# Market Trends for Compound Semiconductor Enabled Devices, 2010 Update

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**Keywords: Smartphones, Barcodes, Evolved EDGE, GPS, Web services, SOAP**

**Abstract**

**At the 2008 CS MANTECH Conference, a paper was presented summarizing the growth of compound semiconductor enabled electronic devices outpacing many other semiconductor markets[1]. This paper provides an update to those trends, primarily focusing on smartphones. The rapid growth of smartphones in the past two years has validated the assertion that mobile communications devices will consume many functions that previously were independent stand-alone products including pagers, alarm clocks, appointment books, watches, MP3 players, cameras and portable navigation devices. Besides functions just described, the growth of smartphones has enabled a new set of services that exploit the integration of these technologies to provide more convenience to the consumers. For example, in 2008 the use of barcodes was discussed to provide an efficient means of entering detailed information into the handset, such as addresses or contact information. In 2009 a number of barcode reader applications emerged that allow the consumer, when visiting a store, to image a product's barcode with the camera on their smartphone, send that UPC code to a webservice, and have the webservice return the price from competitor's stores. In the 2008 paper, a Wi-Fi enabled TV from Hewlett Packard was discussed that enabled multimedia streaming content from your home network as an example of the proliferation of Wi-Fi into more consumer devices beyond the primary application of connecting lap top computers to the internet. This makes Wi-Fi modems the second largest market behind cellular enabled devices for compound semiconductor devices. There is a company that recently announced a Wi-Fi enabled body weight scale that sends its measurement to a web service where you can monitor your weight on your computer or your smarthphone. And, if you would like your friends or the whole world to know how much you weigh today, this device can automatically send your weight out through a "tweet".**

## INTRODUCTION

Compound Semiconductor enabled devices continue to be central to the growth of the largest consumer electronics market in the world today. In the 2008 paper it was reported that approximately 1.144 billion cellular handsets were sold in 2007[1]. The 2008 market data indicates 1.19 billion cellular handsets sold and in 2009 a total of 1.13 billion devices were sold worldwide, a 5.2% reduction[2]. However, in 2009, the smartphone market sales grew by over 15% to 174 million units. Smartphones are expected to take an increasingly larger portion of the overall cellular phone market as consumers move beyond voice calls and text messages as the primary use case for their mobile devices. This paper provides an overview of what sets a smartphone apart from other cellular devices, some of the trends and applications that are being enabled by smartphones and the implications to the compound semiconductor industry.

## SMARTPHONE FEATURES

What defines a smartphone or separates a smartphone from a "regular" phone? There is no rigorous industry definition that precisely classifies a smartphone. However, economically, there is a distinct trend of cellular devices that allow third parties to create applications that will run on these mobile devices. A "regular" phone would be classified as the device mentioned in the introduction which makes phone calls and sends text messages. In between a regular phone and a smartphone are the "feature" phone devices. A feature phone device typically has a one plus feature beyond the regular phone features, such as a limited web browser, MP3 player, and/or built-in appointment calendar functions. However, those features are predetermined when the phone is manufactured rather than by the consumer post-purchase. In order to facilitate the installation of additional applications by consumers, a smartphone has a more complete operating system with accessible APIs. Some of the operating systems provide multi-tasking, allowing multiple applications to be run simultaneously. For example, you would be able to simultaneously listen to music while playing a game or allow your turn-by-turn navigation device to guide you

while still receiving emails. The ecosystem also provides an application development environment that is typically PC based and includes phone simulation and debugging capabilities.

The ability for consumers to choose new applications for their mobile device has created new markets for third party developers. Many of the applications are optimized for a single task like retrieving a stock quote, accessing an airline flight's arrival information, tracking a package, streaming a podcast or even watching the items you are bidding on on eBay. These applications utilize the data connectivity of the mobile device to quickly accomplish the task. The revenue from data traffic applications for carriers was approximately $50 billion in 2008 with a year-to-year growth rate of 24%. This number excludes revenues generated from SMS data and does not include the sales of the applications themselves.

