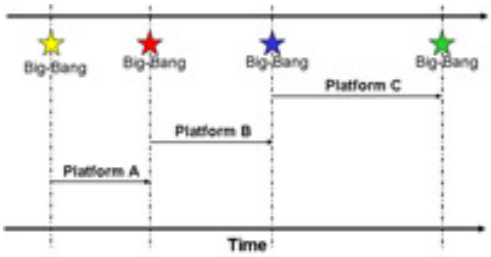
Designing Handsets with Modularity

By Danny Tseng, Cypress Semiconductor

Designing a platform with modularity in mind is one approach that can shorten design time as well as enable easier feature upgrades.



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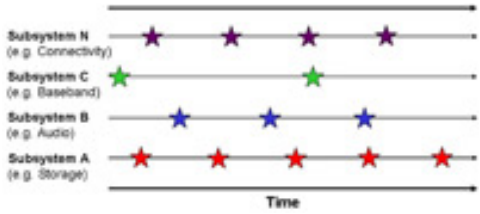
With worldwide shipments of 990 million units in 2006 and in excess of 1.1 billion units in 2007 (source: iSuppli), mobile handsets have rapidly become the most dominant consumer electronics device in the market today. This double-digit year-on-year compounded growth rate is expected to continue for the years to come as many developing countries are quickly ramping up on infrastructures to meet demand. For other technologically savvy countries, it is also not surprising to see the handset adoption rate continue to rise as people begin to own more than one mobile handset (i.e., typically one personal and one for business).

Forward looking, mobile handset OEMs and ODMs will be constantly challenged to stay competitive, and the most difficult task at hand is to attract new adopters as well as to retain current customers. Having periodic product releases that keep consumers freshly engaged is the key to success in this fast-paced market environment. In addition, shorter product design cycles and releasing high-performance products with innovative features have proven to be the most effective ways to capture larger market share.

However, there are some inherent shortcomings in the current handset architecture that prevent design cycles from being further reduced, and it has become harder for handset makers to keep up with the plethora of emerging mobile technologies. Two fundamental limitations that handset vendors must tackle when planning for new products include the exponential increase in technology complexity and the seemingly unsynchronized releases of standards.

Increasing System Complexity

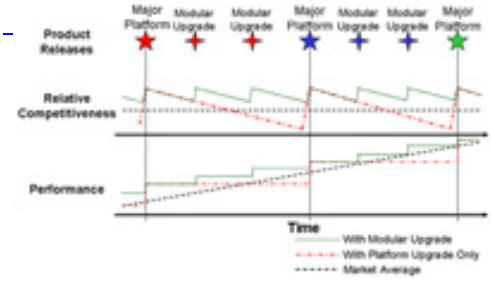


[2]

In the realm of consumer electronics, vendors continuously strive to design products that offer better user experience, which is often achieved by enabling new technologies and introducing innovative features. However, deploying such products in the consumer market space involves more than just routine research and development. Developers must also manage ever-increasing system design complexity. Their ability to do this efficiently often determines the success or failure of the product, and ultimately, of the OEM/ODM.

The time it takes to design more complex and integrated "next-generation" devices lengthens considerably, compared to previous platform releases. As handset technology moves from one node to the next, there exists a longer and steeper learning curve in both hardware and software, and engineers must become familiar with every system component before a platform can be successfully completed. Moreover, as handset vendors aim to lead the market with the most cutting-edge features, these early technology adopters often run into additional unforeseen integration issues, which extend the design cycle time even further.

A classic example of hidden integration challenges occurred when Bluetooth and WiFi were both new to the portable electronics world. Early adopters, integrating these technologies together for the first time, ran into major system level issues. While neither of the two would have caused much headache by themselves, severe complications emerged when both technologies had to coexist on the same platform. In this case, both standards operate on the same 2.4 GHz band, and system engineers had to properly minimize RF interferences.



[3]

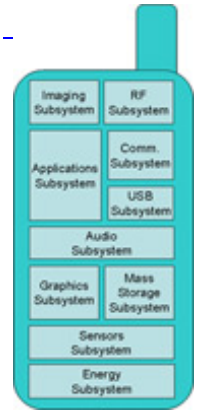
Resolving unexpected integration issues often push out product release, and longer platform rollouts become detrimental to the success of any players in the ultra-competitive consumer electronics market. Figure 2 illustrates the current monolithic approach to mobile handsets, with the design time of each "Big-Bang" platform increasing from one generation to the next.

Moreover, system architects must independently evaluate the different innovative features that may potentially be included in the new platform definition. Unfortunately, each technology evolves at a different pace, thus having different standard release cycles not necessarily in sync with a vendor's ideal release cycle. In practice, platform definitions are anchored on the handset's core baseband technology with support for peripheral features based on what is reasonably available at the time.

