

# Smart Phones – From Luxury Item to Lifestyle Necessity



To capture the market for replacement handsets, the next wave of mobile phones must be smarter, lighter, and last longer on one charge.

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Just as second generation digital wireless technology is ramping up, third generation (3G) wireless services are already under development – and in production. The mobile phone telecommunication industry is targeting “replacement phones” as the market’s biggest revenue window.

Analog (1G) cellular and digital (2G) PCS (Personal Communications Services) phones are too new a phenomenon to just wear out. Industry analysts have defined the mobile phone saturation point to be 65% of the population. According to this statistic, Finland and the UK have just reached saturation, with Central Europe and North America to follow in the next few years. So, creating a demand for new handsets from existing subscribers means mobile phones must provide value-added services to be competitive as replacement handsets.

CoolRunner™ CPLDs (Complex Programmable Logic Devices) – available in very small, lightweight packages and utilizing Fast Zero Power™ technology – work ideally to add advanced features to handheld devices, and as such, they are already being used by mobile phone manufacturers. Additionally, using CoolRunner devices in mobile phones shortens time to market and enables field upgrades.

**Growth in Replacement Handsets**

Figure 1 shows how important the replacement market is to wireless handset manufacturers. As shown, about 40% of the new phones sold in 1999 were replacement handsets. This figure is forecasted to rise to 61% in 2003, which means only about 40% of handset sales in 2003 will be to new customers. Therefore, in the future, it will become increasingly critical for the cellular handset supplier to convince existing subscribers that they “need” the newest technology.

In the coming years, six major types of handsets are (or will be) sold in the wireless phone marketplace:

- Analog cellular
- Digital GSM (Global System for Mobile Communications)
- Digital CDMA (Code Division Multiple Access)
- Digital TDMA (Time Division Multiple Access)
- Digital PDC (Personal Digital Cellular)
- Digital 3G.

Handsets that can handle two frequencies are called “dual-band,” and those that can accommodate three frequencies are labeled “tri-band.” Some handsets are categorized

Many handset manufacturers are worried the handset could become a commodity product, much like the simple calculator. In order to prevent this, and to increase the replacement handset market, some handset manufacturers are adding extra “must-have” functionality.

**3G Enables New Handset Functionality**

Third generation wireless services facilitate applications that were not previously practical or available over mobile networks because of the limitations in data transmission speeds. 3G technology increases available bandwidth up to 384 Kbps for handheld devices that are stationary or moving at pedestrian speed, 128 Kbps in cars, and 2 Mbps in fixed applications.

Because of the 3G bandwidth capabilities, high bandwidth applications are now more feasible than they were with interim technologies such as GPRS (General Packet Radio Service). The new EDGE (Enhanced Data rate for Global Evolution) air interface was specifically developed to utilize 3G bandwidth.

Newly enabled 3G applications range from Web browsing to e-mail to file transfers to home automation – the ability to remotely access and control appliances and machines in the home. Some of the most radical changes in 3G wireless and mobile technology include the following:

- People will look at their mobile phones as much as they listen to them. Television, e-mail, and multimedia services tend to attract attention to themselves. This means 3G devices will be even less safe for motorists. Instead of hands-free kits, we might need eyes-free kits – or heads-up displays.
- Data uses of 3G equipment will be as important as, and very different from, the traditional voice usage.

**Cellular Handsets Sold as Replacements**

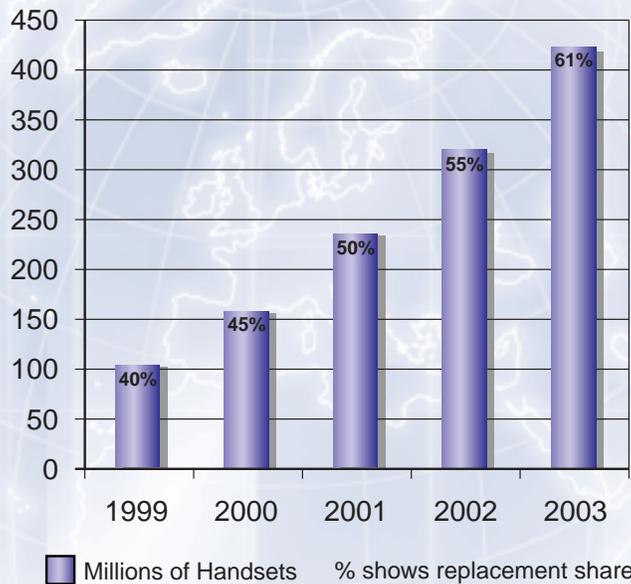


Figure 1 - Cellular handsets sold as replacements

as “dual-mode” or “tri-mode.” A typical multiple-mode handset can access analog AMPS (Advanced Mobile Phone Service) as well as digital PCS. In mid-1999, Nokia introduced a tri-mode CDMA 800/1900/AMPS handset (Nokia 6185) as well as a dual-mode CDMA 800/AMPS handset (Nokia 5180). Handsets sold today are predominantly digital. GSM technology dominates the European market while CDMA-type handsets rule the North American market.



- Mobile communications will be so similar in capabilities to fixed communications that many users may only need one phone.

The mobile phone will become an integral part of many people’s lives. A 3G handset will not be an accessory but rather a necessity. These phones will be like a remote control or a magic wand that lets people do what they want, when they want, wherever they want.

**“Must-Have” Functionality**

In an attempt to keep the Average Selling Price (ASP) high, handset manufacturers such as Samsung have introduced “smart phones.” Smart phones offer standard mobile communications services such as voice telephony, short message services (SMS), phone number memories, and Internet access. The Samsung smart phone, however, also features a Bible, hymnal, Buddhist Canon and songbook, English-Korean and Korean-English dictionaries, an engineering calculator, and electronic games.