### Social Networking and Multimedia

One of the trends that smartphones have helped proliferate is the ability for consumers to more easily create and share content immediately as part of their active lifestyles. Rather than recording the activity, returning to their homes or offices and then uploading the recording to the internet, the consumer updates this information from their mobile device while out in the field. Multiple social media sharing sites and services such as Twitter, Facebook, YouTube, and Instant Messenger have mobile applications that allow you to "tweet" on your device with an immediate update to your profile, provide status updates to Facebook or share that video of an exciting event you just witnessed on YouTube. Conversely you can have immediate consumption of other people's updates. So you keep track of your community even while you are on the go.

The ability to share timely information with your community has started to extend into additional areas as well. For example, Dash turns a GPS enabled smartphone into a monitor of traffic speeds[3]. The information is sent to the network and aggregated together with other probe information to provide a more accurate estimate of traffic congestion and drive times. Then, when you request a navigation route with the PND application on your smartphone, the route will be planned with the most up-to-date, near real time, traffic information provided by other consumers. This type of community sharing of timely information has been enabled by the smartphone's ability to run applications provided by third parties. Additionally, the multi-tasking capability allows the consumer to provide this information with minimal impact to whatever else the consumer would like to be doing with the device, such as talking on the phone or streaming music. Multi-tasking will continue to take on increased importance as more applications are utilized on the device.

### Increasing Bandwidth to the Device

By moving beyond consumption of just voice and text services and into web browsing, video streaming and related services, smartphone devices will continue to consume greater and greater amounts of data across the network. For a pleasant user experience, the network needs to support these increasing data needs. The continued increase in demand for bandwidth fuels the need to deploy advances in technologies of HSPA and LTE that provide higher data throughput, in part, by utilizing higher order modulation schemes. The data throughput of many cellular technologies is limited by the ability to implement higher order modulation schemes, such as 32-QAM as shown in **Figure 1**. One of the metrics that helps to determine the modulation scheme for cellular networks is the availability of highly linear RF amplifiers, a parameter that showcases the advantages of compound semiconductors. In **Figure 1**, an 8-PSK constellation is overlaid on the 32-QAM constellation to show the increased resolution needed.

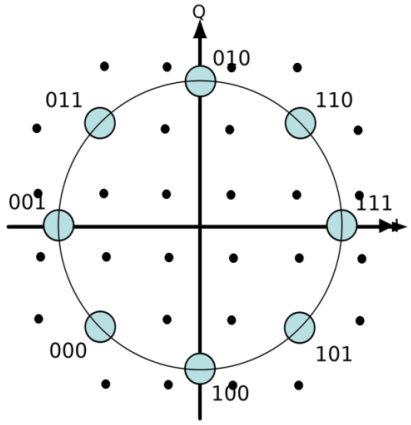


**Figure 1. A 32-QAM Constellation for Evolved EDGE with overlay of 8-PSK showing the increased linearity requirement.**

The evolution and timeline of introducing these technologies is shown in **Figure 2**. Notice the improved throughput over three years from 2006 to 2009 of the downlink speed in HSPA. HSPA evolution provides over seven times the throughput of the 2006 HSPA technology.

