Market Trends for Compound Semiconductor Enabled Devices

Bruce A. Bernhardt

Motorola Mobile Devices, M/S AN2, 600 North US Highway 45, Libertyville, Illinois
bruce.bernhardt@motorola.com (847) 523-0558

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Abstract

The growth in markets for wireless communications devices continues to outpace the market for other semiconductors. At the current pace, thirty-six mobile handsets are purchased world-wide every second. Additionally, mobile communications devices are consuming certain functions that previously were independent stand-alone products such as pagers, alarm clocks, appointment books, watches, MP3 players, cameras and portable navigation devices.

This trend is expected to continue for other items of consumer interest. In general, the belief is that anything consumers place in their pockets is ripe for consolidation into the mobile communications device, such as money, credit cards, subway tokens, and photo albums.

Another trend that will be discussed is the emergence of ubiquitous broadband communication and its ability to enable greater interaction and enjoyment for consumers. For example, compound semiconductor devices dominate the CATV distribution amplifier market. This type of broadband connection helps enable the trend of consumers to watch what they want when they want it instead of timing their activities around a broadcast distribution schedule, and is starting to facilitate personal generation and distribution of video content. The internet bandwidth of YouTube traffic today equals the bandwidth used for all internet traffic of the year 2000. It is expected that in three years over half of the online video traffic will be consumer generated.

INTRODUCTION

Compound Semiconductor enabled devices are fueling the growth of the largest consumer electronics market in the world today. The market data indicates approximately 1.144 billion cellular handsets were sold in 2007. This equates to 36 handsets being sold every second. Besides cellular technology, compound semiconductors play a role in many broadband wireless architectures such as 802.11 and 802.16 devices and wired architectures such as CATV distribution systems. This paper will describe some of the trends energizing the continued growth of these markets and how the ecosystem is adapting to its advantages in the marketplace. Solid state lighting is another area experiencing rapid growth enabled by the advantages of compound semiconductor materials but is beyond the scope of this paper. Finally, some demographics of the users of this technology are described.

THE GROWTH OF THE CELLULAR HANDSET INSTALLED BASE

To understand the impact of the cellular handset market, it is useful to compare its size to other dominant aspirational consumer items and how these items have changed our lives. **Automobile:** One of the most obvious consumer items to emerge in the last one hundred years is the automobile [1]. Particularly in North America, the development and mass production of the automobile changed the way many people work and live. Today, the worldwide installed base of automobiles is approximately 800 million.
Telephone: Another device that changed almost all aspects of life was the development of the fixed line telephone. With an installed base of approximately 1.3 billion today [2], the first home connections were marketed as alert devices in case of fire or other danger. As the availability of telephones increased, it came to be used as a tool for increasing our efficiency of communicating in general, such as for making a doctor's appointment, and eventually becoming a device used for leisure, such as chatting with friends or family to keep in touch.
TV: There are about 1.5 billion television sets in use worldwide in 2006. Many family rooms today are organized with television being the focus of interest. Not only did television change the home, it now dominates the mass media industry for money spent on advertising [3]. New industries from television production studios to video rental companies like Blockbuster and the 35 billion dollar a year video game market were born as the television became widely adopted.
Credit cards: The installed base of consumers who use credit cards number approximately 1.4 billion. Obtaining mass market acceptance in the 1970s, credit cards allowed the consumers to purchase items before one actually had the money to pay for it. Now a consumer can readily charge the item and pay for it later, either after payday or even in instalments. A credit card makes it fast and convenient to purchase many items such as gasoline without having to enter the store, or books and airline tickets over the internet late at night without talking to a person. Many types of businesses, such as car rental companies, actually require the use of a credit card to secure the transaction. Also, the use

Table 1. 2006 Installed Based of Consumer Aspirational Items. Source: http://communities-dominate.blogs.com/brands/.
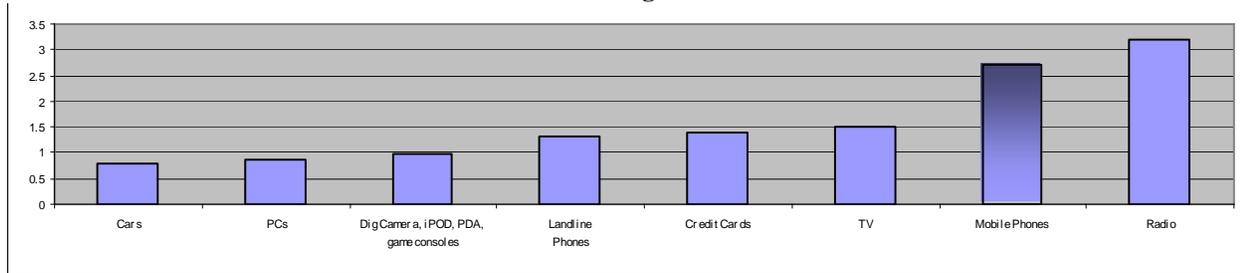
of a credit card simplifies record keeping as the transactions can be electronically downloaded into your personal financial software or used for corporate tracking and reimbursement of expenses.