Next generation mobile phones will also offer the following multimedia functions:

- Personal Digital Assistant (PDA) utilities
- Wireless Access Protocol (WAP), Internet services, and full Web browsing
- MP3 playing functions
- “Smart card” readers for on-line purchases and verification
- Digital radio reception
- Tri-mode and tri-band capability
- Video phone capability
- TV reception
- Global Positioning System (GPS) service
- Games console.

The aim is to integrate and converge as much functionality as possible to increase market share into other electronic equipment sectors, making the mobile phone a “must have” necessity for everyday life.

The next-generation mobile phone “tablet” will feature wireless home/office networking capability. Users will be able to take advantage of landline call rates by connecting via short-range wireless networking systems like Bluetooth™. When wireless phone call charges become equal to those of landlines, and when mobile phones have the capability to change contact number and functionality upon entering a new environment, they will potentially be able to replace all types of communication devices available today.

**Component Integration and Glue Logic**

We are already seeing the integration of the basic handset IC components such as:

- Microprocessor
- DSP core
- Audio codec (analog-to-digital coder/decoder)
- 13 Kbps QCELP (Qualcomm Code Excited Linear Prediction) and EVRC (Enhanced Variable Rate Codec) vocoders (voice compression algorithm codecs)
- CDMA/AMPS modem.

Integration of components allows mobile phone manufacturers to save on the size and weight of the overall mobile handset – even while adding extra functionality. Moreover, to gain market share, manufacturers must be able to add extra functions ahead of the competition. It is well known that the manufacturer who is first to market wins the largest percentage of the available market.

Programmable logic devices give manufacturers a major time to market advantage over chipset manufacturers and ASIC developers. Thus, we are seeing increased use of low power programmable logic devices to “glue” chipsets together, and more recently, to add extra functionality, like MP3 players and PDA functions. Increasingly, Xilinx ultra low power CoolRunner CPLDs are populating must-have mobile phones.

We have already seen a CoolRunner device in a handset with a GPS add-on module. The GPS module can not only be used as a route planner and directional aid, but it can quickly dial emergency services and let them know where you are if you are in danger. CoolRunner devices are also being employed in tri-band (GSM 1900/1800 & 900 MHz) handsets as chipset glue logic to gain time to market advantage.

Two key selling points of mobile phones are “talk time” and “standby time”. These times must be as long as possible – without compromising the size and weight of the handset. CoolRunner CPLDs are being used in handsets because of their exceedingly low power consumption (<100 µA). What’s more, they are available in innovative, small footprint packages. Figure 2 shows a new chip scale package that measures 6 mm by 6 mm and has a pin pitch of only 0.5mm.



Figure 2 - Xilinx CoolRunner CPLD in a chip scale package – small, light, and ultra low power

**Soft Radio**

In the future, we may see “soft radio” technology bring down the IC count in state-of-the-art mobile phones to only two chips – one highly integrated analog RF component and one all-encompassing digital processor/memory device. This very complex “on-

This enhancement could take the form of an MP3 player, for instance. You could simply dial into your tablet manufacturer’s website and pay for an MP3 player hardware description file to be downloaded to your tablet. Then using wireless IRL technology, you could reconfigure your handset to play MP3 audio files.

device is able to download FPGA configuration files for instantaneous reconfiguration. The device shows how value-added services, such as new applications and upgrades, can be remotely configured to FPGA-based products. The proof-of-concept terminal demonstrates that high-gate-count FPGAs can be used to achieve “processor-like” functionality – without the need for a separate embedded processor.

The major design challenge for proof-of-concept IRL was to “fill” these very large FPGAs with complex applications such as VoIP (Voice over Internet Protocol), TCP/IP, MP3, games console, and graphics display. Celoxica’s system-level design suite was used for rapidly designing and prototyping these different applications to target Xilinx FPGAs – in just three months.

**Conclusion**

Demand for wireless handsets for new subscribers will decrease in the next few years as we reach regional saturation points. To combat this slowdown in new subscribers, mobile handset manufacturers are striving to add more functionality, such as PDA utilities, GPS navigation, Internet access and browsing, real-time video services, and MP3 music players. These value-added services will make wireless handsets must-have devices and will boost the replacement handset market.

Time to market is key to these new technologies. With reprogrammable logic and IRL, handset manufacturers can beat the ASIC competition to market and sell highly versatile blank tablet devices that can be reconfigured on the fly over wireless connections to perform whatever services the consumer wants today – and tomorrow.



Figure 3 - Reconfigurable logic in mobile phones

the-fly” (through the RF front-end) software-programmable radio technology won’t be widely available until 2005 at the earliest. When soft radio does become mainstream, however, it will enable true interoperability among mobile phones.

Soft radio technology will be made possible by field programmable gate arrays like Spartan-II™ and Virtex-E™ FPGAs from Xilinx. By using wireless Xilinx Internet Reconfigurable Logic™ (IRL), handsets can be upgraded in the field to enhance hardware functionality or to add completely new options – or to disable the handset if it is stolen.

The next generation mobile phone could feasibly be sold as a blank tablet with as much or as little functionality as you want. For example, you could purchase the tablet with only cellular phone and PDA capability. Later, long after purchase, you might decide to increase or enhance its features.

**Internet Reconfigurable Logic in Action**

Figure 3 shows the use of reprogrammable logic in today’s mobile phones for chipset glue logic – and tomorrow’s fully field reconfigurable and customizable wireless handsets. Celoxica™, Marconi Communications Limited, and Xilinx have already developed a proof-of-concept MultiMedia Terminal (MMT) to demonstrate IRL. (See “Celoxica Implements ‘Soft Hardware’ in Internet MultiMedia Terminals” on Page 52). In a process similar to downloading software, the

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