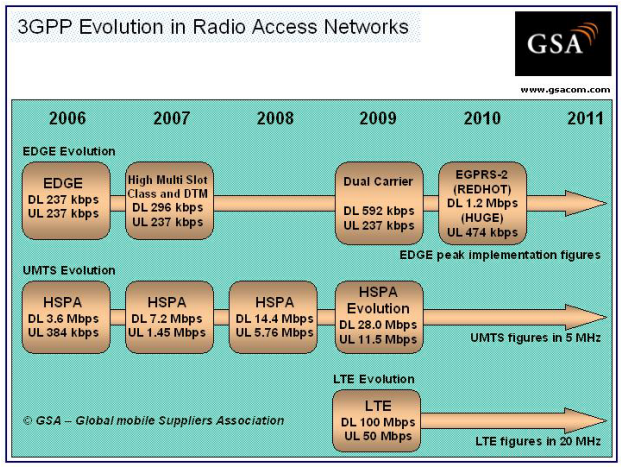


**Figure 2. Time line and network speeds for evolving cellular technologies[2].**

The introduction of WCDMA/HSPA technologies provided the ability for mobile networks to support the bandwidths required for streaming services and richer web browsing experiences. The EDGE data rates of up to 237 kbps are not sufficient to effectively handle the increased performance demands. However, according to the Global Mobile Suppliers Association, the installed user base of GSM subscribers is approximately 4 billion and growing at a rate of about 41 million new subscribers each month. This is compared to approximately 453 million WCDMA/HSPA subscribers or about 9 percent of the GSM subscriber number as shown in Figure 3. The large subscriber base and its attendant network infrastructure have created a strong economic incentive to continue to evolve EDGE technology to support higher data rates. Hence the emergence of Dual Carrier EDGE technology, as shown in **Figure 2**, where two receivers are placed in the mobile device. Besides two receivers, techniques to reduce latency by decreasing the Transmission Time Interval (TTI) from 20 ms to 10 ms and implementing Fast ACK/NACK Reporting (FANR) are expected to reduce the Round Trip Time (RTT) from 135 ms to 70ms[4]. These technology changes substantially improve the performance of EDGE networks for VOIP, gaming and the mobile web browsing experience where user perceptions of latency effects are the greatest.

An example of the improvement in web page download times as a function of the GSM data technology is shown in Figure 4. The download times within the red region on the graph are considered unacceptable from a user experience perspective. The orange region is considered marginally acceptable. The green region should provide an acceptable user experience.

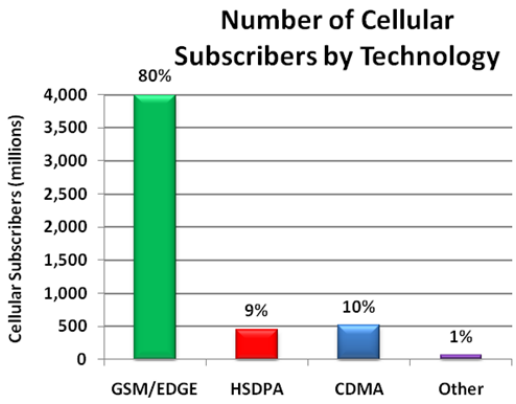


**Figure 3. Cellular Radio Technology Subscriber base as of 3Q2009. Source: gsacom.com[2] and cdg.com.**

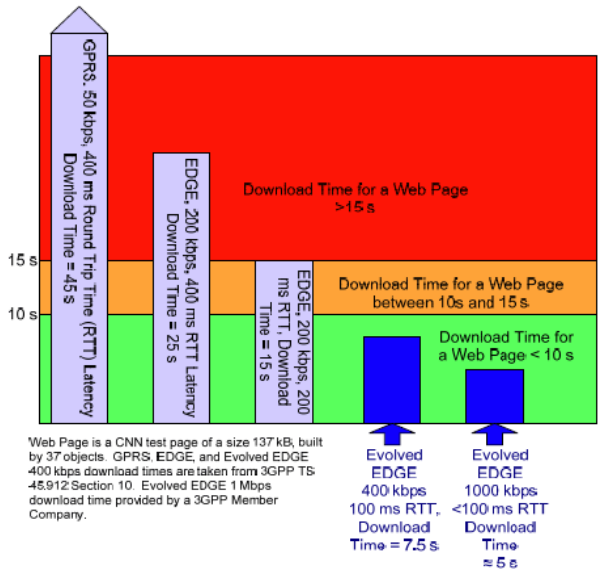


**Figure 4. Web page download times as a function of technology. Source: Global Mobile Suppliers Association[2].**

By utilizing these techniques, the carriers are able to maximize their investment in the infrastructure as no hardware changes need to be made in the networks. Since two receivers are placed in the mobile device, hardware changes necessarily occur. However, consumers replace their mobile devices at much higher rates than carriers replace their basestations.

Carriers originally deployed EDGE capability as an enhancement to their GSM/GPRS network. Subsequently, carriers deployed WCDMA/HSPA capability as an overlay of that network in areas where the population economically supported increased capacity. This means that in areas where the 3G networks become saturated, additional capacity can be added by modifying the EDGE networks to the Evolved EDGE technology. Furthermore, in locations where it was economically unfeasible to deploy WCDMA/HSPA infrastructure, carriers can also upgrade the EDGE network to Evolved EDGE, allowing those areas to support the streaming services and richer web browsing experiences.

## BARCODE READER EVOLUTION

In the 2008 paper, the use of the digital camera was discussed as a method to help overcome the limitations of entering information into a small physical form factor device such as a cell phone. At the time, the expected uses included entering web and physical addresses into your phone or even generic text and number data by scanning QR (2D) "bar" codes. This was enabled by the emerging higher resolution cameras and increased performance of the applications processor which allowed image processing algorithms to operate effectively on the handset. Today, those types of features have been extended into Internet enabled shopping applications where not only is the barcode read for input of data, the information is then sent to a webservice via the SOAP protocol to provide the consumer with pricing and availability information.