It has become increasingly more difficult to ensure a new platform to provide support for the latest technology standards. In many cases, by the time the platform is completely defined and qualified, many of these "latest" adopted standards are no longer leading-edge. Consequently, the platform's competitiveness is compromised, and there is no surer way to fail in the cutthroat consumer electronics market than rolling out products counting on outdated features for their differentiating, competitive edge.

Modularity

Ultimately, there is an apparent need to ameliorate the current approach to handset designs to both shorten design time and to ease feature upgrades. The current "Big-Bang" platform innovations that require the entire system to be revamped for each new design cycle can no longer keep up with the fast moving mobile handset technologies. Many technology standard bodies and handset vendors must deal with these architectural limitations, but only a few have taken the time and effort to find a feasible solution.



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Designing a platform with modularity in mind is one approach that can shorten design time as well as enable easier feature upgrades. The idea is to architect the handset as a collection of different partitions or subsystems, each having the ability to be redesigned or modified independently of the others. The goal of design modularity is to eliminate inter-subsystem dependencies and the need to completely revamp the system every time a feature is added or upgraded.

An example of modularization in mobile handsets is illustrated in Figure 1. The mobile handset is divided into multiple subsystems, and each subsystem supports

an independent collection of "tasks" or "services". For example, the communications subsystem is responsible for baseband signal modulation and demodulation, while the peripheral connectivity subsystem is responsible for connecting the handset to other devices, such as a PC over USB or a headset over Bluetooth. Similarly, other subsystems are dedicated to different functionalities.

As mentioned, subsystems evolve with different and unsynchronized timelines, and it is difficult for a "Big-Bang" platform to sustain support for all of the latest standards. Figure 3 shows how subsystems evolve in parallel and independent of one another. Each "star" denotes a new technology standard release for the respective subsystem; for example, the first star on the mass storage technology evolution timeline might be the release of SD version 1.1 and the subsequent star being the 2.0 release of the same specification.

Breaking down the mobile handset into multiple partitions provides independent migration paths for each technology, in contrast to standalone subsystems, which cannot be upgraded without having to make modifications to several other subsystems. This gives great flexibility to the handset vendor, as the competitiveness of a product family can now be made to gradually increase over time instead of in large discrete jumps which happen only when a platform is completely redesigned.

As a result, modular upgrades of an existing design enable quick derivative rollouts. This allows handset vendors to design products that better cater to targeted customer groups quickly to more easily capture consumer interests and keep them loyal to the brand. Figure 4 compares the competitiveness and performance offerings of the two different approaches to mobile handset architecture.

Architecture modularity eliminates the long design cycle between two "Big-Bang" platform releases, as the numerous modular upgrades to an existing design are turned into a stream of derivatives. The effort needed to revamp the entire platform to achieve performance and competitiveness target can now be broken into multiple steps, where each modular upgrade effort can proceed independently and concurrently.

Having a well-defined plan can also greatly reduce product development risks, as each modular upgrade only involves a limited scope of design changes in addition to isolating potential system issues. With a derivative strategy, a product family's performance and its relative competitiveness are also improved, contrasted to the one-time boost provided by the traditional Big-Bang platform upgrade. For instance, a modular handset platform allows an easy and timely upgrade of its wired connectivity to support Hi-Speed USB for increased PC-to-handset data transfer speed. The improved sideloading performance provides more appealing user experience to the consumers; hence, it is more competitive in the market.

In order to enable a modular handset architecture, both hardware and software interfaces need to be standardized. Essentially, each subsystem becomes a standalone entity that can be designed and adopted independently. An example of this is an open-source initiative taken on by Nokia and backed by several

semiconductor device vendors called Network on Terminal Architecture, or NoTA. NoTA fulfills the vision of system modularization, enables healthy competitions among vendors, as well as accelerates technology innovations. For more information on NoTA, please visit www.notaworld.org. There are already many subsystem solutions on the market that fit very well into the design modularity concept, such as the West Bridge architecture offered by Cypress Semiconductor. Similar to the North and South Bridge in the PC world, the West Bridge enables a modularized mass storage and peripheral connectivity subsystem in handsets and supports the latest technologies that are not yet available in main handset processors. For more information on West Bridge, please visit www.cypress.com/westbridge.

Conclusion

The ability to rollout products faster is the key to success in the ultra-competitive consumer electronics market. Enabling design modularity not only quickens time to market, it also enables better and more frequent product differentiation. Ultimately, modularization is the win-win solution for both handset vendors and consumers, and it is an inevitable step that all OEMs/ODMs must take to maintain market leadership in the mobile handset arena.

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