data rates affect not only the components themselves (CPUs, memory, and interface ICs) but all parts of the design, including cables, connectors, printed circuit boards (PCBs) traces, and even PCB materials.

Trend 3: Turmoil and Uncertainty on the Display Side

The days of "VGA everywhere" are over. Computer outputs and display monitor inputs span a broad range of interface standards, including DisplayPort, HDMI, LVDS, DVI, and VGA. Furthermore, IC manufacturers are eager to limit the number of supported video protocols to save space on the die and reduce the number of pins on the package. This trend is understandable, but it can "strand" users with older, unsupported protocols. As an example, Intel and AMD have announced that their CPU devices will not support VGA after 2015, even though the number of VGA monitors still in use at that time is expected to be in the tens of millions.

These trends have unmistakable implications for PCD and monitor designers alike: They can't count on the IC manufacturers to provide integrated support for legacy video protocols. Therefore, there will be a strong need for adapters and other means of supporting legacy protocols well into the future.

Trend 4: Power Consumption Matters More and More

It's no surprise that PCDs are moving toward greater mobility, meaning that battery life can be an important differentiator in the marketplace. PCD designers are under increasing pressure to minimize power consumption while still providing adequate levels of performance. IC designers are well aware of this need, and seek to minimize energy usage to provide a competitive edge for their products. However, the PCD designer must consider power consumption equally with other design criteria when choosing components for next-generation PCDs.

Trend 5: Everyone is Not Moving at the Same Pace

These trends would be much easier to manage if the entire electronics industry were moving in lock-step. However, that's not the case. Adoption rates for new technologies vary widely from manufacturer to manufacturer, for a variety of reasons. Monitor OEMs may hang on to an older video protocol to keep bill-of-materials costs low, while a CPU manufacturer may discontinue support for that protocol for exactly the same reason. To appeal to the largest number of consumers, PCD designers need to support as many display interfaces as possible while keeping the design within guidelines for manufacturing cost, performance, and power consumption.

How Designers Can Meet these Challenges

The trends outlined above represent daunting challenges for IC, ODM, and OEM engineers who are designing the next generation of PCDs. Fortunately, there are readily available solutions in three key technology areas: high-speed switches, signal conditioning devices, and connectivity bridging. By leveraging these pivotal technologies, PCD designers can respond effectively to the shifting trends of the market and even take advantage of them to gain a competitive edge.

Key Technology 1: High-Speed Switches

Today's microprocessors often implement a number of high-speed interfaces such as DisplayPort, HDMI, PCIe, USB 3.0 and SATA. To keep the pin count as low as possible, I/O pins are often shared; for example, Intel's Eaglelake microprocessor uses the same I/O pins for DisplayPort and PCIe. Using both of these interfaces in an Eaglelake-based PCD requires a multiplexer switch that routes the I/O signals to the DisplayPort and PCIe interface connectors.

As video protocols continue to evolve, these switches must be able to handle ever-higher performance requirements and minimize distortion and attenuation in the switch. The designer must also keep in mind the inevitable new—and faster—versions of the protocol that will surely be developed, perhaps soon.

A good example is the CBTL02043 multiplexer/demultiplexer, recently announced by NXP. The CBTL02043 is designed to support high-speed protocols such as USB3.0 (5 Gbps maximum speed), DisplayPort v1.2 (5 Gbps), SAS/SATA (6 Gbps), and PCIe Gen3 (8 Gbps), with low power consumption and low insertion loss. Rated at 10 GHz bandwidth, the CBTL02043 has a performance margin that can accommodate future upward revisions of key protocols.

Key Technology 2: Signal Conditioning Devices

The continuing trend toward faster PCDs puts increasing emphasis on signal integrity for several reasons:

- As protocols get faster, the voltage swing between the 1 and 0 states gets smaller, often in the 100s of millivolts. This makes the signal more susceptible to corruption from grounding problems and stray noise.
- Longer circuit board traces and external cables contribute noise and can impair the integrity of high-bandwidth signals.

Taken together, these factors require heightened attention to the quality of signals within the transmission channel. One way to accomplish this goal is by inserting a re-driver into the signal path. Re-drivers restore the integrity of a signal that has been attenuated or degraded by electromagnetic inference from nearby signals, reflection from impedance mismatches, and jitter.

A good example of a signal conditioner is the NXP PTN36241B USB 3.0 (SuperSpeed) Re-driver, which enhances signal quality for USB 3.0 data transmissions. Designers incorporate this device into PCDs and other products to ensure good signal integrity across a wide range of system conditions. Space is at a premium in PCDs, so re-drivers may need to be designed into the docking station.

Key Technology 3: Connectivity Bridging

Finally, there is a need to provide support for digital video and data processing protocols that are being or have been discontinued. Two cases in point:

- While IC manufacturers are discontinuing VGA support, the fact is that there are millions of VGA monitors. Some OEMs will want to appeal to these users, and therefore PCDs will need some method for supporting VGA without relying on the IC manufacturer.
- DisplayPort is gaining acceptance as an input standard for monitors. However, it may not always be practical to include DisplayPort support within the device.

Connectivity bridges—devices that translate between protocols, for example, from DisplayPort to VGA—offer a solution to this dilemma. Designers choose connectivity bridges to provide on-going support for legacy interfaces at an affordable price point.

An example of a connectivity bridge is the NXP PTN3392 DisplayPort to VGA Adapter. As noted earlier, Intel and AMD will soon stop supporting VGA on their CPU ICs. Consumers might understandably balk at buying a PCD that cannot drive their existing VGA monitor or projector. However, the PCD manufacturer can overcome this objection with a dongle based on the PTN3392. This simple plug-in device allows the PCD to drive the VGA monitor with no other changes, extending the useful life of VGA monitors and projectors and lessening the impact of the transition on end users.

NXP: Reliable, Innovative Partner for PCD Designers

As PCD designers look to address the challenges of this high-pressure, volatile environment, they must choose vendors who offer the right components and roadmaps that lead to success. NXP has a sharp focus on this market, offering a broad portfolio of high-speed switches, multiplexers/demultiplexers, redrivers, and connectivity bridges. NXP also participates in standards organizations and tailors its product roadmap to meet emerging needs and support new protocols and standards across the entire computer industry. World-class manufacturing facilities and a 50-year legacy of success contribute to making NXP an exceptional choice for PCD designers today and into the future.