

## DSPs Evolving in Consumer Electronics Applications

**Y**ou would be hard pressed to find a consumer electronic product that doesn't require digital signal processing. Consumer electronics is a big market—about US\$165 billion this year (see “What About Consumer Electronics Market Growth and Innovation?”), and the requirement for digital signal processors (DSPs) just keeps growing with the introduction of new, innovative products.

The value of digital signals became clear in 1948 with the invention of error-correcting codes that not only transmitted signals but also detect errors and correct them in transmission.

That was the same year that Bell Laboratories announced the invention of the transistor. It was also the year that Dr. Peter Goldmark, the head of CBS Labs, annoyed by having to turn over a 78 record in the middle of one of his favorite pieces of classical music, invented the long-playing (LP) record. Ampex also began selling tape recorders (reel to reel, of course) in 1948.

But DSPs really started to come into their own as a critical component in consumer electronic products in the 1970s.

The Altair 8800, the first personal computer, sold in kit form beginning in 1975 and was followed by an assembled computer, the Apple II, in 1977. Sony and JVC also began marketing videocassette recorders (JVC in the VHS format, Sony in Betamax) in 1975. DSPs made further inroads into the consumer market with the introduction of a toy in 1978 by Texas Instruments (TI). Called Speak & Spell, the toy featured a digital signal processing-specific speech synthesis chip and taught children to spell

by pronouncing a word and indicated whether their spelling was correct. Other companies also designed and produced single-chip DSPs. (Intel introduced a single-chip DSP in 1979.)

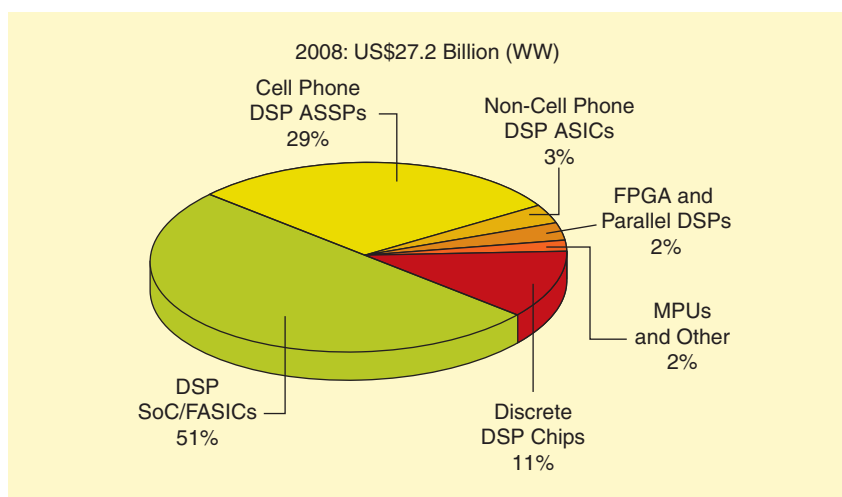
Philips Electronics was granted the prestigious IEEE Milestone Award for its contribution to the development of

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the compact disc (CD). First demonstrated as a prototype device under the code name “Pinkeltje” in 1979, it was the first mass digital consumer product to find its way into almost every consumer's home and one of the first consumer products to benefit from digital signal processing technology.

By 1985, according to *Fifty Years of Signal Processing: The IEEE Signal Processing Society and Its Technologies 1948–1998*, there were only three large commercial markets for DSP chips—speech coding, video compression, and modems. Together, they represented a US\$50 million market. Since then, DSPs have found their way into virtually every sector of electronics, with much of the growth from the development of new and innovative consumer electronic products and applications (Figure 1).

The consumer sector accounted for US\$837 million of the US\$6.5 billion 2008 digital signal processing market, according to Forward Concepts, which specializes in tracking and analyzing digital signal processing markets. Forward Concepts is projecting the worldwide digital signal processing silicon market to grow at a 9.4% rate over five years from 2008 through 2013 to



**[FIG1] The consumer electronics market for DSPs is changing with many DSP chips now being reported or identified as SoC in categories such as ASICs and ASSPs. Off-the-shelf or “discrete DSP chips” have become a small part of the DSP silicon world. In fact, discrete DSPs now constitute only about 11% of the US\$27 billion market. (Used with permission from Forward Concepts.)**

the US\$43 billion level; however, from 2009, the four-year growth rate is forecast at 12.1% compound average growth rate (CAGR). But Will Strauss, founder and president of Forward Concepts, says the wireless and consumer electronics will grow at a much faster rate (Figure 2).

## MARKET, TECHNOLOGY CHANGING

But the market—and the technology—are changing.