Computers: A lot of computers have been sold – well over a billion. However, the replacement cycle of a computer is somewhere between two and five years, reducing the number used to calculate the installed user base. The estimate of active computers is around 850 million. This number is larger than the number of automobiles in use today, but as we will see, much smaller than the number of mobile phones in use.

Gadgets: There are a number of electronic gadgets optimized for a single purpose such as digital cameras, camcorders, iPods, PDAs, and game consoles. According to the blog http://communities-dominate.blogs.com/brands/, the total installed base of each of these devices does not reach 300 million, or less than 1 billion active devices in the aggregate.

Mobile phones: The installed base of mobile phones is over 2.6 billion devices for 2006 (2007 numbers are not yet tallied); and, according to iSuppli, is estimated to grow to over 4 billion devices by the end of 2010. With approximately 1.144 billion mobile phones sold in 2007, there are twice as many mobiles in use today as landline phones, credit cards or televisions, and three times as many mobile phones as PCs or automobiles. Today mobile phones are one of the new aspirational products. Customizing your handset, whether through special ringtones, colors, ringback tones, or skins, is considered a demonstration of your personality. The blog referenced in the previous paragraph indicates that young people demonstrate their emerging personality, their own "coolness" et cetera, through their mobile phone, like older generations did with their first car.

Radios: Although radios have an installed base greater than cellular handsets today, it is expected that with the handset growth rate, handsets will overtake radios in total installed base within the next few years.

WHY DO YOU WANT TO PUT ALL THIS STUFF INTO MOBILE PHONES?

The numbers mentioned in this section are summarized in Table 1, and provide a snapshot of the dominant nature of mobile phones in the consumer electronic aspirational space. The market for these devices is large enough to drive the creation of complete ecosystems to support added features that will bring the consumer to one company's product over another. The desire to capture an increase in share of the available market brings about rapid inclusion of aspirational features such as cameras and music players into new mobile phones.

WHAT CAN YOU PUT INTO MOBILE PHONES?

To look at what can be put into mobile phones, it is useful to understand what, beyond the ability to make a voice call (or enhance the voice call experience with things such as speed dialing, caller id or Bluetooth connectivity to a separate headset), has been added to mobile phones in the past 10 years. For example, 73% of the population now uses the mobile phone as their portable clock. Not all of those have abandoned their wristwatch, but look at the under 30 year olds around you; more often than not, they don't have watches anymore. Have you seen a pager anywhere lately? SMS messages have replaced the pager as a means of communication when it is inappropriate to make a voice call. Two thirds of mobile phone users, 1.8 billion people, are active users of SMS text messaging – more than twice as many people as are active users of e-mail. E-mail is opened in 24 hours and replied to in 48 hours. SMS is read within 15 minutes on average and responded to within 60 minutes. 65% of e-mail is spam, less than 10% of SMS is spam [4]. SMS is the preferred method of communication for Generation-C, described below.

The digital still camera and video camcorder have been consumed by the mobile phone within the last few years. The connectedness of the mobile phone allows the picture or video to immediately be shared with a friend, or a group of friends, and easily be placed on social networking sites, such as CYWORLD [5].

Figure 1 shows the consumption of the typical PDA functions of contact lists, memos, and appointments. Also, the mobile phone has become a personal music player, allowing an immediate download of a new song. The ability to add new features into the mobile handset continues as the bandwidth increases beyond 3G and the economies of scale allow new markets to be created. The next sections describe

emerging functionality that will gather broader insertion into mobile phones within the next few years. Almost all of these features exist in some form or another in some markets today.

THE HANDSET AS THE DIGITAL WALLET

To look at what may be incorporated into the handset, one should examine what is kept in one's wallet or purse. For most consumers this includes credit and debit cards; photographs of loved ones; identification cards, whether for insurance purposes, drivers licenses, or corporate IDs; access cards to offices or labs; appointment or schedule books; notes or memos; and, of course, money. For the purposes of this presentation, money is considered the simple payments for small transactions where credit or debit cards are not normally used. For example, purchase of a candy bar from a vending machine or a subway token for a short ride.

EXPANDING THE CREDIT MARKET USING CELL PHONES

Worldwide, almost twice as many people own cell phones as own credit cards. Legally, one must be 18 or older to own a credit card. For many Europeans, their first cell phone is received around the age of 8, fully 10 years before they would be able to use "credit" in the traditional sense. By enabling a cell phone to be used as a credit card, the credit market is suddenly expanded. The transaction is typically enabled by incorporating an RFID tag into the handset that can be interrogated by the equivalent of a credit card reader. For security purposes, the RFID tag can be disabled when the consumer is not using it to make a purchase. This can be extended to enable multiple credit card types depending on the desired purchase. For example, a consumer may have one credit card for personal use and one for business use. Or a parent may allow the Generation-C child to have credit enabled for food purchases at school. According to Ahonen and O' Reilly, South Korea charged over $1B US in 2005 using mobile phones.