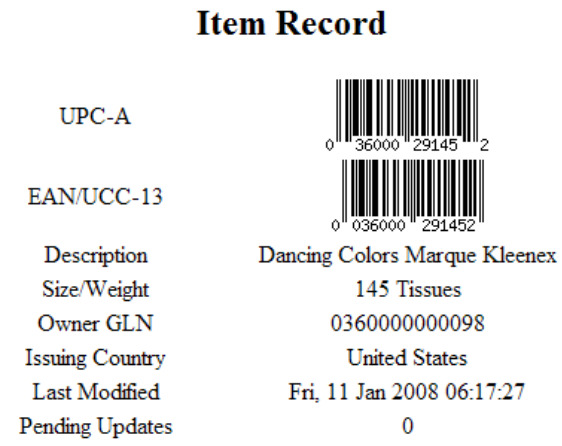


**Figure 5. A UPC Barcode for a consumer item. An application reads the barcode and retrieves the items information via a webservice. Source: upcupdates.com**

Instead of just using the image to input data into the smartphone, the connectivity of the smartphone has created an ability to use that barcode in a more meaningful manner. In this case, it allows the consumer to make more informed purchasing choices in an efficient manner.

## EVEN SCALES CAN HAVE WIRELESS BROADBAND

As the 2008 paper described, wireless broadband has proliferated into a number of consumer devices beyond mobile phones and laptops such as televisions and even automobiles[5]. In 2009, a company called Withings introduced an "internet connected body scale" to automatically record your weight, fat mass, and body mass index. The information is transmitted from a Wi-Fi in the scale to an internet server via your home access point. You may view this information, along with trend data on your computer or through a custom smartphone application. The Withings server will also send a tweet to your community or to an internet based coaching program, if desired.

## CONCLUSIONS

The last few years have witnessed tremendous growth of data capabilities for mobile connected devices. As the data rates of these networks increased, the smartphone has emerged as the aspirational technology of choice for the 5-C consumer described in the 2008 paper[1]. The 5-C consumer is engaged in their community through multiple internet connected social media more than ever[6]. They are able to utilize their smartphones to access information that is relevant to their needs and desires while on the go. The mobile nature of their devices enhances the value of location based information to add more relevance to the results. Enabled by wireless technology, 5-C consumers can almost effortlessly share information with their community, to the point of automatically broadcasting their day's body mass index on Twitter.

The market opportunities presented to the wireless operators for enabling such data capabilities have created a demand for continued innovation in what has traditionally been labeled 2.5G technologies. The technology organizations have responded to this call by developing Evolved EDGE to enable increased data rates for the largest cellular technology market in the world, without needing to install new basestations. Compound Semiconductors have and will continue to remain an essential part of enabling these innovations.

## ACRONYMS

5-C Consumer: a consumer who focuses on community, creativity, content, celebrity and control [4].
HSPA: High Speed Packet Access
LTE: Long Term Evolution
PND: Personal Navigation Device.
PSK: Phase-shift keying.
QAM: Quadrature Amplitude Modulation.
Tweet: a text-based post of up to 140 characters on the micro-blog social networking service Twitter.

## REFERENCES

[1] B. Bernhardt, *Market Trends for Compound Semiconductor Enabled Devices*, 2008 CS MANTECH Technical Digest, April 2008.
[2] The Global Mobile Suppliers Association, *GSM/3G Market Intelligence*. www.gsacom.com.
[3] Dash: The Only Internet Connected Automotive GPS, www.dash.net.
[4] 3GPP TR 45.912 V7.2.0 (2007-02), 3rd Generation Partnership Project; Technical Specification Group GSM/EDGE Radio Access Network; Feasibility study for evolved GSM/EDGE Radio Access Network (GERAN) (Release 7).
[5] Ford Press Announcement on Sync Technology. http://www.ford.com/about-ford/news-announcements/press-releases/press-releases-detail/pr-remarks-as-prepared-for-the-ford-31737.
[6] T. Ahonen and J. O' Reilly, *Digital Korea*, Futuretext Ltd, 2007.