For starters, many of the components that used to be reported as “DSP chips” are now labeled more broadly as systems-on-a-chip (SoCs) in categories like application-specific integrated circuits (ASICs) or application-specific standard products (ASSPs)—even by traditional digital signal processing chip vendors. As a result, most of today’s so-called discrete digital signal processing chips are a small part of the digital signal processing silicon market and are barely counted as DSP chips. Still, Strauss says digital signal processing as a technology is driving the entire semiconductor market and are creating a growing market for application design and development tools.

“With today’s highly integrated chip designs and the growing complexity of programming these advanced processors, development tools are now the key item for DSP selection,” says Strauss.

Strauss’s comments followed the introduction by CEVA, a leading licensor of silicon intellectual property DSP cores and platform solutions in consumer electronics, of an integrated optimizing tool chain that enables end-to-end, fully C-based development flow for licensable DSP cores. CEVA says the development will significantly improve overall product performance and will require a shorter design cycle for SoC designs.

Many companies are reportedly shifting from using proprietary DSPs to CEVA cores, especially in cell phone applications. Reasons given for this trend are chip-pricing pressures, which have prompted a number of chip houses to drop or sell off their cell phone chip lines, as well as increasing competition from baseband chip providers.

## WHAT ABOUT CONSUMER ELECTRONICS MARKET GROWTH AND INNOVATION?

By any measure, consumer electronics is a huge sector of the electronics industry.

Consumer electronics will generate more than US\$165 billion in U.S. shipment revenues this year, a slight increase over 2009 (which saw the industry’s first revenue drop in 20 years), according to the semiannual industry forecast by the Consumer Electronics Association (CEA).

Wireless handsets are expected to be the primary driver for the industry. Smartphones comprise more than 30% of total wireless phone shipments, generating nearly US\$17 billion in shipment revenue for 2010 and more than 52 million unit sales and that number is expected to increase in the years ahead. (Nokia said in January that it expected to sell more than 500 million handsets in 2010, well above market expectations, projecting that this would be about 40% of the global market share.)

Sales of computers are also expected to do well in 2010. Netbook sales more than doubled in 2009 as this relatively new computer category showed stronger sales than previous forecasts predicted. The CEA is projecting that more than 30 million netbooks will be sold in 2010, generating more than US\$14 billion in revenue. “Smartphones and netbooks are primed for strong growth as consumers continue to seek efficient, portable devices,” says Steven Koenig, CEA’s director of industry analysis.

The television market has been one of the primary revenue drivers in the past several years as consumers made the transition to high-definition, flat-panel sets. The CEA believes that unit sales will climb to more than 37 million this year. Innovative TV displays, such as three-dimensional (3-D), Internet connectivity, and organic light-emitting diode technology, are also expected to continue to grow and help maintain revenue in the display category. The CEA anticipates sales of more than 4 million 3-D television sets in 2010.

The automotive sector also continues to play a larger role for consumer electronics vendors as vehicle manufacturers use electronics to help differentiate their products.

Innovation is becoming a more critical part of the growth story for consumer electronics. More than 2,500 technology companies introduced more than 20,000 new products at the International Consumer Electronics Show (CES) in Las Vegas in early January, where the CEA released the results of a Zogby poll that found that 96% of Americans agreed that innovation will play a key role in America’s efforts to remain an economic leader on the global stage.

“I don’t know if there is anything else 96% of Americans agree on,” says Gary Shapiro, the CEA’s president and CEO.

Dr. Paul Jacobs, the chair and CEO of Qualcomm, said during his keynote speech at the CES that “convergence of wireless with consumer electronics would happen in a big, big way” as an increasing number of CE devices would soon have cell-phone capabilities in them.

That may be helped along by the anticipated reallocation of a larger swath of spectrum to wireless carriers in anticipation of new wireless products and applications.

While the growth of wireless devices will be global, most analysts expect the market to be particularly strong in North America where consumers are already accustomed to multiple device ownership.

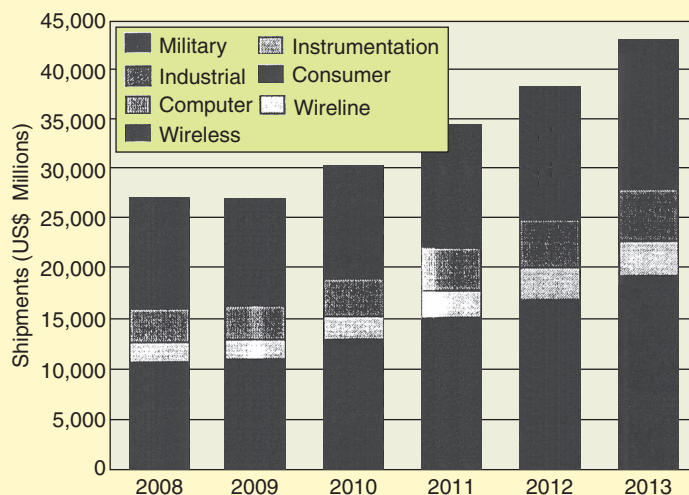
## DSPs FLOURISH IN CONSUMER ELECTRONICS

While mobile phones represent the largest single market for DSP chips (as baseband and application processors), they’re also a critical component in audio equipment.