Barcode reader

To overcome the limitations of entering information, including web or physical addresses into your phone or generic text and number data, the higher resolution cameras can use an image processing application to read a bar code or QR (2D) codes. Reading 2D codes that are printed or displayed on screens allows for easy web access, mail composition, and address book registration without having to "triple-tap". The codes can also be used together with GPS navigation applications such as "EZ Navi Walk." After reading a barcode (2D code) embedded with map information, if you launch "EZ Navi Walk," the phone will automatically record, then guide you to the destination, displaying maps, and saving you the effort of entering the information manually.

PERSONAL NAVIGATION DEVICES

The data collected for Table 1 was the result of examining trends over the last few years in the mobile handset space. There is some lag in the ability to gather the information and

In the Last 10 Years…

Figure 1. Mobile Devices Consumption of Consumer Electronic Items.

verify its accuracy before being able to confidently report the trends. The numbers shown in Table 1 were collected for 2006 after being spotted in previous years and monitored through 2007 to validate the information. One trend that started to grow significantly in 2007 and therefore does not have enough data to validate at the time this paper was submitted, is the proliferation of personal navigation devices based on GPS. The current estimate is that approximately 20 million portable navigation devices were shipped in 2006. The market is now estimating that by 2012 up to 65 million PNDs will be sold. However, in 2006 there were over 109 million GPS-equipped mobile handset shipments, primarily focused on emergency location technology for E911. The current estimate is that by 2011, the number of GPS enabled handsets being sold will rise to 444 million. The combination of GPS and mobile phones is a natural fit. GPS performance is greatly enhanced due to aiding information that may be received over the cellular network, reducing time-to-first-fix and increasing sensitivity. Additionally, maps and points of interests can be kept up-to-date via the network connection, and your position or the location of a meeting place can be sent to your friends. Figure 3 shows a screen shot of a turn by turn navigation application operating on a mobile phone. The application provides a 3D image of

2-D Bar Code

6 to 11cm

Figure 2. QR Code containing up to 4,296 alphanumeric characters capable of being read into the handset via the camera.

your environment and helps direct you to your destination. QR codes may be used to enter your destination into the mobile phone.

BROADBAND MULTIMEDIA DISTRIBUTION ECOSYSTEM DYNAMICS

Another dynamic driving the growth of broadband networks is that the distribution of broadband content is moving from the "business" or planned generated ecosystem in studios to a user generated model. This is moving the distribution system from a broadcast format as traditionally seen in television and cable to an individual distribution as seen on the internet. The individual distribution systems allow the consumer to shift viewing in place, time and device, providing the consumer their desired content on their terms. Within two years over half the online video will be user generated. Today's YouTube traffic alone equals all the data transmitted across the internet in 2000. The explosion of data traffic means more broadband capacity and therefore more opportunities for compound semiconductor based line amplifiers.

EVEN TELEVISIONS ARE GOING WIRELESS BROADBAND

Wireless broadband is not just for mobile phones and laptops either. Hewlett Packard has introduced High Definition Televisions with integrated 802.11n wireless networking to allow streaming of multimedia content from your home network [6]. The proliferation of Wi-Fi into more consumer devices beyond the primary application of connecting lap top computers to the internet is helping to fuel the growth of Wi-Fi modems to be the second largest market behind cellular enabled devices.

CHARACTERISTICS OF THE NEW CONSUMERS OF THIS TECHNOLOGY.

Earlier in the paper, it was described that these trends are being driven by the emergence of a different type of consumer. This consumer has been branded "Generation-C". The "C" has variously been given multiple definitions, with the most common adjectives focusing on community, creativity, content, celebrity and control [7]. The Generation-C phenomenon is meant to describe the occurrence of a flood of consumer-generated 'content' being put out through the World Wide Web. There are "tera-peta bytes" of new text, images, audio and video being added on an ongoing basis. SMS text messaging is the most addictive service used by Generation-C and in some instances extensive use of SMS has been used to differentiate the Generation-C communiy from the mere heavy users of the web. Generation-C is not necessarily defined within a given age bracket, like Generation-X or Generation-Y, but rather as a given type of consumer.

CONCLUSIONS

Broadband wireless technology aided by wired multimedia distributions systems are at the forefront of the largest

Figure 3. Turn-by-turn navigation on a mobile phone. Source: Motorola.

consumer electronics market. To the previous generations, a car was the ultimate aspirational gadget, what young adults would use to define their identity. Today, Generation-C's aspire to be able to communicate, create multimedia content, and share that content with as many friends as possible at any time. One of their main tools for accomplishing this is the mobile phone. In part because of this, the mobile communications industry generated 725 billion dollars in sales in 2006 and grew at a rate of over 100 billion dollars. Before the decade is over, mobile telecoms will be bigger than the global automobile industry, or the global armaments industry, or the worldwide airplane manufacturing business. Compound Semiconductors will remain an essential part of this growth as demand for bandwidth continues to increase.

An excellent book that describes many of these concepts in more detail is "Digital Korea," by T. Ahonen and J. O Reilly, published by Futuretext, Ltd.

ACRONYMS

QR Code: a two-dimensional bar code, "Quick Response" created by Denso-Wave in 1994.
BLOG: personal online journal that is frequently updated and intended for general public consumption.
tera-peta: 10^{12}-10^{15}

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