Several companies are active in this market.

Cirrus Logic has introduced an SoC, the CS47048, targeting audio amplifier applications.

It combines a 32-b audio DSP, high-performance multichannel audio codec and a digital audio receiver/transmitter into a single integrated chip (IC) to dramatically reduce



**[FIG2] Wireless and consumer electronics are the two market sectors projected to show the most growth in DSP shipments worldwide. (Used with permission from Forward Concepts.)**

overall board space requirements and system cost.

Cirrus is currently developing a new line of audio SoCs that combine audio DSPs and various levels of mixed signal content, and that use S/PDIF receivers and S/PDIF transmitters. Most of Cirrus's audio DSP products target consumer applications, focusing on audio, as opposed to general-purpose digital signal processors.

Although National Semiconductor does not manufacture DSP chips, it does integrate a digital signal processor in its mixed-signal audio systems for mobile phones.

National recently extended its family of low-power Boomer Class D audio subsystems with two new devices aimed at simplifying portable product design. The LM49352 integrates audio codec functionality with ground-referenced headphone amplifiers, earpiece driver, Class D loudspeaker, and audio DSP in a 3.3 mm × 3.3 mm package.

National also offers a line of audio products incorporating far-field noise suppression technology that reduces background noise and improved voice communication clarity in mobile phones and powered headsets. National says its PowerWise line consumes one-tenth of the power (1 mA) of comparable digital

signal processor software-based systems without added development time required to write and test voice-processing programming code for a digital signal processor or microprocessor.

Tensilica, Inc. is working with MIPS Technologies to advance SoC designs of Google's Android platform. Tensilica and MIPS jointly demonstrated a processor core integrated with Tensilica's HiFi 2 Audio DSP at the International Consumer Electronics Show (CES) in January. Samsung recently licensed Tensilica, Inc.'s HiFi 2 audio DSP for use in Samsung's next-generation multimedia system products. Tensilica-enabled data plane processor products include Blu-ray disc players, Bluetooth-enabled devices, liquid-crystal display televisions, cell phones, Wi-Fi- and wireless universal serial bus-enabled notebook computers, wireless high-definition multimedia interface, handheld games, and ink-jet and laser printers.

Geneva-based STMicroelectronics also uses dedicated, dual programmable audio DSPs in a new generation of high-definition SoC ICs for the global flat-panel television market. However, in January, STMicroelectronics introduced a single-core multitouch "resistive" touchscreen microcontroller (as the first member of its new STMTouch family of

multitouch devices) and proximity and touch-key sensors that Jim Nichols, general manager of STM's Microcontrollers Division, called an added-value solution compared to other "expensive multicore processor or digital signal processors" requiring specialized programming expertise. Nichols says the new microcontroller was developed to support increasingly sophisticated applications and games in smartphones, mobile Internet devices, and netbooks.

Nichols comment seems to echo what Texas Instruments said last year—that for many designers, the cost and time to set up development tools is a major barrier when evaluating a new DSP platform. TI's response was to introduce its eZdsp USB stick development tool, which dropped the cost of a full-featured emulator and integrated development platform to US\$49. TI said this enabled the rapid creation of DSP applications, including portable audio players, voice recorders, IP phones, portable medical devices, biometric USB keys, software-defined radios, hands-free headsets, and metering applications. The eZdsp requires no other components or cables, allowing the entire development tool to be powered by the USB port. Designers can just plug into the USB port of any laptop or workstation.

In January, TI added two new devices to the lowest power 16-b DSP platform, claiming higher integration and a 20% performance boost for portable devices. The strategy is to allow customers to maintain very low power levels while adding features such as additional encode and decode algorithms in voice, audio, and portable communications applications. Typical of the shift away from stand-alone digital signal processors, the devices also integrate power management features, such as on-chip low-dropout regulators, as well as dynamic voltage and frequency scaling to enable designers to maximize and efficiently manage battery life for portable devices. (TI also continues to heavily promote its high-end triple-core digital signal processors for cellular infrastructure use in wireless long-term evolution original equipment manufacturer (OEM) networks.)

Similarly, Marvell Semiconductor recently introduced a “quadruple” core processor for consumer electronics applications utilizing the ARM instruction set. Weili Dai, Marvell’s cofounder and vice president and general manager of the company’s Consumer and Computing Business Unit, says the quadcore implementation can deliver gigahertz-plus processing per core and is designed for customer-specific products such as mass consumer markets and high-volume gaming applications.

Another digital signal processing-based entry in the audio arena is GN Netcom’s Jabra Cruiser, a Bluetooth wireless speakerphone for mobile phones that features noise blackout technology, and a dual microphone system that eliminates traffic noise.

The Jabra technology uses dual microphones to capture the sound and then filters the ambient noise only. Used together with DSPs for echo reduction, the technology allows both sides of a call to be heard in natural-sounding voice quality.

## TEN TOP CONSUMER MOBILE APPLICATIONS

With mobile handsets leading the way for DSP market growth, what applications (apps) are going to show the fastest growth in the mobile market?

Gartner Inc., a leading information technology research and advisory organization, has produced a list of what it believes are the top ten consumer mobile applications for 2012. The list is based on their impact on consumer and industry players, considering revenue, consumer loyalty, business model, consumer value, and estimated market penetration.

According to Gartner, the top ten consumer mobile applications in 2012 will include the following:

- 1) *Money Transfer*: This service enables people to send money to others using short message service (SMS). Its lower cost, faster speed and convenience have strong appeal to users in developing markets. There is some risk here, however, of regulatory challenges.
- 2) *Location-Based Services (LBS)*: LBS form part of context-aware ser-

vices, which Gartner expects will be one of the most disruptive in the next few years. Gartner predicts that the LBS user base will grow globally from 96 million in 2009 to more than 526 million in 2012.

3) *Mobile Search*: Gartner says it ranked mobile search number three because of its high impact on technology innovation and industry revenue. Gartner expects loyalty on the mobile phone to be shared between a few search providers that have unique technologies for mobile search.

4) *Mobile Browsing*: Mobile browsing technology gets its high ranking because of its appeal to all businesses. It’s available in more than 60% of the handsets shipped in 2009; Gartner expects it to climb to about 80% in 2013.

## INNOVATION IS BECOMING A MORE CRITICAL PART OF THE GROWTH STORY FOR CONSUMER ELECTRONICS.

5) *Mobile Health Monitoring*: This is in the early stages of implementation and has been slow to grow, but it is viewed as having great potential because of its mobility aspect compared with fixed networks, especially in developing countries.

6) *Mobile Payment*: Mobile payment is a way of making payments when few alternatives are available. It’s also an extension of online payment, and it is an additional factor of authentication for enhanced security. It potentially impacts a broad range of businesses, including banks, retailers, consumers, and mobile carriers. The downside is that the implementation of different technologies and business models may create a very fragmented market.

7) *Near-Field Communication (NFC) Services*: NFC enables contactless data transfer between compatible devices by placing them close to each other, within 10 cm. Key apps include retail purchases, personal identification, and loyalty cards. The

biggest challenge for NFC is reaching business agreement between mobile carriers and service providers. Gartner expects to see large-scale deployments of NFC at the end of 2010.

8) *Mobile Advertising*: Viewed as an important way of monetizing content on the mobile Internet, mobile advertising is already a growth area despite the economic downturn. Total spending on mobile advertising in 2008 was US\$530.2 million and is projected to grow to US\$7.5 billion in 2012.

9) *Mobile Instant Messaging (IM)*: Price and usability issues have held back the wide use of mobile instant messaging, but Gartner sees user demand and market conditions that are conducive to its future adoption. Mobile IM is viewed as an opportunity for mobile advertising and social networking, which have been built into some of the more advanced mobile IM clients.

10) *Mobile Music*: Although a disappointing market sector to date (except for ring tones and ring-back tones, which have become a multibillion-dollar business), consumers are demonstrating that they want music on their mobile phones. New, innovative models and service plans are expected to turn this into a growth area by 2012.

“Consumer mobile applications and services are no longer the prerogative of mobile carriers,” says Sandy Shen, research director of Gartner. “The increasing consumer interest in smartphones, the participation of Internet players in the mobile space, and the emergence of application stores and cross-industry services are reducing the dominance of mobile carriers. Each player will influence how the application is delivered and experienced by consumers, who ultimately vote with their attention and spending power.”

Any or all of these could have an impact on the DSP market and how the technology plays out as well as how they’re integrated into a new and ever-growing range of mobile products. **SP**